INDIGO
Crisis Management Solutions

D4.3.2 EUROPEAN EMERGENCY 2D/3D SYMBOLOGY REFERENCE	
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Abstract	
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Preparation Slip				
	Name	Company	Date	Signature
From	M. Schaap/ F. Bynander	CRISP/ CRISM	12/2012	Maaike Schaap
Approved by	A. Ahmad	DXT	12/2012	Alexandre Ahmad
For delivery	M. Julien	DXT	12/2012	Martine Julien

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Content

List of Figures

1   Introduction

The aim of the INDIGO project is to research, develop and validate an innovative system integrating the recent advances in Human Computer Interaction and Virtual Reality in order to homogenise and enhance both the operational preparedness and the management of an actual complex crisis. INDIGO will enable:

- The 3D interactive and realistic visualisation of the complete crisis environment, including data coming from the field, and simulation results;
- The creation and simulation of different evolving scenarios for planning, training, and anticipating future states and impending developments during operations, and analysing events after the crisis;
- The simultaneous training of decision makers, crisis managers and first responders that will be influenced by the simulated scenario and that will reciprocally influence its development;
- The involvement of multiple participants, thanks to its distributed architecture, while offering a unique pictorial way of sharing and communicating complex knowledge across organisational boundaries.

In addition, the INDIGO project proposes a European emergency symbology reference for 2D/3D maps. This will fill an important gap by offering a common visual reference that can be used across Europe to facilitate the immediate understanding of the situation, thus improving decision making across organisational and national boundaries.

1.1   Purpose of this document

This document presents the final results of the INDIGO project regarding the European emergency symbology reference for 2D and 3D maps, called the INDIGO Emergency Symbology Set. The document gives an overview of the theoretical lessons learned in creating standardised emergency symbology sets. Furthermore, it assesses the results of the end-user workshops held in France and Sweden and their contribution to the development and validation of the proposed Emergency Symbology Set by INDIGO.

The INDIGO Emergency Symbology Set will be placed in the public domain, on the website of the INDIGO project[1].

1.2   Organisation of the document

This document is organised in the following way. Chapter 2 presents a summary of the 'Symbols, Symbology and Systems: A Comprehensive Overview' (I4.4.3) report that was made at the start of the INDIGO project. Chapter 3 summarises the development methodology used regarding the Emergency Symbology Set. Chapter 4 provides the end-user results and recommendations inferred from the end-user workshops in France and Sweden. Chapter 5 presents the main conclusions and recommendations for the INDIGO project regarding the European Emergency Symbology Set. Finally, the annexes of this document present the initial symbol set and the final symbol set resulting from the work carried out in the scope of the INDIGO project.

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[1] http://www.indigo-project.eu

2 Symbols, symbology and systems: theoretical underpinnings

The development of the final Emergency Symbology Set introduced in this document was preceded by a thorough review of the existing literature on the subject of symbols, symbology and systems. This amassed knowledge base provided a point of departure and intended to inform the creation of a common Europe-wide emergency symbology reference. The findings from this review can be found in the INDIGO project deliverable "I4.4.3 Symbols, Symbology and Systems: A Comprehensive Overview". This chapter summarizes the main findings and recommendations that were relevant for the development of the final INDIGO Emergency Symbology Set.

2.1 Symbology and overview of symbol types

In the literature [EA96; M95] three types of symbols are prevalent and similarly defined, i.e. geometric, pictorial and associative symbols. Geometric (or abstract) symbols have a message that is not easily conveyed, commonly shown as circles, diamonds, and triangles that are often complemented with a legend [M95]. Pictorial symbols, or image-related or representational [EA96], are "similar in appearance to their referent" [M95, p. 258], meaning that if the symbol is successful, legends are superfluous. Associative symbols, also regarded as "emblems", represent the referent through some analogous relation of parts of other commonly recognised symbols in combination [M95]. Figure 1 illustrates the described symbol types.
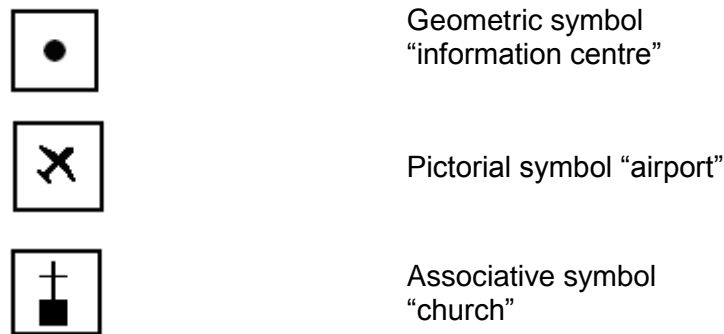

	Geometric symbol "information centre"
	Pictorial symbol "airport"
	Associative symbol "church"

Figure 1: Examples of geometric, pictorial, and associative symbols[2].

In addition to these three types of symbols, we also define symbols that strive to convey a concept. These symbols are less intuitively understood and to be effective they should readily evoke the concept. Examples of these symbols are "biohazards" and "radiation" [L03]. Conceptual symbology development is highly socially constructed and dependent on the changing nature of the physical and social world we live in. A universal symbol for nano-hazards for example, does not yet exist [ETC].

Figure 2: Conceptual symbols and the lack of an internationally recognised symbol for nano-hazards (Source: [ETC]).

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[2] Source: Adapted from the Atlas of Canada's web page [AOC].

Research on symbol design and evaluation has shown that symbols depicting "generally known specific terms", such as fire and explosion, fare much better than higher level concepts that represent a range of things at the concrete level, such as an emergency or an environmental incident [K07, p. 6]. Furthermore, symbols are best understood if they are of simple design, have a close relationship to the features they represent, have a precise meaning without demanding supplementary explanation, and when size, colour and background are easily perceived [D03]. Familiarity of symbols within the media and the public are also of importance for a widespread recognition [D03]. Finally, it is important to make a difference between symbols that are used for the public and symbols that are used for trained professionals, such as police and fire fighters. The former do not receive education on symbols and thus require more intuitive and pictorial symbols. The latter however, receive training and have cognisance of which symbols are used and what meanings are ascribed to them.

2.2 Symbol comprehension and affecting factors

Prior to the implementation of symbols, certain reliability and validity levels need to be reached. In order to verify whether a symbol is understood or interpreted as expected by the symbol designers, testing and evaluating the levels of comprehension is needed. Organisations that provide standards on how these tests are to be conducted are for example the International Organisation for Standardization (ISO) and the American National Standards Institute (ANSI). In developing an effective Emergency Symbology Set for Europe, the INDIGO project did not limit its focus to the processes and methods that are embodied in these and other standards. However, a broad "thinking outside the box", possibly using non-standardised and maybe even unconventional, yet still high quality or promising methods, was advocated.

The relational theory of affordances, as originally proposed in the 1950s [G94], provides an insight on the influence on our comprehension of symbols: what we can offer or afford. The affordances in the original theory are separated [H03] into four constituents: cognitive, physical, functional, and sensory. Emphasize must be made on the cognitive and the functional constituents during the design step of emergency symbols: "A cognitive affordance is a design feature that helps, aids, supports, facilitates, or enables thinking and/or knowing about something" [H03, p. 319]. Symbols that are precise and clear can thus be a cognitive affordance that could help crisis managers to understand the meaning of a symbol. Functional affordances give information about what action assessment participants might make. It is a design feature that aids the user in doing something [H03, p. 319].

Recent research on display salience and knowledge in [HCF10] suggests that the comprehension of symbols can be facilitated by guiding visual processes in a top-down fashion. However, similar research did "not reveal top-down components of visual attention" [GF09].

