

U.S. National Grid Location Marker
Minnesota “Best Practices” – Draft 2.3
September 1, 2010

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U.S. National Grid (USNG) Background: In many instances, a street address is an inappropriate way to describe a location during an emergency response. Examples include:

- Areas where there has been major/total loss of street markings – such as following a major flood, tornado, hurricane or earthquake.
- Large acreage tracts known by a single address - parks, industrial complexes, government centers, and shopping malls.
- Seasonal events like ice fishing encampments, fair grounds/carnivals and outdoor exhibits/concerts.
- Emergencies taking place far removed from any formal address such as a rural train derailment, plane crash or wild fire.

To accommodate the above instances and many more like them, over the year’s emergency responders have developed a variety of localized approaches. Unfortunately, to the detriment of mutual aid compacts, this situation has created a nation-wide, hodge-podge of map coordinate systems for relating geospatial position during a disaster. Furthermore, as highly portable and affordable GPS systems have become available in recent years, latitude/longitude coordinates have come into vogue as the solution for this problem. In this context, however, there are a variety of problems associated with using latitude/longitude coordinates to relate location:

- Because lines of longitude come closer as they travel from the equator to the poles, the east-west width of a degree of longitude shrinks as it makes that journey (from 69.172 miles per degree at the equator, to zero miles at the pole). Consequently, standard gridding and intuitive understanding of distance between two points becomes problematic.
- For a latitude/longitude coordinate to have usable precision, it requires an extended numerical format that can be related either as “tens”, “degrees, minutes, seconds” or a combination of the two. For example, the intersection of County Road C West and Snelling Ave. N near the Rosedale Mall, in Roseville, Minnesota, can alternately be described as N45.021855 W93.167324 (tens), N45°01’15” W93°10’34”, (“degrees, minutes, seconds”), or N45-1.254 W93-10.556 (combination). A situation certain to cause confusion – particularly so during a disaster when communication about location is critical. In contrast, a standard, 8-digit USNG coordinate (one more digit than a phone number) provides positional accuracy of 33 feet (10 meters).

National Acceptance of the USNG: Because of the above issues and others that exceed the scope of this background discussion, the Federal Geographic Data Committee, FEMA and the National Search and Rescue Committee have endorsed the USNG as a “Best Practices” approach. Based on techniques used by the military for more than 50 years, it offers an inexpensive way for the general public and all components of the emergency response community to have a common geospatial frame of reference while serving as an “always ready” backup for high-tech systems. Effectively, the USNG interlocks Geographic Information Systems (GIS), Global Positioning

System (GPS) receivers, and the basic hand map in a way that creates a uniform, easy-to-use methodology for quickly geo-locating points with a high degree of precision. As such, the USNG is being promoted by the following additional national efforts:

- On May 28, 2009, the Director of FEMA, Mr. Craig Fugate, set agency-wide implementation of the USNG for emergency response as a near term priority.
- The National Geospatial-Intelligence Agency has announced it will no longer produce map products for U.S. disaster events that do not incorporate the USNG.
- The U.S. Geological Survey’s new topographic map series, the US-Topo, currently in release, prominently incorporates the USNG as the primary reference system.
- More and more GPS units are coming onto the market with USNG as a selectable display, while many others incorporate it through display of the Military Grid Reference System in the NAD83/WGS84 mode.
- The National Search and Rescue Committee has designated the USNG as the primary system for conducting land based search and rescue.
- USNG is being used as the location reporting standard for U.S. Fire Administration fatality statistics.

Minnesota Acceptance of the USNG: Outside of federal efforts, nation-wide implementation of the USNG is gaining momentum with Minnesota positioned as one of the vanguard states:

- In March 2009, the Minnesota Governor’s Council on Geographic Information approved the USNG as a Minnesota state cartographic standard.
- Maps produced by the Minnesota Pipeline Safety Office and State Fire Marshal’s Office now incorporate the USNG.
- Several metro municipalities/counties have commenced production of USNG map books for use on their fire trucks.
- The Emergency Preparedness Committee of the Minnesota Governor’s Council on Geographic Information used the USNG to standardize production and access to maps produced for the Red River Valley flooding event in 2009 (see www.sharedgeo.org).

