



eNOTICE-2

EU Network of Training Centres for preparedness to CBRN Events

D1.1 Assessment of topics to prioritise increasing CBRN preparedness

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Executive Summary

This document is the first report for eNOTICE-2 Work Package 1 (M1-M14) on **Review of the CBRN teaching courses**. This report falls under Task 1.1: *Identification of topics to improve preparedness (M1-M6)*.

D1.1 aims to identify, assess, and prioritise **relevant training and research topics to increase preparedness and improve response to CBRN, HAZMAT events, and cross-border crises**.

The main objectives of this document are to **outline the topics identified by eNOTICE-2 stakeholders** and provide **recommendations for improved training and research** to enhance, standardise, and harmonise CBRN preparedness and response mechanisms across Europe.

To achieve the objectives of Task 1.1, this report will be organized in the following manner:

Chapter 1 provides a summary of the eNOTICE-2 project's scope and objectives. It also offers an outline of the objectives of Task 1.1, the methodology utilised for this task, and its relation to future tasks and deliverables of eNOTICE-2. In doing so, it sets the framework by which this document aims to achieve the task objectives.

Chapter 2 elaborates on the methodological process used for the development and identification of the hot topics priorities. It also outlines the results of the research conducted, including insight from eNOTICE-2 project partners, CBRN Training Centres and end-users on the priorities for improved CBRN, HAZMAT, and cross-border preparedness and response.

Chapter 3 provides a summary of the work conducted for this task and offers recommendations for its application to the related tasks which will succeed T1.1 as part of the eNOTICE-2 project.

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Nomenclature

AI	Artificial Intelligence
CBRN	Chemical, Biological, Radiological, Nuclear
CPE	Collective Protective Equipment
DIM	Detection, Identification, and Monitoring
DRM	Disaster Risk Management
ENCIRCLE	European CBRN Innovation for the Market Cluster
eNOTICE	European Network of CBRN Training Centres
FDDO	Fire Department of (the City of) Dortmund
FLO	Front Line Officer
FR	First Responder
GFET	Graphene Filed Effects Sensors
HESAR	Health Safety Environmental Research Association Rome
IAEA	International Atomic Energy Agency
JCBRND COE	Joint CBRN Defence Centre of Excellence
METU	Middle East Technical University
PPE	Personal Protective Equipment
RPE	Respiratory Protective Equipment
SICC	Scientific International Conference on CBRNe
SDS	Safety Data Sheet
SOP	Standard Operating Procedure
TC	Training Centre
UCLouvain	Université catholique de Louvain
UCPM	Union Civil Protection Mechanism
UNITOV	University of Rome Tor Vergata
VESTA	Campus Vesta APB
WMP	West Midlands Police

1 Introduction

1.1 eNOTICE-2 scope and objectives

Over the past years, the threat of CBRN intentional attacks, technological accidents or natural hazards has led governments and international organisations to adopt far-reaching regulations and programmes to defend populations against the associated risks, while complementing national measures that address existing gaps and promote exchanges of information and best practices. To improve preparedness for CBRN events of deliberate, accidental or natural origin, the eNOTICE Network of Practitioners project was initiated in 2017 (finished in August 2023) which built an EU network of CBRN civilian and military training centers, testing and demonstration sites, and its goals are fully in line with the UCPM general objectives. The network comprising 53 training centers from 22 countries (17 EU Member States and 5 countries outside the EU) prioritizes multidisciplinary and multiagency training to enhance interoperability, cross-border training with a focus on standardized approach to comply with procedures and standards of neighbours, legal, administrative and organizational aspects; as well as training based on various scenarios including combined C, B, R threats of accidental or deliberate nature, hybrid threats and emerging threats, with testing and validating innovative technologies at different stages of development.

eNOTICE-2 Project consists of the members of the created network of CBRN training centers, and is supported by associated civil protection actors from the corresponding Member States and UCPM countries. eNOTICE-2 focuses on **improvement of the overall preparedness and capability** for responding quickly to major cross-border crises involving C, B or RN agents or a mixture thereof. eNOTICE-2 is building on lessons learned from eNOTICE-1 as well as on gaps identified during the 17 field exercises, table tops, simulations and serious gaming Joint Activities that were held with participation of CBRN practitioners – first responders, crisis managers, civil protection, training professionals, CBRN technology developers, policy makers, and volunteers from civilian population. eNOTICE-2 continues to bring together all the multidisciplinary stakeholders during four simulation exercises (SimEx) during the project to ensure **cooperation, coordination, compatibility and complementarity** between all the actors. The intense **knowledge sharing, comparison of operational procedures, identification of good and best practices across the actors in participating countries will strengthen knowledge partnerships between civil protection, DRM actors, ensure cross-**

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fertilization with the R&D sector, selecting most promising results for uptake from the scientific community, most innovative DRM tools from technology developers, and enrich the contents of the training courses.

Despite the abundance of material resources, expertise, and procedures, one of the major identified gaps occurs in CBRN decontamination, which has been consistently identified by eNOTICE-1 first responders (FR), and which is one of the UCPM rescEU CBRN priorities. eNOTICE confirms that there are currently no shared EU-MS guidelines or procedures. Furthermore, there are significant gaps in the way to conduct a decontamination that is safe for both the FR and the victims, especially when the decontamination activity involves a large number of FR and victims and lasts for several hours. And the emergence of new CBRN threats (such as Novichok, steadily emerging biological threats including toxins that necessitate regular updates to practices, procedures, guidelines, and policies) makes these gaps even deeper and more critical.

