Proposal to Encode Nautical Chart Symbol used in Running Text

Date: 06-Feb-2012 – Initial Draft, Rev 6
Source: Asmus Freytag, Michel Suignard (SEI), Eberhard R. Hilf (ISN), Karl Pentzlin (DIN)

Summary

This document presents a proposal to encode a subset of symbols used in nautical charts. As documented, the characters in this particular subset occur regularly in running text and are therefore suitable to encoding as characters. This document also provides background information on the general nature of symbols used in nautical charts, with particular emphasis on those that appear in publications in text form. Nautical chart symbols contain features that can be represented as combining characters. Some of the symbols are similar to existing Unicode characters, requiring the discussion of the extent of possible unification. The proposal concludes with a tabular listing of the proposed repertoire of nautical chart symbols for use in running text.

1. Uses of Nautical Chart Symbol in Running Text

Charts vs. Running Text: Notice to Mariners

The use of nautical charts (or their approved digital equivalent) is required for maritime navigation. Unlike terrestrial maps, nautical charts contain an extensive set of landmarks plotted at their individual positions as well as the location and nature of artificial aids to navigation from buoys to lighthouses.

Whenever the location, characteristics or presence of these features change, charts must be updated in order to satisfy the requirements of safe navigation. All publishers of charts, such as NOAA in the US or the National Hydrographical Office in the UK (UKHO), issue weekly Notices to Mariners with update information for the charts they maintain.

These notices are republished in a variety of places, for example in print, in boating magazines, by makers and distributors of electronic navigation systems and digital nautical charts and others. Such republication efforts go beyond merely hosting digital copies of the original notices, they involve selection for the relevant audience and reformatting, whether for print or viewing on devices.

Unlike the charts themselves, which are drawings, the Notices to Mariners are text documents.

Nautical Chart Symbols in Running Text

In many instances, primarily where they concern aids to navigation and designation of obstructions, the Notices to Mariners refer to the feature to be updated by using the actual symbols, as they appear in the charts. In other words, the subset of symbols used for these notices is the subset that appears regularly (weekly) in running text. They are therefore a proper target for standardization as characters.

Here is a typical example from the weekly Notices to Mariners issued by UKHO with symbols for various types of buoys and light floats occurring fully inline in the text.

3333* IRELAND - West Coast - River Shannon - Kilcredaun Point Eastwards and South-eastwards -Buoyage.
Source: Commissioners of Irish Lights
Chart 1547 [*previous update 1551/11*] OSI DATUM
Substitute   *Q.R (sync) Kilcredaun* for *Fl(2+1)R.10s*

Kilcredaun	52° 34′ 42N., 9° 41′ ·16W.
Q.G (sync) Tail of Beal for *Q(9)15s Tail of Beal*	52° 34′ 37N., 9° 40′ ·71W.
Fl(2)G.6s (sync) Beal Spit for *VQ(9)10s Beal Spit*	52° 34′ 80N., 9° 39′ 94W.
Fl(2)R.6s (sync) Carrigaholt for *Fl(2)R.6s*	
Carrigaholt	52° 34′ 90N., 9° 40′ 47W.

The symbols, such as   or   , that appear in this manner in running text form a more or less well-defined subset of the complete set of all symbols defined for nautical charts. A survey of such Notices published by several European authorities yields broad agreement on which types of symbols are included in the repertoire used for text documents.

SHOM, the hydrographical service of France, redistributes these UKHO notices in HTML format, viewable with existing browsers after installing a font, which is publicly available from their site.