USNG Location Marker Best Practices: To complement the USNG method of defining location as described above, this document serves as the Minnesota “Best Practices” standard (draft) for marking locations with USNG coordinates - when and where appropriate and desired. The information and Figures contained herein were initially developed by the Emergency Preparedness Committee of the Minnesota Governor’s Council on Geographic Information in 2009, and subsequently refined in 2010 by its successor organization, the Emergency Preparedness Committee of the Minnesota Geospatial Information Office. Individuals in Minnesota government, as well as USNG and geospatial experts in Florida, Mississippi, North Carolina and Washington DC were also consulted in the development of this document.

It is emphasized that these examples are being offered as a way to standardize USNG location markings for those entities *who wish to use them!* Although the potential for their use is wide and diverse – *there is no requirement!*

Explanation of Figures: Since this document concerns a visual product, a series of Figures has been used to relate concepts. Accompanying each Figure is a series of comments to assist with understanding.

Figure 1 - Vertical Style: U.S. National Grid Trail/Location Marker. This Figure provides an example of a USNG location marker appropriate for use when marking a specific location, such as along a trail. This vertical style marker serves as the preferred marking standard.

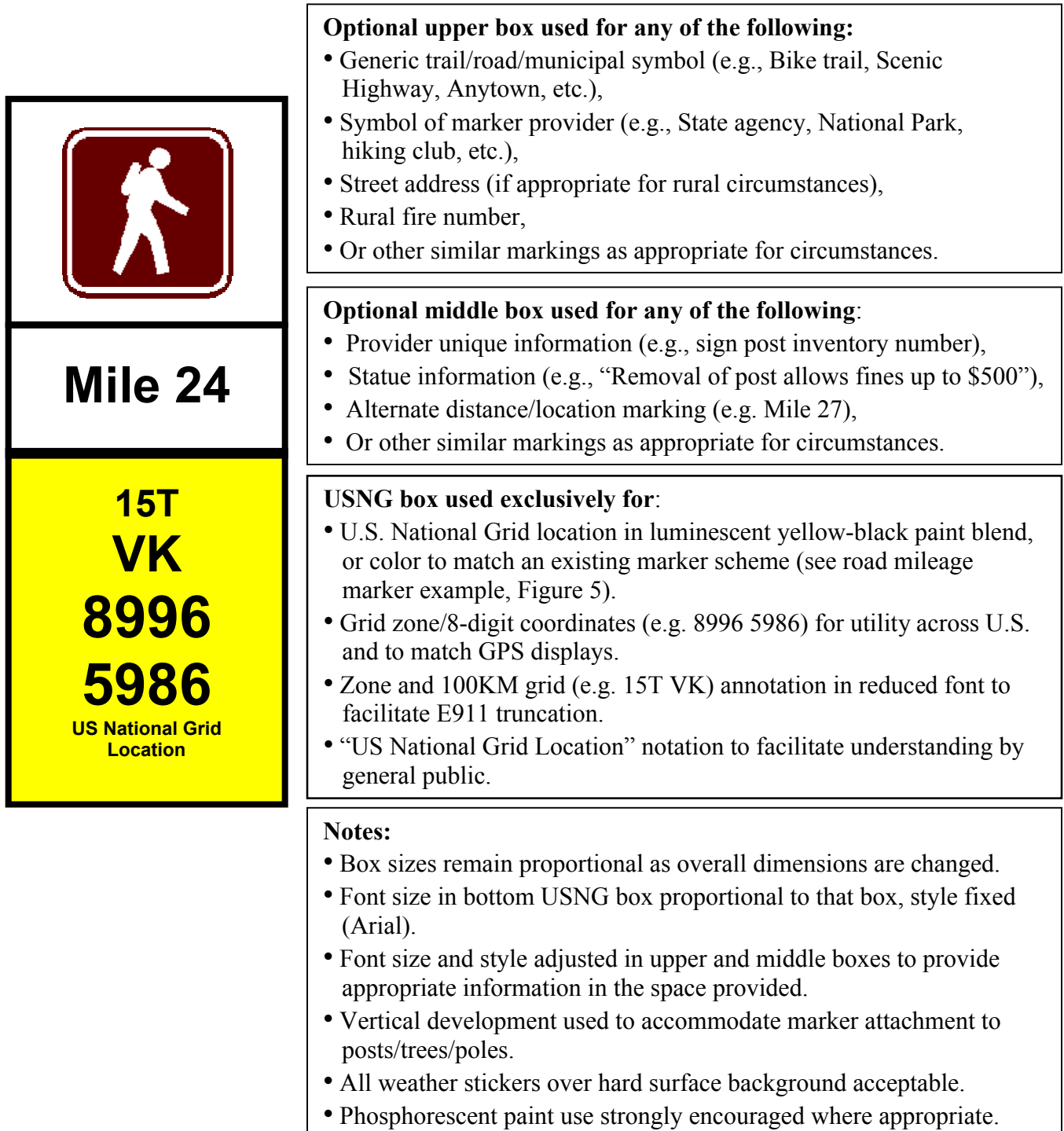
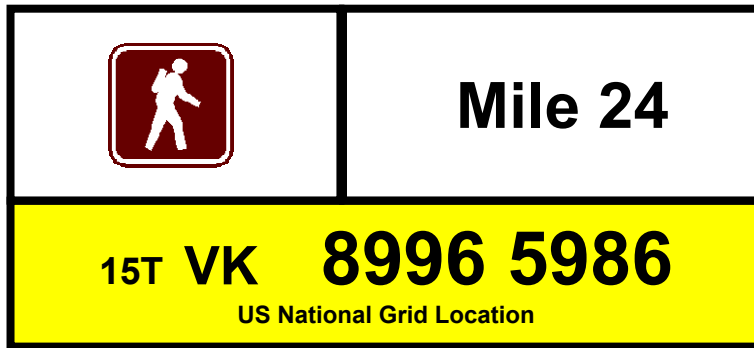