To fill this gap, the eNOTICE-2 project includes several new dimensions that will have several expected effects at institutional and individual levels. eNOTICE-2 considers CBRN decontamination in its broadest sense, including conventional and new emerging threats while considering together common healthy and vulnerable people, and focusing on a major well-known gap that is the decontamination of prosthetic and orthotics that are used by disabled people (wheelchair, hearing aids, breathing device, exoskeletal prostheses – such as hand, arm, foot, leg, finger and toe prostheses). As a result, **eNOTICE-2 substantially broadens the spectrum of organisations contributing to DRM and strengthens UCPM while remaining in line with the civil protection mandate to support EU Member States' DRM activities.**

Direct engagement of the end-user community, the advisory group of disabled patients guiding the project findings and providing recommendations will contribute to raising **awareness of citizens and authorities on the CBRN risks**, while carefully taking their needs and concerns into consideration, and provide possibilities to reduce their vulnerability.

1.2 eNOTICE-2 Project: report's scope, objectives, and methodology

1.2.1 Scope of this deliverable

The goal of D1.1 is to elaborate on the work which was conducted as part of Task 1.1 to identify and review priority, or “hot topics”, for improved preparedness and response to eight main areas

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of focus: **CBRN, HAZMAT, cross-border crises, operational aspects, decontamination, protection, emerging methods, and rapid threat detection**. The main objective in identifying these topics is to promote increased harmonisation by honing **collaborative efforts to standardise critical elements of First Responder training and CBRN response operations**, such as safety measures, equipment use, and monitorisation or decontamination procedures, for both civil and military operators. Additionally, identifying these topics will shed increased light on **persistent gaps and training needs**, enabling more **focused efforts to decrease these existing issues** in future training and field operations across Europe.

1.2.2 Links to other tasks

The work of this report is related to several tasks and their correlated deliverables which will be produced throughout the eNOTICE-2 project:

Task 1.2: New CBRN risks basic course design (M3-M14)

The results from this task will directly influence the work and output of **Task 1.2: New CBRN risks basic course design**. The hot topics and priorities defined in Task 1.1 will contribute to update of existing training courses and **strategic design of a new CBRN course module**, focused specifically on the training needs and priorities identified in this document.

Task 2.1: CBRN-centred digital library populating (M7-M16)

This task is also related to **Task 2.1: CBRN-centred digital library populating** (SO-3 of eNOTICE-2) which will aim at the creation of a **digital library** designed to provide a **standardised outlet of information related to CBRN training and response**. The hot topics and priorities defined in Task 1.1 will provide a targeted reference for the documents and materials to be uploaded in this dedicated library.

1.2.3 Methodological approach

To achieve the objectives of Task 1.1, a **2-step approach** (Fig. 1) was employed, in which **Artificial Intelligence (AI)** was utilised to narrow down an extensive list of topics provided by two recent research endeavours in the field of CBRN: (1) the gaps, needs, and research priorities consolidated by ENCIRCLE project for the EC to serve the basis of CBRN Cluster part b) calls in 2017, 2018, 2019 and the final version in 2021, and (2) the topics of the 3rd Scientific International Conference on CBRNe. This **provisional list of topics**, which was generated

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using Chat GPT, was then circulated to both eNOTICE-2 project partners as well as external stakeholders, namely CBRN Training Centers and end-users, for **feedback and additional input** based on their experiences as prominent actors in the field of CBRN training, management, R&D&I, etc. Upon gathering their feedback, a **final list of priority topics** was produced.