Here is an additional example of the use of nautical symbols in text; this one was published in Japan:

```
★２３年２０９項　　　四国南岸　　―　　　灯浮標設置
記　載　　『 ☼ Mo(U) 8s　No 20』（海図W157上は、『 ☼ 』）
　　　　　　　　　　　　　　　　　　　　　　(1)　33-01-00N　133-35-00E
　　　　　『 ☼ Mo(U) 8s　No 21』（海図W157上は、『 ☼ 』）
　　　　　　　　　　　　　　　　　　　　　　(2)　32-23-12N　132-28-51E
海　図　　(1)Ｗ１０８[22-1300]―(1)ＪＰ１０８[22-1300]―(2)Ｗ１２０[22-861]―
　　　　　(2)ＪＰ１２０[22-861]―Ｗ１５７[22-1452]
参照書誌　４１１　3069.85番、3102.75番
出　所　　交通部
```
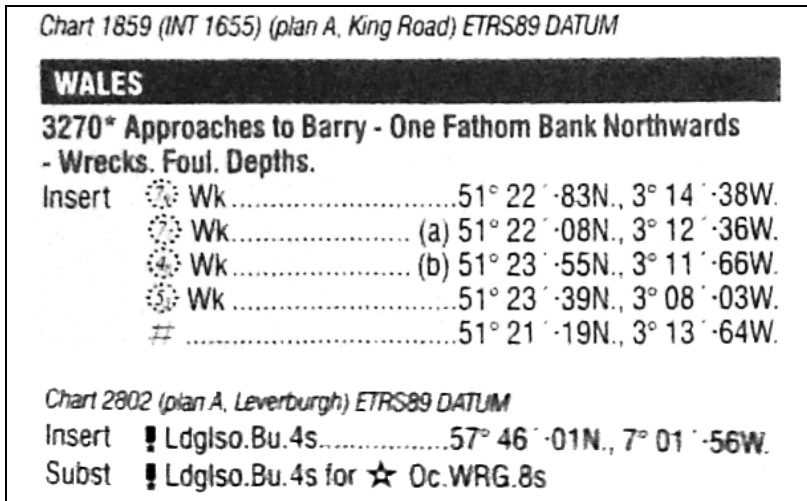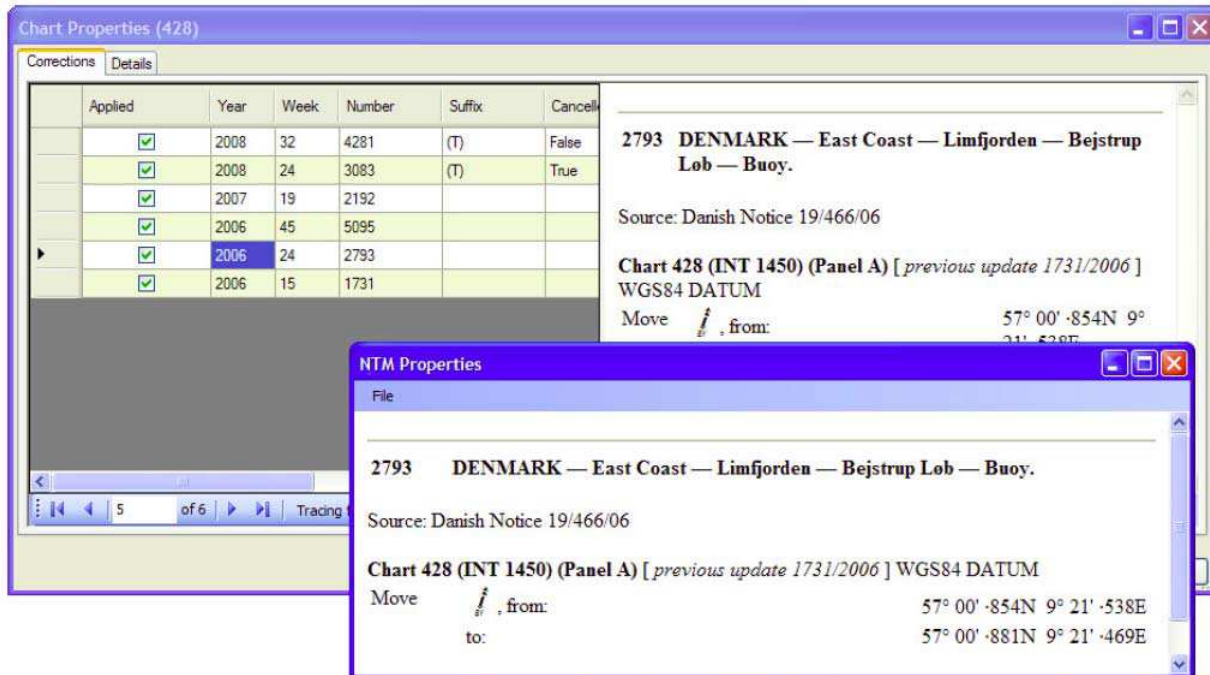
On the following page is an example of the official UKHO information being republished in a commercial publication (PBO) with a slightly different layout. The publication makes a monthly collation containing selection of the information most relevant to its readers. This particular scan shows an example. This particular example happens to cover several different members of the set of these symbols:

Chart 1859 (INT 1655) (plan A, King Road) ETRS89 DATUM

WALES

3270* Approaches to Barry - One Fathom Bank Northwards - Wrecks. Foul. Depths.

Insert Wk .... 51° 22´ ·83N., 3° 14´ ·38W.
        Wk .... (a) 51° 22´ ·08N., 3° 12´ ·36W.
        Wk .... (b) 51° 23´ ·55N., 3° 11´ ·66W.
        Wk .... 51° 23´ ·39N., 3° 08´ ·03W.
        # .... 51° 21´ ·19N., 3° 13´ ·64W.

Chart 2802 (plan A, Leverburgh) ETRS89 DATUM

Insert Ldglso.Bu.4s .... 57° 46´ ·01N., 7° 01´ ·56W.
Subst   Ldglso.Bu.4s for ☆ Oc.WRG.8s

Finally, there exist software packages that manage the required updates for nautical charts for professional mariners. Here's a screenshot from the user manual of one such package:

Chart Properties (428)

Corrections | Details

Applied	Year	Week	Number	Suffix	Cancell
☑	2008	32	4281	(T)	False
☑	2008	24	3083	(T)	True
☑	2007	19	2192		
☑	2006	45	5095		
☑	2006	24	2793		
☑	2006	15	1731		

2793   DENMARK — East Coast — Limfjorden — Bejstrup Løb — Buoy.

Source: Danish Notice 19/466/06

Chart 428 (INT 1450) (Panel A) [*previous update 1731/2006*] WGS84 DATUM

Move , from: 57° 00' ·854N 9°

5 of 6 Tracing

NTM Properties

File

2793   DENMARK — East Coast — Limfjorden — Bejstrup Løb — Buoy.

Source: Danish Notice 19/466/06

Chart 428 (INT 1450) (Panel A) [*previous update 1731/2006*] WGS84 DATUM

Move , from: 57° 00' ·854N 9° 21' ·538E
      to: 57° 00' ·881N 9° 21' ·469E

The same user manual contains instructions on how to install the aforementioned font in Windows. The conclusion is that the data are transmitted as text in HTML or XML with only minor markup for headers and general text styles, and not in some other format that contains embedded images or fonts.

Fonts and Repertoire

Several issuing authorities have created fonts to support the publication of their Notices and some of these fonts are downloadable. The sets of nautical chart symbols in these fonts overlap significantly, but

the fonts differ in whether certain aids to navigations are encoded as precomposed entities or to be built up from combining characters.

All font collections surveyed in the preparation for this proposal contain only a subset of the full set of symbols defined and used in the nautical charts themselves. Symbols not covered tend to be those that mark features on the charts that are not plotted at a definite position and are not individually used for navigation (such as the depiction of coastal vegetation by small symbols for representative plants). Those aspects make such types of symbols much less likely to be needed in a chart update. It is also worth noting that, with few exceptions, the downloadable fonts are specifically collections of nautical symbols and do not contain any "miscellaneous" or non-nautical symbols. In other words, these fonts represent a core set of shapes used in representing nautical chart symbols in running text.