Below is a list of recommendations the designers of the INDIGO Emergency Symbology Set took into account in the development process:

- Flicker paradigm: attention is characterised by bottom-up (stimulus driven) and top-down (goal-driven) attentional control [GF09];
- Change blindness: the failure of a visual system whereby significant changes remain undetected by observers [GF09]. Combining flickering graphic representations with interesting graphics might combat this change blindness;
- The individual's prior knowledge has a major influence on the individual understandings of a symbol, according to the Langefors Infologic Equation [PS02].

In order to mitigate potential misunderstandings, symbol design should attempt to be culturally neutral. Although this is a bit of an illusion, it is argued that – since cultural and subcultural bias as well as stereotypes are often deeply entrenched – pictorial symbols have the potential to be culturally neutral [EA96].

Problems with visual interpretation of symbols are similar for the entire population, particularly relating to colour and correct interpretation. Colour blindness is one factor that has a bearing on the ability of people to understand symbols with a high degree of accuracy and speed. Research on how to facilitate the understanding of symbols by the visually impaired has exploded in recent years. Of interest to the INDIGO project is the research of specialists in Taiwan who developed an algorithm that can re-colour images so that the original colour contrast can be well preserved for colour vision impaired viewers [HWC08]. Others [K08] suggest that visual cues can act as general tools to facilitate the understanding for all users.

Colour is valuable when devising or interpreting symbols. In general, people discern colour scales more accurately than two distinct colours, colour blind or not. To improve colour accessibility for the perception for all, and in particular for the colour deficient, research has been made on the elaboration of a Colour Universal Design (CUD) [OI09]. The American USGS and the Arc/INFO colour standards respectively combine 1000 colours and 999 colours. These standards could serve for the colour design of the INDIGO Emergency Symbology Set.

Hägglund [H08] cites a number of general recommendations with respect to colour:

- Black, white, yellow and blue are most readily seen by all, even colour blind;
- Red is typically used for warning, but red is dull for the colour blind; bright yellow is preferable to red but may still be mistaken for green by the colour blind;
- Never red and green in the same symbol;
- Colours and patterns together decrease clarity; black and white patterns are more differentiable;
- Colour differences are difficult to perceive when several colours are in close proximity in limited spaces [H08].

Users under pressure (e.g. during a crisis) may be confused while using a new European Emergency Symbology Set. Time is required for users to feel comfortable and competent with this new symbol set, leaving their previously used symbology set behind. Situations will occur where old symbols may be more readily available than the new ones. Under pressure, users will search for familiar cues in personal experience [BB'tH04]. To avoid this situation, users must become familiar with the new symbols through, for example, training sessions.

2.3 Praxis and politics of standardisation

During the last decades a growth in the number of international and regional standards was triggered by revolutionary technological developments and economic integration on a regional and global level [MB03]. According to Mattli and Büthe, active participation in international standardisation needs significant economic resources and technical expertise [MB03].

Standards Developing Organisations (SDOs), as well as "unofficial" standardisation bodies are highly relevant to the INDIGO project and its aims:

- ISO: The International Organisation of Standardization, a non-governmental network comprised of the national standards institutes of 163 states with one member per state;

- CEN: The European Committee for Standardisation, which is the only recognised European organisation according to Directive 98/34/EC for the planning, drafting and adoption of European Standards in all areas of economic activity with the exception of electrotechnology and telecommunication [CEN];
- CENELEC, ETSI: The European Committee for Standardisation of ELECtrotechnical Standardisation and the European Telecommunications Standards Institutes, committees which concerns electrotechnical and telecommunication standardisations;
- Open Geospatial Consortium (OGC)[3]: an international industrial consortium composed of 483 companies, government agencies and universities.

In [MB03], the authors mention that there are two contesting views of international standards:

- A world society approach, which sees "international standardisation as a resolutely cooperative venture – devoid of distributional consequences and not reducible to the interests of relative power of regions, states, or firms" [MB03, p. 14];
- The other is a more practical approach, which sees "the economic might of states as the principal force in setting the agenda and determining success in international standards setting" [MB03, p. 17]. According to [MB03], the society approach is devoid of politics and contestation, not considering differences in material interests and power. This approach, on the other hand, fails to consider the private sector's institutional dynamics [MB03].

2.4 Standardized symbology sets

From the theoretical aspects in the former paragraphs, we now shift towards the existing and applied symbology schemes and sets that are in use today. From our research the only set of standardised emergency symbology existing is the symbology set used in the United States, developed by the US Federal Geographic Data Committee Homeland Security Working Group (FGDC HSWG) and standardised by the American National Standards Institute (ANSI). Under the review of becoming an Australian standard, is the emergency symbology set developed for use in Australia and New Zealand, named the 'Australasian All-Hazards Symbology'. This set is developed by the Intergovernmental Committee on Surveying and Mapping (ICSM) and the Victoria-based company Spatial Vision. A full list of the current FGDC HSWG and Australasian ICSM symbology can be found in deliverable I4.4.3. These, FGDC HSWG and ICSM, are the only two symbology sets to be consistently used by a broader range of emergency managers on a national or regional basis.

The FGDC HSWG symbology divides the symbols into four categories [KA09]:

- Incidents: cause of action or source of disaster;
- Natural events: phenomenon created by naturally occurring conditions;
- Infrastructure: basic facilities, services and installations needed for the functioning of a community;
- Operations: capabilities or resources available during or implemented due to an emergency.

Borders and patterns around these shapes are used to visually classify the symbols into their respective groups [FGDCa]. The FGDC HSWG Emergency Management Symbology is designed in black and white. There are concerns regarding the accuracy of the Symbology library, the limited reference to point symbols, the large amount of detail in the indications of status levels, a very low level of adoption of the FGDC symbology library, and the absence of evaluation with regard to

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[3] http://www.opengeospatial.org

cultural independence and generalizability. To understand why symbols change, it is advisable to study the changes to the FGDC's emergency management symbology library in greater detail [FGDCb].

The initial process of the Australasian ICSM symbology development, focussed on developing symbology for bushfires and State Emergency Services (SES). The ICSM report recommended a hierarchical approach that catered to all levels of practice or control [ICSM07], i.e. jurisdiction, region, event/incident, the role of mapping and the specific needs for each level. Two major tasks were identified afterwards. The first task was to compile a nationally consistent Incident Management System (IMS) symbology resource catalogue, by conducting an audit of key agencies involved in emergency management and response [ICSM07, p. 10]. The second task was to investigate which symbols were currently in use and where [ICSM07, p. 10]. Three major parameters define the Australasian All-Hazard symbology approach: categories; status; and definition. The symbols are further divided into three categories [ICSM07]:

- Incidents: features relevant to incidents for any hazards including natural events, civil activities, policing and counter terrorism;
- Operations: features relevant to planned and operational responses to events and incidents including supporting intelligence;
- Assets: assets or infrastructures which are relevant to an incident or event or operation response, such as assets at risk, or critical infrastructure that requires protection.

In each of these three categories, features are designed to be recognisable by their frame shapes. An advantage of the Australasian symbology set is that the audit process with stakeholders as held during its development was very thorough. Problems arise with respect to the absence of information regarding how this symbology set was comprehended by users, and regarding implementation risks. The latter are especially relevant in the European context since a greater number of states is targeted to endorse a common symbology set. Three overarching risks [ICSM07], that INDIGO held in mind, were:

- Limited adoption by agencies due to a lack of acceptance of the standard or low prioritisation by agencies;
- Symbols do not meet the needs of the sector;
- Constraints to adoption presented by costs of changes to systems, procedures, and training.

The first two risks can, to some extent, be mitigated by a thorough and inclusive validation process. The third risk pertains to the impact the proposed symbology set may have on existing investments, agencies, workforce skills, system documentation and operational practices and procedures.