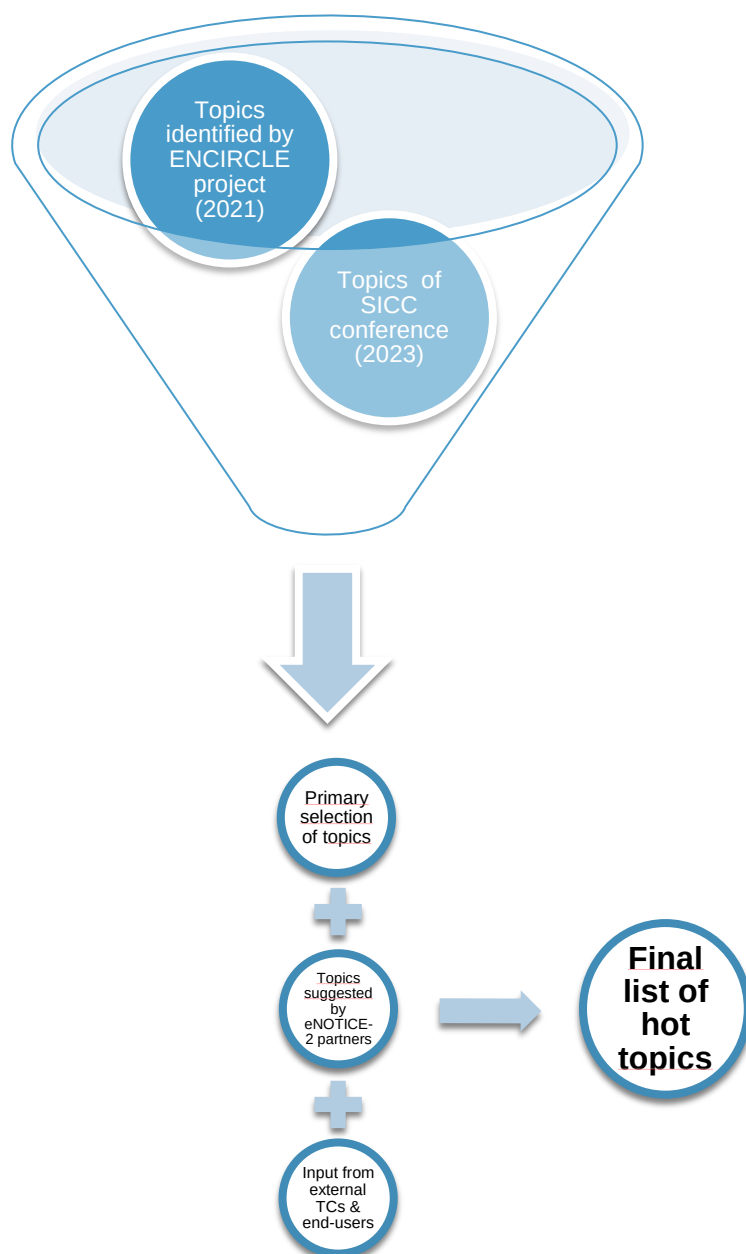


Figure 1 - Task 1.1 Methodological Approach¹

¹ Adapted from eNOTICE-2 presentation given by Daniele Di Giovanni, Ph.D. (UNITOV) at the Intl. Conference on CBRNE Research & Innovation in Strasbourg, March 2024.

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ENCIRCLE Project – European CBRN Innovation for the Market Cluster²

As part of the first step in identifying the priority topics, reference was made to a **database³ of key CBRN needs, functions, and gaps**, created under the Horizon-2020 ENCIRCLE (European CBRN Innovation for the Market Cluster) Project which ended in 2021. This database was part of a years-long endeavour to develop an extensive list of CBRN functions and their related sub-functions to highlight existing needs and gaps in training as well as R&D&I. The database is comprised of 17 functions in total, spanning nearly 1,900 rows of identified information.

Function	Description	Sub-function	Gaps	Need
F1	RISK ASSESSMENT AND REDUCTION			
F1.1	RISK ASSESSMENT AND REDUCTION	Risks assessment, modelling and impact reduction	Lack of awareness regarding food defence in the food industry within production processes by food safety authorities and food inspectors. Lack of knowledge, guidelines and training on risk assessment methods adapted to Food Defence (ORM, VACCP, TACCP, CARVER+Shock). Lack of correlation between epidemiological information and foodborne issues.	There is a need to develop standardised methodology, processes and tools of risk assessment, as well as regulations allowing to set up standards for detection, identification, and monitoring. There is a need for evaluation of risks related to residual contamination levels regarding food defence.
F1.1	RISK ASSESSMENT AND REDUCTION	Risks assessment, modelling and impact reduction	Lack of capabilities for real time threat assessment.	There is a lack of the capabilities for real-time threats assessment which will be able to: 1. Detect and continuously monitor threats and hazards on the incident scene in real time; 2. Assess threat and hazard data to provide appropriate guidance and decision support to responders and commanders; 3. Provide visualization capability of threat locations and proximity to responders.
F1.1	RISK ASSESSMENT AND REDUCTION	Risks assessment, modelling and impact reduction	Large variations between different countries in the EU Member States when it comes to implementation of risk assessment. Every country follows its own procurement procedures and opportunities for the pooling of resources are lost. (HIGH). National risk and vulnerability assessment of all major population areas and assess the implications for medical assistance is not conducted in all countries. Capacity assessment of local infrastructures, involved in emergency response, is not done in all countries. This includes all first responder units (health, fire brigade, police, civil defence units, volunteers (NGOs)). National and local assessments of equipment and drug availability for emergency situations are not done in all countries. In advance of an event there is a lack, in some MS, of measures and regulations for setting up minimum standards of decontamination. Lack of common risk assessment processes, lack of processes for the sharing of results. Lack of general knowledge regarding available methodology and lack of standardised approaches to measure residual risks of secondary exposure and to set allowable levels of contamination. "Best practice" should be set as benchmark	There is a need to improve general approach to risk assessment. The necessary activities should include development among many of the: methodologies and tools of risk assessment; common risk assessment processes; processes for the sharing of results; methodologies and standardised approaches to measure residual risks of secondary exposure and to set allowable levels of contamination; regulations according to which are set up standards for detection, identification, and monitoring; measures and regulations for setting up minimum standards to ensure the use of adequate detection equipment; legal tools that can be applied to a situation when a "state of siege" is declared by a Member State; clear exceptions on privacy rights in case of extreme crisis situations in applicable legal framework at the EU level.

Figure 2 - Example of ENCIRCLE needs and gaps database⁴

² <https://encircle-cbrn.eu/>

³ Excel file shared by ENCIRCLE consortium leader (UCLouvain)

⁴ Ibid.

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Due to its large size and content, this database was **uploaded to Chat GPT** where it was then filtered to highlight the main topics specifically related to the keywords for this project task: **CBRN, HAZMAT, cross-border crises, operational aspects, decontamination, protection, emerging methods, and rapid threat detection**. The output generated from this database served as the starting point in identifying major areas of focus for increased CBRN training and response. However, since the research conducted to create this database was concluded in 2021, it was important to integrate these topics with additional, more recent and emerging priorities through other resources such as the SICC conference (see below).

