Incident Map Symbology Report & Guideline Version 1.0

A final report and initial guideline for Incident Level Mapping Symbology

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National Alliance for Public Safety GIS Foundation (NAPSG)
Lt. Chris Rogers, Kirkland Fire Department& NAPSG Technical Advisor

NAPSG Foundation

Introduction

Every day, first responders use maps to navigate to emergency calls. Some responders may use their own personal knowledge (a "mental map"). Some use a paper map (hand or computer drawn). Yet a growing number are using high quality computer based maps utilizing software based on the latest Geographic Information Systems (GIS). Not only do responders use the latter form of information to navigate to calls, but they also use information on the "map" to identify features relating to incidents and hazards that may cause the responders harm.

These maps can be in the form of

- Street maps
- Emergency preplans
- Area map books
- Mapping software
- Any other maps based on the need and output ability

To support the practical use of maps across multiple map types and job disciplines, there needs to be consistency and flexibility in the maps. While there are several ways to provide consistency across multiple map products, such the use of a standardized grid (i.e. the U.S. National Grid – USNG), the most important way to provide consistency is to have clear symbology that is understandable for responders and citizens.

There have been several efforts to create a symbols standard for public safety. While there has been some great success in discipline focus symbology, there hasn't been much success in creating an "all hazards" symbol set. Why? Much has to do with the fact that

- Responders missions are very diverse in nature
- Incident scale can vary from small to large
- Maps may not be not usable for the responders or accessing the information on the map is complex

Below is basic evaluation that the Incident Symbology Workgroup (ISWG) did on existing efforts.

Existing Map Symbology Efforts

NWCG

First, it should be acknowledged that there is a success story for public safety map symbology -- the standardization of symbols for wild-land fires by the National Wildfire Coordination Group (NWCG) symbology. So why isn't this symbology used for all hazards? Simply put, those symbols are tailored to wildland fires. There are common features in the symbology for features that relate to "all hazard" incidents and the incident command system (ICS) such as a Command Post, Base, and Staging. However, the NWCG symbols are primarily include features pertinent only to wildland fires. It should be noted that many of these symbols can be used as a starting point and modified to support other disciplines and needs.

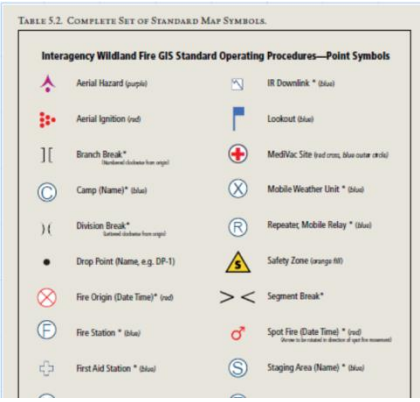


Table 5.2. Complete Set of Standard Map Symbols.

Interagency Wildland Fire GIS Standard Operating Procedures—Point Symbols

Aerial Hazard (purple)	IR Downlink * (blue)
Aerial Ignition (red)	Lookout (blue)
Branch Break*	MediVac Site (red cross, blue outer circle)
Camp (Name)* (blue)	Mobile Weather Unit * (blue)
Division Break*	Repeater, Mobile Relay * (blue)
Drop Point (Name, e.g. DP-1)	Safety Zone (orange fill)
Fire Origin (Date Time)* (red)	Segment Break*
Fire Station * (blue)	Spot Fire (Date Time) * (red)
First Aid Station * (blue)	Staging Area (Name) * (blue)

U.S. Department of Homeland Security and the Federal Geographic Data Committee Symbology

One effort to establish a standardized public safety and homeland security symbol set that included all hazards was initiated by the U.S. Department of Homeland Security (DHS) and the Federal Geographic Data Committee (FGDC). The resulting work created the following four categories of symbols:

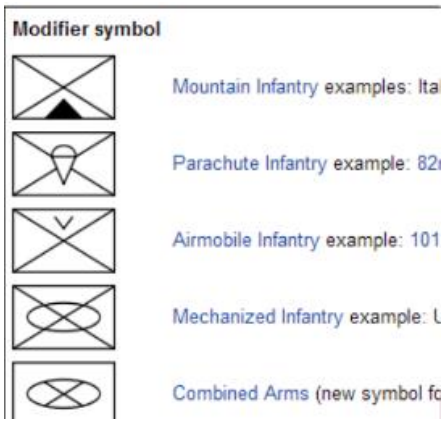
- Incident
- Infrastructure
- Sensors
- Command Features

This effort created over 200 symbols for various features. In addition, the command and infrastructure symbology included the option to set a "status" of that feature in the rendering and a consistent look and feel. However, after some study and testing some things were realized:

1. The symbols were very graphical and would be impossible to hand draw on paper. This requirement is important since there is the definite possibility that a map user during an incident will need to hand draw a symbol on a map.
2. Some of the individual features were vague in application. For example, the Emergency Staging Symbol means different things to different response agencies.
3. Even with the breadth of symbols there were still a lot of missing symbols.

North American Treaty Organization (NATO)

Even though military symbols tend to be focused on operations related to conflict, it should be noted that the structure used by most public safety agencies for the management of an incident is similar to that used by the military. Also, the military does play a huge role when it comes to responding to large scale incidents. Consequently, there are several advantages to the NATO Military Symbol set:



- Used for decades
- Geared for displaying units
- Can be recognized based on symbol design and shape without total familiarity of the feature

Other Public Safety Map Symbology Efforts

There are several other national and international efforts to create a standard for public safety incident mapping. Some of these are not necessarily focused on operational incident mapping. Below is a summary of the other efforts.

Canadian Emergency Mapping Symbology

The CEMS uses the DHS and FGDC symbology as the basis and has been modified to give it a more "iconic" look. Some of the challenges the NAPSG Symbology Working Group (SWG had with this symbol set include the following:

- Required a lot of color
- Couldn't be hand drawn
- Seemed quite complex

Australasian All Hazards Map Symbology

This represents an incident level symbology effort led public safety authorities in Australia and New Zealand. While there are some major differences in terms and operational methods, there was a lot to learn from their efforts. Some of the benefits of the symbology:

	Possible Probable Confirmed	An explosive device fused to detonate under specific conditions. (Source: International military definition) (FGDC)	1) Label with Location; Name; DTG 2) Use at Event/Incident to Jurisdictional levels
	Unconfirmed Confirmed	Insect Infestation (Infestation) - A harassing or troublesome invasion of insects. (Source: derived from the definition of	1) Label with Location; Name; DTG 2) Use at Regional to Jurisdictional levels eg. for Aust Plague Locust

- Capable of being hand drawn
- Includes a dashed line indicating "planned" or "future" feature
- More focused on ground level information
- Good effort at an "all hazards" approach

NAPSG's Symbology Working Group

Background Phase 1

In December of 2009, a plan came together to look at the interaction of map symbols for the fire service in a pre-incident to incident environment. With the help of the National Alliance for Public Safety GIS (NAPSG) Foundation, the DHS Science & Technology (DHS S&T) First Responders Group put together a working group of public safety professionals that also had operation and technical geospatial and map making expertise.

Planning for the SWG started with the following:

- Assembling a small group of public safety professionals from different parts of the country
- Preparing members of the workgroup ahead of time with "homework" so that when they came to an in-person meeting they would have a frame of reference for the discussion

During Phase 1 the SWG came together for an in-person meeting and developed several lessons learned and tasks to be completed. Provided below is a summary the lessons learned in both Phase 1 and Phase 2. Initial tasks were completed by the leadership team; along with members of the group created and tested map symbols. This continued even after funding was discontinued. After much work and thanks to a lot of peoples efforts Phase II moved forward.