2.5 Relevant non-standardized symbology sets

Dymon, in [D03], conducts a preliminary investigation into emergency mapping symbology of various agencies and institutions, resulting in a matrix documenting different symbol schemes from the Western industrialised world, with the exception of Japan and Mexico [D03, p. 229]. In addition to these symbology schemes, the United Nations (UN) has also created standards in its United Nations Military Symbols Handbook [DPKO00] that focus on peace keeping. Within this United Nations umbrella, the International Search and Rescue Advisory Group (INSARAG) developed standards focussing on urban search and rescue (USAR).

Similarly to the UN, the Northern Atlantic Treaty Organisation (NATO) has developed its own standards for mapping symbols ("Standardized Agreement", STANAG APP-6A) to assure consistency throughout their organisation. The symbols are designed to enhance NATO's joint interoperability, and a vast majority of these symbols is relevant for military operations and not for civilian response [NATO86]. This symbology has, to a large extent, been adopted by Australia. This adoption implies that these standards have a "broader appeal", since Australia is not a NATO member state.

The Environmental Systems Research Institute's (ESRI) symbol catalogue contains symbols for the statues of demining operations. Furthermore, the Canadian Government has developed a national standard for hazardous classification and communication, called the Workplace Hazardous Materials Information System (WHMIS), that is primarily used in environmental and workplace health, but also in response [NDC09]. In addition, the International Atomic Energy Agency (IAEA) developed two radiation warning standard symbols, one for the more traditional trefoil radiation warnings and a newer supplementary symbol for ionising radiation warnings. Moreover, the Australasian ICSM survey of symbology systems holds an interesting inventory of relevant symbology sets.

2.6   Conclusions and recommendations based on theoretical underpinnings

This chapter aims to provide an overview of existing (and developing) symbology standards. The initial report (I4.4.3) identified lessons learned drawing from the experiences of previous developers in their attempts to create standardised emergency symbology sets. Moreover, another objective of this chapter was to identify factors in need of consideration when aiming for symbol standardisation. The most striking conclusion was the existence of a plethora of symbols and symbol schemes, but few standardised symbology sets.

The effort of a fully standardised and adopted European Emergency Symbology Set for crisis management is a too ambitious goal for the INDIGO project given human resources and time constrains of the INDIGO project. Therefore, the objective became to develop an initial set of workable European symbols. To fit the European environment, symbols should be as far as possible culturally independent.

The following aspects were identified (based on the theoretical underpinnings) to be addressed in the interactive validation process for the INDIGO Emergency Symbology Set:

- If possible use existing emergency and hazard mapping symbols used by European organisations and agencies;
- Prior to implementing symbols in a European Emergency Symbology Set, levels of comprehension should be tested and evaluated and reach certain established reliability and validity levels;
- Validation processes should be designed to provide opportunities for feedback and subsequent improvement;
- Symbols should be made as readily accessible to practitioners as possible;
- Awareness raising and training activities should support endorsement of the symbols;
- To ensure that proposed symbols are in fact effective, symbol comprehension tests should be conducted;
- To assist agencies in their transition process to a harmonised European Emergency Symbology Set, a funding mechanism should be established;
- Clearly established governance arrangements can facilitate and support implementation;

- Formal accreditation of the developed symbology for Europe as an endorsed standard should be sought by following thorough testing and evaluation. In this regard, CEN's contribution to the INDIGO project and research conducted in the context of the American FGDC symbology library is deemed valuable.

Concerning symbology set design, the following aspects were considered of value in the INDIGO development effort:

- Particularly important for emergency management is grouping symbols into categories by frame shape;
- It is advisable to design a symbol set that is distinctive in both colour and black and white environments;
- A European symbology set should possibly include some status indication;
- A European symbology set ought to include point, line, and polygon symbols;
- Analysis of the changes and suppression of symbols of the FGDC's emergency management symbology library [FGDCb] will help the design of the European from ground start;
- Focus should be made on similar commonly used symbols, in sectors such as emergency management. This will reduce the risk of adoption of this new Emergency Symbology Set.

Furthermore, addressing human sensory issues would minimize reading ambiguities, especially important in stressful situations:

- In symbol design, colour and other visual and cognitive aspects should not be taken lightly [K08];
- Thoughtful research-grounded use of colour in the development of a symbology set is essential [H08];
- Careful attention towards cognitive and human-machine-interface issues and important sensory problems such as "change blindness" is recommended [GB09, p. 204].

Finally, the rich history of European research in the area of symbology and cartography, such as standardisations of the national Swedish Institute of Standards (SIS) [N08], but also the "Atlas of Switzerland" [SSW05], and the findings of Hopfstock [H07] were considered in the design and development stages of the INDIGO Emergency Symbology Set development.

3 Development methodology regarding the INDIGO Emergency Symbology Set

The process of developing the final INDIGO Emergency Symbology Set used within the INDIGO project comprised five steps, some of which have run parallel to one another. Briefly, the development process included: 1) a theoretical review of existing symbology literature; 2) a review of existing national and international symbology standards/sets; 3) end-user input; 4) symbology set design, and 5) validation and revision.

The initial stages of the development process, namely reviews of the existing literature and of symbology standards/sets, respectively, have been described in the previous chapter. One way in which the INDIGO project was able to carry out the development was with the help of various end-user groups, but particularly in France, the Netherlands and Sweden. These groups have gone on to provide the INDIGO project with valuable inputs in developing the various components of the INDIGO tool, including the symbology set. Using a variety of fora, including one-on-one and group meetings, teleconference calls, web-based questionnaires, and end-user workshops held in France (2011) and Sweden (2012), INDIGO was able to capture end-user needs in the field of both organizational and even common symbology development, but also their thoughts on the utility of the INDIGO Emergency Symbology Set.

3.1 Symbology set design

End-user input, coupled with a number of the theoretical considerations and inspiration from certain national and international symbology standards/sets, have informed the process related to the development of the Emergency Symbology Set. A number of visual aspects have been considered in the development of each symbol, which should, to reiterate, be easily perceived and understood by, at the very least, emergency/crisis managers and first responders across Europe.

The development of coherent and distinct symbols is imperative, in order to provide the INDIGO end-users with a visual representation that improves the cognitive representation of complex operative environments and facilitate their focus on core facts of their operative domain. The rationale for creating a symbology set is to enhance the ability of emergency managers to better understand information at a glance during critical decision moments, to facilitate the exchange of information between emergency managers, and to strengthen coordination and communication between responders and planners within and across operative domains and countries. During the design of the Emergency Symbology Set the INDIGO consortium has complied with the objectives of the EU INSPIRE Directive on Infrastructure for Spatial Information in Europe with respect to interoperability of geoinformation and data.

A specific challenge for INDIGO was to optimize the size of the symbology set in order to achieve a workable and comprehensive frame of reference for a wide array of emergency management practitioners. The INDIGO consortium proposed and developed a limited initial set of workable symbols (which was validated during the end-user workshops) rather than aspiring to develop an all-encompassing standardised symbology set for universal use. Considering the plenitude of agencies and actors that ultimately needed to agree on symbols within Europe in order to realise a European standard, it deemed most realistic to focus on proposing symbols for sectors of emergency management that already have similar symbols in their respective symbol documents. To this end, a parallel draft typology of symbols providing an inventory of commonly used symbols in European crisis management was initiated. This draft typology allowed comparison and subsequently validation of symbols used within Europe by emergency services personnel in civilian crises. This cumulative approach allowed the INDIGO consortium to address the relevance of the

symbology set without crowding the user interface with overlapping or interchangeable symbols. The INDIGO consortium also identified gaps where operative needs demanded to devise additional symbols.