As will be described below (see Section 2, *Symbols Used in Nautical Charts*), the system of symbols used for aids to navigation has its own regularities. Like sets of digits or case-pairs in a natural alphabet, some of the symbols form logical sets. This is particularly true for the set of buoy and topmark shapes, which show highly systematic variations.

The members of these pairs or sets can safely be inferred from the description of the overall notational system for nautical charts. Such a description can be found in Chart INT 1, published by the International Hydrographical Organization (IHO), and, in national editions, by hydrographical institutions world-wide. More in depth instructions on how to plot aids to navigation and other features in nautical charts can be found in document S-57. These and other documents are cited in the list of sources.

Because of the regularity of the system a basic validation would in principle suffice to show which pairs or sets of related symbols are typically referred to in the Notices. For example, each of the basic buoy shapes in the brief excerpt above exists in both black and white forms. It would be a pointless exercise to track through the actual weekly notices to "discover" all permutations of these well-known forms. Even if at any time a citation for any particular white or black form may be lacking, there is no reason to exclude it from this proposal.

Defining a Repertoire

What then is a suitable way to arrive at a repertoire? The repertoire has to be based on a-priori knowledge of the notational system, but also on some indication whether a particular symbol is liable of appearing in the kinds of text documents that form the basis for this proposal. In this context, the available fonts created by the issuing authorities in and of themselves define a subset. Given this, and given the overall context of use, it would make sense to treat these particular font collections as de-facto compatibility character sets. These character sets therefore provide the needed starting point for a repertoire.

Some issuing authorities do not publish their font collection. In that case, additional symbols from the actual published notices need to be considered using the more traditional method of citing instances in

text. However, whenever instances are found for one member of a pair or set, the internal logic of the system demands that the full pair or set be covered simultaneously.

For example, the symbols for the withies, which are small marks that are used to mark minor channels in the German sands or UK estuaries, exist in a port hand and starboard hand form:

Therefore, the following citation of a port hand form in the set of German chart updates argues conclusively for the inclusion of both forms in the repertoire, even though this particular instance only cites a port hand form.

★ (21) 90 INT 1461 3012, 3015 Letzte NfS 12/11 Streiche *Delete*	**Memmertbalje. Nordland-Fahrwasser**		(WSA Emden 30, 34/11) 14/11
ₚ *M 6a / NL 2*			53° 37,6' N 006° 57,1' E
ₚ *NL 8*			53° 38,3' N 006° 57,6' E
		zwischen/*between*	53° 39,2' N 006° 58,0' E 53° 38,5' N 006° 57,5' E

The full set of these particular aids to navigation includes symbols for the doubled withies that are used to mark the beginning or end of a channel, as well as the stylized variants consisting of a stake with a V or upside down V topmark. (See the next section for a discussion of topmarks).

2. Symbols used in Nautical Charts

This section gives some basic background on the system of symbols for nautical charts, with emphasis on the types of symbols commonly found in running text.

Nautical charts contain a variety of symbols, including the symbols for navigational aids, landmarks and obstructions. The use of these symbols is internationally standardized by the IHO and documented in chart INT 1 (or national equivalents thereof). National issuing authorities on occasion use certain national only symbols either in addition or in place of the international symbols.

This section gives a brief overview of the basic features of this system, with emphasis on characteristics of interest to character encoding. Documents and organizations referenced in this section and elsewhere in this document are cited in the References section below.

Symbols for Aids to Navigation

Symbols for aids to navigation designate the nature of the feature, its distinctive shape, color markings and special attachments (called topmarks). Additional designators show the presence of lights, radar reflectors or foghorns.

Examples of basic shapes:
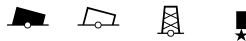
Symbols for aids to navigation that are floating are always drawn inclined (slanted) and those mounted in a fixed position (on land, or on a rock) are drawn upright.

