

ACTIVE PCP

Pre-Commercial ProCurement of Innovative Personal Protective for First Responders Equipment

ANNEX 3

Challenge Brief, requirements and scenarios



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Abbreviations and acronyms

Abbreviation	Full Term / Meaning
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
AEGL	Acute Exposure Guideline Levels
API	Application Programming Interface
AR	Augmented Reality
ATEX	Appareils destinés à être utilisés en ATmosphères EXplosives (EU Directive for Explosive Atmospheres)
BLE	Bluetooth Low Energy
BMI	Body Mass Index
CBRN	Chemical, Biological, Radiological, and Nuclear
CEP	Circular Error Probable
CFU	Colony Forming Unit
CVSS	Common Vulnerability Scoring System
CWA	Chemical Warfare Agent
DPA	Data Protection Authority
DPIA	Data Protection Impact Assessment
DPO	Data Protection Officer
DWR	Durable Water Repellent
EC	European Commission
ECG	Electrocardiogram
EMS	Emergency Medical Services
EPA	Environmental Protection Agency (US)
EU	European Union
FOV	Field of View
GC-MS	Gas Chromatography-Mass Spectrometry
GDOP	Geometric Dilution of Precision
GDPR	General Data Protection Regulation
GM	Geiger-Müller (Radiation Detector)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HAZMAT	Hazardous Materials
HCN	Hydrogen Cyanide
HF	Hydrogen Fluoride
HR	Heart Rate
HSTS	HTTP Strict Transport Security
HTTPS	Hypertext Transfer Protocol Secure
HUD	Heads-Up Display
IAEA	International Atomic Energy Agency
IAM	Identity and Access Management
ICD	Interface Control Document
IED	Improvised Explosive Device
IDLH	Immediately Dangerous to Life or Health
IMS	Ion Mobility Spectrometry
IMU	Inertial Measurement Unit
LAMP	Loop-Mediated Isothermal Amplification
LCA	Life Cycle Assessment
LED	Light Emitting Diode / Law Enforcement Directive
LFA	Lateral Flow Assay
LOD	Limit of Detection
LPG	Liquefied Petroleum Gas

MDR	Medical Device Regulation
MFA	Multi-Factor Authentication
MOLLE	Modular Lightweight Load-carrying Equipment
MTTR	Mean Time To Repair
MVTR	Moisture Vapour Transmission Rate
NIOSH	National Institute for Occupational Safety and Health
NORM	Naturally Occurring Radioactive Material
NPS	Novel Psychoactive Substances
PALS	Pouch Attachment Ladder System
PAPR	Powered Air-Purifying Respirator
PCP	Pre-Commercial Procurement
PCR	Polymerase Chain Reaction
PFAS	Per- and polyfluoroalkyl substances
PPE	Personal Protective Equipment
PTT	Push-To-Talk
PVC	Polyvinyl Chloride
R&D	Research and Development
RBAC	Role-Based Access Control
RDD	Radiological Dispersal Device ("Dirty Bomb")
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RH	Relative Humidity
RID	Regulation concerning the International Carriage of Dangerous Goods by Rail
ROM	Range of Motion
RPE	Respiratory Protective Equipment
SCBA	Self-Contained Breathing Apparatus
SIEM	Security Information and Event Management
SLAM	Simultaneous Localization and Mapping
SOP	Standard Operating Procedure
SpO₂	Peripheral Oxygen Saturation
SVHC	Substance of Very High Concern
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
TIC / TIM	Toxic Industrial Chemical / Toxic Industrial Material
TLS	Transport Layer Security
TRL	Technology Readiness Level
TTS	Temporary Threshold Shift
TUIS	Transport Accident Information and Assistance System
UTC	Coordinated Universal Time
UWB	Ultra-Wideband
VHF	Viral Hemorrhagic Fever
WNV	West Nile Virus

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1 Introduction

First responders such as police forces, and firefighting services, but also additional stakeholders including emergency medical services (EMS) operate at the frontline of increasingly complex and multi-hazard environments that involve CBRN (Chemical, Biological, Radiological, and Nuclear), HAZMAT (Hazardous Materials), natural disasters, and terrorist incidents. Despite their differing operational roles, all require personal protective equipment (PPE) that is reliable, adaptable, and high-performing across different threat scenarios.

Existing PPE solutions, especially for those who arrive at the scene first, do not meet these requirements. Designed primarily for single-hazard scenarios, they lack mobility, durability, thermal regulation, and integrated capabilities such as physiological monitoring, geolocation tracking, and CBRN detection, which are all directly compromising responder safety and operational effectiveness. This gap is further compounded by three systemic issues evidenced across Member States. First, the COVID-19 pandemic exposed critical supply chain vulnerabilities, resulting in widespread shortages of essential protective gear. Second, operations in conflict-affected environments have highlighted the need for scalable, reusable, and field-maintainable PPE solutions. Third, inconsistent technical standards across Member States continue to hinder cross-border interoperability during joint emergency responses.

ACTIVE PCP (Pre-Commercial Procurement of Innovative Personal Protective Equipment for First Responders) is a European Union-funded project that brings together first responders, public authorities, and technology providers to co-create innovative solutions for next-generation Personal Protective Equipment (PPE) for first responders. The project addresses the growing challenge of keeping responders safe and operationally effective amid evolving threats – from CBRN incidents and HAZMAT situations to complex emergencies triggered by terrorism, industrial accidents, or natural disasters. Developing effective PPE solutions that meet diverse operational needs across different countries and responder organisations remains difficult, as many off-the-shelf products are inadequate, fragmented, or optimised for single-hazard scenarios. ACTIVE PCP seeks to overcome this gap by actively involving the "demand side" (public safety buyers and end-users such as police, firefighters, and emergency medical services) in defining their unmet needs and steering industry R&D efforts towards those needs.

Following the EC Guidelines on Pre-Commercial Procurement (PCP), through a competitive series of design, prototype and pilot steps, the ACTIVE PCP will contract suppliers to deliver the creation and deployment of the envisaged PPE Solutions.

2 Vision

The vision of the ACTIVE PCP project builds the foundation for the development of innovative Personal Protective Equipment (PPE) systems designed to overcome the fundamental shortcomings of current gear. By integrating advanced materials and smart technologies, the project aims to significantly enhance the safety, operational efficiency, and adaptability of first responders, providing a leap forward in protection for those facing evolving multi-hazard threats, including Chemical, Biological, Radiological, and Nuclear (CBRN) incidents.

This section elaborates on the shortcomings of the current state of the art and elucidates why existing solutions do not meet the needs of first responder organisations in the field, necessitating a Pre-Commercial Procurement (PCP) process to acquire new R&D services. Based on in-depth assessments, it is evident that an innovative PPE system must be developed to address critical gaps in **protection, usability, comfort, and real-time monitoring**.

Current practices in PPE often fail to address unknown or emerging hazards and lack the adaptability required for diverse operational settings. For instance, many CBRN resistant suits cannot withstand heat, and heavy, restrictive designs frequently lead to overheating, fatigue, and reduced fine motor precision. Furthermore, poorly fitting gear - particularly for female first responders - can compromise protection and lead to non-compliance in the field. The ACTIVE PCP project envisions a solution where equipment is no longer a hindrance but a seamless extension of the responder.

A system that truly impacts the work of emergency teams must provide enhanced situational awareness. The ACTIVE PCP vision includes the integration of miniaturised sensors within the PPE to track responders' health and environmental hazards in real-time, coupled with secure data transmission. This technological leap ensures that commanders and peers have immediate access to life-saving data, such as physiological strain and location tracking, during complex operations.

To reach the desired quality and efficiency improvements, suppliers must focus on several **Key Innovation Areas**:

- **"All-Hazard" Fabric Solutions:** Developing lightweight, high-performance materials that provide comprehensive protection across a wide spectrum of CBRN and thermal hazards.
- **Adaptive and Modular Design:** Creating configurable systems with interchangeable layers that allow responders to quickly adapt to different roles and threat scenarios without frequent equipment changes.
- **Ergonomics and Comfort:** Utilising stretchable fabrics and advanced ventilation to reduce physical strain and heat stress, enabling sustained performance during extended shifts.
- **Sustainability and Maintenance:** Developing self-cleaning or antimicrobial materials to reduce the heavy logistical burden of decontamination and ensure supply chain resilience through durable, reusable designs.

Furthermore, the solution must prioritise interoperability. ACTIVE PCP aims to strengthen cooperation across European agencies and borders, ensuring that PPE solutions comply with emerging EU standards and certifications. This alignment supports coordinated multi-stakeholder operations and ensures that first responders from different nations can work together effectively using compatible, high-standard equipment.

Ultimately, improving PPE solutions means to provide:

- Improved protection of first responders in **complex and multi-hazard environments**, including CBRN, HAZMAT, terrorist attacks, and natural disasters.
- Enhanced **usability, comfort, and mobility** of PPE, reducing physical strain, heat stress, and fatigue while enabling sustained operational performance.
- Increased **adaptability and versatility** of PPE solutions, allowing responders to operate effectively across different threat scenarios without frequent equipment changes.
- Improved **responder safety and situational awareness** through the integration of advanced technologies such as physiological monitoring, environmental sensing, and location tracking.
- Strengthened **interoperability** of PPE across agencies and borders, supporting coordinated multi-stakeholder and cross-border emergency operations in line with EU requirements.
- Greater **resilience and sustainability** of PPE systems, through reusable, easy-to-maintain designs that reduce dependency on fragile supply chains.

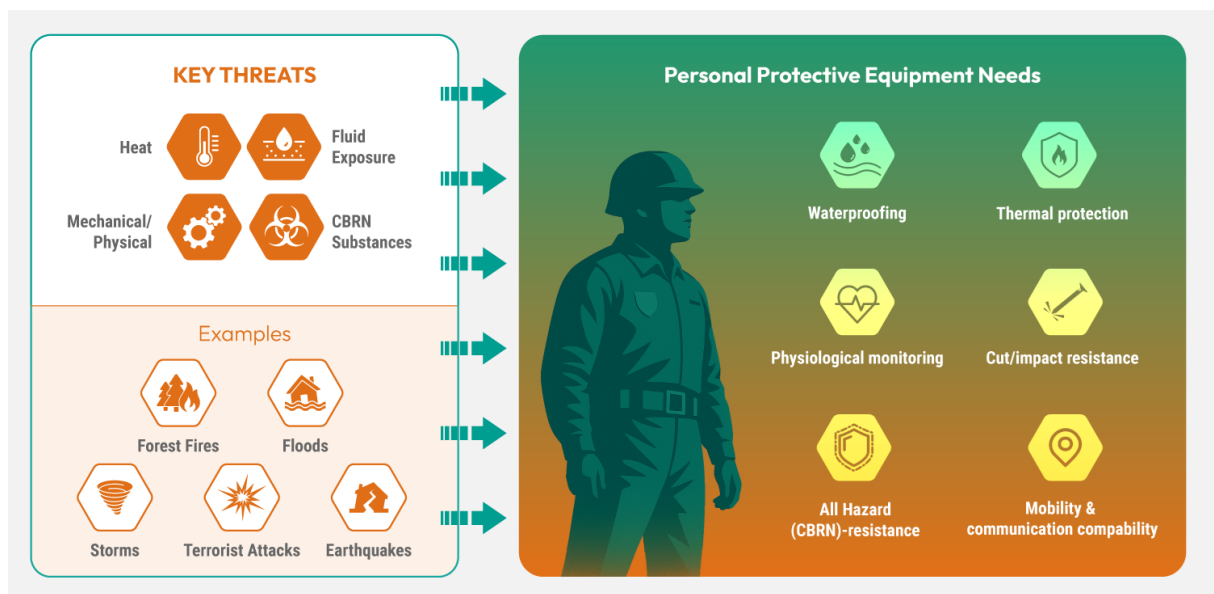


Figure 1: ACTIVE PCP – Conceptual graphic

3 Key Threats

The identification of key threats was one of the central steps in the development of the ACTIVE PCP Common Challenge and in the preparation of the subsequent procurement specifications and requirements. The baseline of the project was the need for innovative personal protective equipment for first responders operating in complex, multi-hazard environments, where chemical, biological, radiological, nuclear, thermal, fluid, mechanical and operational risks may occur in combination rather than as isolated events. The key threats analysis therefore provides the bridge between the broad operational reality of first responders and the more precise functional and non-functional requirements that will guide the ACTIVE PCP process.

The purpose of this chapter is on one hand to present the final agreed key threats, on the other hand also to explain how the consortium moved from an initial wide understanding of possible hazards to a consolidated set of threat categories that can meaningfully structure scenario development, requirements definition, solution mapping, and innovation gap analysis. This is particularly important for ACTIVE PCP because the project – in line also with the PCP main objectives - seeks to stimulate the development of an integrated smart PPE solution that responds to operationally validated needs across different responder groups (with focus on firefighters and Law Enforcement Agencies), Member States, and incident types.