Figure 2 - Horizontal Styles: U.S. National Grid Trail/Location Marker. Acknowledging that there are instances where the vertical style USNG location marker will not work, this Figure offers formats for horizontal display.

Primary Style with Optional Boxes



Alternate Style without Optional Boxes



USNG box used exclusively for:

- U.S. National Grid location in luminescent yellow-black paint blend, or color to match an existing marker scheme (see road mileage marker example).
- Grid zone/8-digit coordinates (e.g. 8996 5986) for utility across U.S. and to match GPS displays.
- Zone and 100KM grid (e.g. 15T VK) annotation in reduced font to facilitate E911 truncation.
- “US National Grid Location” notation to facilitate understanding by general public.

Notes:

- Other basic features as described for Figure 1.
- Box sizes remain proportional as overall dimensions are changed.
- Font size in bottom USNG box proportional to that box, style fixed (Arial).
- Font size and style adjusted in upper boxes to provide appropriate information in the space provided.
- Horizontal development used to accommodate marker attachment to wide signs.
- All weather stickers over hard surface background acceptable.
- Phosphorescent paint use strongly encouraged where appropriate.

Figure 3 – Quick Response (QR) Matrix Styles: U.S. National Grid Trail/Location Marker. This Figure depicts two dimensional QR coding for a USNG location marker. In its most robust application, this style can provide embedded digital coding that is readable by most cell phones for all core and optional items of the previous Figures, such as trail name, mile maker name, and USNG coordinate. If a data link is available, an encoded URL to a GIS display showing location can also be incorporated and deciphered.

Primary Style – Stand Alone Style



As a stand alone marker:

- Digitized coding of location (e.g. 15T VK 8996 5986) that is readable by applications on smart cell phones or similar hand-helds.
- Provides better location accuracy than cell tower triangulation alone.
- Independent of GPS so it will work in situations where satellite signal reception is bad.
- USNG location can be transmitted as a SMS.
- Plain text location shown for verbal use with non-smart phones.
- With data link, URL link to GIS display showing location is also possible.
- The printing and reader applications to implement this approach are available for free.
- Up to 1/3 of marker can be destroyed or obscured and it is still readable.
- It can also be used to inventory items by location (e.g., sign post inventory number).
- “US National Grid Location” notation to facilitate understanding by general public.
- Black-white color blend used, or can be matched to another existing color scheme.