*SICC Conference 3rd Edition – Scientific International Conference on CBRNe*⁵

The same process as described above was then employed for the list of **conference topics**⁶ for the 3rd Edition of the Scientific International Conference on CBRNe (SICC) which was hosted by the University of Rome Tor Vergata (UNITOV) and the Health Safety Environmental Research Association Rome (HESAR) in September 2023. These topics were specifically selected for the conference and identified as the most relevant areas of interest in existing CBRNe R&D&I, and in light of the current geopolitical framework at the time in which the conference took place. There were a total of 142 topics which aimed at covering the most crucial aspects of CBRNe detection, prevention, preparedness, and response and which were used as a guideline for the work presented by the conference participants.

⁵ <https://www.sicc-series.com/>

⁶ <https://www.sicc-series.com/topics-sicc-2023-1/>



-
- Accredited laboratories
 - Active Learning
 - Adaptation Strategies
 - Analysis and Evaluation of CBRNe Threats
 - Artificial Intelligence Towards Safety & Security
 - Augmented Reality
 - Bacteria
 - Big Data Analysis applied to CBRNe safety and security
 - Biological Agents (BAs)
 - Biological Agents Decontamination
 - Biological emerging and re-emerging threats and Epidemiology
 - Biological Warfare Agents (BWAs)
 - Biosafety
 - Biosecurity
 - Bioterrorism
 - Business continuity
 - CAs (Chemical Agents)
 - Case and CWAs
 - CBRNe Awareness and Preparedness, Technologies for teaching and education
 - CBRNe Events - Prediction and Management
 - CBRNe Hazard Simulation
 - CBRNe Risk Mitigation
 - CBRNe Risk Scenarios

Figure 3 - Example of SICC conference topics⁷

Feedback from eNOTICE-2 partners

The next step to achieve the final list of “hot topics” for increased CBRN preparedness involved circulating the provisional list, generated from a combination of results from the above-mentioned resources. The provisional list was sent via email and consortium partners were

⁷ Ibid.

asked to provide expertise in the form of **feedback and input** on any modifications or additions they viewed as necessary to create a final list of priority topics.

Feedback from the network of CBRN Training Centres and end-users

The input received from eNOTICE-2 consortium partners was then integrated with feedback received from **external stakeholders**, namely **CBRN Training Centres and end-users** whose input was also requested via email by the Project Coordinator. These individuals were asked to offer their opinion on the provisional list of topics and to provide **insight based on expertise and/or knowledge of relevant resources** to identify additional priorities. Several responses from experts and CBRN advisors were received, including input based on work conducted for other EU-funded CBRN projects.

2 Results of Task 1.1: Identification of hot topics

2.1 Provisional list from ENCIRCLE & SICC

The following figure (Fig. 4) is the **provisional list of topics**, resulting from the output generated via AI for the purposes of this task. As mentioned in Chapter 1, a specific set of keywords was used to collect all relevant data from the resources selected for topic analysis. The results were then organised into a Microsoft Excel file, grouped according to these areas of focus, and categorised using a color-coding system to differentiate the original sources.

Table 1 - Provisional list of topics - Part 1

CBRN	HAZMAT	Cross-border crisis	Operational aspects
Risk assessment and reduction - Risk assessment, modelling, and impact reduction - Risk reduction	Hazardous materials		Exercise, simulation, and training - First responders/decisions makers - Population
Situation awareness & assessment - Situation assessment			Intelligence - Information management based on all tools: FR, defence, social media, etc.
Psychological and social aspects - Team and organisational psychology - Pre, during, and post event behavioural observation data reporting and management			Intervention and neutralization - Medical countermeasures
Control of disarmament/fight against proliferation			Crisis/Operations management - Population warning and alert

- Control and track of flows, substances and materials			systems - Optimisation, Planning, and Decision Support Systems - Event response
Analysis and Evaluation of CBRNe Threats			Search, rescue, and evacuation
Big Data Analysis applied to CBRNe safety and security			Support - Ground systems technology
CBRNe Awareness and Preparedness Technologies for teaching and education			
CBRNe Events - Prediction and Management			
CBRNe Hazard Simulation			
CBRNe Risk Mitigation			

CBRNe Risk Scenarios			
CBRNe scene vs Crime scene			
Chemical Biological Radiological threats to medical management			
Command and Control of CBRNe Events			
Evolution of CBRNe threats			
First Response in case of CBRNe events			
International legal frameworks governing CBRNe: gaps and opportunities			
Non-Conventional Threats (NCT)			

Table 2 - Provisional list of topics – Part 2

Decontamination	Protection	Emerging methods	Rapid threat detection
Decontamination and de-pollution - Zone - Persons - Vehicles/mobile equipment - Infrastructures and networks	Protection - Protection doctrine & operation - First responders protection - Population protection - Critical infrastructures and networks - Hospital protection - Other assets - Public infrastructures or areas		Search and detection - Devices for detection and identification - Alarm detection (person-based) - Buildings/infrastructures
Decontamination of CBRNe agents	Collective Protective Equipment (CPE)		Identification and authentication - CBRN identification

Biological agents' decontamination	Collective Protective Equipment (CPE) materials, technologies, and systems		Detection of CBRNe agents
Engineering applications for Ce and CW agents decontamination protection risks reduction	Personal Protective Equipment (PPE) materials, technologies, and systems		New technologies and application for detection
R/N protection and decontamination	R/N protection and decontamination		New technologies for Biological agents detection
Experimental and applied physics for Ce agents' decontamination protection risks reduction			
Colour Legend:			
ENCIRCLE			
SICC 2023			

2.2 eNOTICE-2 consortium & external experts' feedback

As described in the methodology, the final list of topics was achieved by **integrating the provisional list with valuable feedback** received from both internal project partners and external experts in CBRN training and response. All the data collected was formulated into a new document which included all the relevant feedback and ideas proposed by each of the abovementioned sources into a **fully defined list of priorities**. This new document was then re-circulated to project consortium partners, where **additional analysis** was performed, and further feedback was provided to finalise the topics.

