# Standardizing Map Symbology for Critical Incidents

Alan M. MacEachren | maceachren@psu.edu Anthony C. Robinson | arobinson@psu.edu Robert E. Roth | reroth@psu.edu Kristin A. Cook | kris.cook@pnl.gov



#### Overview

The **Department of Homeland Security (DHS)** contains many diverse organizations that produce or use maps to plan for and respond to critical incidents. Audiences for these maps range from geospatial analysts, through emergency response personnel, to the general public. While individual organizations have their own conventions for map symbology, there is not a consistent set of symbols shared across all DHS missions.

The Homeland Security Working Group of the Federal Geographic Data Committee developed a formal standard (**ANSI INCITS 415-2006**) to address point symbology needs for some elements of the emergency management community. The ANSI standard focused on a narrow subset of mapping needs for technology that changes rapidly. For both reasons, it is important to learn how widely the ANSI standard has been adopted and what map symbol needs are not currently addressed by the standard.

INCIDENTS		NATURAL EVENTS	OPERATIONS		INFRASTRUCTURE		
civil disturbance incident	flammable gas	after shock	emergency medical	law enforcement operation	food retail	natural gas	Airport
civil demonstrations	flammable liquid	avalanche	EMT station locations	ATF ATF ATF ATF Bur. Alcohol, Tobacco, Firearms & Explosives	grain storage	🛞 🛞 🛞 nuclear facilities	XXXX bridge
civil displaced	flammable solid	earth quake epicenter	ambulance	border patrol	<b>\$ \$ b</b> anking finance & insurance	petroleum facilities	bus station
civil rioting	non-flammable	landslide	The second secon	customs service	ATMs	propane facilities	Le Le ferry terminal
criminal activity incident	organic peroxides	subsidence	health department facility	DEA (DEA) (DEA) (DEA) Drug Enforcement Administration	S S S banks	government site	helicopter landing site
bomb threat	oxidizers	volcanic eruption		Department of Justice	👑 避 🛞 bullion storage	military	
bomb	radioactive material	volcanic threat	hospital ship	<b>FBI (FBI</b> ) <b>(FBI</b> ) <b>(FBI</b> ) Federal Bureau of Investigation	federal reserve banks	🛋 🔜 🔜 military armory	maintenance
bomb explosion	spontaneously combustible	drizzle	(1) (1) (1) (1) medical facilities out patient		financial exchanges	Military base	port
looting	toxic gas	drought	morgue	(III) (III) (III) prison	tinancial services	postal service	
poisoning	toxic and infectious	flood	R R R R P pharmacies	Secret service	Commercial infrastructure	B B B B C postal distribution center	The stop
shooting	unexploded ordnance	fog	triage	TSA TSA TSA TSA TSA Security Admin.	chemical plant	post office	ship anchorage
fire incident	air incident	hail	emergency operation	US Coast Guard	firearm manufacturers	1 public venues infrastructure	toll facility
hot spot	air accident	inversion	emergency collection evacuation point	US Marshalls Service	Fig. Fig. Fig. firearm retailers	enclosed facility	traffic control
non-residential fire	air hijacking	rain	emergency incident command center	Sensor operation	hazardous material production	open facility	traffic inspection facility
origin	marine incident	sand dust storm	emergency operations	i 🛞 🛞 🛞 🧑 biological sensor	ball the storage hazardous material	A A A A A recreational area	🙈 底 🔝 tunnel
residential fire	marine accident	snow	emergency public information center	Chemical sensor	industrial site	religious institution	water supply infrastructure
school fire	marine hijacking	thunder storm	emergency shelters	() () () () () () () () () () () () () (		Special needs infrastructure	Handfill
smoke	rail incident	tornado	emergency staging	🛞 🛞 🛞 🧭 nuclear sensor	R R R pharmaceutical manufacturer	Adult day care	🕮 🔝 🌆 dam
special needs fire	rail accident	tropical cyclone	emergency teams	radiological	Superfund sites	kild day care	discharge
wild fire	rail hijacking	tsunami	emergency water distribution center		toxic release inventory	A A A A A A A A A A A A A A A A A A A	<u> </u> ふ <u> ふ</u> ground well
hazardous materia	l vehicle incident	bird infestation	emergency food distribution center	പ്പി പ്രി പ്രി agriculture and food	educational facilities	telecommunications	III III III III III III IIII IIII IIII IIII
chemical agents	vehicle accident	insect infestation	fire suppression operation	agricultural laboratories	College university	telecommunications	reservoir
corrosive material	vehicle hijacking	microbial infestation	(a) (b) (b) fire hydrant	animal feedlots	schools	telecommunications	storage tower
hazardous when wet	Ŷ	reptile infestation	other water supply location	commercial food distribution center	energy facilities	Contraction Infrastructure	surface water intake
explosive		rodent infestation	fire station	Ste Ste Ste farms ranches	Environ and the station station station station stations	air traffic control facility	water treatment facility
				food production center	*yellow highlight = symbols changed in latest release, green highlight = new symbols in last release		