Background Phase II

After over a year delay, support moved forward for Phase 2. Due to the fact there was a long delay between phases there was a fairly substantial review of the previous work. The group was made up with a more diverse group of responders to include wild land fire, law enforcement, emergency management, and search and rescue. The goals of the group from the outset included:

- Evaluate the symbology and maps produced by the SWG through a map test
- Provide a recommended incident symbol set to serve not as a *starter* for public safety communities to derive their symbols.
- The incident symbology framework, guideline, and symbol set must be flexible and scalable. This will ensure that they are capable of being used as an incident increases and decreases in scale and complexity.

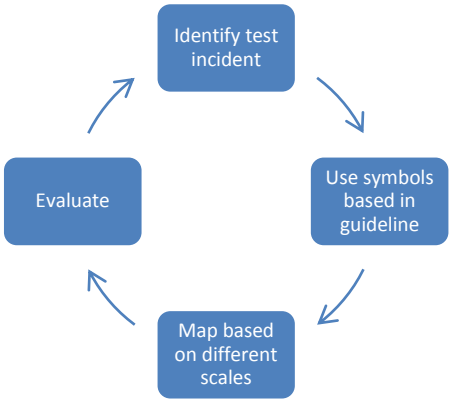
Ensure the incident symbology guideline and symbol set is capable of being used in both paper-based and computer-based maps.

This initial in-person meeting of the SWG was conducted in December of 2012 and resulted in the development of a version 1.0 incident symbology framework and symbol set. After the December meeting, several virtual meetings were conducted with the SWG to refine the framework and symbol set in preparation for its release.

Approach and Lessons Learned

Symbols Test

As a part of the testing process in both Phase 1 and Phase 2, the SWG tested existing map symbols on frequently used incident maps unique to each of the communities that the SWG members represented. At the conclusion of the symbol testing, evaluation, and consensus-based discussions, the SWG developed the version 1.0 of the incident symbology framework and symbol set.



The maps created were based on the everyday incidents where the Incident Command System (ICS) and NIMS concepts and principles are employed during response operations. Examples of the types of incidents that were mapped included structural fires and law enforcement incidents involving special weapons and tactics (SWAT) resources. The SWG completed the following steps as a part of the testing approach.

- Created a map that shows the following features
  - Hazards on an incident
  - Features that can help mitigate an incident
  - Mapping of where command functions are located
  - Identify any access problems
- Identified challenges and questions with each map
- Modified guidelines based on feedback

Findings

Below are the key findings that resulted from the conclusion of the first and second phases of the incident symbology efforts.

- The approach of establishing a consistent guideline (instead of a formal standard) was validated by the SWG members. This was due to the fact that there is a large amount features that is possible on an emergency map and the broad diversity of needs that must be addressed, including the examples below:
  - Map product (Paper or Computer-based maps)
  - Type of responder
  - The immediate needs of the responders
  - The level of decision making that the responder is responsible for. Examples of the levels range from task level (e.g. Firefighter) to executive level (e.g. Fire Chief).

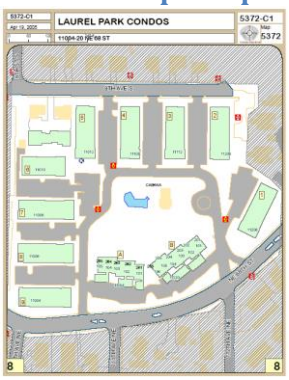
- The need for symbols that could be hand drawn was re-enforced. This was needed even if the initial map was generated using desktop GIS software.
- Symbols can't require a lot of training to be easily understood.
- Symbology must be usable in the routine business of public safety agencies. This helps to ensure that the symbols are a part of daily planning and operations so that first responders are not attempting to interpret symbols in higher stress environments during larger incidents.
- The three primary symbol categories include the following:
    - Pre-incident
    - Hazard
    - Incident command
- Defined two types of types of incident maps – tactical and strategic
- Key attributes of all the symbols were:
    - The shape of symbols was defined by the category
    - What was in the shape of the symbols was dependent on the map output and use
- Symbol design needs to be flexible to allow for the following factors:
    - Map Scale
    - Priority of information to the responder
    - The need for more or less detail
    - Color vs. non color
- Symbol density or clutter became quite a problem. While scale dependencies have helped, there needed to be a way to dynamically define and query view. This is due to the fact that at the small incident level there may be a lot of features that need to be represented in the continuum of preplan to incident mapping. It was recommended that in the next phase the workgroup tackles the problem of creating a scheme to dynamically query a map.