The key threats analysis supports the broader ACTIVE PCP objectives in three ways. First, it ensures that the project remains grounded in real operational risks faced by police, fire and rescue services. Second, it helps distinguish between general wished features and those threat areas where unmet needs are sufficiently significant to justify an innovation procurement process. Third, it provided a structured basis for assessing whether existing market solutions, emerging technologies, and patented developments can meet the identified needs, or whether targeted R&D remains necessary.

The scope of the analysis covers five final key threat categories identified in the consolidated:

- Chemical Substances;
- Heat and Thermal Threats;
- Fluid Exposure;
- Mechanical and Physical Violence Threats; and
- Operational Barriers and Limitations.

These categories reflect direct environmental hazards and cross-cutting operational constraints that affect responder safety, performance and mission effectiveness. They are linked to the scenario definitions, which demonstrate how the threats may appear in realistic indoor and outdoor response situations, including public event incidents, traffic accidents with delayed CBRN identification, illicit laboratory explosions, and public facility chemical releases.

3.1 Definition of the Key Threats

The move from a wider list of possible threats to the final set of key threats was based on a structured qualitative narrowing-down process. The consortium considered which threats were most relevant to end users, most likely to appear across different operational settings, most severe in terms of responder safety, and most clearly linked to gaps in current PPE solutions. Especially, the Key Threats

were narrowed down considering that the ACTIVE PCP project decided to **focus on those first responders who enter the scene first**.

Operational relevance was the primary filter. Threats were prioritised where they directly affected first responders during the early and uncertain phase of an incident. This was especially important for chemical and CBRN-related threats, where responders may not initially know whether they are dealing with a toxic liquid, aerosol, gas, contaminated water, smoke, fire, explosive residues or biological contamination. The scenarios show that delayed hazard identification is a recurring operational problem, particularly in public events, traffic accidents and public facilities.

Severity and potential impact also shaped the selection. Chemical exposure, heat stress, burns, smoke inhalation, contaminated liquid exposure, mechanical injury and loss of situational awareness can all directly compromise responder safety. They may also reduce mission effectiveness by forcing early withdrawal, slowing rescue operations or increasing the need for specialist intervention. For ACTIVE PCP, this means the threat categories must support PPE requirements that protect the wearer while still allowing movement, communication, detection, decontamination and long-duration operation.

The selected threats are not limited to one national context or one responder organisation. They are relevant to police, fire and rescue services, HAZMAT teams, EMS interfaces and command structures. They also support the project's broader European objective of improving interoperability and addressing shared gaps in first responder protection.

The key threats reflect areas where current solutions are insufficient not because no PPE exists at all, but because existing solutions do not adequately combine protection, mobility, reusability, sensor integration and operational adaptability. The final set of key threats therefore represents a pragmatic consolidation of operational risk, end-user need, market gap and procurement relevance.

3.2 Key Threat 1: Chemical Substances

CBRN Substances constitute the primary threat category for ACTIVE PCP. Initially, the discussion focused on C (Chemical) only, but in a later stage, it was decided to expand it to BNR as well. The conducted analysis identified the need for chemical resistance against unknown liquids, aerosols and gases, as well as broad-spectrum barrier materials and decontamination-resistant materials. This reflects a core operational reality: first responders often encounter chemical hazards before the exact substance, concentration, exposure route or escalation potential is fully known.

This threat is highly relevant for ACTIVE PCP because chemical exposure appears in several final scenarios, including the festival drone-based chemical dispersal, the motorway crash with delayed CBRN identification, the illicit fentanyl laboratory explosion and the public facility chemical leak. In each case, responders are required to act before the situation is fully characterised. They may need to rescue affected persons, isolate the area, provide support to evacuation, suppress fire, manage panic, secure evidence or coordinate with specialised CBRN/HAZMAT units.

The operational challenge is that current PPE may provide protection only against specific known hazards or may require specialist deployment conditions. In the early response phase, however, uncertainty is unavoidable. Responders require PPE that can provide a meaningful level of protection against unknown or mixed chemical exposures while maintaining mobility, compatibility with respiratory protection and the ability to support detection or identification systems. Decontamination resistance is also critical, because reusable PPE must remain safe and functional after exposure and cleaning.

This threat was selected because it is both severe and cross-cutting. It represents the clearest link between end-user operational needs, the project's CBRN focus and the innovation potential of smart textile PPE.

3.3 Key Threat 2: Heat and Thermal Threats

Heat and Thermal threats cover exposure to high temperatures, open flames, steam, smoke, ash and particulate matter, as well as the internal physiological burden created by prolonged wear of protective garments. The final analysis identified the need for flame-retardant and non-melting materials, heat insulation, breathable design and thermal regulation.

This threat is relevant to firefighters and to police – potentially also to other responders - operating in mixed incidents, public events, forest fires, heatwaves, explosions or vehicle fires. In the final scenarios, heat and thermal hazards appear particularly in outdoor chemical dispersal and motorway crash situations, where responders may face fire, smoke, toxic vapours and prolonged physical effort. Even when the external thermal hazard is not the primary threat, the PPE itself may create heat stress if it is heavy, impermeable or poorly ventilated.

One of the operational challenges is the balance between protection and endurance. PPE that provides high chemical or thermal protection may restrict heat dissipation, reduce mobility and accelerate fatigue. Overheating may shorten mission duration, impair judgement and increase medical risk for the wearer. Current mitigation approaches, such as separate cooling elements or add-on systems, may introduce additional weight, complexity and compatibility challenges.

Heat and Thermal threats were selected because they represent a high-impact operational risk and a clear innovation gap. ACTIVE PCP should therefore consider thermal performance not as an isolated fire-protection requirement, but as part of an integrated multi-hazard garment design.

3.4 Key Threat 3: Fluid Exposure

Fluid Exposure includes rain, flooding, sweat, oils, contaminated water and liquid chemical exposure. The final analysis identified waterproof and water-resistant materials, semi-permeability for sweat management, protection against contaminated water, stable grip considerations, mobility, low weight and quick-drying or drainage-capable materials. One partner observation also refers to anti-fog mask lens considerations, which should be verified before final submission.

This threat is relevant because fluids can act both as a direct hazard and as a carrier of other hazards. In a motorway crash, for example, rainwater may mix with leaked chemicals, creating slipping hazards, dermal exposure and environmental contamination. In flooding or contaminated-water incidents, responders may face biological and chemical pollutants. In prolonged PPE use, sweat management also becomes important because excessive moisture can reduce comfort, increase fatigue and affect thermal regulation.

The operational challenge is to achieve a balance between liquid protection, breathability, mobility and compatibility with the wider PPE system. Fully impermeable materials may protect against liquids but worsen heat stress and reduce comfort. Highly breathable materials may improve endurance but fail to provide adequate protection against contaminated fluids. The final analysis showed that core fluid-protection needs were prioritised highly, while some associated elements, such as quick drying and footwear-related slip resistance, require further scoping.

Fluid Exposure was selected because it frequently interacts with chemical, biological and thermal threats. It is also important for ensuring that PPE remains usable in realistic weather and environmental conditions rather than only under controlled test conditions.

3.5 Key Threat 4: Mechanical and Physical Violence Threats

Mechanical and Physical Violence Threats include abrasion, cutting, tearing, puncture and the need for reinforced padding in critical body areas. Compared with chemical and thermal threats, the final analysis indicated more mixed prioritisation for this category. However, cut-resistant materials and targeted reinforcement remain relevant to the operational scenarios.

This threat is particularly relevant in mixed security and safety incidents. Police officers may operate in environments involving armed suspects, crowd pressure, debris, sharp objects, damaged infrastructure, improvised devices or attempts to destroy evidence. Fire and rescue services may also face mechanical risks in confined spaces, traffic accidents, structural damage and post-explosion environments.

The operational challenge is that mechanical protection can add stiffness, weight and bulk. If overemphasised, it may conflict with the equally important need for mobility, thermal regulation and rapid donning and doffing. For this reason, the category should not be interpreted as a requirement for heavy tactical armour. Rather, it reflects the need for appropriate textile-level resistance, targeted reinforcement and compatibility with mission-specific protective equipment. This threat was selected because mechanical and physical hazards are present in several scenarios and are critical during escalation.

3.6 Key Threat 5: Operational Barriers and Limitations

Operational Barriers and Limitations are included as a key threat because the effectiveness of PPE depends not only on material protection, but also on whether responders can perform their tasks while wearing it. This includes high mobility and flexibility, enhanced visibility and identification/localisation, compatibility with communication and situational-awareness tools, ergonomic design for long-duration wear and rapid adaptability to changing conditions.

This category is highly relevant across all scenarios. Responders must move quickly, assist casualties, communicate with command structures, coordinate with other services, operate in indoor and outdoor environments, and adapt as the incident develops. In several scenarios, the hazard is initially unknown or changes classification during the response. PPE must therefore support the responder during uncertainty, not only after a fully defined hazard assessment has been completed.

The operational challenge is that many existing PPE solutions are protective but operationally burdensome. Heavy, hot or restrictive garments may reduce agility. Poor fit may exclude or disadvantage certain wearer groups. Limited visibility, weak identification or lack of localisation may undermine command and control. Communication difficulties under masks or in noisy environments may create safety risks. Lack of integration with wearable sensing or monitoring systems may also prevent commanders from understanding responder status in real time.

This category was selected because it cuts across all other threats. A PPE solution that protects against chemicals or heat but prevents effective movement, communication or long-duration use will not meet the ACTIVE PCP Common Challenge. Operational usability must therefore be treated as a core requirement, not as an optional comfort feature.

4 Scenarios

The scenarios below have been created to highlight the operational context under which the described key threats and innovation needs should be considered.

SCENARIO ID	01 - Security and Safety (Mixed)
SCENARIO NAME	Festival Drone-Based Chemical Dispersal
TYPE	SECURITY/SAFETY-ORIENTED
CLASSIFICATION	Public Event Chemical Attack + Drone-Based Delivery
DESCRIPTION	During an open-air festival, several visitors suddenly experience irritation of the eyes and respiratory tract in front of a stage area. The cause is initially unclear; visitors see drones flying around the festival area, dispersing unknown substances. First responding fire and rescue teams must immediately rescue affected persons, provide medical assistance, and secure the area, although the type and extent of the chemical hazard are initially unknown. Only later is the incident classified as a chemical hazardous materials event, and specialised units are requested.
SECURITY THREATS	- Coordinated drone attack - Potential multiple drones - Terrorist or extremist intent - Secondary strike risk - Mass panic
SAFETY THREATS	- Airborne toxic exposure - Heat exhaustion - Delayed evacuation - Large-scale contamination
KEY ROLES	Police: Area isolation, threat neutralisation, public order Fire Service: Ventilation, containment, structural safety
THREATS	KEY THREAT 1, KEY THREAT 2, KEY THREAT 4, KEY THREAT 5
DURATION	4-6 hours
CASUALTIES	20–80 persons
AREA	Outdoor

SCENARIO ID	02 - Safety
SCENARIO NAME	Motorway Crash with Delayed CBRN Identification
TYPE	SAFETY-ORIENTED
CLASSIFICATION	Traffic Accident + Delayed Hazardous Materials (CBRN) Event

DESCRIPTION	In a heavy rain day, after a traffic accident between a passenger car and a truck at a motorway rest area, the fire service is dispatched due to a vehicle fire with a person trapped inside. Initially, there are no indications of hazardous materials involved. Upon arrival, the passenger car is fully engulfed in flames, with one person trapped inside. The truck is located in close proximity and shows no visible hazardous goods markings. The truck driver is injured and unable to provide information. Due to the immediate threat to life, the first responding crews immediately initiate rescue operations and fire suppression while wearing breathing apparatus. During these operations, firefighters experience irritation of the eyes and respiratory tract, and a colourless liquid is observed on the roadway. Only after the immediate rescue phase is completed is it identified that the truck was transporting damaged IBC containers containing a corrosive chemical. The incident is subsequently classified as a hazardous materials (CBRN) event, and specialised response units are requested.
SECURITY THREATS	Illegal trafficking of unknown dangerous goods (possible explosive devices/substances)
SAFETY THREATS	• Vehicle fire and explosion risk • Toxic vapor inhalation • Corrosive liquid dermal exposure • Slipping hazard due to chemical + rain • Environmental contamination • Delayed hazard recognition
KEY ROLES	Fire Service: Ventilation, containment, structural safety
THREATS	KEY THREAT 1, KEY THREAT 2, KEY THREAT 3, KEY THREAT 5
DURATION	1 - 3 hours
CASUALTIES	5
AREA	Outdoor

SCENARIO ID	03 - Security
SCENARIO NAME	Illicit Fentanyl Mega-Lab Explosion + Armed Threat
TYPE	SECURITY-ORIENTED
CLASSIFICATION	Organised Crime + CBRN Incident + Improvised Chemical Process Hazards
DESCRIPTION	During a targeted police operation against a high-capacity clandestine fentanyl production lab hidden inside a residential building, criminals trigger an improvised explosive device (IED) designed to disperse fentanyl powder and volatile precursors. A violent chemical flash-reaction occurs due to uncontrolled acetyl chloride vapours, creating a toxic airborne cloud inside confined spaces. Multiple police officers are exposed while criminals remain armed and mobile within the structure. Fire rapidly propagates through improvised extraction systems, threatening structural integrity and trapping civilians on upper floors.
SECURITY THREATS	• Armed organised-crime group with counter-intervention tactics • Secondary IEDs and booby traps targeting responders • Attempted destruction of chemical evidence and digital records • Possibility of barricaded suspects or hostage-holding • Surveillance blockers & jammers used inside the lab