Within the design of the Emergency Symbology Set, the INDIGO partners decided to focus solely on the development of the 2D design and not on the 3D symbols. End-users validated the 2D symbols more realistic and usable than 3D symbols at this point. More information regarding the choice and consideration for the design of 2D symbols (instead of both 2D and 3D symbols) is presented in Section 4.3.

In the end, the number of symbols the consortium arrived at after the several rounds of validation is roughly sixty (see the latest version in Annex 2). There is a sharp priority to be made between the ability to reflect every aspect of reality and accommodating for the cognitive limitations represented by an emergency situation. The primary qualities that INDIGO needs to address in its initial deployment are coherence, shared understanding (across agencies, professions, and national borders), as well as visual clarity. The symbol categories that are at the core for the situations envisioned in INDIGO imply a limited number of choices within the main graphic/operational categories. The main goal in subjecting end-users to the imagery centred around these symbols was to create spontaneous situational understanding, and there, available research indicated a limited set of distinguishable and structured symbols would be sufficient.

3.2   Validation and revision

The INDIGO Emergency Symbology Set is routinely subjected to validation by the INDIGO partners and, more importantly, by end-users in France, the Netherlands, and Sweden. Two validation end-user workshops were carried out in November 2011 and October 2012, where French, Dutch and Swedish end-users provided feedback on the symbols, but particularly in relation to how they were perceived. The Emergency Symbology Set has since been revised, and updated. Chapter 4 will go more into detail regarding the end-user workshops and validation

3.2.1   Usability

In the validation process, the INDIGO consortium focused on usability (see also deliverables D9.2.2 Beta Release Validation Report from January 2012 and D9.2.4 Final Release Validation Report to be delivered in April 2013). Usability is the measure of the quality of a user's experience when interacting with a product or system - whether a website, a software application, a mobile technology, or any other user-operated device.

Usability is a combination of factors that affect the user's experience with the product or system, including:

- Ease of learning: How fast can a user who has never seen the product or user interface before learn it sufficiently well to accomplish basic tasks?
- Efficiency of use: Once an experienced user has learned to use the system, how fast can he or she accomplish tasks?
- Memorability: If a user has used the system before, can he or she remember enough to use it effectively the next time or does the user have to start over again learning everything from scratch?

- **Error frequency and severity:** How often do users make errors while using the system, how serious are these errors, and how do users recover from these errors?
- **Subjective satisfaction:** Does the user like using the system?

In the validation tests laid out in the validation plans, the INDIGO consortium assessed the following general features, used in usability engineering studies, which are supposed to provide a good usability assessment of the INDIGO tools and symbology:

- Easy to learn
- Efficient to use
- Easy to remember
- Few errors
- Subjective assessment

The approach regarding the symbology validation tests was to determine whether end-users were able to clearly understand the symbols introduced and use them satisfactorily for their respective purposes. The focus validation tasks also compared how efficient INDIGO was to work with for end-users compared to their typical manners of working, i.e. their respective organisational praxis and routines. Is it, for example, faster to use the symbols in INDIGO and does the symbology aspect of INDIGO make it easier to convey what has happened at a scene or do the symbols in INDIGO actually impede or make more difficult the work that needs to be accomplished by the different end-users?

The INDIGO Emergency Symbology Set was mainly tested on three out of the five usability factors presented above: ease of learning; efficiency of use; and subjective satisfaction.

3.2.2 External symbology monitoring

It should be noted that external symbology monitoring is just as important as end-user input to the revision process. Particularly in the United States (US), the work of maintaining effective symbology is particularly dynamic. INDIGIO partners were active in following the work of the various working groups both in the US and Europe tasked with regularly reviewing symbology so as to ensure that the INDIGO symbology is informed by current thinking in the field.

4 Validating the symbols

4.1 Initial symbology set

As a first step in the development of the INDIGO Emergency Symbology Set, a survey was made to which more than forty worldwide crisis managers, crisis trainers and first responders answered. An analysis of their answers resulted in the following principles that were used in order to create the initial symbol set:

- Do not use too many symbols;
- Three categories are sufficient to classify information;
- Use unique and clearly distinguishable frame shapes per category (such as incident; operation; and infrastructure);
- There is a clear need to distinguish between reliability of information and resource numbers;
- Prioritize visual clarity over informational comprehensiveness.

Furthermore, analysis showed that colours were not necessarily required when creating symbology sets. Colours could, however, be used for specific purposes (i.e. reliable information can show the symbol with a green colour or could be used to identify different fire brigade units). Based on this information, frame shapes were chosen to indicate specific categories (see Figure 3). This led to the development of an initial symbol set, named the INDIGO Beta Emergency Symbology Set, as can be found in Annex 1 and freely available online[4].
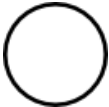
Frame Shape	Name	Definition
	Incident frame shape	This diamond shape is used to identify the item as an incident.
	Infrastructure frame shape	This square shape is used to identify an infrastructure. A roof shape has been added in order not to confuse with the incident diamond shape.
	Operation frame shape	This circle shape is used to identify operations.
	Planned operation frame shape	This circle shape is used to identify operations, and the dot line to express a planned event.

Figure 3: Frame shapes as chosen for the INDIGO Beta Emergency Symbology Set.

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[4] http://www.indigo-project.eu follow links to downloads and symbology.

As the reader can see, the INDIGO Emergency Symbology Set deviates markedly from the contour designs used in the American FGDC and the Australasian symbology sets, respectively. Rather, the suggested frame shapes are concurrent with those used in the MNE5/SHIFT- project. A full seven EU member states are parties to this project. As the INDIGO project strives to create symbols for common use within Europe, it is particularly important to develop symbology that is synergistic in relation to other symbology development efforts in Europe.

4.2   Validation

The validation plans for INDIGO, for both the Beta Release and Final Release version of the INDIGO system and symbology, aimed to evaluate the usability of the developed system in a crisis training environment. To ensure the developed INDIGO system and symbology were easy to use and perform well in accordance with end-user needs; they were tested by the end-users themselves.

Validation of the Emergency Symbology Set was done by organising two end-user workshops, one in France (2011) and one in Sweden (2012)[5]. The end-user workshop in France was based on the Beta Release Validation Plan, which aimed for suggestions and recommendations regarding the Beta Emergency Symbology Set. Analysis of the feedback, suggestions and recommendations assisted the development of the final INDIGO Emergency Symbol Set, which was tested in the end-user workshop in Sweden.

The INDIGO consortium prepared validation plans for both end-user workshops. For both symbology validation tests, the goal was to determine whether end-users were able to clearly understand the symbols introduced and use them satisfactorily for their respective purposes.

Respectively, the Beta Release Validation Report (D9.2.2) and the Final Release Validation Report (D9.2.4) present feedback of end-users on the specific focus validation tasks in the French and the Swedish workshops. The following paragraphs summarise the results from the French and the Swedish end-users regarding symbology.

4.2.1   Results from France

The goal of the symbology validation test in France was to determine whether end-users were able to clearly understand the symbols introduced, and if they were able to use them satisfactorily for their respective purposes. During the carrousel exercise on the 22nd of November 2011, the validation for the symbology tested whether the end-users "generally" understood the symbols without learning.

In general, end-users found it interesting that there was progress towards a European Emergency Symbology Set. One end-user commented that the symbology was very intuitive and good for quick understanding. However, the interpretation of some symbols, such as avalanche, isolated person, and chemical risk, worked poorly. French end-users had difficulty with understanding whether symbols indicated risks or incidents. Furthermore, French end-users normally used colour codes to characterise intervention types. Dutch end-users however, indicated that the symbology was appropriate and matched the one they normally use. Concerning "colour", there was general agreement that the Emergency Symbology Set would greatly improve if colour was to be added.