The ANSI INCITS 415 point symbology standard for emergency mapping developed by the Federal Geographic Data Committee Homeland Security Working Group (source: http://www.fgdc.gov/HSWG/)

The purpose of the research sponsored by DHS Science & Technology project is three-fold:

- Survey use of existing map symbols and symbol palettes and use of the existing standard to understand what needs exist
- Develop a repeatable process for developing, adapting, and sharing map symbology standards
- Test the process on a selected domain or application



An example map using the ANSI INCITS 415 point symbology standard (source: http://www.fgdc.gov/HSWG/)

### **Standardization Process**

## Survey of Existing Symbology

A set of **semi-structured interviews** were conducted to survey existing map symbology for critical incidents used within DHS. Fourteen 60-minute interviews were completed with mapmakers and map users at a range of DHS mission areas, including: Customs and Border Patrol (CBP), Infrastructure Information Collection Division (IICD), United States Coast Guard (USCG), United States Fire Service (USFS), National Operations Center (NOC), Federal Emergency Management Agency (FEMA), and the Domestic Nuclear Detection Office (DNDO). A total of twenty-one interview questions were developed to cover the following topics: adoption and use of the ANSI Standard, the use of other map symbol standards, critical incidents with respect to the use of map symbology, technical/organizational challenges with respect to standard development, and ideas for candidate processes to develop new symbol standards.

The key finding of the research was that **it is more realistic for each mission to develop and share their own in-house standard** rather than to generate a comprehensive standard for all of DHS. The following recommendations for developing in-house standards were identified from the interviews:

- Symbols must support wide range of mission needs beyond basic emergency response
- Symbols must support wide range of output formats and map scales
- Symbols must be as simple as possible to avoid interpretation issues
- The process of standardization must involve map users as well as mapmakers
- Symbol categorization can be as important as the symbols themselves
- The ability to see a map from one's preferred perspective is important during

Using the input from the interview study with DHS domain experts, we drafted a **repeatable process** for developing, adapting, and sharing map symbology specifications and standards. The process can be applied within each DHS mission area to produce mission-specific symbology for critical incidents. The process is divided into four broad phases, with a series of individual activities associated with each phase. Input is solicited from mapmakers and map users at all phases of map symbol standard development.

The four phases in the map symbology specification/standardization process are:

- Phase #1: Needs Assessment. The mapping needs of the mission are determined and a set of design guidelines are generated.
- Phase #2: Specification/Standard Development. Existing symbols are refined and new symbols are created where necessary.
- Phase #3: Quality Control. The symbols are refined by cartographers to improve design consistency across symbols
- Phase #4: Implementation. Generation of symbols in appropriate formats and sharing of symbols with other DHS missions.

- an emergency
- In house symbol standards can be used to inform development of new formal standards
- Organizational structures must be implemented to foster the development and use of symbol standards

#### **Testing the Process**

To test the process, we have developed an asynchronous and distributed web-based application that implements a **modified Delphi study**. We expect the use of distributed, asynchronous methods to improve the application of the symbology development process, as busy professionals are not required to gather in person at the same time. Each phase in the process is implemented as a Delphi **round** lasting one week, with multiple **activities** included in each round. Participants offer input and feedback for each activity in the form of individual response to questions, group discussion boards, and/or voting/polling. After a round closes, a moderator summarizes the contributions for use as a jumping-off point in the following round.

A pilot study for the symbology development process is scheduled with **Customs and Border Patrol** in the month of February, 2010.