2.3 Final list of topics

The following table is the **final list of CBRN research, development, teaching and training priority topics** identified for Task 1.1. After assessing the feedback and input as previously described, the final topics were grouped into two overarching categories: **(1) Procedures and (2) Technologies**. These were then categorised further into the following sub-topics:

- **Improving training and technological awareness – raising threats awareness**
- **Detection, Identification, and Monitoring (DIM)**
- **Decontamination**
- **PPE**
- **Curative and preventive treatment – psychological welfare**
- **Emergency response guidelines – Standard Operating Procedures (SOPs) – Safety Data Sheets (SDSs) and operating procedures & documentation**
- **Complementary technologies**

Table 3 - Final list of CBRN priorities

Topic	Reasons why it is considered a priority
Procedures	
PREPAREDNESS: Improving Training and Technological Awareness - Raising Threats Awareness	
Raise awareness among organisations – such as border guards, customs	Not only for FR, but also, e.g. for the border guard and customs and for those responsible for the security of critical infrastructure. Customs, for example, have a very important role in blocking suspicious shipments (strategic goods, chemicals, etc.) both entering and leaving the country. Similarly, those who have to ensure the operation of activities or functions that are strategic to the country may find themselves exposed to CBRN threats. Knowledge of unconventional CBRN threats and the relevance of these in relation to the specific activity performed or role held is crucial. There are no many research articles considering different roles of organisations. It is important to raise awareness that CBRN means co-operation, and everybody plays the role. NOTE: IAEA on the basis of the work done with Customs and Border Guards on the detection and identification of RN materials, through its Front Line Officer (FLO) Network, has developed several guidance documents on this issue. These documents could easily be widened to include C (and maybe B) with the right expertise
'First responder' CBRN awareness /response procedures/capabilities (for non-CBRN trained/equipped emergency services Additionally, key civilian sectors such as crowded places and public transport need specific support to strengthen response capabilities and enable scaling up these efforts.	There is a lack of CBRN training and awareness for non-CBRN trained FR. Large public spaces, e.g. shopping malls, places of worship, stadiums-arenas, hotels- arenas etc. are so big that local FR are not enough if something happens, such large objects need their own response capability. The security managers of the facilities, so called 'instant

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	responders' are at the location of the CBRN event at the exact moment it occurs. It would be useful for them to have a basic knowledge of CBRN threats, because they can certainly play a key role in transferring information to the actual First Responders (fire brigades, medical personnel), but they cannot replace them in terms of functions. NOTE: Interpol and IAEA have developed activities with States to prevent, detect and respond to RN incidents, including for Major Public Events and Major Cities (Major Urban Areas) and have several training courses and pieces of guidance on these subjects.
CBRNe Awareness and Preparedness Enhancing CBRN Decision Support and Response Planning: The Role of Teaching and Education Technologies - Hazard Simulation and Its Impact on Training and Preparedness - Adapting Educational Technologies for Citizen Training on CBRNe Threat Assessment and Protection through correct behaviour	Rapidly emerging technologies and the outcomes of European projects that develop mature TRL technologies are not fully exploited at the operational and tactical levels to improve the training processes of first responders (FR). There is a gap between existing technologies and their application for the benefit of FR. Not only should the technological and operational content of a course be updated, but the teaching methodology should also be revised to integrate new teaching and learning technologies. This includes new training methods involving Augmented and Extended Reality simulation, AI-supported technologies to automate and simplify their on-site use by FR and experienced operators, as well as AI-enhanced safety documents used on-site by First Responders (FR), such as Safety Data Sheets and Emergency Response Guide Red Pages. The course should include Information about the benefits of new mature technologies for enhanced safety in the field, and particularly for improved risk assessment during crisis responses (enhanced situational awareness);

	Training should enable first responders (FR) to perform tasks that contribute to the quality of results obtained with these technologies, while collaborating closely with expert field operators—for instance, in adequate sampling. Additionally, the level of competence of responders should match the operational requirements of using new technology. It will be a pity to only iteratively develop tools that will never be used, since the reason of failure or difficulties are responders and not the systems. Training to FR, upskill, moving to cursor of technological awareness and understanding and associated skills to the right. Make sure that every technology, every innovation is adapted to be used in the field. FR should provide feedback on emerging technologies tested on site to drive innovation towards greater automation and ease of use such as by integrating more AI. Improvements should also include enhancing course content to incorporate the technological dimension of risk assessment and situational awareness.
In general, it is important to have a clear view of which new technologies or tools are immediately available at TRL 7. If they are operationally relevant, this understanding can help push them toward industrialization to reach TRL 9 and prevent reinventing the wheel.	Regular updates should be made available on which CBRNe-relevant technological breakthroughs are occurring, along with their associated timing, to ensure they can be quickly optimised to become operational.
There is currently a significant gap in our global understanding and assessment of biological hazards. This challenge is partly due to the intricate nature of biological threats.	Closing this gap and enhancing preparedness and response to major biological crises, while aligning with public health and biological and toxin hazards needs is a primary objective.