After the Beta Validation, it was clear that some symbols needed to be changed with regard to their contour. The contour categories that needed revising were:

- **"Risk"** (for an incident) that should be depicted as a downward-pointing triangle;

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[5] The first end-user workshop of the INDIGO project was organized in The Hague (the Netherlands) in 2010. This first workshop aimed to validate the user requirements and did not yet focus on testing of tools and/or symbols.

- Actual **"incidents"** should be depicted using something akin to the French fire fighting symbol for an incident, namely a squiggly red line or, alternatively, a red box with crosshairs. These symbols are less likely to be misunderstood when using the map device (i.e. when reading upside down);
- Fixed (and semi-permanent) **"infrastructure"** should be depicted using a square;
- **"Mobile resources"**, such as vehicles and road barriers should be depicted using a circle.

Proposed changes to individual symbols were:

- **"Earthquake"** – several suggestions to consider, including a house to complement the existing symbol;
- **"Medical"** – suggestion to consider the universal snake symbol or a cross. For fixed medical infrastructure, such as a hospital, there was general agreement to use a simple "H";
- **"Media"** – it was suggested to develop a clear idea as to what the "media" symbol is intended to visualise. Once this is done, evaluation of the utility of the current symbol can begin. Some end-users understood the current symbol to mean a location where a live camera feed was set up;
- **"Incident command/EOC"** – this symbol, using a flag, was still misunderstood, but used correctly during the exercise itself. It was suggested to leave this symbol unchanged for the time being;
- **"Chemical incident"** – suggestion to consider depicting this symbol as a cracked beaker, since the current symbol tended to be understood as a warning for chemicals;
- **"Control point"** – the symbol was difficult to understand, however no good alternatives were suggested;
- **"Shelter"** – suggestion to return to a first try of the symbol that included more people under the roof;
- Include symbols indicating risk for and incidents of **"avalanches"** and **"rock slides"**.

Additional symbols regarding mobile resource symbols for "military units" and "municipal authorities" could be added. Moreover, a symbol suggesting "collapse risk" should be considered.

Following the French end-user workshop, the user requirement concerning symbology needed to be adapted as follows:

EUR/SR/14	Symbology	Mandatory

End-users prefer to share symbology at a central European level, but this symbology is still in development and in the meantime end-users need to use their own symbology. Therefore the INDIGO software needs to support "multiple symbologies" via some kind of modular system.

UPDATE: This requirement changed from interesting to mandatory. Given the fact that users find it interesting to have a shared symbology, there is a need to facilitate the use of symbology within the INDIGO system.

Overall, it became clear that the INDIGO Emergency Symbology Set needed to be subjected to additional end-user scrutiny in other parts of Europe to ensure its usability and to add additional improvements. Therefore, the suggestions of the end-users were incorporated into the Emergency Symbology Set and tested again during the end-user workshop in Sweden.

4.2.2   Results from Sweden

The goal of the symbology validation test in Sweden was, just as in France, to determine whether end-users were able to clearly understand the INDIGO Emergency Symbology Set – as improved after the end-user workshop in France – and if they were able to use them satisfactory for their respective purposes. During the carrousel exercise, the validation test of the scenario aimed to find out whether end-users "generally" understood the symbols without learning. The final INDIGO Emergency Symbology Set, as tested during this exercise, can be found in Annex 2.

In general, Swedish end-users commented that they were very pleased by the idea of a common symbology. End-users were equally divided in their thoughts about how easy the symbols could be learned. Some end-users found it hard to understand the symbols while others did not encounter difficulties. Comments of end-users were that some symbols were clearer than others and that the frame shape enhanced understanding of the symbols. One end-user commented that once users would be familiar with the symbols they would be very easy to use.

Most end-users agreed that the symbols would be efficient in daily use. The symbols generate a common understanding and language that contributes to quickly getting the same grasp of a situation. One end-user added to this that the symbols are especially efficient because of their frame shape. Another end-user added that the symbols are specifically useful in describing functions in a page. However, one end-user commented that the symbols were not very intuitive in every instance.

The figure below shows that 80,6% of all symbols was guessed correct by the end-users, 19,4% was guessed incorrect by end-users. From the incorrect answers, a total of 66,7% (which is 12,9% of the total) received 'no answer' and can be considered unclear for end-users. It is important to make note that the guesses on the symbols were done without learning. Annex 3 presents the complete overview of results from the symbology validation in Sweden.

Answer	Percentage	Explanation
Correct	80,6%	50 symbols out of 62 symbols
Incorrect	19,4%	12 symbols out of 62 symbols
No answer	66,7%	Out of the mostly incorrect answers, 8 symbols received 'no answer' (which is 12,9 % of the total answers)

Figure 4: Overview results symbology validation in Sweden

Overall, what end-users considered to be very good about the Emergency Symbology Set were the categorised risks and accidents and the advantages of the frame shapes. Symbols understood by everyone, divided by category were:

- Actual "**incidents**" (related to bomb; explosion; fire; hurricane; flood; water);
- "**Risks**" (related to bomb; hurricane; nuclear; plane; water; explosion);
- "**Infrastructure**" (related to water point; military);
- "**Mobile resources**" (related to firemen operation).

Not satisfactory were the symbols on infrastructures and planned operations. The symbols that were most difficult to understand were the symbols related to a communication operation and those indicating a municipality infrastructure.

One end-user mentioned that providing an explanation of the symbols could be an advantage. In addition, end-users indicated that there were some symbols missing in de Emergency Symbology Set, namely:

- An **"empty symbol"** that can be filled on the spot;
- A symbol for **"fuel storage"**;
- A symbol for **"gas storage"**;
- A symbol expressing who is in **"command of an area"**;
- A symbol for an **"important building"**.

To ensure the usability of the Emergency Symbology Set, recommendations for improvement from the Swedish end-user workshop, will be incorporated in the updated Emergency Symbology Set at the end of the project.

4.3   3D symbols

In the validation process, the INDIGO consortium made a decision regarding the development of a 3D symbology. The INDIGO project initially aimed to provide the symbols in both 2D and 3D representation. The consortium tested the 2D and 3D symbols with different end-users which led to the conclusions that "2D symbols are much clearer" in both 2D and 3D maps.

Regarding the 3D symbols, the consortium proposed the following conditions:
- The consortium created a high quality 3D object for an end-user to see when he/she would be close to the symbol in a 3D map;
- Moving away from the symbol, the symbol would switch to a "yellow representation" and this yellow representation kept a constant size (i.e. it did not become smaller or larger);
- When moving closer again, the symbol switched back to the high quality 3D representation.

In the figure below, some examples of the high quality 3D objects are displayed.
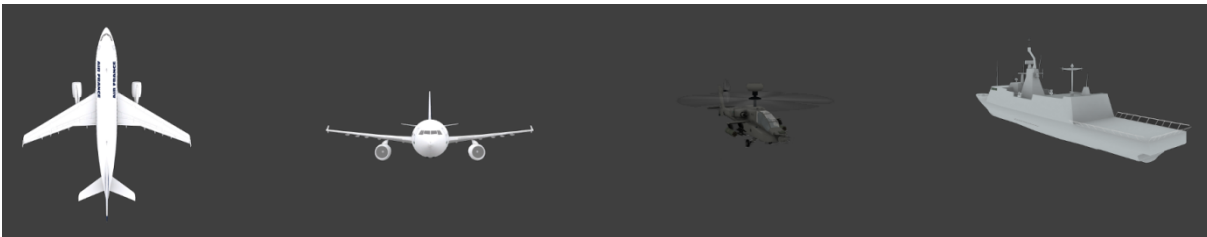
Figure 5: Example of high quality 3D symbols

Figure 6 displays the smaller "yellow representation". These yellow symbols have the same screen surface (in pixels) as the high quality 3D objects in the figure above. Changing the point of view in a 3D map with 3D symbols makes the yellow symbols appear smaller because of the angle perspective. It is clear that, depending on the camera point of view, objects can be hardly distinguishable, which can lead to a loss of information.