SAFETY THREATS	• Extreme fentanyl toxicity (airborne micro-particles, dermal exposure) • Highly volatile precursors • Toxic combustion products • Severe respiratory threats in confined areas • Risk of building structure collapse
KEY ROLES	• Police: Armed threat neutralisation, officers rescue • CBRN/HAZMAT: Substance ID, confinement, decontamination • Fire Service: Fire suppression, structural stabilisation • EMS: High-risk chemical triage • Command: Scene Safety, Zone control, Monitoring, Coordination
THREATS	KEY THREAT 1, KEY THREAT 4, KEY THREAT 5
DURATION	2–4 hours
CASUALTIES	5–10 persons
AREA	Indoor

SCENARIO ID	04 - Security and Safety (Mixed)
SCENARIO NAME	Public Facility Chemical Leak & Crowd Exposure
TYPE	SECURITY/SAFETY-ORIENTED
CLASSIFICATION	Public Safety Incident + Suspicious Chemical Release
DESCRIPTION	A public building such as an administrative facility, shopping centre, or railway station, an incident occurs during normal operations. Several people suddenly report irritation of the eyes and respiratory tract, and some show signs of disorientation. At the same time, a suspicious container leaking liquid is reported in a side room.
SECURITY THREATS	• Possible intentional chemical release • Suspicious container possibly linked to sabotage or terrorist • Risk of secondary devices • Panic-induced crowd surge • Potential attacker among civilians
SAFETY THREATS	• Toxic inhalation • Dermal chemical exposure • Slipping hazard from leaked liquids • Fire or explosion risk • Secondary contamination spread
KEY ROLES	Police: Area isolation, threat neutralisation, public order Fire Service: Ventilation, containment, structural safety
THREATS	KEY THREAT 1, KEY THREAT 4, KEY THREAT 5
DURATION	3-5 hours
CASUALTIES	20–80 persons
AREA	Indoor

5 Requirements

The final outcome of the in-depth needs assessment resulted in a comprehensive list of requirements that an innovative solution should deliver. Finally, a total number of 79 Requirements was defined. The requirements were structured against the identified Key Threats.

Table 1: List of Requirements

ID	Requirement Name	Topic	The ACTIVE PCP solution shall...	Type	PRIORITY
1. CBRN REQUIREMENTS				<i>F= Functional NF=NonFunctional</i>	<i>1 = Must 2 = Important 3 = Nice to Have</i>
R 1.1	All-Hazard Protection	Multi-Hazard	...protect wearer against all hazard's threats simultaneously, without requiring them to switch suits or compromise protection.	F	1
R 1.2	Protection During Initial Approach at the Scene (Chemical)	Chemical	...provide an enhanced level of Chemical protection beyond the current baseline, integrated into the standard operational uniform, effective from the moment of initial approach before the hazard is confirmed.	F	1
R 1.3	Protection During Initial Approach at the Scene (Biological)	Biological	...provide an enhanced level of biological protection beyond the current baseline, integrated into the standard operational uniform, effective from the moment of initial approach before the hazard is confirmed.	F	1
R 1.4	Protection During Initial Approach at the Scene (Radiological + Nuclear)	Radiological + Nuclear	...provide an enhanced level of Radiological and Nuclear protection beyond the current baseline, integrated into the standard operational uniform, effective from the moment of initial approach before the hazard is confirmed.	F	1
R 1.5	Radiological Protection	Radiological + Nuclear	...provide validated protection against radiological particulate contamination (alpha, beta).	F	1
R 1.6	Early Warning Detection (Chemical)	Chemical	...feature early-warning detection that alerts at an early stage for chemical hazards to the wearer and operational command.	F	2
R 1.7	Early Warning Detection (Biological)	Biological	...feature early-warning detection that alerts at an early stage for biological hazards to the wearer and operational command.	F	2

R 1.8	Early Warning Detection (Radiological + Nuclear)	Radiological + Nuclear	...feature early-warning detection that alerts at an early stage for radiological and nuclear hazards to the wearer and operational command.	F	2
R 1.9	Monitoring – Contamination (Chemical)	Chemical	...monitor chemical agent exposure in real time (e.g., substance, concentration, cumulative dose) and transmit data to the wearer and operational command.	F	2
R 1.10	Monitoring – Contamination (Biological)	Biological	...monitor biological agent exposure in real time (e.g., substance, concentration, cumulative dose) and transmit data to the wearer and operational command.	F	3
R 1.11	Monitoring – Contamination (Radiological + Nuclear)	Radiological + Nuclear	...monitor radiological and nuclear agent exposure in real time (e.g., substance, concentration, cumulative dose) and transmit data to the wearer and operational command.	F	3
R 1.12	Alerting – Contamination (Chemical)	Chemical	...alert the wearer before crossing critical contamination levels, without requiring additional hand-held detectors and before the protective performance of the clothing is compromised, for chemicals.	F	2
R 1.13	Alerting – Contamination (Biological)	Biological	...alert the wearer before crossing critical contamination levels, without requiring additional hand-held detectors and before the protective performance of the clothing is compromised, for biological	F	2
R 1.14	Alerting – Contamination (Radiological + Nuclear)	Radiological + Nuclear	...alert the wearer before crossing contamination levels, without requiring additional hand-held detectors and before the protective performance of the clothing is compromised for radiological and nuclear.	F	2
R 1.15	Reusability (Chemical)	Chemical	...be reliably reusable after standard chemical decontamination procedures without loss of protective performance.	F	2
R 1.16	Reusability (Biological)	Biological	...be reliably reusable after standard biological decontamination procedures without loss of protective performance.	F	2
R 1.17	Reusability (Radiological + Nuclear)	Radiological + Nuclear	...be reliably reusable after standard radiological and nuclear decontamination procedures without loss of protective performance.	F	2
R 1.18	Self-Cleaning / Antimicrobial	Biological	...incorporate self-cleaning or antimicrobial surface properties that reduce biological contamination residue and extend service life.	F	2
R 1.19	Decontamination – Verification (Chemical)	Chemical	...provide a verifiable method to confirm chemical decontamination effectiveness, enabling informed reuse decisions after each incident.	F	2
R 1.20	Decontamination – Verification (Biological)	Biological	...provide a verifiable method to confirm biological decontamination effectiveness, enabling informed reuse decisions after each incident.	F	2

R 1.21	Decontamination – Verification (Radiological)	Radiological + Nuclear	...provide a verifiable method to confirm radiological decontamination effectiveness, enabling informed reuse decisions after each incident.	F	2
R 1.22	Suit Seams – All Hazard Permeation	Multi-Hazard	...ensure that all seams, welds, and closure points provide the same resistance as the textile.	F	1
2. HEAT AND THERMAL REQUIREMENTS					
R 2.1	Monitoring – Thermal Warning	Heat and thermal	...monitors the thermal heat in real time and transmit data to the wearer and operational command.	F	1
R 2.2	Alerting - Thermal Warning	Heat and thermal	...warn the user during thermal stress before the clothing fails, and transmit the information to operational command.	F	2
R 2.3	Thermal Management	Heat and thermal	...be thermally sufficient (active or passive thermal regulation) for interior firefighting while remaining lightweight and breathable, so that it can be worn in other operational scenarios, ideally with a system to cool the body.	F	2
R 2.4	Suit Design / Standards	Heat and thermal	...continue to meet performance level 2 in accordance with DIN EN 469	F	1
R 2.5	Breathability Material	Heat and thermal	...use breathable materials that manage heat and moisture effectively, enabling extended operations without physiological heat stress.	F	1
R2.6	Double-Hazard Protection (Chemical + Fire)	Chemical + Thermal	...combine chemical barrier protection with resistance to fire radiation exposure.	F	1
R 2.7	Anti-Static Properties	Heat and thermal	...incorporate anti-static properties to reduce the risk of ignition caused by electrostatic discharge in environments containing explosive substances or flammable chemicals	F	1
3. FLUID EXPOSURE REQUIREMENTS					
R 3.1	Fluids Repellent	Fluid	...remain oil-, chemical-, and fuel-repellent	F	1
R 3.2	Fluid Material - PFAS free	Fluid	... be PFAS-free	NF	1
R 3.3	Fluid Material - Waterproof	Fluid	...be waterproof/liquid-proof	F	1
R 3.4	Fluid Material - Breathability	Fluid	...provide high breathability/moisture wicking	F	1

R 3.5	Ease of Use / Donning	Fluid	...remain easy to put on even when sweaty, wet or damp on the inside due to perspiration. Without making dressing more difficult or slower.	F	1
R 3.6	All-Hazard Protection (Fluids + Additional Threats)	Fluid	...maintain fluids barrier integrity when simultaneously exposed to several threats (e.g., chemical agents, water - e.g. activated sprinklers -, fire etc.)	F	1
4. MECHANICAL AND PHYSICAL VIOLENCE REQUIREMENTS					
R 4.1	Mechanical Protection - Stabbing	Mechanical	...provide protection against stabbing	F	2
R 4.2	Mechanical Protection - Piercing	Mechanical	...provide protection against piercing	F	2
R 4.3	Mechanical Protection - Punching	Mechanical	...provide protection against punching	F	2
R 4.4	Mechanical Protection - Cutting	Mechanical	...provide protection against cutting	F	2
R 4.5	Abrasion Protection - Cushioning	Mechanical	...provide cushioning properties	F	2
R 4.6	Abrasion Protection - Abrasion	Mechanical	...provide abrasion resistance.	F	2
5. OPERATIONAL BARRIERS AND LIMITATIONS					
R 5.1	Ease of Use / Donning & Doffing - General	Usability	...be able to be put on and taken off quickly.	F	1
R 5.2	Flexibility	Usability	...provide maximum freedom of movement.	F	1
R 5.3	Safe Doffing (All Hazard)	Usability	...allow easy removal to avoid further contamination and exposure.	F	1
R 5.4	Visibility	Usability	...ensure good all-round visibility, even with full equipment.	F	2
R 5.5	Suit Design – Attachment	Usability	...provide sufficient, but reduced, attachment points for mounting essential devices and other equipment.	F	1

R 5.6	Mobility	Usability	...adequately protect the wearer using stretchable and flexible materials without restricting mobility.	f	1
R 5.7	Ergonomic Fit – Tactile Usability	Usability	...ensure fine motor skills and tactile sensitivity.	F	2
R 5.8	Lightweight	Usability	...be light to wear and allow effective performance across multi-hour operations.	F	1
R 5.9	Portability / Quick Deployment	Usability	...can be packed into a compact, lightweight format and can be carried individually.	F	2
R 5.10	Costs	Efficiency	...be cost-effective, affordable, quick, and easy to decontaminate.	F	2
R 5.11	Washable	Operational	.. be washable with integrated sensors.	F	1
R 5.12	Non-Shrinking	Operational	.. not shrink during washing.	F	1
R 5.13	Sustainability	Efficiency	...consider all three dimensions of sustainability (ecological, economic, and social) throughout the entire supply chain.	NF	3
R 5.14	Ergonomics / Fit - Body Shape	Usability	...provide an ergonomic and functional fit for different body shapes	F	2
R 5.15	Ergonomics / Fit - Physiological Needs	Usability	...provide an ergonomic and functional fit, considering gender based physiological needs - especially for women.	F	1
R 5.16	Suit Design / Fit	Usability	...guarantee a consistently secure and comfortable fit.	F	1
R 5.17	Maintainability	Efficiency	...have components that can be replaced quickly and easily.	F	1
R 5.18	Modular Design (All Hazard)	All Hazard	...have a modular design enabling rapid adaptation of all threats protection level to match evolving operational roles and threat levels.	F	1
R 5.19	Equipment Compatibility (All Hazard)	All Hazard	...be compatible with additional PPE carried by wearer.	F	1
R 5.20	Data – Vital Signs	Monitoring	...integrate real-time sensors monitoring key vital signs (heart rate, body temperature, SpO ₂)	F	2

R 5.21	Data – Location Tracking	Monitoring	...integrate reliable real-time location tracking of wearer, visible to incident command even in GPS-denied environments (indoor, smoke-filled).	F	2
R 5.22	Data Recording - Real-Time Data Transmission	Monitoring	...transmit live data to operational command to ensure immediate situational awareness.	F	2
R 5.23	Data Recording -Long-Term Recording & Forensic Storage	Monitoring	...maintain long-term data recording for post-mission analysis, legal admissibility, and system diagnostics	F	3
R 5.24	Data - Offline Behaviour (Caching)	Interoperability	...continue to record and cache sensor data locally when the network connection is lost, and automatically synchronize when reconnected.	NF	2
R 5.25	Data - API	Interoperability	...provide open APIs that allow integrating real-time data into existing solutions and third-party software.	NF	2