Protecting the population: Educating and Training to Better Address CBRN Threat	Civil protection and civil defence, or retired military officers need to train population (starting from schools, colleges) how to protect themselves and others, how to use gas masks, how to make first aid, where to find shelter. Most simple measures and skills help the population also in case of HazMat situations. In addition, this type of training provides basic knowledge and terminology that helps in an emergency to carry out effective emergency communication and avoid panic situations.
Preparedness to “mega” scenarios - terrorist attack using toxic materials (now also including WMD agents, as nerve agents), and the challenges it creates, a war, CBRN as a “hybrid” tool	Possible mass attacks or mass incidents. We are experiencing a phase of high conflict, globally the number of conflicts is constantly growing and unfortunately this trend does not seem to be changing for the time being. In this context, social media and bad press contribute to generating a feeling of insecurity and fear, which in the event of a real mass event could lead to an amplification of the effects of the event itself. To prepare for such scenarios, it is necessary to work on several levels, with first responders and the population, creating the conditions for an effective response, including self-sustainability.
Train-the-Trainer topics on Civ-Mil cooperation	In recent years, both because of conflicts and because of climate change and the resulting environmental emergencies, civil-military cooperation has assumed a key role in the response of individual countries in these types of situations. It is therefore crucial to remove all forms of inefficiency that could slow down or hinder this cooperation. The focus must therefore be on full interoperability, the sharing of SOPs (as far as possible in view of the confidential nature), and careful work to identify any differences and similarities in the various systems. This process must concern leaders and commanders first.

	NOTE: IAEA runs workshops on the need for all stakeholders, including civil and military organisations, to work together in the development of a national framework for responding to RN incidents. They also have guidance on this issue
Live agents training including communication on the response scene. Necessary not only for first responders, but also for their leadership, commanders	Live agent training is mandatory for validating many types of equipment, devices, and procedures used on-site by first responders, whether it be for the adequacy of PPE, decontamination, or detection, identification, and monitoring methods.
PREPAREDNESS and RESPONSE: Detection, Identification and Monitoring (DIM)	
Enhanced Surveillance and Early Identification of Biological Agents Using an Agnostic and Targeted Syndromic Approach in the Post-Release Response Phase.	The current syndromic approach is quite limited and relies mainly on commercial automates, such as BIOFIRE® FILMARRAY® (Biomérieux, France) and GeneXpert (Cepheid, USA). Both systems use expensive cartridges that allow only a limited spectrum of targeted biodetection. There is a need to develop generic (agnostic) and expanded targeted biosensing methods that can enable the surveillance and identification of a much broader panel of high-consequence pathogens that could be deliberately released. Improved detection is crucial both in the surveillance phase and in the response phase, where early diagnosis is essential to deliver the most suitable therapy.
Comprehensive Surveillance and Early Identification of all-types CBRN agents Using a combination of AI-supported Agnostic and Targeted approach	There is a need to monitor and detect the presence of any unknown CBRN threats using a combination of B, C, RN and E sensors connected to validated reference databases and based on AI-supported algorithm (with appropriate prior training for FR)

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On-site DIM of biological agents and biotoxins	Detecting biotoxins on-site remains a major gap. The methods used in reference laboratories, such as mass spectrometry, are not portable, which prevents them from being easily used on-site. Lack of reliable technologies, training and standards. Basic training for FR and population would be important as well, such as training on recognition of symptoms, correct use of PPE, taking measures like keeping the distance, etc.
On-site DIM of emerging biothreats (incl. synthetic biology and gene-editing)	Gain-of-function and genetic engineering of biological agents may enable them to evade conventional DIM methods, allowing them to remain 'under the detection radar'. There is an urgent need to develop methods that can screen for genetic manipulations in current biological agents, detect emerging threats, and contribute to the process of attributing genetic engineering by rogue or malicious non-state actors. Lack of reliable technologies, training and standards
Early Contamination Identification Using Generic and Specific Biomarkers using new type of biosensors like GFET (graphene field effect sensors)	The principle involves the detection and quantification of blood or tissues biomarkers to quickly and accurately identify contamination before widespread physiological or clinical damage occurs in individuals potentially contaminated by an unknown agent. It is vital to have a monitoring system that can signal the presence of contaminants early on. Early identification enables timely preventive actions and targeted responses, which can significantly mitigate the impact of the contamination and enhance public safety and health. Biomarkers are biological molecules found in blood, other body fluids, or tissues that indicate a normal or abnormal process, or a condition or disease.