Tactical vs. Strategic Maps

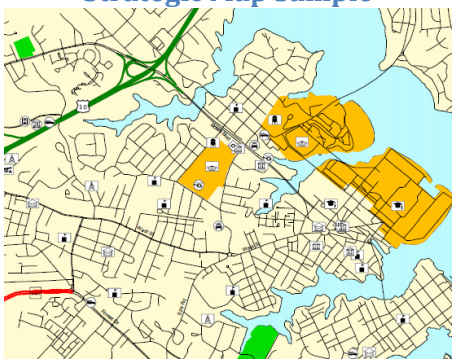
The SWG briefly discussed the difference between "tactical" and "strategic" mapping since incidents often require separate map products to support different levels of incident decision making. Below is a table that outlines the key characteristics of these two types of incident map products.

Map	What is viewed on map	Examples	Symbols Examples
Tactical	A single problem emergency	Building fire, active shooter, kidnapping, single wildfire, search for single victim	NWCG
Strategic	A multiple problem emergency	Earthquake, Tsunami, Multiple wildland fires, urban conflagrations, civil disturbances	The DHS Symbology

Tactical Map Sample



Strategic Map Sample



Incident Map Symbology Guideline – Version 1.0

Below is the version 1.0 of the Incident Map Symbology Guideline produced by the SWG at the end of the second phase.

Incident Symbols

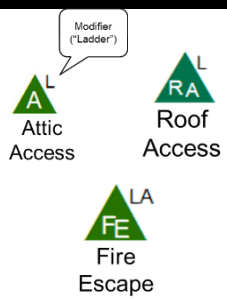
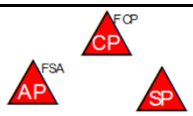
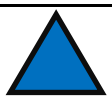
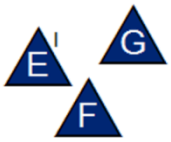
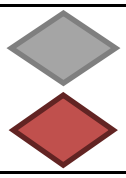
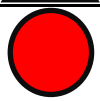
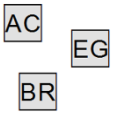
Symbols or features collected at the scene include:

- Collected at incident
- Clear background that don't require the symbol to be filled-in
- May be hand drawn

	Purpose	Examples	Shape	Examples Symbols
Incident Symbols	Incident Resources and Fixed Command Features			
	Features with a semi fixed position that supports the management of the incident	• Equipment • Locations for responders and civilians to assemble • Useful landmarks pertaining to the incident		C B
	NIMS Command Structure Locations			
	Location of features that relate to the National Incident Management System Command Structure. Can be used for semi static mapping or if possible, active mapping of commanders at an incident.	• Task Forces and Strike Teams • Groups and Divisions • Sections • Branches • Support	NIMS	FIRE SAR I C PIO
	Unit Symbols			
	Symbols representing the semi-static to active location of a unit. Based on FEMA Resource Typing. Also based on the location of where the unit is "working"	• Fire Companies (Engine, Brush, Ladder, etc.) • HazMat • Police Units (Patrol Car, SWAT, Canine, etc.) • EMS (Medic, Ambulances) • SAR (Team) • IMT • Public Health	Unit	E WT COM AMB
	Exposures			

The side visible in an incident. Define the section of the incident	"A" (Label in quotes)	"A", "B", "C", "D"	