6. SECURITY AND PRIVACY REQUIREMENTS

R 6.1	GDPR Compliance	Privacy	...ensure full compliance with GDPR for all collected responder biometric, exposure, and location data.	NF	1
R 6.2	Access Control & Authorization	Security	...ensure only authorized personnel have access to real-time sensitive health, vital signs, and location data of wearer.	NF	1
R 6.3	Data Encryption	Security	...provide necessary measures to ensure data privacy by encrypting to recent standards all transmitted and stored biometric, location, and operational data.	NF	1
R 6.4	Secure Networks (VPN/HTTPS)	Security	...allow access to data only through secure channels, such as HTTPS-encrypted web connections or Virtual Private Networks (VPNs).	NF	1
R 6.5	Audit Trails	Privacy	...create an audit trail logging exactly who accessed responder vital signs and tracking data, and when.	NF	1
R 6.6	Impact Assessment	Security	...undertake a formal impact assessment of potential security and privacy risks arising from the use of the solution's sensors and digital integration.	NF	1

7. ORGANISATIONAL AND PILOTING REQUIREMENTS

R 7.1	Prototype Installation	Testing	...demonstrate the necessary prototype systems (V1 and V2) at the premises of each procurer.	NF	1
R 7.2	Pilot Operation Maintenance	Testing	...maintain the operation of all systems during pilot exercises, providing a response team to physically and/or remotely resolve any technical issues.	NF	1
R 7.3	Helpdesk Support	Testing	...set up and operate a help service and maintenance response team to address hardware or software problems faced by end-users from phase 2 Round 1 onwards, including the testing phases.	NF	1
R 7.4	Procurement Reporting	Testing	...provide regular progress reports (e.g., bi-monthly status calls) throughout the different phases of the PCP (Design, Prototyping, Operational Testing).	NF	1
R 7.5	Pilot Feedback Mechanism	Testing	...enable a simple, easy-to-use error/bug reporting and general feedback module that allows end-users to instantly submit feedback on the prototypes.	NF	1
R 7.6	Quality Management & Certification	Testing	...provide a quality management strategy that supports certifying the solution's integrated vital sign sensors as medical devices (e.g., MDR compliance), if necessary.	NF	1
R7.7	Number of Garments	Testing	... total of at least 4 garments shall be provided for each procurer (1x male and 1x female version and 2x unisex). At least 1 unisex garment to be provided in Phase 2 to each of the PB, the rest must be provided in Phase 3.	NF	1
R 7.8	Harmonized Terminology	Testing	...use harmonized terminology following relevant standards to ensure data is universally understood across agencies.	NF	1

6 Context Information: Agents Overview

ACTIVE PCP: Chemical, Biological, and Radiological Agents Overview **(Field Reference for First Responders)**

While protecting against every CBRN threat is extremely challenging, the consortium has provided a non-exhaustive list to help suppliers prioritize agents based on their frequency and importance.

PART I - CHEMICAL AGENTS

Based on the operational tolerance limits list from the German Fire Protection Association (VFDB)¹, the following categorization reflects operational frequency and tactical importance across fire, rescue, and law enforcement services, not only toxicological severity.

CATEGORY 1 - High Frequency / High Importance

Carbon Monoxide (CO)

The most frequently encountered toxic gas in fire and rescue operations. Produced by any incomplete combustion — house fires, defective heating, indoor grills, wood pellet storage. Binds to haemoglobin ~240× more readily than oxygen; victims lose consciousness before sensing danger. Poses direct risk to responders during overhaul. Post-incident CO screening for crews should be standard.

Carbon Dioxide (CO₂)

Common in beer cellars, fermentation silos, dry-ice logistics, and industrial refrigeration. Fixed CO₂ suppression systems (server rooms, ship engine rooms, archives) discharge rapidly without warning — the resulting atmosphere is immediately asphyxiating. SCBA before entry is mandatory when a suppression system has activated.

Ammonia (NH₃)

Present in aging refrigeration systems (ice rinks, cold storage, slaughterhouses), agricultural use, and road/rail transport. Corrosive vapour cloud; can progress to pulmonary oedema at high concentrations. Incidents at legacy installations are frequent due to infrastructure age across Europe.

Formaldehyde (CH₂O)

Released during combustion of MDF, plywood, carpets, and adhesives — present in virtually every structural fire. Also, a routine hazard in mortuaries and hospital settings. IARC Group 1 carcinogen. Chronic exposure from repeated early SCBA removal during overhaul is under tracked in post-incident health monitoring.

¹ https://www.vfdb.de/media/referate/referat10/doc/RL_10_01_Anlage1_ETW_Ref10_2022_73_.pdf

Natural Gas (Methane) and LPG (Propane / Butane)

One of the most common emergency call types in Europe. Primary hazard is explosive/asphyxiant rather than acutely toxic. LPG is denser than air, pools at ground level, and travels far from the leak source — particularly relevant in Greece, the Balkans, and rural Mediterranean areas where LPG replaces mains gas.

Hydrogen Chloride / Hydrochloric Acid (HCl)

Released whenever PVC burns (cable insulation, flooring, pipe fittings, textiles). Near-constant presence in structural fire smoke alongside CO. Respiratory and mucosal irritant; compounds physiological load on victims and responders.

Solvents (Acetone, Alcohols, and Related Compounds)

Ubiquitous across industrial, commercial, and domestic contexts. Vapour accumulation in confined spaces carries both inhalation toxicity and explosive risk. Alcohol fires produce a nearly invisible flame in daylight — a documented cause of responder injury.

Synthetic Opioids and Novel Psychoactive Substances (NPS)

A critical emerging hazard for law enforcement and EMS. Fentanyl analogs — particularly carfentanil (~100× more potent than fentanyl) — can cause opioid toxidrome through skin contact or inhalation of particle-sized quantities. Standard nitrile gloves are permeable over sustained exposure.

Three primary exposure scenarios:

- Drug seizure operations: treat any unknown powder as fentanyl-class until proven otherwise; full respiratory protection for unknown powders.
- Clandestine production facilities: composite toxic/explosive hazard from precursors and solvents; specialist decontamination required.
- NPS (New Psychoactive Substances) incidents: unpredictable toxicological profiles, naloxone may be ineffective, violent presentation creates secondary hazard for personnel.

CATEGORY 2 - Medium Frequency / Important**Chlorine (Cl₂)**

Found at swimming pool treatment facilities and heavy chemical manufacturing. Dense — accumulates in low-lying and enclosed spaces. Severe inhalation hazard above a few ppm. Always approach upwind and uphill.

Nitrogen Dioxide (NO₂)

Insidious: minimal immediate symptoms at hazardous concentrations. Pulmonary oedema and chemical pneumonitis develop hours after exposure. Encountered in silo fermentation incidents, nitric acid transport accidents, and high-temperature combustion. Delayed clinical presentation is the primary danger.

Sulfur Dioxide (SO₂)

Industrial bleaching, food preservation, chemical manufacturing, winery operations, waste management. Even moderate concentrations cause severe bronchospasm; high risk for individuals with underlying respiratory conditions.

Hydrogen Sulfide (H₂S)

Characteristic of sewers, sewage treatment plants, manure pits, and biogas facilities. At dangerous concentrations, it paralyses the olfactory nerve — the smell disappears, creating a false sense of safety. Multiple-casualty incidents follow a predictable pattern: first victim collapses, unprotected colleague enters, becomes second casualty. Atmospheric testing and confined space protocol before entry are non-negotiable.

Nitric Acid (HNO₃)

Metal processing, labs, fertilizer production. Accidents involve spills or transport leaks. Reacts with metals and organic materials to generate NO₂ — the orange-brown fume cloud is both a warning and an active secondary hazard.

Toluene, Benzene, and Styrene

Signature compounds of petrochemical operations, fuel transport, and tyre fires. Benzene is an IARC Group 1 carcinogen present in most fuel mixtures — respiratory protection and post-incident air monitoring at benzene incidents are health protection measures, not formalities.

CATEGORY 3 — Low Frequency / Highly Specialized

Incidents in this category involve CBRN-level response.

Phosgene / Carbonyl Chloride (COCl₂)

Closed-loop chemical manufacturing; malicious synthesis outside plant walls. Delayed pulmonary toxicity — symptoms appear hours post-exposure.

Arsine (AsH₃)

Semiconductor and microchip fabrication. Negligible risk outside these facilities.

Hydrogen Cyanide (HCN) and Cyanogen Chloride (CK)

HCN is a toxic combustion byproduct (wool, nylon, polyurethane, ABS) — present in structural fire smoke, not a chemical warfare agent in this context. CK is a Schedule 1 chemical warfare agent (CWC). The distinction matters for tactical classification and medical response protocols.

Hydrogen Fluoride (HF)

Used in metal etching, glass refining, semiconductor manufacturing. Unlike other acids, HF penetrates intact skin without immediate pain, causing systemic fluoride poisoning — hypocalcaemia, cardiac arrhythmias — from small exposure areas. Standard acid burn protocols are insufficient. Calcium gluconate antidote required. Brief responders on this mechanism before any HF approach.

Hydrazine (N₂H₄) — Rocket propellant, aerospace maintenance, industrial boiler water treatment.

Acrolein, Acrylonitrile, Epichlorohydrin

Chemical intermediates for plastics and resins; plant accidents and major rail derailments. Acrolein is also present in structural fire smoke as a combustion byproduct.

Toluene Diisocyanate (TDI)

Polyurethane foam manufacturing. Respiratory sensitizer; repeat low-level exposure causes occupational asthma.

Halogenated Hydrocarbons

Legacy dry-cleaning solvents and degreasers; rare in modern circulation due to EU environmental regulation.

OPERATIONAL CONTEXT: ADR / RID and Seveso Installations.

Most medium-to-high consequence chemical incidents in Europe arise from the routine movement or storage of industrial chemistry, not from deliberate releases:

ADR (road) and RID (rail) govern dangerous goods transport across EU states. The orange placard system on tankers and freight containers — UN number plus hazard code — is the primary field identification tool at transport incidents. TUIS (Transport Accident Information and Assistance System) is the escalation contact. High-risk corridors include the Rhine, Po, Danube, and Trans-Balkan routes.

The Seveso III Directive (2012/18/EU) requires identification of industrial sites above hazardous substance thresholds, mandatory internal/external emergency plans, and information access for local emergency services. First responders in the vicinity of Seveso establishments should know the substances handled, site layout, and internal emergency coordinator contacts in advance. The agents most commonly associated with Seveso incidents are those in Categories 1 and 2: ammonia, chlorine, LPG, flammable liquids, and reactive intermediates.

PART II - BIOLOGICAL AGENTS

Governed by EU Biological Agents Directive 2000/54/EC; national doctrine in FwDV 500 (DE/AT). Categorization follows Risk Group classification (RG 1–4). Unlike chemical hazards, most biological exposure in operational settings is low-level, cumulative, and easily underestimated.

CATEGORY 1 - High Frequency / High Importance

Bloodborne Pathogens (HIV, Hepatitis B & C)

Daily exposure risk across technical rescue, road accidents, overdose response, and encounters with IV drug paraphernalia. Post-exposure protocols, current HBV vaccination, and consistent PPE use are the baseline — not the exception.

Highly Infectious Respiratory Viruses (Influenza, SARS-CoV-2, RSV)

Constant background risk during patient transport, medical assist calls, and operations in enclosed spaces. Respiratory protection protocols should reflect current epidemiological conditions, not pre-pandemic defaults.

Gastrointestinal Pathogens (Norovirus, Salmonella, E. coli O157)

Relevant during operations in nursing homes, schools, hospitals, and — critically — flooding and sewage incidents involving faecally contaminated water. Cross-contamination risk in both directions.

Tuberculosis (*Mycobacterium tuberculosis*)

Occupational risk during sustained contact in high-prevalence settings: migrant reception centres, homeless shelters, prisons, and vessels carrying undocumented persons. MDR-TB and XDR-TB strains, prevalent in Eastern Europe, present treatment-resistant profiles. Minimum FFP2/FFP3 protection during extended patient contact in these environments; post-incident health monitoring pathway required.

Tetanus (*Clostridium tetani*)

Puncture wound risk at collapse, extrication, and industrial accident sites. Entirely preventable through vaccination. Inclusion here is a prompt: verify team vaccination currency.

CATEGORY 2 - Medium Frequency / Important**Zoonotic Diseases**

A systematically underweighted risk category for European responders, particularly in southern and southeastern Europe. Agricultural incidents, rural fire operations, and flooding create direct exposure pathways

Q Fever (*Coxiella burnetii*)

Shed by infected cattle, sheep, and goats in birth products, urine, and faeces. Forms environmentally resistant spore's viable in dust for months. Airborne transmission — no direct animal contact required. Endemic in Greece and the Mediterranean; active gap in responder awareness.