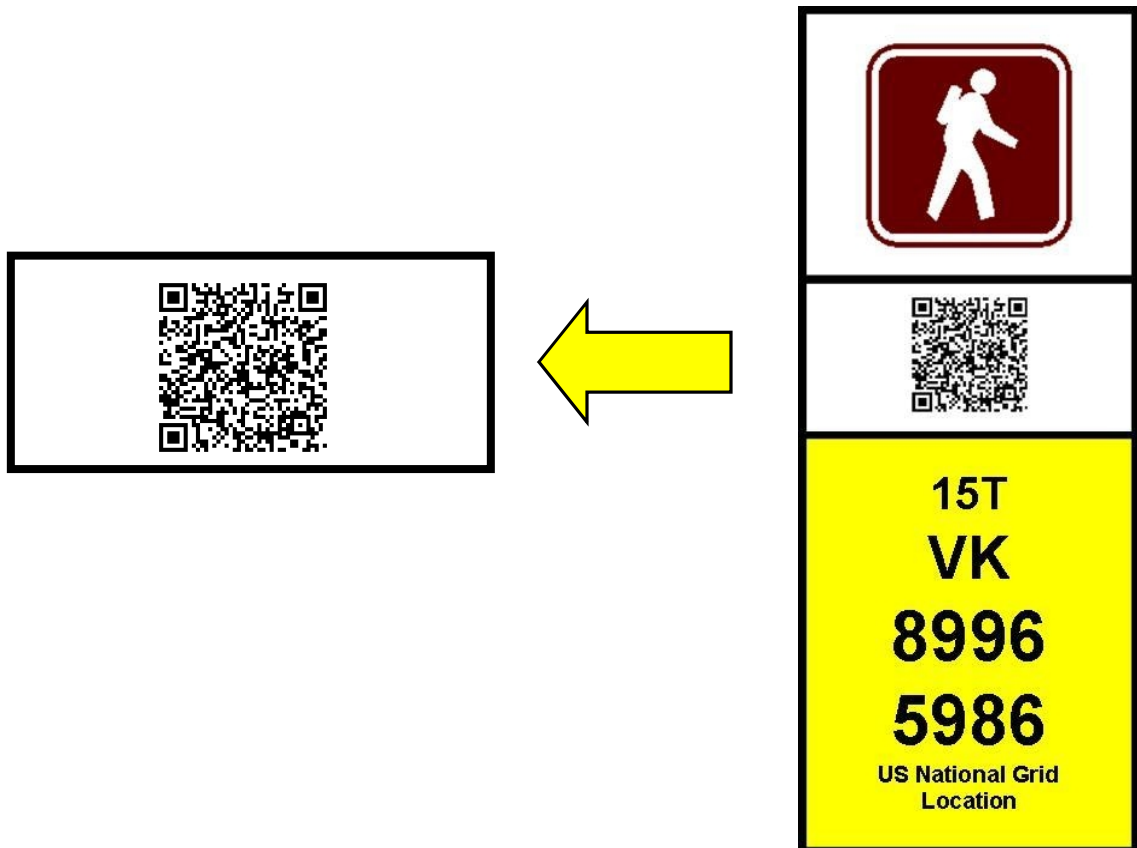
Notes:

- Box sizes remain proportional as overall dimensions are changed.
- Font size proportional to that box, style fixed (Arial).
- All weather stickers over hard surface background acceptable.

Figure 3

Figure 4 – Quick Response (QR) Matrix Styles: U.S. National Grid Trail/Location Marker Alternate Style. Acknowledging that there are instances where the QR matrix style might be displayed in an optional box with a primary marker style that already shows the USNG coordinates for a location, this Figure offers the format for display in that situation.

Alternate Style – In Optional Box with Other Sign Styles



As displayed in an optional box of other marker styles:

- “US National Grid Location” notation and coordinates deleted due to entry in accompanying USNG box.
- All other features as described above for Figure 3.

Notes:

- Box sizes remain proportional as overall dimensions are changed.
- All weather stickers over hard surface background acceptable.

Figure 4

Figure 5 - USNG Location Marker Derivative: Highway Mileage Marker Add-On. This Figure shows an example of a vertical style USNG location marker used in conjunction with a highway mileage marker. Since current highway mileage markers denote distance from a point of origin that is unknown to most motorists or responders on a given road, the core value of these signs is determination of *relative distance* along a route. On the other hand, because the depicted “add-on” USNG marker provides information *about position in a grid that is standardized across the U.S.*, the combination of current mileage marker and derivative USNG marker could be used to quickly determine *both relative distance and location for routine navigation by the public and emergency responders.*