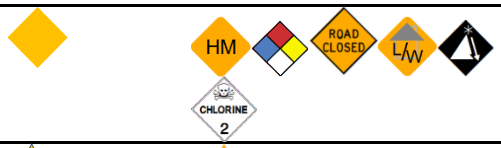
Pre-Incident Symbols

Symbol Category	Definition	Physical Examples	Symbol Shape	Symbol Examples	Standard Taken from
Access Point	Access point and ways to access a building or incident area and features related to	Knox Box, Elevator, Access Point			NFPA, Traffic Color
Assessment Features	Alarms and other	Burglar Alarm, Fire alarm control			NFPA
Utility Shutoffs	Location of where you shutoff utilities				NFPA
Detection/Extinguishing Equipment	Detectors and building extinguishment systems	Smoke, Duct, Pull Station			NFPA
Ventilation	Place to manage the exhaust of gases	Skylight, Smoke Control			NFPA
Water Flow Control Valves and Water Sources	Water flow devices	Fire department connections, PIV			NFPA
Equipment Rooms.	Location of features				NFPA

- Collected before incident
- NFPA 170
- Colored Background
- May use graphic or simple text

Hazard Symbols

H	Hazards

The location of any hazard that may cause harm, create hassle, inhibit access to responders and the public. Hazards should be mitigated, observed, or avoided Symbols are variable other than shape	• NFPA 704 • DOT Placarding • Orange Diamond • FDCG incident Symbology	
Safe Zone	Consistent with NWCG	

Modifiers

Each symbol should be able to be adapted to allow for effective scalability and flexibility. Below are some modification options:

Clear Text

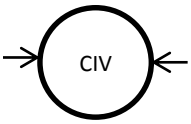
To enhance the meaning of symbol or to help explain a symbol, common text can be used in addition to the graphic of a symbol. For example the command post symbol is a square divided in half diagonally blue and white. While this is a common symbol, it may be hard to understand. To increase the meaning, use "clear text" which is a part of the NIMS and ICS common language. In the case, add "CP" below the symbol.

Planned Features

Use dashed outline to describe "planned" or "future" feature. This may be convenient to denote a feature that doesn't exist yet. This technique was derived from the Australian All Hazards Symbol Set

Colored Incident Symbols

If a color represents meaning at an incident then it is okay to apply a color to that symbol. For example a "Green" patient treatment section 



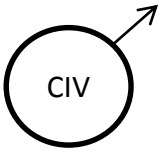
Assemble Indicators

Uses arrows directed at symbol to indicate assembly point.

Direction Indicator

Use arrow pointing away from symbol to denote direction. This can be useful when a

- Feature is located off of a map
- The feature is located remotely from a different location such as a GPS

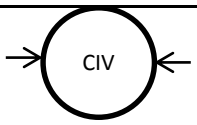
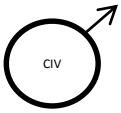


Military Indicator

The military uses indicators on top off their symbology to denote the level in the chain of command. This might be useful to interoperate with the military. More evaluation needs to happen

Type Abbreviations

The workgroup tested adding abbreviations to the symbols to enhance meaning. The use of this is somewhat subject but can be useful.

	Features and landmarks that help mitigate the incident						
Preplan Symbols	**Access Features:** Features that identify access point or barriers to access. Includes key boxes, main entry, elevator, stairs, ladders	**Geographic Building Features:** Features inside a building such as rooms, common areas, businesses, or other features with a specific purpose	**Fire Suppression Features:** Primarily for fire units. Examples include fire department connection, sprinkler shutoff, hose connections	**Shut off utilities or product:** Examples include electrical, gas, water, and communication shutoff	**Ventilation:** Feature that help remove airborne hazards that health problems (smoke, chemical vapors, fart bombs, smelly laundry)	**Local Alarm:** Examples include fire alarm panel, burglar alarm, smoke detector	**Detectors and building extinguishment systems:** Smoke, Duct, Pull Station
Modifier	**Clear Text**	**Colored Incident Symbols**	**Planned Features**	**Assemble Indicators**	**Direction Indicator**	**Military Indicator**	**Type Abbreviation**
	To enhance the meaning of a symbol use a commonly accepted acronym next to symbol	If a color represents meaning at an incident. For example a "Green" patient treatment section	Use dashed outline to describe "planned" or "future" feature	Uses arrows directed at symbol to indicate assembly point	Use arrow pointing away from symbol to denote direction	(Experimental) Optional to add Pip, Hash marks to show level in chain of command	Add abbreviation to help define type of feature
							