Brucellosis (*Brucella abortus*, *B. melitensis*)

Classically Mediterranean. Contact with infected animal products — birthing, slaughter, carcass handling. Causes chronic debilitating illness (undulant fever, joint pain, fatigue). Relevant at agricultural callouts and livestock accident response.

Leptospirosis (*Leptospira* spp.)

Transmitted through contact with water contaminated by infected animal urine. Significant risk during flood and sewage operations — entry through skin abrasions. Waterproof PPE and wound coverage are the primary mitigations.

Hantavirus

Transmitted by inhalation of dried rodent excreta. Risk during operations in abandoned rural buildings, agricultural barns, and forest fire suppression in rodent-dense areas. Puumala and Dobrava strains endemic in Central and Eastern Europe.

Crimean-Congo Hemorrhagic Fever (CCHF / *Nairovirus*)

Risk Group 4 pathogen. Tick-borne (*Hyalomma* spp.) with confirmed endemic presence in Greece, Bulgaria, and Turkey. Human-to-human transmission through blood contact is documented. Tick-check protocols and patient handling precautions mandatory for rural operations in affected regions during tick-active months (spring–autumn).

West Nile Virus (WNV)

Mosquito-borne; endemic in Greece, Italy, Romania, Hungary. Background risk during outdoor operations near standing water in summer months. Severe neuroinvasive outcomes in a minority of cases.

Legionella (*Legionella pneumophila*)

Risk arises from aerosolization of contaminated standing water during firefighting or overhaul — not specific to flashover incidents. High-risk structures: old hotels, hospitals, industrial HVAC and cooling tower systems. Respiratory protection during extended overhaul of water-damaged buildings with aged plumbing is advisable.

Anthrax (*Bacillus anthracis*) — White Powder Protocol

Actual releases are exceedingly rare; white powder hoax letters are not. Protocol: treat as genuine Risk Group 3 B-incident until mobile laboratory clearance. No shortcuts on scene containment.

Mold Spores and Fungi (*Aspergillus* spp.)

Relevant in silo fires, demolition of abandoned structures, and post-flood clean-up. High spore concentrations are an underweighted occupational respiratory risk for responders, independent of patient exposure.

CATEGORY 3 - Low Frequency / Highly Specialized**Full CBRN protocols**

Viral Hemorrhagic Fevers (Ebola, Marburg, Lassa) — RG4. European first responder involvement is limited to pre-planned specialist patient transport from point of entry to high-level isolation units. Preparation is everything; improvisation is not an option.

Plague (*Yersinia pestis*) and Tularemia (*Francisella tularensis*) — Naturally endemic in Eastern and Southeastern Europe via wild rodent populations. Low background risk; relevant during wildland fires or agricultural incidents in specific regions.

Biological Toxins — Ricin (CDC Category B) and Botulinum Toxin (CDC Category A — most acutely lethal substance known by weight). Encountered in counter-terrorism contexts: illegal lab discovery, suspicious packages, suspected poisoning. Category A/B distinction drives escalation and notification protocols.

Smallpox (*Variola major*) — Eradicated; any case indicates deliberate release or catastrophic biosecurity breach. Immediate international public health emergency.

PART III - RADIOLOGICAL AGENTS

Radiological incidents are rarer than chemical or biological ones, but the failure to recognize a radiological hazard before personnel are already contaminated is the defining error in this category. Detection — with a functioning instrument in hand — precedes all other action.

Core operational principle: Time — Distance — Shielding. Minimize time in the field, maximize distance from source, interpose appropriate shielding. Applies at every category level below.

CATEGORY 1 - Highest Relative Frequency

Orphan Radioactive Sources

The most common real-world radiological incident type in Europe. Lost, abandoned, or improperly disposed sources — primarily Cs-137, Ir-192, and Co-60 from radiotherapy, industrial gamma radiography, and well-logging equipment — appear at scrapyards, landfill sites, and construction sites. IAEA Category 1 and 2 sources can cause acute radiation injury and death through prolonged proximity. Most common trigger: portal monitor alarm at a metal recycling facility. Response: isolate, identify, notify national nuclear regulatory authority. No specialist training required — a functioning Geiger-Müller detector and a clear escalation pathway are sufficient.

Medical and Industrial Sources in Transit

Nuclear medicine and industrial radiography sources are in regular road transport. Vehicle accidents can produce radiological incidents secondary to an otherwise conventional traffic emergency. ADR markings (UN 2910–2913, radiation trefoil on packaging) are the field indicators.

CATEGORY 2 - Medium Frequency

Radiological Dispersal Device (RDD / "Dirty Bomb")

Conventional explosive combined with radioactive material to disperse contamination. Not a nuclear weapon — no nuclear explosion, no nuclear casualty profile. The primary harm is from the blast, panic, and long-term area contamination rather than acute radiation injury. Key implication: any unexplained explosion in a complex security environment should be treated as a potential contamination incident until radiological status is confirmed. Do not advance before detection sweep.

NORM / TENORM (Naturally Occurring Radioactive Material)

Concentrated naturally occurring radionuclides (Ra-226, Ra-228, Pb-210) present in oil and gas production, mining, and geothermal infrastructure as scale deposits on equipment. Unexpected radiological contamination on accident debris at these facilities is an underappreciated hazard. Pre-incident familiarization with the radiological status of major industrial facilities in the response area is worthwhile.

CATEGORY 3 - Low Frequency / Highly Specialized

Nuclear Facility Accidents

Nuclear power plants, research reactors and radioactive waste storage or disposal facilities across Europe operate under strict safety and security frameworks, making significant accidental releases relatively rare. However, both accidental failures and intentional threats — such as sabotage, terrorist attacks, physical intrusions or cyber-adversarial acts — may result in radiological consequences extending beyond the facility boundary. First responders operating in the vicinity of such facilities should be familiar with the applicable emergency planning zones, incident response and notification procedures, pre-planned evacuation and shelter-in-place arrangements and, where applicable, iodine

prophylaxis procedures, as well as the notification chain to national nuclear regulatory and security authorities.

Special Nuclear Material / Nuclear Terrorism

Weaponization of highly enriched uranium or plutonium by non-state actors remains beyond realistic operational reach. Included for framework completeness; relevant to national-level CBRN planning rather than first responder doctrine.

7 Context Information: Compatible Gear

The table below provides some examples of relevant gear that ideally should be compatible with the provided solution.

Table 2: Compatible Gear (Examples)

Main Category	Sub-Category / Type	Hardware / Supplier Examples	Key Standard(s)
Head, Face, and Neck Protection	Smart & Structural Fire/Rescue Helmets	MSA Gallet F2XR, Rosenbauer Futura X8, Colsmann (H2 helmet), PAB, Rosenbauer, SICOR S.p.A.	EN 443, EN 16471, EN 16473
	Fire Hoods	COMAZO GMBH & CO. KG, VIKING	EN 13911
	Helmet-Integrated HUDs/AR	MSA LUNAR, Qwake Tech Insight	Must integrate with SCBA masks/helmets without voiding certifications
	Ballistic/Tactical Helmets	Ops-Core FAST SF, Team Wendy EXF-FP	NIJ 0106.01, STANAG 2920, EN 1385
Foot Protection	Structural Firefighting Boots	Haix, FAL Seguridad A.S., Rosenbauer	EN 15090:2012
	Chemical-Resistant Boots	Strauss (rubber boots), DuPont Tychem Overboot	EN 13832-3, EN 943-1 (boot interface)
Communication, Data & Tracking	Radios & Mask Comms	HYTERA / AIRBUS (Tetra/DMR), Dräger FPS COM 7000, MSA Gallet F1XF, Savox Headsets	ETSI EN 300 392, TETRA MoU, ATEX Category 2/3
	Network & Data Nodes	HiMoNN-Node, Silvus StreamCaster, TrellisWare, Harris RF-7800	Operates on special 5 GHz BOS frequencies, IP-based encryption
	Location & Telemetry	Motorola MTM800, ATAK / Coban GPS trackers, Equivital EQ02, Zephyr BioHarness	ATEX 2014/34/EU, IEEE 802.15.4a (UWB)
	Mobile Devices	iPhone, Samsung, and rugged IP-67 tablets	IP67
Respiratory Protective Equipment (RPE)	SCBA (Self-Contained Breathing Apparatus)	MSA G1 SCBA, Drager PSS 7000, Scott Sigma 2	EN 137:2006, NFPA 1981
	PAPR & Gas Masks	3M Versaflo TR-800, Avon C50	PAPR: EN 12941:1998+A2, EN 14594; Masks: EN 136:1998, EN 14387, STANAG 4632
Body Armour & Load-Bearing Equipment	Ballistic Vests & Plates	Point Blank Alpha Elite AXII (soft), Survitec Dyneema HB212 (hard)	Soft: NIJ 0101.06, EN 1621-1, DEF STAN 95-83; Hard: NIJ 0101.06 Level III/IV, STANAG 2920

	Carriers & Belts	5.11 Tactical TacTec (carrier), Safariland 6360 ALS (belt)	Carriers: EN 1621-2:2014; Holsters: NIJ 0117.00
Environmental, Lighting & Situational Awareness	Thermal & Immersion Protection	MSA Cairns Proximity suit, Viking RescueFlex cold/immersion suit	Proximity: EN ISO 11612, EN 1486:2007; Immersion: EN ISO 15027-1:2012, SOLAS 74/Ch.III
	Lighting	Petzl Pixa 3 ATEX (torch), Peli 9430 RALS (scene illuminator)	Helmet Torch: ATEX II 1G Ex ia / EN 60079, EN 60598-1; Scene: EN 60598-1, IEC 62560
	Situational Awareness	FLIR K65 (TIC), Drager PASS 3	TIC: EN 13202:2002, IEC 61010- 1; PASS: EN 13794:2002, NFPA 1982

8 Context Information: Measures

The table below provides additional context regarding typical baselines and ideal targeted metrics for the ACTIVE PCP project. This information should be considered as general guidelines rather than rigid criteria.

Table 3: Measures

ID	Measure
1. CBRN REQUIREMENTS	Include standards or parameters (E.g. EN ISO 9151 or Heat resistance 5 minutes at 260°C: shrinkage ≤ 5% without ignition, without fusion)
R 1.1	Baseline: EN 943-1 Type 1 (gas-tight chemical), EN 14605 Type 3–4 (liquid chemical), EN ISO 13982-1 Type 5 (dry particulate), EN 14126 (biological), EN 1073-2 (radiological) — currently required as separate stand-alone suits. ACTIVE PCP Target: integrated operational garment/ensemble simultaneously meeting the defined chemical, biological, radiological and thermal performance requirements, without requiring replacement by a separate conventional protective suit during the defined operational phase. Complying with EN 943-1 Type 1 chemical permeation, EN 14126 biological barrier (ISO 16604 Class 6), EN 1073-2 Class 2 radiological particulate, and EN 469 Level 2 thermal performance. No suit-switching between operational phases. Overall certification: EN 943-1 Type 1 (highest classification).
R 1.2	Baseline: EN 14605 Type 3 or 4 (liquid splash/spray); EN ISO 6529 Method B permeation breakthrough time ≥ 60 min for standard TICs/TIMs (current commercial Type 3/4 suits). ACTIVE PCP Target: Chemical permeation breakthrough time ≥ 180 min against TICs/TIMs per EN ISO 6529 Method B; validated against ≥ 10 representative agents (including HD, GB, GD, TDI, NH₃, HCl, HF) from NATO STANAG 4632 priority list; EN 943-1 Type 1 gas-tight classification maintained from first approach. Protection effective before hazard confirmation. RED FLAG: 180 min permeation in a suit simultaneously meeting EN 469 thermal requirements exceeds all current commercial products.
R 1.3	Baseline: EN 14126 (protective clothing vs infective agents); ISO 16604 Class 3 viral penetration resistance (1,000 Pa, pass/fail — minimum for Type 3B classification). ACTIVE PCP Target: ISO 16604 Class 6 viral penetration resistance (highest, 20 kPa pressure test); EN 14126 Type 3B–4B classification minimum; ISO 22611 resistance to blood/body fluid splash maintained; barrier effective from first approach without dedicated bio-suit change.
R 1.4	Baseline: EN 1073-2 Class 1 radioactive particulate protection (commercially available as a stand-alone coverall; not integrated into primary CBRN suit). ACTIVE PCP Target: EN 1073-2 Class 2 minimum integrated into the multi-hazard ensemble from the moment of approach; no additional anti-contamination coverall required. NOTE – Relationship to R 1.5: R 1.4 defines the approach-phase compliance classification; R 1.5 defines the quantitative particle leakage performance target. Focus on alpha and beta radiation.
R 1.5	Baseline: EN 1073-2 Class 2 whole-suit total inward leakage (TIL) ≤ 1×10⁻⁴ (manikin test); this corresponds to max ≤ 0.01% ambient concentration reaching wearer. ACTIVE PCP Target: Whole-suit particle leakage ≤ 0.05% of ambient concentration (attenuation factor ≥ 2,000) for particles ≥ 0.5 µm AMAD; validated for alpha- and beta-emitting particulates (AMAD 1–5 µm range); performance retained after 30 decon cycles; compatible with simultaneous EN 943-1 Type 1 chemical barrier.
R 1.6	Baseline: Handheld chemical detectors (e.g. Dräger X-am 8000, Chempro X): response time 10–60 sec; not integrated in PPE suit. ACTIVE PCP Target: Integrated/body-worn chemical sensor alarm ≤ 30 sec from first CWA/TIC exposure with visual/audible alerting; detection threshold (LOD) ≤ 0.1 × AEGL-1 (US EPA) or ≤ 0.1 × IDLH (NIOSH) for priority TIC/TIM list; simultaneous visual + audible alert to wearer AND command link; ATEX Zone 2 compatible (IEC 60079-0) for explosive atmosphere scenarios; false-alarm rate < 1 per 8-hour shift.