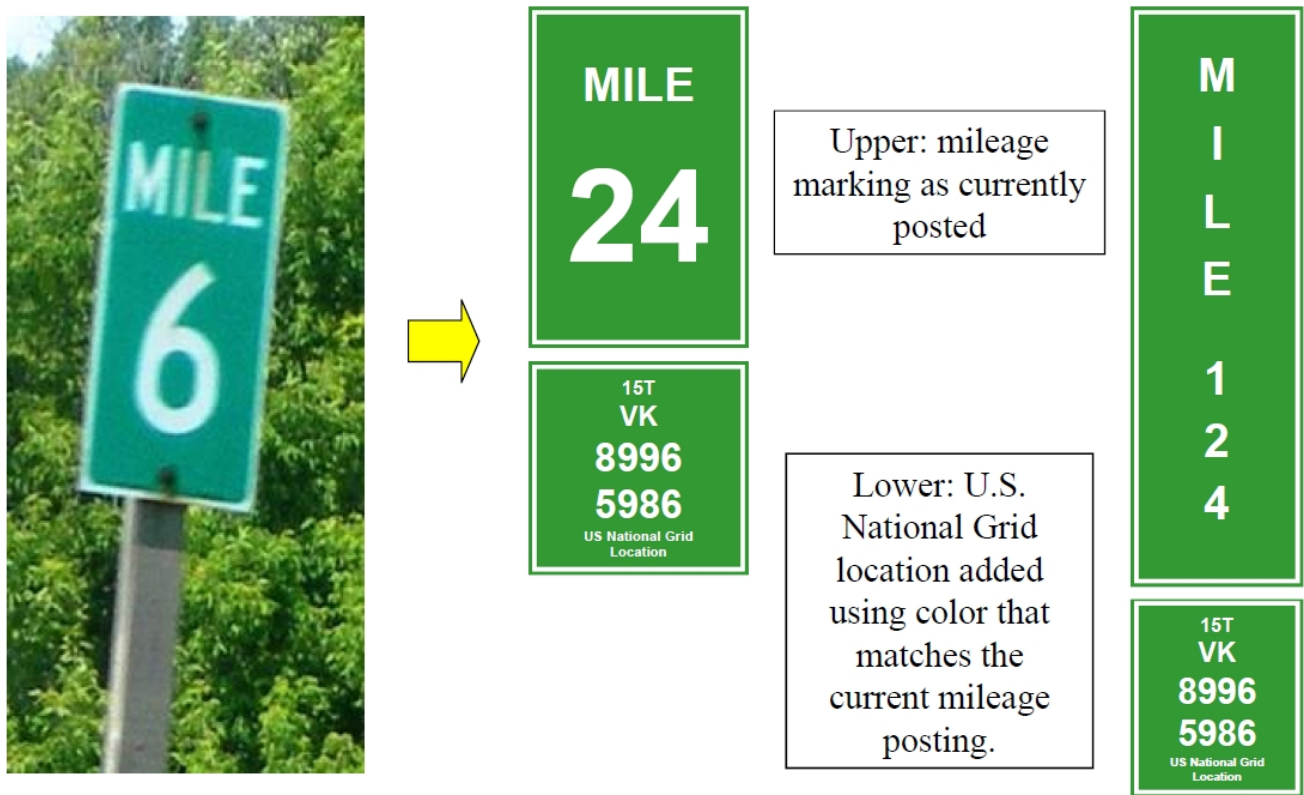


Figure 5

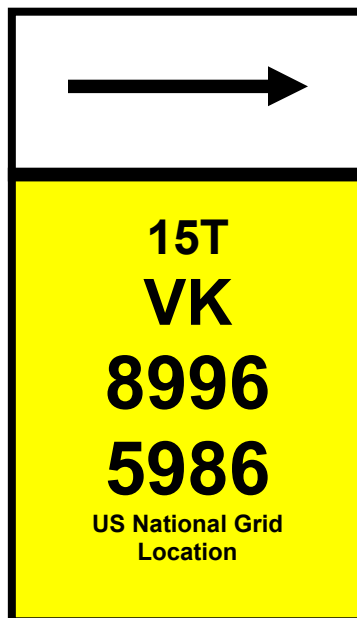
Amplifying Points and Issues Considered. This section provides expanded information about selected items from above and/or insights about some issues that have been considered while creating this document

1. “Phosphorescent paint use strongly encouraged where appropriate.” (Unchanged from Draft 1.0). Phosphorescent paint has been used for many years to mark location and exit routes in the interior of U.S. Navy ships. That is because this type of paint doesn’t require a light source to be visible – it glows in the dark on its own. This feature has saved many lives across the years since

it allows an understanding of location in total darkness. Consequently, there may be some instances where this type of paint would be helpful when posting a USNG location; extended tunnels, heavily forested campsites and trail locations, and interior locations in sprawling buildings, are some examples.