Figure 6: Example of the smaller "yellow representation" of 3D symbols

A challenge in 3D visualization is that there are many 3D representations of one incident. For example, an aircraft incident can be for example a crash, nose in the ground, a broken wing, a bad landing, or anything else. End-users expect realism in the representation in a symbolic manner when using 3D. The end-user would like to see in 3D symbols for example the aircraft wing to be visually broken. If an end-user observes a crack in the 3D mountain due to an earthquake, they expect this crack to represent the real size of the crack of the current crisis, and be able to work around it.

End-users can easily imagine what is behind a symbolic 2D representation, but when it comes to 3D (e.g. when end-users can turn around a symbol and the symbol looks real), end-users have to make an effort to understand that part of what they see in the 3D map is quite realistic (such as real mountain heights and real orthographic imagery) and part of it is not what is on the field (i.e. the 3D symbol representation). Using 3D symbols might even confuse end-users while trying to manage a crisis.

Based on the tests with the 3D symbols and the difficulty for end-users to understand them, the consortium decided to develop 2D symbols that can be used in both 2D and 3D maps and provide a much clearer understanding to end-users.

4.4 Dissemination of symbols

To encourage the adoption of the Emergency Symbology Set by European organisations, the INDIGO consortium decided to release this set in the public domain, available on the website of INDIGO. To facilitate the use, the set is available in a Portable Network Graphic format and in a True Type Font format. The former enables one to insert the symbol as an image in software or for printing purposes, while the latter enables one to make use of symbols inside a text editor. Moreover, a Scalable Vector Graphics format is also available, which can be seen as an "open" editable file format, if one needs to customize the symbol for specific organisation use.

The symbols have been diffused to civil security and industrial organisations during two end-user workshops. In addition, the Emergency Symbology Set has been proposed and used by at least three other FP7 projects, namely E-SPONDER, BESST and ESS. The ESS project has even proposed new symbols respecting the final INDIGO Emergency Symbology Sets' graphics design. It was decided not to validate the request as it was too specific; adding specific icons would lead to a huge set of symbols, which would be contradictory with the small in size constraint.

Furthermore, to enable a formal diffusion of the Emergency Symbology Set, work is on-going to prepare the European standardisation stage. A European standard stamp would make the set more trusted by European organisations, however, it will not force them to adopt this future "European" Emergency Symbology Set.

5 Conclusions and recommendations

5.1 Conclusions

Contemporary crises are often transboundary in character, necessitating involvement of different nations, different levels of government, and their respective agencies. When a crisis demands attention and resources from different jurisdictions and nations, communication and coordination of information typically becomes troublesome. Maps can be of great assistance, summarising and describing a situation visually, thereby presenting a variety of actors with a Common Operational Picture (COP). Increasing use of integrative Geographic Information Systems (GIS) has highlighted the need for standardised symbology to be used on these maps. Using a common symbology facilitates the exchange and quick interpretation of vital information between both decision makers and emergency responders, which is often crucial to successful crisis management.

Furthermore, a shared European Emergency Symbology Set benefits emergency managers by [D03, p. 228]:

- Facilitating exchange of information and data;
- Promoting universal understanding of hazardous and vulnerable locations;
- Addressing the communication of mission critical information across agencies, jurisdictions, and all levels of public and private sectors;
- Strengthening coordination and communication between planners;
- Enhancing the ability of emergency managers to better understand information at a glance during critical decision-making moments.

In sum, the INDIGO consortium followed most recommendations coming from the literature, e.g. regarding the use of existing European symbols, testing and validation of the Emergency Symbology Set, frame shape, distinctive in colour and black and white environment, and focus on similar commonly used symbols. In addition, the validation during the end-user workshops generated valuable recommendations for improving the Emergency Symbology Set. And in the end, the INDIGO consortium was able to realise a final Emergency Symbology Set.

5.2 Recommendations

To improve decision making across organisational and national boundaries and to make sure that the Emergency Symbology Set will and can be used across Europe, the INDIGO consortium recommends to:

- Make the INDIGO Emergency Symbology Set publicly available on the INDIGO website;
- Make the INDIGO Emergency Symbology Set collaborative. European organisations need to be able to propose modifications or new symbols. Changes will need to be validated by a dedicated consortium;
- Provide the INDIGO Emergency Symbology Set to use in other FP7 projects;
- Distribute the INDIGO Emergency Symbology Set across other European agencies and consortia (both public and private) focusing on crisis management. In addition, encourage them to distribute the Emergency Symbology Set towards their national and local contacts;
- Keep practicing with the INDIGO Emergency Symbology Set as often as possible and improve symbols where necessary according to technological and practical improvements and changes;
- Try to standardize the Emergency Symbology Set in Europe in order to gain more trust in and support for the symbol. CEN's contribution to the INDIGO project is deemed valuable in this regard.

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7 Annex 1: Initial INDIGO Emergency Symbology Set divided by their frame shape and category

Incidents

Symbol	Name	Definition
	Avalanche	*Avalanche, rock slide (Geologic)* – A large mass of snow, ice, soil, or rock, or mixtures of these materials, falling, sliding, or flowing very rapidly under the force of gravity. (Source: Dictionary of Geological Terms, 2rd Ed.).
	Biological incident	Poisonous, infectious and/or bio hazardous materials that may cause a serious disease resulting in illness or death (Drawn from Canadian definition).
	Bomb	The presence of bomb or an expressed intention to detonate a bomb.
	Chemical incident	The unintended release of a chemical substance, which may result in psychological disorientation, serious injury, incapacitation or death.
	Contagious illness	The presence of a disease or illness that has a considerable risk of being transmitted.
	Earthquake	The passage of seismic waves causing the earth to vibrate.
	Electricity failure, power outage	A temporary or long-term disruption in the supply of electricity/power in a certain area.
	Explosion	The uncontrolled or potentially dangerous presence of any substance or object equipped to detonate followed by the risk of a chemical reaction.
	Fire	The destructive act of something burning (US FGDC Homeland Security).
	Flood	An area of land that is not normally covered by water, covered by or submerged by a large amount of water.
	Hurricane	The movement of air exceeding normal levels in mass, force or speed.

Symbol	Name	Usage
	Hurt/lost individual	The presence of an individual in need of medical and/or rescue services.
	Maritime incident	An event involving a boat or ship resulting in damage, bodily injury, death, or the disruption of transportation service (US FGDC Homeland Security).
	Nuclear incident	The uncontrolled or potentially dangerous presence of any material having a specific activity greater than 70Bq per gram (US FGDC Homeland Security).
	Aircraft incident	An event involving an aircraft resulting in damage, bodily injury, death, or the disruption of transportation service (US FGDC Homeland Security).
	Riot	A public disturbance involving a threat, intention, or execution to commit violent acts.
	Automobile incident	An event involving a wheeled or tracked vehicle resulting in damage, bodily injury, death, or the disruption of transportation service (US FGDC Homeland Security).
	Train incident	An event involving a train resulting in damage, bodily injury, death, or the disruption of transportation service (US FGDC Homeland Security).
	Water disruption	A temporary or long-term disruption in the public water supply in a certain area.

Infrastructure

Symbol	Name	Usage
	Division command	The location at an incident from which the Division Commander operates (AIMS).
	Electricity point	A point where electricity is generated.
	Fire brigade	A place where fighting fire services are available.
	Medical	A fixed infrastructure where medical services are available.