R 1.7	Baseline: No integrated suit-embedded real-time bio-detector. Nearest: LFA strip tests (BioThreat Alert, 15–30 min) and PCR confirmation (hours). No continuous bio-monitoring standard exists. ACTIVE PCP Target: Integrated or body-compatible bio-threat indicator providing visual/audible alert ≤ 30 sec from presumptive positive signal; sensitivity threshold covering Tier-1 agents (B. anthracis spores ≥ 500 CFU/m³, VHF virus aerosol, Y. pestis) at exposure-relevant concentrations; false-positive rate $< 5\%$; confirmed positive triggers Command alert ≤ 60 sec; CWA 16849 compatible data output.
R 1.8	Baseline: External personal dosimeters (e.g., Mirion RDS-30, Thermo Fisher RadEye): alarm at configurable dose rate, response time typically < 5 sec. Not integrated in PPE suit. ACTIVE PCP Target: Integrated radiation sensor (GM or scintillation) alarm ≤ 30 sec from dose-rate threshold with visual/audible alerting; configurable levels: warning ≥ 1 mSv/h (IAEA Tier 1 intervention level), evacuation ≥ 10 mSv/h; gamma energy range 50 keV–3 MeV; visual + audible alert to wearer AND command; IP68 rated; IEC 62401 compliant; output integrates with R 1.11 monitoring log.
R 1.9	Baseline: Handheld multi-gas detectors: 15–30 sec update interval, ppm-level readout. No suit-integrated continuous chemical monitoring standard. ACTIVE PCP Target: Continuous chemical concentration logging interval ≤ 15 sec; measured parameters per data record: agent class identification, instantaneous concentration (ppm/ppb), cumulative dose estimate (mg-min/m³); data timestamped (UTC ± 1 sec) and transmitted to command in real time; sensor covers minimum: CX, HD, GA, GB, GD, CK + top-10 TICs per NATO STANAG 4632 priority list; calibration lifetime ≥ 12 months.
R 1.10	Baseline: No continuous biological monitoring standard. Field PCR: hours. LFA strips: 15–30 min. No logging interval standard for bio-monitoring exists. ACTIVE PCP Target: Continuous bio-aerosol particle count logging interval ≤ 15 sec (presumptive threat level indicator); confirmed agent-class identification result transmitted to command within ≤ 90 min via LAMP or LFA reader; cumulative exposure duration logged; data timestamped (UTC ± 1 sec); CWA 16849 compatible output; alarm integration with R 1.7.
R 1.11	Baseline: IEC 62401 personal dosimetry; external dosimeters log dose rate and accumulated dose at configurable intervals (typically 1–10 sec). ACTIVE PCP Target: Integrated dose-rate logging interval ≤ 15 sec; measured parameters: instantaneous dose rate (μSv/h), accumulated effective dose (mSv), alert flags per R 1.8 thresholds; nuclide identification (coarse gamma spectroscopy) where TRL permits; IEC 62401 compliant; output integrates with R 1.8 alarm system and R 5.22 / R5.23 data recording.
R 1.12	Baseline: EN 457 (audible safety signals, machinery reference): signal ≥ 65 dB(A) or ≥ 15 dB above ambient. Current standalone detectors: 80–95 dB at 1 m (too loud for integrated helmet use without hearing protection conflict). ACTIVE PCP Target: Audible alarm 65–85 dB at 1 m (audible through EN 352-3 helmet hearing protection; avoids TTS risk); visual LED ≥ 100 cd/m² (360° visible in daylight); alarm activation ≤ 5 sec after threshold detection (per R 1.6); distinctive chemical alarm pattern (e.g., continuous tone) distinguishable from biological (pulsed) and radiological (rapid beep) alarms; simultaneous alert to wearer AND command.
R 1.13	Baseline: EN 457 (audible safety signals reference). No standard for integrated PPE bio-hazard alarms. ACTIVE PCP Target: Audible alarm 65–85 dB at 1 m; visual LED ≥ 100 cd/m² (360°); alarm activation ≤ 5 sec after threshold detection (per R 1.7); distinctive biological alarm pattern (e.g., slow pulsed tone) distinguishable from chemical (continuous) and radiological (rapid beep) alarms; simultaneous alert to wearer AND command.
R 1.14	Baseline: IEC 62401 dosimeter alarm standard; personal dosimeter alarm typically 80–90 dB. No standard for integrated PPE radiological alarms. ACTIVE PCP Target: Audible alarm 65–85 dB at 1 m; visual LED ≥ 100 cd/m² (360°); alarm activation ≤ 5 sec after threshold dose rate (per R 1.8); distinctive radiological alarm pattern (e.g., rapid-interval beep) distinguishable from chemical and biological alarms; simultaneous alert to wearer AND command.
R 1.15	Baseline: No standard mandates minimum reuse cycles for chemical CBRN PPE. Current EN 943-1 suits: typically single-use or limited reuse (5–10 cycles max). ACTIVE PCP Target: Minimum 30 chemical decontamination cycles (standard decon protocol: ClO₂ or hypochlorite wash per NATO AEP-66 Vol. II) without: (a) chemical permeation breakthrough time decreasing $> 10\%$ vs new baseline (EN ISO 6529), (b) seam peel strength dropping below 50 N/5cm (EN 1773), (c) dimensional change $> 2\%$ (EN ISO 5077), or (d) loss of EN 943-1/EN 14605 protection class certification.

R 1.16	Baseline: No standard mandates reuse cycles for biological PPE. EN 14126 suits are typically single-use; limited data on decon and reuse. ACTIVE PCP Target: Minimum 30 biological decontamination cycles (H₂O₂ vapour or chlorine solution per WHO/CDC bio-PPE decon guidance) without: (a) viral penetration resistance class loss (ISO 16604 class retained), (b) EN 14126 classification downgrade, (c) antimicrobial coating log-reduction < 2 (EN ISO 20743), or (d) seam or fabric structural failure (EN 13935).
R 1.17	Baseline: No standard mandates reuse cycles for radiological PPE. EN 1073-2 suits intended for decontamination and reuse but no cycle limit specified. ACTIVE PCP Target: Minimum 30 radiological decontamination cycles (aqueous wash per ISO 7503-2 decontamination protocol) without: (a) increase in whole-suit particle leakage index beyond EN 1073-2 Class 2 limit, (b) fabric dimensional change > 2%, or (c) residual surface contamination above ISO 7503-1 clearance levels before each re-use.
R 1.18	Baseline: ISO 22196 (antibacterial activity on plastics/textiles); EN ISO 20743 (antimicrobial textile activity). ACTIVE PCP Target: Log₁₀ reduction ≥ 3 (99.9%) against <i>S. aureus</i>, <i>E. coli</i>, and MRSA per EN ISO 20743 after 50 wash cycles (ISO 6330 40°C). Photocatalytic or nano-silver surface without SVHC substances.
R 1.19	Baseline: No field standard. Lab verification via EN 14325 + GC-MS residual analysis (laboratory only, hours delay). ACTIVE PCP Target: The effectiveness of chemical decontamination shall be verified using a validated, agent-specific method suitable for the chemicals identified in Annex I. Residual contamination shall be assessed on representative external and internal garment surfaces using validated wipe sampling, extraction, rinse sampling or direct-reading techniques, as appropriate. Results shall be expressed as residual mass per unit area (e.g. µg/cm²) and compared with predefined agent-specific acceptance limits. The verification shall include areas particularly susceptible to contamination retention, such as seams, closures, folds and interfaces. The method shall provide sufficient evidence to support a documented decision whether the garment is safe for reuse following decontamination.
R 1.20	Baseline: No operational field standard. Lab confirmation via PCR (hours). Colorimetric swab kits (e.g., BioDetection Instruments) available but not suit-integrated. ACTIVE PCP Target: LAMP (Loop-mediated isothermal amplification) based field reader confirming absence of Tier-1 bio agents within ≤ 30 min; or immunoassay LFA confirmation strip (CWA 16849 compatible). Result accessible via suit-integrated display or companion device.
R 1.21	Baseline: ISO 7503-1 (surface contamination measurement); clearance levels ≤ 0.4 Bq/cm² beta/gamma, ≤ 0.04 Bq/cm² alpha (IAEA Safety Series 119). ACTIVE PCP Target: Integrated or suit-attachable swipe-scan probe confirming surface activity ≤ 0.04 Bq/cm² (alpha/beta) within ≤ 2 min post-decon; compatible with third parties, such as Mirion/Ludlum detector ecosystem; result transmitted to incident command. Clearance decision within ≤ 5 min total.
R 1.22	Baseline: EN 943-1 Annex B (seam permeation = fabric performance); EN 13935 (seam tensile/tear strength ≥ fabric); EN ISO 6529 applied to seam tape. ACTIVE PCP Target: Seam/weld breakthrough time ≥ fabric breakthrough time for all CWA classes (EN ISO 6529 Method B); seam peel strength ≥ 50 N/5cm (EN 1773); flex-crack resistance ≥ 100,000 cycles (ISO 7854 Method B) without delamination; seam integrity maintained after 30 decon cycles.

2. HEAT AND THERMAL REQUIREMENTS

R 2.1	Baseline: ISO 9886 (evaluation of thermal strain by physiological measurements); WBGT index (ISO 7933). No PPE-integrated thermal monitoring standard. External clinical thermometers: ±0.1°C accuracy. ACTIVE PCP Target: Skin temperature accuracy ±0.5°C; core temperature (zero-heat-flux patch or ingestible capsule) ±0.2°C (ISO 9886 protocol); configurable warning threshold at core temp ≥ 38.5°C, evacuation alarm at ≥ 39.5°C (ISO 9886 heat strain intervention limits); alert latency ≤ 5 sec; data transmitted to incident command; sensor does not compromise CBRN suit barrier; battery ≥ 8 h.
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R 2.2	Baseline: IEC 62368-1 (audio/video and IT equipment safety — reference for wearable electronics general safety); EN ISO 4869-1 (hearing protector insertion loss); no dedicated wearable thermal alert standard. ACTIVE PCP Target: Integrated alarm ≥ 65 dB(A) at wearer ear level OR visual LED ≥ 100 cd/m² (360°); wearable subsystem rated IP67 minimum (IEC 60529); ATEX Zone 2 compatible per IEC 60079-0 and Directive 2014/34/EU (for fire/chemical explosion scenarios); alert latency from R 2.1 threshold detection ≤ 5 sec; independent backup power ≥ 2 h.
R 2.3	Baseline: No standard addresses active/passive thermal regulation in CBRN PPE. Reference: EN 469 Level 2 thermal endurance (HTI24 ≥ 13 s, HTI12 ≥ 9 s); ISO 9886/ISO 7933 heat strain limits. Typical safe work time at 35°C ambient in standard EN 469 suit: ~45–60 min. ACTIVE PCP Target: Thermal regulation system (active or passive) extending safe work time at 35°C / 80% RH by $\geq 30\%$ vs EN 469 Level 2 baseline (ISO 9886 validated, WBGT protocol). Passive option: PCM inserts ≥ 100 kJ/kg latent heat; active option: liquid cooling vest ≥ 200 W cooling capacity. System weight ≤ 1.5 kg; must not compromise CBRN chemical barrier or EN 469 Level 2 thermal protection values.
R 2.4	Baseline: EN 469:2020 Level 2 performance parameters: flame spread (ISO 15025 Class 1), heat transfer (HTI24 ≥ 13 s, HTI12 ≥ 9 s per EN ISO 9151/6942), water penetration (EN ISO 811 $\geq 8,000$ mm H₂O), tear strength (≥ 30 N, EN ISO 13937-2), breathability (Ret ≤ 20 m²Pa/W, EN ISO 11092). Current approach: multiple separate garments combined. ACTIVE PCP Target: All EN 469:2020 Level 2 performance parameters met in a single-piece or minimum-layer integrated ensemble without combining separate garments. Panic/emergency zipper fully openable in ≤ 5 sec under load. Electronic sub-systems: IP67 minimum (IEC 60529); ATEX Zone 2 compliance (IEC 60079-0 and Directive 2014/34/EU) for components used in potential explosive atmospheres (S02/S03 scenarios). The configuration intended for firefighting operations shall demonstrate the applicable EN 469:2020 Level 2 performance requirements, including flame spread, convective heat and radiant heat protection. The required performance shall be demonstrated on the final ACTIVE PCP operational garment/ensemble. The design may incorporate integrated functional layers or modular components, provided that no separate conventional firefighting suit is required to achieve the specified protection level.
R 2.5	Baseline: EN 469 Level 2 requires MVTR ≥ 150 W/m² (moisture vapour resistance Ret ≤ 20 m²Pa/W per ISO 11092). EN 343 Class 3 breathability. ACTIVE PCP Target: Ret ≤ 15 m²Pa/W according to EN 31092 (ISO 11092) while maintaining full CBRN chemical barrier; thermal manikin validated work extension $\geq 30\%$ vs. standard EN 469 suit at 35°C/50% RH (ISO 9886 heat strain protocol). Active moisture transport rate Class 4 (ISO 21701).
R2.6	Baseline: No single EN standard covers both. EN 469 (thermal) and EN 943 (chemical) are mutually exclusive in practice. Typical workaround: Type 1 over firefighting suit (4+ kg penalty). ACTIVE PCP Target: Single-layer or laminated construction achieving simultaneously: (a) EN 469 Level 2 (HTI24 ≥ 13 s, HTI12 ≥ 9 s; EN ISO 9151/6942); AND (b) EN 14605 Type 3 liquid spray resistance + EN ISO 6529 permeation breakthrough ≥ 30 min for TIC/CWA. Total weight ≤ 3.5 kg.
R 2.7	Baseline: EN 1149-3 (surface resistance $\leq 2.5 \times 10^9$ Ω; charge decay T₅₀ ≤ 4 s) - mandatory for EN 943-1 Type 1 suits. ACTIVE PCP Target: EN 1149-5 compliant (electrostatic properties maintained after ≥ 50 wash cycles); ATEX Zone 1 (IEC 60079-0) compatible for explosive-atmosphere operations; charge decay T₅₀ ≤ 2 s after 50 decon cycles.