Other Phase 2 Accomplishments

1. Expanded from the work initiated in the first phase:
    a. Validated initial symbology framework and symbol set through another round of testing
    b. Increased the number of incident symbol categories
    c. Increased the number of discrete incident symbols
2. Developed version 1.0 of the incident symbology guideline included here.
3. Developed version 1.0 of the incident symbol set. This is provided as a separate attachment as a "Quick Reference Guide" and in multiple formats.
4. Created an ArcGIS Online resource for user to download and test the symbology. This resource is located at: http://napsg.maps.arcgis.com
5. Created a temporary image website that hosts the individual PNG files for all of the symbols that are part of the version 1.0 incident symbol set. This resource is located at: http://symbols.firemapping.com
6. Conducted one national virtual training session as an initial outreach and education effort.
7. Created short video explaining NAPSG incident symbology guideline and symbol set. This resource is available at: http://napsgfoundation.org/resources/?q=symbology

Future

While the SWG made significant progress in filling mission critical gaps in incident symbology during the first and second phases there remains a number of areas where additional work is needed, this includes the following:

1. Test the symbology guideline in a blind test. It would be beneficial to test the symbols guideline on a small incident drill that starts the local responder level and then scales to include multiple jurisdictions and potentially to the state level. The test would include the following:
    a. A simple 10-minute training video geared towards responders
    b. A more complex 30-minute training program for GIS professionals to create maps based on the guidelines this would include
        i. Customizing symbols on the fly
        ii. Helping to establish workflow for the proper information to the proper level of audience
    c. Test maps using multiple platforms
    d. Evaluate the use are each level of responder
    e. This would be similar to the "Map Challenges" that the ISWG conducted during their meetings
2. We started work on creating a scheme to dynamically query information based on the following
    a. Role in the incident
    b. Time into the incident
    c. Predefined level of priority
    d. Pre-designated priority of symbol
3. Develop a more robust and supported website to host the symbology.
4. Work on line and polygon features

Conclusion

In the world of mapping, cartographers get caught up in the creation of the beauty of their maps. While this is extremely important, it is also equally important for map to convey the "message" of the map. In the public safety world that "message" is information that can prevent harm to the responder, help fix the incident problem, or at the very least help the responder get to where they need to go. Since the map is a communication tool, it becomes as important as a radio, telephone, or other communication device to the responder community.

Report and Guideline Contributors

- *Captain Steve Pollackov, GIS Unit Commander, Fire Department of New York City*
- *Firefighter Peter Hanna, Baltimore City Fire Department*
- *Captain Jim Potteiger, Baltimore City Fire Department*
- *Firefighter Ron Wieland, SeaTac Fire Department*
- *Captain Bryan Green, Surrey BC Fire Department*
- *Mike Price, Independent Consultant*
- *Chief Dustin Morrow; Assistant Chief, Tualatin Valley Fire and Rescue*
- *Firefighter Len Waterman, Redmond Oregon Fire Department*
- *Firefighter Brent Sytsma, Woodinville Fire Department*
- *Peter DiTuri, fmr. Seattle Fire Department*
- *Rusti Liner, Louisiana Department of Emergency Management*
- *Sandi Stroud, Baltimore Metropolitan Council*
- *Tricia Toomey, Technical Advisor, NAPSG*
- *Jennifer Schottke, ESRI*
- *Carolyn Fish, ESRI*
- *Walt Potts, ESRI*
- *Vanessa Glynn-Linaris, Bureau of Land Management*
- *Lorie Peltz-Lewis, U.S. Forest Service*
- *Melissa Lanclos*
- *Rand Napoli, ret. Florida State Fire Marshal*
- *Bruce Oswald, NAPSG Project Manager*