Each basic shape of a given aid for navigation could exist with a range of different topmarks and colorings. The term topmark refers to the actual distinguishing marks added to a buoy or beacon, not merely their graphical representation. Given the internal logic of the system of aids to navigation not all combinations of topmark and base exist. However, the total number of possible combinations is significant.

Examples:

In translating this to digital symbol sets, different issuing authorities have taken different routes. Some are using "precomposed" symbols, while others use base symbols with overlays, something that is akin to combining characters in Unicode.

Examples:

The use of overlays (combining marks) for certain features allows them to be printed in a contrasting color to the base character whenever the symbol appears in rich text. For example, the indicator for a

the combining light cone ( ) which indicates a mark equipped with a light is shown in actual charts either in a contrasting color (purple or magenta) or in some other color indicating the color of the light (such as green):

Some hydrographical offices use the ability of rich text to show some types of overlays in a contrasting color even in text. (Topmarks are consistently shown in black or white only).

Examples:

These examples show some of the additional features shown with overlays, which, besides light, are radar reflector, sound and a large thin circular overlay indicating some type of radio feature. In actual use, the symbol is accompanied by a label which gives additional information.

Topmarks

Buoys, beacons, and towers are often decorated with a topmark, for example, indicating the direction for cardinal marks in the system defined by the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), where ⚑ represents North, ⚑ South, ⚑ East and ⚑ West. Some widely used existing fonts realize these topmarks as overlay glyphs, hence the proposal to treat them as non-spacing combining marks (above) in the Unicode context.

Floating aids to navigation use symbols that are inclined, while fixed aids use symbols that are upright (see preceding set of examples). Likewise, the symbols for topmarks come in two varieties, inclined and upright. Fonts that use overlays for topmarks therefore need two sets. These fonts are designed, incidentally, so that the overlay behavior works without any special layout engine support in regular word-processing software or in standard browsers when viewing HTML.

Colors

The actual colors of a navigational mark in the real world are noted in nautical charts by small abbreviations which are placed directly below the symbol as recommended by the IHO. In many styles of Notice to Mariners, this is achieved in running text by use of overlays. In the Unicode context, these color designators would become combining characters (below).

As for the topmarks, there are two sets for color designators. One for use with floating marks for which the symbols are drawn inclined, and the labels are oblique; the other for use with fixed marks, for which the labels are upright. The alignment in each case is with the small circle on the symbol, which is positioned further to the left for symbols that are drawn inclined.

Examples: vs.

To aid in identification of buoys, printed charts use black (filled in) symbols for marks that are painted red or black and white (hollow) symbols for marks in other colors.

Some issuing authorities use adjacent subscripts for color designation instead, or even use full size letters. These styles do not need any special support in the standard, as in that case the labels are simply sequences of ordinary Latin letters, perhaps with subscript styling applied.

Examples: RW   vs.
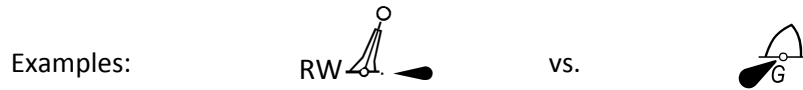
The style with labels below represents the IHO recommended way to draw these symbols in charts. Many national authorities follow this style in the text their notices as well. These two representations effectively represent two different notations for the same thing. They should be considered distinct on the character encoding level.

Printing in Color

Nautical charts are produced in color, and the light cone, in particular, might be printed in a color that is related to the color of the light beam on the actual aid to navigation (which is not necessarily the same as the color of the mark itself). Sometimes, charts are printed with the use of a single contrasting color (magenta or purple). If either of these color choices are also followed for the presentation of this information in running text, they would require the use of styled text – there is nothing in this proposal that would encode color display directly: the color designations are simply text labels explaining a real-world color of a navigational mark and they themselves are without exception printed in whatever standard text color is used (black).

Some offices do publish their Notices in color in this way.