3. FLUID EXPOSURE REQUIREMENTS

R 3.1	Baseline: ISO 6530 (liquid repellency index $\geq 80\%$ for EN 469); EN ISO 4920 spray rating ≥ 4; AATCC 22 water repellency ≥ 90. ACTIVE PCP Target: ISO 6530 Class 3 for hydrocarbons, polar solvents and aqueous contamination simultaneously; PFAS-free DWR treatment maintaining EN ISO 4920 spray rating ≥ 4 after 20 wash cycles (ISO 6330 40°C); oil repellency $\geq$ Grade 5 (AATCC 118).
R 3.2	Baseline: REACH PFAS Universal Restriction (ECHA 2023, in effect 2025–2026 for key PPE applications); OECD PFAS definition (2+ fluorinated carbons). ACTIVE PCP Target: Zero PFAS (all compounds within OECD PFAS definition) verified by LC-MS/MS per EN 17519 and CEN/TC 351; compliant with REACH Annex XVII Entry 68 (PFAS restriction); alternative DWR chemistry (dendrimer, wax, bio-based) demonstrated with equivalent performance.

R 3.3	Baseline: EN ISO 811 hydrostatic resistance $\geq 8,000$ mm H ₂ O (EN 469 Level 2 requirement); EN 343 Class 3 ($\geq 13,000$ mm). ACTIVE PCP Target: Hydrostatic resistance $\geq 20,000$ mm H ₂ O (EN ISO 811) after 50 wash cycles and 30 decon cycles; seam and closure waterproofness per EN 1772 $\geq$ fabric rating; concurrent CBRN barrier maintained under hydrostatic pressure (combined threat test at 5,000 mm/30 min).
R 3.4	Baseline: EN ISO 11092 Ret ≤ 20 m ² Pa/W (EN 469 Level 2). No wicking standard for CBRN PPE. ACTIVE PCP Target: Ret ≤ 15 m ² Pa/W (EN ISO 11092); wicking transport rate $\geq$ Class 4 (ISO 21701 horizontal/vertical spreading speed); inner surface moisture management index ≥ 0.5 (AATCC 195); validated by thermal manikin test for 4h continuous operation at 35°C / 60% RH (ISO 9920).
R 3.5	Baseline: EN 13921 (PPE ergonomics principles); no quantitative donning-time standard for CBRN PPE. ACTIVE PCP Target: Full donning time ≤ 3 min 30 sec (solo, moist inner surface conditions); validated by EN 13921 ergonomic assessment protocol with ≥ 10 test subjects; inner lining kinetic friction coefficient ≤ 0.25 (ISO 8295 modified for textile) when moisture-laden.
R 3.6	Baseline: No combined standard. EN 14605 Type 3 covers liquid chemical spray; EN 469 covers water penetration; no simultaneous threat test protocol exists. ACTIVE PCP Target: Simultaneous combined-threat exposure test: CWA simulant spray (EN ISO 6529 modified simultaneous) + water jet at ≥ 1 bar (EN ISO 17491-4 Type 3) for ≥ 30 min with no protection degradation; performance retention $\geq 95\%$ vs. single-threat baseline.

4. MECHANICAL AND PHYSICAL VIOLENCE REQUIREMENTS

R 4.1	Baseline: HOSDB Body Armour Standard UK (2007) KR1 level (≥ 24 J knife); EN 13999-1 cut/stab resistance for protective clothing. ACTIVE PCP Target: HOSDB/CAST Level KR2 (knife ≥ 33 J at 0° and 45°) AND SP1 (spike ≥ 24 J); integrated into CBRN outer shell without exceeding +0.8 kg/m ² areal density penalty; NIJ Standard-0115.00 Stab Resistance Level II as alternative reference.
R 4.2	Baseline: EN 13999-1 pierce resistance; NIJ 0115.00 spike Level P1 (≥ 24 J). ACTIVE PCP Target: NIJ 0115.00 Spike Level 2 (≥ 36 J perpendicular impact); hypodermic needle-stick resistance per EN 388:2016 puncture Level 4 (TDM-100 force ≥ 20 N); relevant for drug-seizure scenarios with fentanyl-contaminated sharp objects.
R 4.3	Baseline: EN 1621-1 impact protector Level 1 (≤ 35 kN transmitted force at 50 J impact); EN 13158 equestrian/impact. ACTIVE PCP Target: EN 1621-1 Level 2 (≤ 20 kN) at key anatomical strike zones (shoulder, elbow, forearm, knee); non-Newtonian or rate-sensitive material (D30 / STF equivalent); total additional weight at impact zones ≤ 400 g; freedom of movement retained $\geq 85\%$ (EN 13921-4).
R 4.4	Baseline: EN 388:2016 cut Level C (TDM-100 blade method) for general work gloves. ACTIVE PCP Target: EN 388:2016 cut resistance $\geq$ Level E (TDM-100) for integrated glove system; upper arm and forearm cut panel $\geq$ EN 388 Level D; performance maintained after 30 wash cycles and 20 decon cycles.
R 4.5	Baseline: EN 1621-1 Level 1 impact absorbers (≤ 35 kN); no CBRN PPE cushioning standard. ACTIVE PCP Target: Peak transmitted force ≤ 35 kN at critical anatomical zones — knee, elbow, shoulder (EN 1621-1 Level 1 minimum); gel or foam insert total additional weight ≤ 400 g; cushioning retained after 50 compression cycles (ISO 3386-1).
R 4.6	Baseline: EN ISO 12947-2 (Martindale) $\geq 2,000$ cycles for EN 340 general PPE; EN 388 abrasion Level 3 (Martindale $\geq 8,000$ cycles) for hand protection. ACTIVE PCP Target: Outer shell Martindale abrasion $\geq 25,000$ cycles (EN ISO 12947-2) without CBRN barrier breach; knee/elbow/boot reinforcement zones $\geq 50,000$ cycles; performance maintained after 50 launderings (ISO 6330).

5. OPERATIONAL BARRIERS AND LIMITATIONS

R 5.1	Baseline: EN 13921 ergonomic principles; no quantified time standard for CBRN PPE (NFPA 1500 recommends but does not mandate). ACTIVE PCP Target: Base ensemble full donning ≤ 5 min (solo, no assistance); CBRN integrated top-level ≤ 10 min (2-person buddy system); emergency rapid doff (all closures released) ≤ 60 sec. Validated per EN 13921 protocol with ≥ 10 test subjects in simulated operational conditions.
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R 5.2	Baseline: EN 13921-4 range-of-motion protocol; no specific threshold in EN 469. ACTIVE PCP Target: Retained range of motion $\geq 85\%$ vs. unencumbered baseline at all major joints: shoulder flexion $\geq 160^\circ$, hip flexion $\geq 100^\circ$, knee flexion $\geq 120^\circ$, elbow flexion $\geq 140^\circ$; validated by EN 13921-4 goniometric protocol on at least 10 subjects (5M / 5F).
R 5.3	Baseline: OSHA 1910.120 Appendix B doffing guidance; CDC/WHO bio PPE doffing protocols; no EN standard with pass/fail criteria. ACTIVE PCP Target: Doffing procedure ≤ 8 sequential steps (documented SOP); zero self-contamination in $\geq 90\%$ of untrained attempts (fluorescent tracer protocol per CDC doffing validation method); red/green zone visual indicator visible from ≥ 2 m during procedure.
R 5.4	Baseline: EN ISO 20471 Class 3 high-visibility (≥ 0.80 m ² retroreflective + ≥ 0.50 m ² fluorescent); EN 168 optical class 1 for visors. ACTIVE PCP Target: Minimum 180° horizontal / 70° vertical FOV through visor (EN 168 optical class 1); retroreflective material Class 3 (EN ISO 20471) on exterior ≥ 50 cm ² ; night conspicuity distance ≥ 50 m at vehicle headlight (EN ISO 20471 test); visor anti-fogging treatment maintained ≥ 6 h at operational temperature range.
R 5.5	Baseline: MIL-W-43703 MOLLE/PALS (50mm $\times$ 38mm webbing grid); no EN PPE standard for attachment points. ACTIVE PCP Target: Minimum 4 standardized PALS/MOLLE-compatible attachment points (MIL-W-43703); each rated ≥ 50 N static tensile load without garment deformation; compatible with standard operational accessories (radio, IFAK, GPS tracker); attachment/detachment ≤ 30 sec per accessory.
R 5.6	Baseline: EN 14704-1 fabric extensibility; EN 13921-4 ROM assessment. ACTIVE PCP Target: Fabric extensibility $\geq 40\%$ (warp and weft) without barrier compromise (EN 14704-1); permanent set/residual elongation $\leq 5\%$ after 1,000 stretch-relaxation cycles (ISO 37); stress at 20% elongation ≤ 15 N/50mm (ISO 13934-1) for comfort without restriction.
R 5.7	Baseline: EN 420 glove dexterity Level 2 (picks up 3 mm pin); EN 388:2016. ACTIVE PCP Target: Outer glove EN 420 dexterity $\geq$ Level 4 (picks up a 10 mm pin); Purdue Pegboard test score $\geq 60\%$ of ungloved baseline; operator able to manually actuate weapon safety mechanism, medical syringe (10 mL), and standard radio PTT button - validated per EN 13921-2 (tactile sensitivity protocol).
R 5.8	Baseline: No EN weight limit for CBRN PPE. Typical EN 469 Level 2 suit: 3–4 kg. Typical EN 943 Type 1: 5–8 kg. Combined: 8–12 kg. ACTIVE PCP Target: Complete integrated multi-hazard ensemble ≤ 5.0 kg (jacket + trousers + gloves + hood). The limit does not include detachable elements such as electronic modules, batteries, active cooling systems, respiratory protection, helmet, footwear or other external equipment carried by the responder; individual garment areal density ≤ 450 g/m ² ; validated heat stress equivalent $\leq$ standard EN 469 Level 2 suit (ISO 9886 thermal strain index); all components meet performance targets at this weight.
R 5.9	Baseline: No standard; NFPA 1500 recommends pre-staged PPE kits; typical CBRN kit bag ~ 20 L / 8–12 kg. ACTIVE PCP Target: Complete packed ensemble ≤ 15 L / ≤ 5.5 kg (fits standard patrol vehicle side pocket); deployment-ready (full donning initiated) ≤ 120 sec from packed/stored state; carry bag integrated or MOLLE-attachable; packaging survives ≥ 500 handling cycles without degradation of contents.
R 5.10	N/A
R 5.11	Baseline: ISO 6330 (domestic washing 40°C); EN ISO 15797 (industrial). IEC 60529 IP68 for electronics; IEC 62368-1 safety. ACTIVE PCP Target: All electronic modules IP68 rated (IEC 60529; ≥ 1 m / 30 min); full ensemble machine washable at 40°C (ISO 6330 Programme 4A) for ≥ 50 cycles without $>5\%$ degradation in any protective property; sensor modules tool-free detach/reattach in ≤ 2 min; wash cycle does not void calibration.
R 5.12	Baseline: EN ISO 5077 (dimensional change); EN 340 requires $\leq 3\%$ change after washing per test conditions. ACTIVE PCP Target: Dimensional change $\leq 2\%$ in warp/weft after 50 wash cycles (ISO 6330 40°C); critical sealing zones (neck, wrist, ankle interface) $\leq 1\%$ dimensional change; validated at both 40°C and 60°C wash temperature (emergency decon washing).