	Generic biomarkers are broad indicators that may signal the presence of various contaminants or stressors in the body but are not exclusive to one particular agent. Specific biomarkers are unique to particular pathogens or chemicals, providing a clear indication of the presence of a specific contaminant. Advanced technologies, such as high-throughput screening, mass spectrometry, or biochips, are often employed to quickly detect these biomarkers at low concentrations. Emerging technologies including artificial intelligence, nanotechnologies, and new types of bioreceptors have the potential to overcome the current limitations of existing technologies.
How Clean is 'Clean'? Assessing Cleanup After Dispersion of Highly Hazardous Compounds	Improved agnostic and targeted DIM methods are needed to assess the remaining CBRN risk after thorough decontamination. Non-Contact, Short-Distance Standoff Monitoring Based on LASER: Addressing the Current Gap with a New Methodology.
PREPAREDNESS And RESPONSE: DECONTAMINATION	
Management of Mass contamination following dispersion of persistent low volatility hazardous compounds (e.g. V agents, opioids, rad compounds, toxins...)	The focus shall be placed on detection of those B, C, R agents that most likely to be dispersed in mass contamination events; on management of the risk of secondary contamination (at the incident site and outside: transportation of victims, hospital, home...) Emergency DECON SOPs have to be developed to evaluate if the place is clean enough to re-occupy. Another serious challenge is efficient communication to potentially exposed population in case of a mass contamination incident

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Management of Mass contamination following dispersion of CBR particles (dust/powder) inside the decontamination tent Evaluation of transfer of contamination following mass exposure of civilian populations to contaminants	When conducting mass decontamination, especially if the process lasts for hours, a significant level of contamination inside the decontamination tent is expected. This can pose risks to first responders and victims starting the decontamination process. The level of residual CBRN threats inside the tent should be monitored using autonomous CBRN sensors. If the mass decon is performed in a decontamination tent, then the aim of the decontamination is to ‘trap’ particles (for example wet decon to wash particulates off and trap them in the liquid), then the liquid, rather than the particles, becomes the issue of concern. In case the mass decontamination is performed in open air, without tents, then the appropriate risk mitigation procedures have to be put in place as decontamination plans are developed. Possible cross-contamination at the victims collecting point during emergency DECON and treatments has to be avoided. Another problem that has to be addressed is raising awareness among the population, especially for the cases of people escaping the incident location, and decontaminating themselves at home with an augmented risk of contamination at home, in the sewer canals etc. DECON kits and instructions have to be provided to the population for self-DECON. And evaluation of the self-DECON by civilian populations need to be developed according to a systematic and harmonized approach.
Education of the population on emergency decontamination (expected behaviour in the 30min following a CBRN exposure)	To evaluate and how to perform in a systematic way (long term approach) A combination of education of the public and training for FRs on the instructions to give to the public following CBRN exposure may be the best way to achieve the desired

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	behaviour by the population. Education alone is unlikely to be successful as there is no guarantee that everyone affected will have received the education / retained the information
Evaluation of transfer of contamination related to dead bodies	This risk is still poorly controlled, and the risks associated with the remnants thereof over time are not fully understood and are probably overlooked by some early first responders (Level 1).
Decontamination of toxins	Toxins present steadily increasing risks that are often overlooked by first responders. Although natural degradation may eventually render these toxins non-functional and eliminate their lethal potential, toxic effects can occur very quickly, making immediate intervention crucial.
Generic CBRN-Biotoxins decontamination methods	While decontamination methods for chemical threats have been widely developed, there is still a lack of generic, on-site usable methods that enable thorough decontamination of all types of CBRN risks, including bio- and non-biotoxins.
On-site management of waste after decontamination	There is a major gap in the on-site decontamination of waste after mass decontamination events. A portable, efficient decontamination procedure would enhance the safety and security of first responders. A portable efficient decontamination procedure would add to the safety and security of first responders
Management of electronic sensitive equipment on-site	Major gap. There are no validated methods that can be deployed on-site for this purpose, but there are promising—albeit still experimental—technologies that deserve development and validation
PREPAREDNESS And RESPONSE: PPE	

Evaluation of PPE efficiency (including protection properties but not only) on the field (field tests)	Lab tests too far from the (civilian) context of exposure
Improved portable headset needed for protecting first responders against air-transmissible high-consequence biological and chemical agents	There is a clear gap in respiratory protection, as current solutions lack a portable headset that enables clear vision, clear communication, and efficient filtering without the need for a heavy, autonomous respirator. Such a headset should also allow for easy decontamination after use. This gap is particularly concerning in cases involving high-consequence pathogens with efficient air transmissibility.
Respiratory Protective Equipment (RPE) and Personal Protective Equipment (PPE) for Early Responders: Level 1 Police, Fire Brigades, Healthcare Emergency Personnel, and Civil Protection	Need for specific CBRN stuff in addition to existing equipment and procedures for FR (<i>note - no possibility to replace, only add? Addition will mean more weight, more volume – frustration</i>)
PREPAREDNESS And RESPONSE: CURATIVE AND PREVENTIVE TREATMENT – PSYCHOLOGICAL WELFARE	
Mass exposure: Efficiency of antidotes logistics in view of saving intoxicated populations	Systemic approach (« from stockpiles to the victims who need it »)
Preventive and curative biotoxins antidotes	Several experimental neutralising antidotes are currently being developed, including various types of antibodies (monoclonal, polyclonal, chimeric, humanized, bispecific, and cocktail of antibodies) and even vaccines. However, these are all experimental and have only been tested on animal models. There is a need for more active, efficient, and safe preventive and curative methods. Camelid antibodies offer promising perspectives due to their sensitivity in binding to toxins, toxin neutralisation, and potential for preventive and therapeutic use.