2. Coordination per national and state standards for signs. (Modified in Draft 2.3). It is understood there are national and state standards for many types of signs. To ensure conformity with those standards before release of a final “Best Practice” document, coordination is underway to ensure signage as proposed will comply with those standards. Although both the Minnesota Department of Resources and the Minnesota Department of Transportation have standards for informational signs associated with thoroughfares (e.g. snowmobiling, hiking, rest stops, etc.) there is currently no Minnesota standard for posting coordinates.

3. Marker location – Actual location versus “Access To”. (Modified in Draft 2.0). Comments from rural fire fighters indicate the need for a sign “notation” that denotes whether a sign’s coordinates show the location of the sign, or the entrance to the posted location. This is because unlike urban street addresses that are typically located on, or very near a structure, it is often necessary to position a rural response number on a major road far from the actual structure. Similarly, even in urban areas, there may be sprawling clusters of buildings where a single exterior address alone does not clearly indentify an internal address requiring a response (e.g. rambling apartment complexes). In response to this type of situation, many municipalities, corporations and other comparable entities use a combination of “arrow signage” or “Access To” signs to denote an entrance or path to an address. Building on that concept, it has been suggested that an arrow should be included in the optional middle box, and by orientation of that arrow, the general route to a structure would be indicated. An example of this modification is provided below:



In addition, use of an arrow will allow association of coordinates on a remotely located sign with the name of the described building’s owner. This feature could then be used to *confirm* the route to a specific structure from a main road. For example, in many rural areas it is customary to mark a circuitous or branching route to an individual’s home by placing arrow shaped signs bearing the family name along the route from the main road. Thus, by adding a family name to the arrow in the optional middle box, a USNG location marker with multiple addressing features would be possible.

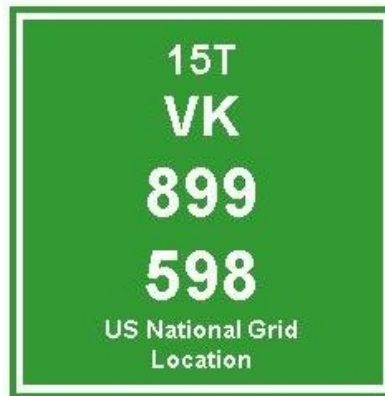


4. Truncation of USNG coordinates. (Deleted in Draft 2.0, partially reinserted in 2.3). One of the strongest features of the USNG approach for describing location is the ability to truncate those parts of the USNG descriptor that are locally understood, and consequently not needed. For example, if a municipality’s political boundaries fall entirely within a 100,000 meter square (e.g. 15T VK in the above example), local responders for that community would be able to appropriately discuss location without ever using the 15T VK part of the descriptor. Similarly, by removing the trailing “6s” in the example above, the description of location changes from accuracy of a point found somewhere within a 10x10 meter square, to one describing a point found somewhere within a 100x100 meter square (roughly football field by football field). Thus, depending on the need for accuracy, the USNG coordinate pair of the descriptor can also be truncated or expanded.

On review of this issue, it was determined that an approach should be used that would balance accuracy and utility while providing a means to *standardize display* in all parts of the United States. This standardized approach is thought essential for not only promoting understanding of the USNG method for marking locations, but for supporting adoption of the USNG as well. For those reasons, the grid zone and 100,000 meter square identifications are *always* included as parts of the standard sign configuration. However, in order to increase the readability of the “easting” and ‘northing” portions of the coordinate - digits that will be unique within approximately 62 miles of the sign’s location - reduced font size is used for the zone and 100KM grid square descriptors.