R 5.13	Baseline: EU ESPR Regulation (EU) 2024/1781 (Eco-design); EU Textile Strategy COM/2022/141; ISO 14040/14044 (LCA). ACTIVE PCP Target: Life cycle assessment (LCA) per ISO 14040/14044 documented for final product; carbon footprint ≤ 30 kg CO₂eq per ensemble (cradle-to-gate); $\geq 30\%$ recycled or bio-based fiber content; end-of-life material recovery pathway defined; supply chain due diligence per EU Corporate Sustainability Due Diligence Directive.
R 5.14	Baseline: EN 340 sizing (ISO 13402 coding system, XS–4XL); EN 13921 ergonomic principles. ACTIVE PCP Target: Available in ≥ 8 standard sizes (EN ISO 13402) accommodating 5th–95th percentile body dimensions (CEN body measurement database); validated fit by 3D body scan protocol (EN ISO 20685-1) for BMI range 18.5–35; size grading does not degrade CBRN seal geometry at any size.
R 5.15	Baseline: Same as R5.14 but female-specific; ISO 13402 includes female sizing tables. ACTIVE PCP Target: Dedicated female-pattern garments (not resized male cut) validated at female 5th–95th percentile dimensions (SizeUK/SizeEurope female database); hip-to-waist ratio accommodation; chest relief without compromising CBRN collar seal.
R 5.16	Baseline: EN 340 general PPE fit; no retention standard for CBRN garments. ACTIVE PCP Target: ≥ 5 independently adjustable closure zones (neck, waist, wrist $\times 2$, ankle $\times 2$); dimensional retention of critical fit parameters $\geq 98\%$ after 50 wash + 30 decon cycles; no accidental opening of any primary closure under ≤ 50 N pull force (EN 1773 modified); self-adjusting stretch inserts at elbow, knee, and lumbar.
R 5.17	Baseline: IEC 60300-3-14 (maintenance engineering); ISO 9001 quality management; no PPE-specific maintainability standard. ACTIVE PCP Target: Any single sensor module field-replaceable ≤ 10 min (standard screwdriver only, no soldering); outer fabric panel replaceable by trained user ≤ 30 min with provided tool kit; spare parts availability guaranteed ≥ 10 years from first delivery; MTTR (Mean Time To Repair) ≤ 2 working days for electronic faults; user-replaceable battery with hot-swap capability.
R 5.18	Baseline: No EN standard; NATO STANAG 4150 modular equipment concept; MIL-STD-1472G (human engineering). ACTIVE PCP Target: Published Interface Control Document (ICD) specifying mechanical, electrical and data connectors for all interchangeable modules; independent upgrade of: (a) outer protective shell, (b) integrated sensor layer, (c) communication/data module without replacing full ensemble; backward compatibility ≥ 2 generations; module exchange ≤ 15 min (trained user).
R 5.19	Baseline: EN 13921 compatibility protocol; no mandated compatibility matrix for CBRN PPE. ACTIVE PCP Target: Documented and tested compatibility matrix with: EN 136 full-face SCBA masks (e.g., MSA G1, Dräger PSS 7000), NIJ IIIA soft armour vests (standard police issue), EN 443 firefighting helmets, TETRA radios (e.g., Motorola APX / Sepura SC21 form factor), EN 659 firefighting gloves, EN 343 Level 3 overboots; no mutual degradation of performance; compatibility test report per EN 13921.
R 5.20	Baseline: IEC 60601-2-27 (ECG monitoring); ISO 80601-2-61 (SpO₂ pulse oximetry); IEC 62368-1 (wearable electronics safety); Bluetooth LE 5.2 (IEEE 802.15.1). ACTIVE PCP Target: HR accuracy ± 5 bpm (validation per ISO 80601-2-61 methodology); SpO₂ accuracy $\pm 2\%$ at 70–100% saturation; core/skin temperature $\pm 0.2^\circ\text{C}$ (ISO 9886 thermometry protocol); data transmission latency ≤ 2 sec end-to-end; continuous operation ≥ 8 h on single charge; IP68; battery hot-swap ≤ 60 sec.
R 5.21	- Outdoor: GPS/GNSS accuracy ≤ 3 m CEP under suitable satellite visibility. - Update & Power: Position update rate ≥ 1 Hz; operational battery life ≥ 8 h continuous. - Indoor (Infrastructure-Assisted): In GPS-denied environments where local positioning infrastructure (e.g., UWB anchors) is available, target positioning accuracy shall be ≤ 1 m, with floor-level discrimination in multi-storey structures. - Indoor (Infrastructure-Free): In unknown environments without external positioning infrastructure, the system shall maintain continuous wearer localisation via IMU, SLAM, or dead-reckoning. Automatic failover between localization methods must not interrupt reporting. - Drift & Safety Limits: Infrastructure-free tracking must maintain a target drift of ≤ 5 m over 10 minutes. The system must actively communicate positioning uncertainty/estimated error margins to incident command to ensure operational safety.

R 5.22	Baseline: ISO/IEC 27001 (data management). ACTIVE PCP Target: Continuous real-time transmission of critical operational and sensor data. Timestamps must be UTC-synchronized ± 1 sec (GPS-disciplined). In the event of a network drop, the system must perform an automatic, encrypted cloud sync of the most recent operational data (e.g., the last 10 minutes of cache) within 60 sec of connectivity restoration.
R 5.23	Baseline: GDPR Art. 5 (storage limitation); no PPE-specific data recording standard. ACTIVE PCP Target: Local on-device storage of ≥ 72 h of multi-sensor data at a 1 Hz sample rate across all channels. Post-mission data retention must be configurable between 5–365 days per local GDPR policies. All recorded batches must include a tamper-evident hash (e.g., SHA-256) to guarantee legal admissibility during post-incident investigations.
R 5.24	Baseline: No specific standard; ISO/IEC 27001 A.12; RFC 7234 (HTTP caching). ACTIVE PCP Target: Local cache capacity ≥ 24 h maximum sensor sampling rate (all channels); automatic reconnection and sync within 60 sec of network restoration; zero data loss during connectivity transitions; AES-256 cache encryption; circular buffer with configurable retention 24 h–7 days; sync progress visible on companion app.
R 5.25	Baseline: OpenAPI Specification 3.1 (openapi.org); HL7 FHIR R4 (health data); REST architectural style (RFC 7231). ACTIVE PCP Target: Fully documented RESTful API per OpenAPI 3.1; HL7 FHIR R4 compliant data objects for all biometric parameters (LOINC codes); API response time ≤ 200 ms (p95); supports ≥ 20 simultaneous device connections without degradation; API versioning maintained ≥ 3 years; sandbox environment for integrator testing.
6. SECURITY AND PRIVACY REQUIREMENTS	
R 6.1	Baseline: GDPR Regulation (EU) 2016/679; Law Enforcement Directive (LED) 2016/680; ENISA guidelines on personal data breach. ACTIVE PCP Target: DPIA (Data Protection Impact Assessment) per GDPR Art. 35 completed prior to any prototype deployment; data minimization by design (only vital signs, location, exposure; no audio/video without explicit consent); DPO notification per Art. 37; full LED 2016/680 compliance for EΛ.AΣ. law enforcement data; consent withdrawal mechanism operable without removing PPE.
R 6.2	Baseline: ISO/IEC 27001 IAM controls; NIST SP 800-63B (digital identity); OWASP ASVS Level 2. ACTIVE PCP Target: RBAC per NIST SP 800-63B AAL2 (phishing-resistant MFA for command dashboard); automatic session timeout ≤ 15 min inactivity; emergency override mechanism logged and attributed; access revocation propagated ≤ 60 sec across all nodes; segregation of responder health data from operational tactical data.
R 6.3	Baseline: AES-256 (NIST FIPS 197); TLS 1.3 (RFC 8446); ECRYPT-CSA post-quantum roadmap. ACTIVE PCP Target: AES-256-GCM encryption at rest; TLS 1.3 mandatory for all transmissions (no TLS 1.2 fallback); end-to-end encryption for biometric streams; key management per NIST SP 800-57 Part 1; classified command channel: NATO RESTRICTED-compatible crypto (CCEB/MC 0471); post-quantum migration pathway planned per NIST FIPS 203/204 (CRYSTALS-Kyber/Dilithium). EMERGING REQUIREMENT: Post-quantum cryptography transition deadline per EU NIS2 Directive guidance by 2030. Solution must include upgrade pathway.
R 6.4	Baseline: RFC 8446 (TLS 1.3); ETSI EN 300 392 TETRA TEA2/TEA3 encryption; IETF RFC 7296 (IKEv2/IPsec). ACTIVE PCP Target: All web interfaces HTTPS-only with HSTS (RFC 6797) enforced; VPN: IKEv2/IPsec with AES-256-GCM; certificate pinning for all mobile app API calls; no unencrypted fallback permitted at any layer; TETRA E2E encryption (TEA3) activated for classified operational channel.
R 6.5	Baseline: ISO/IEC 27001 A.12.4 (logging requirements); GDPR Art. 5(2) accountability principle; Art. 30 (records of processing). ACTIVE PCP Target: Immutable audit log capturing: timestamp (UTC), user ID, role, data type accessed, action and outcome; log hash-chained (SHA-256) for tamper detection; retention ≥ 5 years; SIEM-compatible export (CEF/LEEF format); GDPR Art. 30 records maintained and auditable by DPA on request; daily integrity check with automated alert on anomaly.
R 6.6	Baseline: GDPR Art. 35 DPIA; ISO 31000 (risk management); ENISA AI cybersecurity assessment. ACTIVE PCP Target: Formal DPIA completed and filed before V1 prototype deployment; annual penetration test by accredited third party (CREST / OSCP certified); risk register reviewed quarterly; critical findings (CVSS ≥ 9.0) remediated ≤ 14 days; high findings ≤ 30 days; AI/ML components assessed per EU AI Act Art. 9 risk management if applicable.
7. ORGANISATIONAL AND PILOTING REQUIREMENTS	

R 7.1	Baseline: PCP Procurement Guidelines (EC 2020); ISO 9001:2015 QMS; IEC 61508 (functional safety for electronic systems). ACTIVE PCP Target: V1 prototype installed and operational at all 4 procurer sites by M18; V2 by M30; site acceptance test (SAT) protocol with ≥ 40 measurable pass/fail criteria per procurer; installation completed within 5 working days per site; SAT signed-off by procurer representative within 10 working days of installation.
R 7.2	Baseline: IEC 60300-3-14 (maintenance engineering); ISO 20000-1 (IT service management); ITIL v4. ACTIVE PCP Target: Remote support MTTR ≤ 4 h for P1 (system inoperative) faults; on-site intervention ≤ 48 h; dedicated named support engineer per procurer during all scheduled exercises; system uptime $\geq 99\%$ during pre-notified exercise windows; monthly health-check report per procurer.
R 7.3	Baseline: ISO 20000-1; ITIL v4 incident management; SLA standard practice. ACTIVE PCP Target: Helpdesk operational ≥ 12 h/day weekdays during pilot phases; P1 response ≤ 1 h, P2 ≤ 4 h, P3 ≤ 1 business day; multilingual support (English + national languages of all procurers); ticket resolution rate $\geq 90\%$ within SLA commitments; end-user satisfaction $\geq 4/5$ in quarterly survey.
R 7.4	Baseline: Horizon Europe Grant Agreement; EC PCP Reporting Guidelines ACTIVE PCP Target: Monthly 2-page status report per EC template; quarterly KPI dashboard published on project platform; deliverable submission ≤ 5 working days after phase completion; reporting format EC Portal compatible (PDF + structured data); financial reporting per EC Model Grant Agreement Article 20.
R 7.5	Baseline: ISO 9241-210 (human-centred design); System Usability Scale (SUS); JIRA/ServiceNow standard. ACTIVE PCP Target: Feedback submission ≤ 3 taps/actions from any screen; SUS score baseline measured at V1 deployment; target SUS ≥ 70 at V2 (industry good threshold); structured bug-report template with optional photo/video attachment; feedback aggregation dashboard updated ≤ 24 h; response rate $\geq 80\%$ active users per exercise.
R 7.6	Baseline: ISO 13485:2016 (medical device QMS); EU MDR 2017/745; PPE Regulation (EU) 2016/425; IEC 62133-2 (Li-ion battery safety). ACTIVE PCP Target: ISO 13485:2016 certification for vital signs monitoring subsystem before V2 deployment; CE marking under PPE Regulation 2016/425 Category III (CBRN) for protective garment; IEC 62133-2 battery safety compliance; if biometric sensors qualify as medical devices: MDR 2017/745 Class IIa conformity pathway initiated by M12 (notified body selected).
R7.7	Garments or material samples required for destructive laboratory testing in Phase 2, repeated decontamination, washing, ageing or durability testing should be provided separately and should not reduce the number of garments available for operational validation.