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Traceability of therapeutics administration in the warm zone	The current methods prove not efficient, further development is needed
Medical countermeasures – efficacy and range	
Psychological and social aspects	Team and organisational psychology Pre, during, and post event behavioural observation data reporting and management
Emergency Response Guidelines – Standard Operating Procedures – Safety and Security Data sheet and operational procedures and documentation	
Tactical command access to scientific advice	This goes currently to strategic commanders and must be filtered down. It depends on the national model, as some States provide access to scientific advice and support at multiple command levels
SOPs for B, for RN	Development of those SOPs for first responders that are currently missing, and harmonisation of SOPs between Member States
Single agencies knowing their own response and activation mechanism, but not learning or being aware of the structures of the agencies and organisations they would indeed be working with in an all-out effort of a CBR response	Need to teach (or at least encourage) inter-agency collaboration, interoperability, improve communication. At national level? Or possible at cross-border level as well? See what would be best format for such teaching/training – tabletops or joint exercises, or any other, or a combination thereof
International mapping and shared threat assessments	Mapping of the capabilities, vulnerabilities and potential risks.

	Conventional and non-conventional risk scenarios are constantly evolving. As an example, terrorist actions in recent decades have undergone a transformation. Crucially, terrorists increasingly employ less sophisticated weapons - such as dual-use objects and techniques - to carry out attacks than those used in the past. Whereas before 9/11 terrorist actions were logistically complex and often aimed at hostage-taking or mass casualties at high-value sites, the phenomenon has evolved. The new trend of terrorist attacks after 9/11 was characterised by a strong concentration on logistically easy-to-hit sites, but the lethality of attacks remained high. Similarly, critical events due to climate change have become more violent and increasingly frequent. The need for a coordinated risk mapping action at international level is therefore evident; only in this way can we hope to have a correct perception of the evolution of this phenomenon and calibrate an effective response. Sharing Threat Assessments may be very challenging as threats are sensitive issues for States and are very much specific to each State. Sharing threat assessment methodologies may be more achievable and realistic.
Single collection/set/database of drills/exercises/scenarios to organise exercises in different countries with the same scenario, under same conditions	To be able to compare the capabilities, procedures, level of preparedness in different countries/regions – it's possible to do only when making exercises with the same scenario, putting all actors under same conditions
Have a clear view on the various scenarios	Scenarios need to be developed to illustrate the operational processes depending on countries, not to develop new things/SOP/tools/technologies, but to know what was studied
Command and Control of CBRNe Events	This is a significant issue for all States. Without effective multi-agency command and control arrangements in place, no amount of training and equipping of responders will

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	deliver an effective response, as commanders need to take the decisions to deploy staff based on the existing situation at the time
Crisis/Operations management	Population warning and alert systems Optimisation, Planning, and Decision Support Systems Event response
Technologies	
PREPAREDNESS And RESPONSE: COMPLEMENTARY TECHNOLOGIES	
Collective Protective Equipment (CPE), materials, technologies and systems	Need to develop collective protection systems to provide safe environments (e.g. in buildings, tents, containers, ground vehicles, ships and aircraft) protected against CBRN agents, which allow personnel to carry out their tasks and rest without wearing individual protective equipment.
Cybersecurity technologies	Addressing vulnerabilities in CBRN-related infrastructure, such as nuclear power plants or chemical and biological (BSL3-BSL4) facilities, to prevent cyberattacks and sabotage NOTE: IAEA delivers a range of courses on the protection of computer systems for Nuclear Facilities, and have several guidance documents on the subject
Emerging technologies – AI, robotics, nanotechnology	Exploring the potential of emerging technologies to enhance CBRN defence capabilities.

Secure communication systems	Ensure secure channels of communication, and security of the data transferred via these channels.
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3 Conclusions and recommendations

Task 1.1 involved the **identification of priority topics to increase and improve CBRN training and response capabilities**. This task was conducted through qualitative desk research, in which topics were selected based on output from reputable and recent sources in the field of CBRN research. A provisional list was obtained by uploading an extensive database of topics from the ENCIRCLE project and the SICC conference into Chat GPT (Release Vs. 4.0), where an extraction was then made to **determine the most relevant topics** related to keywords previously identified by the eNOTICE-2 project for the purposes of this task (see Section 1.2.3). The topics generated using AI were then distributed to the project consortium and external experts for **review and assessment**. Feedback was received from partners, CBRN Training Centers, and end-users and contributed to the **refined version** of these **priority topics focused on existing and urgent needs and gaps in CBRN preparedness, response, and technology**.

The results of Task 1.1 provide a starting point for the succeeding tasks T1.2 (course module design) and T2.1 (digital library creation). The topics identified and described in this document are a crucial **first step in evaluating existing CBRN courses** offered by the eNOTICE-2 TCs and higher education institutions. These topics should be considered throughout the assessment process and contribute to the design of CBRN course modules in training centres which accurately reflect the current shared needs in CBRN training efforts from both a military and civilian perspective. Similarly, these topics will offer a vital contribution in the design and creation of a digital library, by providing **specific areas of focus for the identification of open-access documents** for standardised reference among CBRN professionals and researchers.

While this task has highlighted the most recent areas of focus for improved CBRN training and response, it is important to note that the field of CBRN is **ever-changing** and largely based on **current geopolitical situations, emerging research, innovative technology, increased knowledge sharing**, etc. Therefore, the topics proposed in Task 1.1 aim to provide a targeted focus for current training initiatives but should be **continuously evaluated and updated** as

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necessary to ensure priorities accurately **reflect future needs and gaps**. The methodology utilised to complete this task offers a path to enable researchers, TCs, policy makers, and other CBRN stakeholders to successfully conduct future assessments as the field of CBRN continues to evolve.