With regard to the positional accuracy of the “easting” and ‘northing” parts of the coordinate, it was decided that the precision required for describing a location for an emergency response should be the deciding factor. For this reason, an “8” digit format was selected since it provides accuracy to within 33’. “6” digit positional accuracy of 330’ was thought to be inadequate for a wide variety of circumstances, while “10” digit positional accuracy of 3.3’ was thought to be unnecessary. Additionally, based on the realization that production of signs implies cost to government, it was thought that use of a standardized approach to reduce expenses was imperative.

Against this back drop, it is understood there may be circumstances where coordinate truncation may be necessary to facilitate functionality. Principal in this discussion has been consideration that the “8” digit style USNG coordinate sign may not be readable while driving at normal highway speeds (see Figure 5). The proposed solution for this issue is to display only “6” digits on highway signs or similar situations where quick recognition is important. Thus, a modified highway sign would look as follows:



While the “6” digit approach is allowed by this document, in order to facilitate national standardization and public understanding/acceptance, it is stressed that deviation from the preferred “8” digit format should only be used where absolutely required and only after careful consideration by the implementing agency. Similarly, use of “10” digits for marking a location should only be used where that degree of precision is truly required.

5. Color differentiation. (Modified from Draft 2.0). Rather than allowing a USNG sign to be the same color as its “partner” sign on a host pole, consideration continues concerning use of only one color combination for all applications. This concept is being reviewed as a way to facilitate recognition and set apart USNG coordinate signage.

Adoption of this approach in Minnesota could also provide the opportunity to set a uniform national coloration standard for all USNG signage. For example, by using a color combination that is currently not used in any other national marking program - red and yellow, as an example – all markers showing a USNG coordinate would appear the same, in every part of the country, no matter what the application.

Thus, the highway variation might appear as depicted on the following page.



Similarly, a self standing QR coded marker/sticker that includes USNG coordinates and an online mapping URL might appear as follows:



6. QR style marker. (Added in Draft 2.1) As a way to further interlock the basic USNG map with advances in technology, a QR style marker is included in the range of “Best Practices” USNG marker formats. First introduced by the Japanese car manufacturing industry, a Quick Response (QR) style two dimensional matrix code is capable of encoding up to 4296 characters of information. Correspondingly, the camera feature of nearly all modern cell phones can read these codes if a QR reader application has been installed on the cell phone. However, there are certain limitations with regard to this implementation:

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- While a QR code can be text, phone number, SMS message, URL, coordinate, or mixture of these items, readability for cell phone applications is enhanced by keeping character strings to less than 80, and preferably, to less than 60. In addition, recognition is enhanced by including white space around the QR border, and using a symbol size of least 1.5 x 1.5 inches.
- Although color can be used when constructing a QR code, approximately 55% contrast must be maintained to achieve readability. Consequently, black and white is the recommended color combination for most applications.
- While a USNG logo could be placed in the center of a QR code as an easy way to uniquely indentify the marker, that approach is considered inappropriate as a practical matter because it reduces marker readability for older generation cell phones.
- The suggested input QR code formatting is: USNG coordinate to eight digits, then a URL to a location associated web application (if applicable), and then optional information as the remaining character spaces will allow.

Additional information on QR markers can be found at:

- General information: http://en.wikipedia.org/wiki/QR_Code
- Example QR code creator: <http://qrcode.kaywa.com/>
- Phone application downloads: <http://www.mobile-barcodes.com/qr-code-software/>
- Google efforts: <http://www.google.com/help/maps/favoriteplaces/business/barcode.html>

Other Information.

Mobile sign printing grant. (Added in Draft 2.1). Materials and equipment needed to conduct mobile printing and installation of USNG markers will soon begin field testing under an Operational Research Assistance (OPERA) program grant funded by the Minnesota Local Technical Assistance Program, Center for Transportation Studies, University of Minnesota. Developments to date have been positive with project completion anticipated in spring 2011.

In addition to the marker uses shown above, other applications might include:

- Location marking and inventory control of utility infrastructure – e.g. telephone poles,
- Campsite numbering,
- “Addresses” of railroad crossings,
- Maintenance tracking for major transportation structures like highway bridges,
- Numbering of boat landings, and
- Other ideas only limited by imagination!

For additional information about the U.S. National Grid, to include a link to the Minnesota USNG cartographic standard, go here:

<http://www.mngeo.state.mn.us/committee/emprep/download/USNG/index.html>

Free Computer Aided Dispatch software incorporating the USNG can be obtained here:
<http://openises.sourceforge.net/tickets01.html>