	Police	A place where police resources are located and/or available.
	Shelter	A basic architectural structure or building that provides cover or temporary protection from harmful or dangerous elements.
	Water point	A place where public drinking water is available.

(Planned) Operations
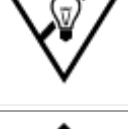
Symbol	Name	Usage
	Automobile	A wheeled motor vehicle used primarily for transporting passengers that also carries its own engine or motor.
	Planned automobile	
	Control point	A designated meeting place to be used after an emergency, natural disaster, or evacuation.
	Planned control point	
	Division command	The location at an incident from which the Division Commander operates.
	Planned division command	
	Evacuation	An emergency exit from a dangerous place.
	Planned evacuation	
	Fire brigade	The presence of a public, private or volunteer organisation with fire fighting capacity.
	Planned fire brigade	

	Helicopter	A type of rotorcraft that can lift, thrust, take off and land vertically, hover, as well as fly forwards, backwards, and laterally.
	Planned helicopter	
	Media	An official media information centre (CB) where information is obtained and then distributed via television, radio, newspaper, or social media.
	Planned media	
	Medical	Available medical services.
	Planned medical	
	Police	A constituted body of persons empowered by the state to enforce the law, protect property, and limit civil disorder.
	Planned police	
	Road block	A temporary installation set up to control or block traffic along a road.
	Planned road block	
	Truck	A wheeled motor vehicle designed to transport cargo and that carries its own engine or motor.
	Planned truck	

8 Annex 2: Final INDIGO Emergency Symbology Set

Incidents / Risks

Symbol					Name	Definition
Black & White		Color				
	PNG SVG		PNG SVG		Aircraft incident	An event involving aircraft resulting in damage, bodily injury, death, or the disruption of transportation service (US FGDC Homeland Security).
	PNG SVG		PNG SVG		Aircraft risk	
	PNG SVG		PNG SVG		Automobile incident	An event involving a wheeled or tracked vehicle resulting in damage, bodily injury, death, or the disruption of transportation service (US FGDC Homeland Security).
	PNG SVG		PNG SVG		Automobile risk	
	PNG SVG		PNG SVG		Avalanche incident	*Avalanche (Geologic)* - A large mass of snow, ice, soil, or rock, or mixtures of these materials, falling, sliding, or flowing very rapidly under the force of gravity. (Source: Dictionary of Geological Terms, 3rd Ed.)
	PNG SVG		PNG SVG		Avalanche risk	
	PNG SVG		PNG SVG		Biological incident	Poisonous, infectious and/or biohazardous materials which may cause a serious disease resulting in illness or death (Drawn from Canadian definition).
	PNG SVG		PNG SVG		Biological risk	
	PNG SVG		PNG SVG		Bomb incident	The presence of bomb or an expressed intention to denote a bomb.
	PNG SVG		PNG SVG		Bomb risk	

					Symbol	Description
	PNG SVG		PNG SVG	Chemical incident	The unintended release of a chemical substance, which may result in psychological disorientation, serious injury, incapacitation or death.
	PNG SVG		PNG SVG	Chemical risk	
	PNG SVG		PNG SVG	Contagious illness incident	The presence of a disease or illness which has a considerable risk of being transmitted.
	PNG SVG		PNG SVG	Contagious illness risk	
	PNG SVG		PNG SVG	Earthquake incident	The passage of seismic waves causing the earth to vibrate.
	PNG SVG		PNG SVG	Earthquake risk	
	PNG SVG		PNG SVG	Electrecity failure, power outage incident	A temporary or long-term disruption in the supply of electricity/power in a certain area.
	PNG SVG		PNG SVG	Electrecity failure, power outage risk	
	PNG SVG		PNG SVG	Explosion incident	The uncontrolled or potentially dangerous presence of any substance or object equipped to detonate followed by the risk of a chemical reaction.
	PNG SVG		PNG SVG	Explosion risk	
	PNG SVG		PNG SVG	Fire incident	The destructive act of something burning (US FGDC Homeland Security).
	PNG SVG		PNG SVG	Fire risk	

					Name	Description
	PNG SVG		PNG SVG		Flood incident	An area of land, which is not normally covered by water, covered by or submerged by a large amount of water.
	PNG SVG		PNG SVG		Flood risk	
	PNG SVG		PNG SVG		Hurricane incident	The movement of air exceeding normal levels in mass, force or speed.
	PNG SVG		PNG SVG		Hurricane risk	
	PNG SVG		PNG SVG		Hurt/lost individual incident	The presence of an individual in need of medical and/or rescue services.
	PNG SVG		PNG SVG		Hurt/lost individual risk	
	PNG SVG		PNG SVG		Maritime incident	An event involving a boat or ship resulting in damage, bodily injury, death, or the disruption of transportation service (US FGDC Homeland Security).
	PNG SVG		PNG SVG		Maritime risk	
	PNG SVG		PNG SVG		Nuclear incident	The uncontrolled or potentially dangerous presence of any material having a specific activity greater than 70 Bq per gram (US FGDC Homeland Security).
	PNG SVG		PNG SVG		Nuclear risk	
	PNG SVG		PNG SVG		Riot incident	A public disturbance involving a threat, intention, or execution to commit violent acts.
	PNG SVG		PNG SVG		Riot risk	

Symbol				Name	Usage
	PNG SVG		PNG SVG	Rock slide incident	A rockslide is a type of landslide caused by rock failure in which part of the plane of failure passes through intact rock and where material collapses en masse and not in individual blocks. The rocks tumble downhill loosening other rocks on its way also smashing everything in its path (Source: Dictionary of Physical Geography).
	PNG SVG		PNG SVG	Rock slide risk	
	PNG SVG		PNG SVG	Train incident	An event involving train resulting in damage, bodily injury, death, or the disruption of transportation service (US FGDC Homeland Security).
	PNG SVG		PNG SVG	Train risk	
	PNG SVG		PNG SVG	Water disruption incident	A temporary or long-term disruption in the public water supply in a certain area.
	PNG SVG		PNG SVG	Water disruption risk	

Infrastructure

Symbol Black & White | Color				Name	Usage
	PNG SVG		PNG SVG	Division command	The location at an incident from which the Division Commander operates (AIIMS).
	PNG SVG		PNG SVG	Electricity point	A point where electricity is generated.
	PNG SVG		PNG SVG	Fire brigade	A place where fighting fire services are available.
	PNG SVG		PNG SVG	Medical	A fixed infrastructure where medical services are available.
	PNG SVG		PNG SVG	Military authorities	A military is an organization authorized by its greater society to use lethal force, usually including use of weapons, in defending its country by combating actual or perceived threats. The

Symbol		Name	Usage
			military may have additional functions of use to its greater society, such as advancing a political agenda e.g. military junta, supporting or promoting economic expansion through imperialism, and as a form of internal social control.(Source: Wikipedia)
PNG SVG	PNG SVG	Municipality authorities	A Municipal Authority is a form of special-purpose governmental unit. The municipal authority is an alternate vehicle for accomplishing public purposes without the direct action of counties, municipalities and school districts. These purposes commonly include the acquisition, financing, construction and operation of projects such as water supply and sewer systems, airports, transit systems, parking garages, flood control systems, parks, and similar entities (Source: Wikipedia).
PNG SVG	PNG SVG	Police	A place where police resources are located and/or available.
PNG SVG	PNG SVG	Shelter	A basic architectural structure or building that provides cover or temporary protection from harmful or dangerous elements.
PNG SVG	PNG SVG	Water Point	A place where public drinking water is available.

Operations

Symbol		Name	Usage
Black & White | Color		Name	Usage
PNG SVG	PNG SVG	Automobile	A wheeled motor vehicle used primarily for transporting passengers, which also carries its own engine or motor.
PNG SVG	PNG SVG	Planned automobile	
PNG SVG	PNG SVG	Control point	A designated meeting place to be used after an emergency, natural disaster, or evacuation.