Symbols for Obstructions

In addition to aids to navigations, nautical charts also mark the location and feature of obstructions. The nature of the obstruction is generally indicated by the symbol, and the presence of the dotted outline (not an overlay, but built into the symbol) is an indication that it rises substantially above the sea floor.

Examples:

Note that many of these symbols contain a dotted circle as part of the symbol itself and the dotted circle by itself is also a symbol. The series of these fixed combinations is small and limited, some of the symbols have oval outlines, rather than a circle. Also, the inside shapes are always a smaller copy of the

independent shape, which would necessitate some layout trickery if these were realized as combining marks. Therefore, it's best to encode this small set 1:1.

Some of these symbols are discussed below under Unification.

The fourth symbol shows a combining underbracket, which indicates that the depth of the obstruction (a submerged rock) was established by dragwire (the depth value would be written next to the symbol).

A related series of symbols represents obstructions by giving the depth of the obstruction (they are further discussed under "Enclosed Digit Sequences" in Section 3 *Encoding Related Consideration*). A combining overbar indicates that the value represents a guaranteed minimum clearance above the obstruction. The small digits show values in a fractional or minor unit, such as feet if soundings are in fathoms, or decimeters if they are in meters.

Examples: $\vdots 2 \vdots \quad \vdots 2_5 \vdots \quad \vdots \overline{12} \vdots \quad \vdots 15_5 \vdots \quad \vdots 120 \vdots$

No Advanced Font or Layout Requirements

All of the examples so far in this section were realized using one of the publicly available font in a standard word processor, using no special layout support whatsoever. The same is true for the reproduction of the first boxed example in Section 1. Some examples were implemented via simple overlays, similar to having a combining character with one, two or (at most) three base characters.

This is the established practice across much of the field today. It allows the accurate depiction of a core subset of nautical symbols in running text – without the need for advanced font technology or layout engine support. Most overlays can be treated as simple combining marks in the Unicode context, without the requirement for particularly advanced font technology. In a few cases, such combining marks would need to span two or, at most, three base characters.

Care should be taken when encoding these symbols in Unicode so as to not suddenly require sophisticated layout engine support, extensive markup, or advanced font technologies. None of these are inherently required for the task and making them required as part of encoding these symbols in Unicode would most likely adversely affect or altogether endanger any of the migration to the new encoding.

However, this does not mean that we advocate that every single feature of these documents be representable exclusively in plain text. As the examples show, the use of ordinary, general purpose rich text features in these documents is common, and there's no requirement to replace all of them by special character code hacks.

Rather, the design goal should be to allow, for example, existing HTML documents to be transcoded to use a Unicode-encoded equivalent font and have these files be successfully viewable in the same off-the-shelf user agents (browsers) as they are today.

National Symbols

For historical reasons many charts are still printed using national symbols in addition or in place of the international symbols defined in chart INT 1. Because of that, it would be appropriate to encode a subset of the most important national symbols as well.

For example, in US charts, one doesn't find the same detailed depiction of the various buoy shapes. Instead, a small inclined diamond shape on a circular base is used generically for any type of buoy. Where needed, the details of buoy shape (whether can, nun, or spherical) is provided by an annotation.

Examples:

Some of the national symbols might appear to be merely minor glyph variants at first sight, raising the possibility of unifying them *within* the system of nautical symbols.

Examples: vs   vs

However, the very first document investigated (the weekly correction for the first four weeks of this year for French charts) shows the use of both sets of these symbols in the same document using the same font. We therefore feel that the usual source separation rules might be applicable.

Even among national symbols there's considerable overlap in usage, especially as some offices maintain charts covering foreign waters, where buoyage may partially follow national convention. There are some additional national symbols under review, and over time, extensions to the set may be proposed.

Some offices do not maintain their own listing of symbols, instead formally referencing the list of symbols published in other countries. For all of these reasons, these symbols that are supposedly "national" see much wider use than that in practice. This applies to the national additions to the core repertoire in this proposal.