PNG SVG	PNG SVG	Planned control point	
PNG SVG	PNG SVG	Division command	The location at an incident from which the Division Commander operates.
PNG SVG	PNG SVG	Planned division command	
PNG SVG	PNG SVG	Evacuation	An emergency exit from a dangerous place.
PNG SVG	PNG SVG	Planned evacuation	
PNG SVG	PNG SVG	Fire brigade	The presence of a public, private or volunteer organization with fire fighting capacity.
PNG SVG	PNG SVG	Planned fire brigade	
PNG SVG	PNG SVG	Helicopter	A type of rotorcraft which can lift, thrust, take off and land vertically, hover, as well as fly forwards, backwards, and laterally.
PNG SVG	PNG SVG	Planned helicopter	
PNG SVG	PNG SVG	Media	An official media information center (CB) where information is obtained and then distributed via television, radio, newspaper, or social media.
PNG SVG	PNG SVG	Planned media	
PNG SVG	PNG SVG	Medical	Available medical services.

PNG SVG	PNG SVG	Planned medical		
PNG SVG	PNG SVG	Military	Available military services.	
PNG SVG	PNG SVG	Planned Military		
PNG SVG	PNG SVG	Police	A constituted body of persons empowered by the state to enforce the law, protect property, and limit civil disorder.	
PNG SVG	PNG SVG	Planned police		
PNG SVG	PNG SVG	Road block	A temporary installation set up to control or block traffic along a road.	
PNG SVG	PNG SVG	Planned road block		
PNG SVG	PNG SVG	Truck	A wheeled motor vehicle designed to transport cargo and which carries its own engine or motor.	
PNG SVG	PNG SVG	Planned truck		

9   Annex 3: Results symbology validation in Sweden, October 2012

Results per symbol

Risk related to car

Correct	Incorrect	Remarks mentioned
5	4	Traffic jam

Incident related to Rockslide

Correct	Incorrect	Remarks mentioned
8	1	

Planned meeting point

Correct	Incorrect	Remarks mentioned
7	2	

Risk related to chemicals

Correct	Incorrect	Remarks mentioned
7	2	

Firemen infrastructure

Correct	Incorrect	Remarks mentioned
8	1	

Incident related to biological

Correct	Incorrect	Remarks mentioned

| 6 | 3 | Disease, chemical |

Related to a medical operation

Correct	Incorrect	Remarks mentioned
8	1	

Risk related to earthquake

Correct	Incorrect	Remarks mentioned
5	4	No answer, chemical

Medical infrastructure

Correct	Incorrect	Remarks mentioned
8	1	

Incident related to bomb

Correct	Incorrect	Remarks mentioned
9	0	Some called it explosion

Risk related to Avalanche

Correct	Incorrect	Remarks mentioned
2	7	Flooding, volcano

Related to a communication operation

Correct	Incorrect	Remarks mentioned
0	9	Radio, transmitter, repeater, sending, broadcast

Related to a truck or big vehicle operation

Correct	Incorrect	Remarks mentioned
3	6	Fire, logistics, truck parking area, no answer

Risk related to hurt or lost person

Correct	Incorrect	Remarks mentioned
7	2	Many specific answers: falling, slipping

Incident related to chemicals

Correct	Incorrect	Remarks mentioned
6	3	No answer, electricity failure

electricity **infrastructure**

Correct	Incorrect	Remarks mentioned
8	**1**	

Risk related to rock slide

Correct	Incorrect	Remarks mentioned
8	1	

water **infrastructure**

Correct	Incorrect	Remarks mentioned
9	0	

Incident related to electricity

Correct	Incorrect	Remarks mentioned
7	2	

Incident related to earthquake

Correct	Incorrect	Remarks mentioned
5	4	No answer, chemical incident

Risk related to contagious illness

Correct	Incorrect	Remarks mentioned
1	8	Risk of pollution, -gas, -intoxication, -smoke

Risk related to electricity

Correct	Incorrect	Remarks mentioned
8	1	

Incident related to explosion

Correct	Incorrect	Remarks mentioned
9	0	

Related to a firemen operation

Correct	Incorrect	Remarks mentioned
9	0	

Incident related to fire

Correct	Incorrect	Remarks mentioned
9	0	

Risk related to flood

Correct	Incorrect	Remarks mentioned
9	0	

Police **infrastructure**

Correct	Incorrect	Remarks mentioned
7	2	

Related to an evacuation operation

Correct	Incorrect	Remarks mentioned
2	7	Not specific enough: exit, emergency exit, escape

Incident related to plane

Correct	Incorrect	Remarks mentioned
8	1	

Risk related to bomb

Correct	Incorrect	Remarks mentioned
9	0	

Incident related to nuclear

Correct	Incorrect	Remarks mentioned
8	1	Many specified by talking about radiation

Risk related to hurricane

Correct	Incorrect	Remarks mentioned
9	0	

Incident related to marine

Correct	Incorrect	Remarks mentioned
8	1	

Incident related to hurt /lost person

Correct	Incorrect	Remarks mentioned
6	3	Many people were talking about falling/slipping

Related to a car operation

Correct	Incorrect	Remarks mentioned
2	7	Parking garage, evacuation route, car parking, no answer

Risk related to nuclear

Correct	Incorrect	Remarks mentioned
9	0	

Incident related to riot

Correct	Incorrect	Remarks mentioned
8	1	

shelter **infrastructure**

Correct	Incorrect	Remarks mentioned
4	5	No answer, assembly point, family

Incident related to hurricane

Correct	Incorrect	Remarks mentioned
9	0	

Risk related to train

Correct	Incorrect	Remarks mentioned
8	1	

division command **infrastructure**

Correct	Incorrect	Remarks mentioned
2	7	No answer, rescue post

Incident related to flood

Correct	Incorrect	Remarks mentioned
9	0	

Risk related to biological

Correct	Incorrect	Remarks mentioned
7	2	

Planned division command

Correct	Incorrect	Remarks mentioned
2	7	No answer, rescue post

Incident related to train

Correct	Incorrect	Remarks mentioned
8	1	

Planned helicopter

Correct	Incorrect	Remarks mentioned
7	2	

Risk related to marine

Correct	Incorrect	Remarks mentioned
7	2	

Incident related to car

Correct	Incorrect	Remarks mentioned
6	3	Description too general (traffic incident), road

Related to a police operation

Correct	Incorrect	Remarks mentioned
7	2	

Incident related to water

Correct	Incorrect	Remarks mentioned
9	0	

municipality **infrastructure**

Correct	Incorrect	Remarks mentioned
0	9	No answer, police

Risk related to plane

Correct	Incorrect	Remarks mentioned
9	0	

Planned roadblock

Correct	Incorrect	Remarks mentioned
5	4	No answer

Incident related to contagious illness

Correct	Incorrect	Remarks mentioned
1	8	Health, pollution, toxic, gas, smoke

Incident related to avalanche

Correct	Incorrect	Remarks mentioned
2	7	Flooding, volcano

Risk related to water

Correct	Incorrect	Remarks mentioned
9	0	

Risk related to fire

Correct	Incorrect	Remarks mentioned
8	1	

military **infrastructure**

Correct	Incorrect	Remarks mentioned
9	0	

Risk related to explosion

Correct	Incorrect	Remarks mentioned
9	0	

Planned medical operation

Correct	Incorrect	Remarks mentioned
7	2	

Risk related to riot

Correct	Incorrect	Remarks mentioned

8	1	

Planned military operation

Correct	Incorrect	Remarks mentioned
8	1	