3. Encoding Related Considerations

This section discusses issues that arise in encoding the proposed repertoire in the context of the Unicode Standard.

Unification

A small minority of nautical symbols appear similar enough to existing Unicode characters to necessitate their evaluation for possible unification with these characters. On the other hand, there are several nautical symbols that, despite superficial similarities, seem distinct enough in size, stroke width or position to warrant separate encoding. For example, FOUL GROUND has a rather distinct appearance from the typical NUMBER SIGN, even though both share a similar arrangement of 4 strokes:

$\sharp$ vs. #

Likewise, the symbol for leading lights (indicating two lights lining up along the bearing given in the charts) has no semantic connection to 2260 ≠ NOT EQUAL TO and is only superficially similar in appearance, as can be seen in this example of actual use:

2 Bns ≠ 270,5°

Several other nautical symbols are superficially similar to existing characters, except in vertical alignment. They occur centered on or slightly above the baseline, rather than centered on the math axis, or some other mid-level line. Unification of these symbols without regard to such differences in alignment would appear inappropriate.

The following examples are all excerpted from the relevant publications and show the alignment of characters to adjacent text.

Examples: + (1) Rep   ✳ (0 7) with   ◢ • Fl ⊙ Tm. ⊙ Y Lt

All nautical symbols denoting rocks (like the "+") in these samples appear roughly centered on the baseline, or just slightly above. Taller ones descend appreciably below the baseline, but even the one looking like a "+" sits lower than 002B + PLUS. Their mathematical or punctuation lookalikes, all have their centers aligned on the math axis, which is a line that runs more in the middle of the character cell.

A square cross "+" is one of the most primitive graphical shapes and does not allow much distinction in execution. However, there's a big leap from noting that a "rock" in nautical usage is marked by such a stubby cross to asserting that this forms a usage of the existing character defined as PLUS. There's simply no convincing evidence that these are related in origin or interpretation in any way.

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For another example, note the heavy dot signifying a pile, or in this instance, a light. This dot clearly sits almost on the baseline and is not centered vertically like 2022 • BULLET and should therefore not be unified with it.

The small white circle with dot in the example above is a *position circle* that signifies that the plotted position is an accurate position. The symbol is usually accompanied by a label indicating the feature for which the accurate position is plotted. Both it and a larger version, also used in nautical charts, are aligned on the same lower line as the "light", and therefore do not form part of the series of general geometric symbols or math operators in Unicode (which are aligned on the math axis or some other line close to the mid level).

The same applies to several other nautical symbols, such as the small white circle at the baseline, indicating an approximate position. Nautical symbols that represent features that are plotted at a specific position have the small white circle built into the symbol, usually in the center of a horizontal line, which symbolically indicates ground or water level.

In case of the five pointed star below, both the normal form (unifiable with 2605 BLACK STAR) and the lowered form can occur in the same document, depending on whether the star is used as a bullet (part of the chart number, example on the left) or to designate the location of a light. In the latter case its center lines up with the other symbols for lights, such as the heavy dot discussed above.

Examples: ★ (17) 23   ★ Fl.R

In addition to the use of the star as bullet, the Notices and related publications sometimes use geometrical shapes when discussing the shape of topmarks (or of equivalent daymarks on beacons).

The relevant characters form a series that also includes full-size, non-combining versions of the other topmark shapes (those based on two circles or two triangles). This proposal assumes that the simple (single) geometrical shapes can be unified with the geometric shape characters for triangle, circle, square, lozenge and rectangle. When used in this manner, the symbols are in the same vertical alignment as regular geometric shapes, which further supports the proposed unification.

The following samples show some of those forms, including one of the simple geometric shapes that the proposal assumes can be unified.

39661	– Oberfeuer r. Pfahl mit r-w. wgr. gestreifter ✕ (Tagmarke) und nachts r. ▽ (LED), 400 m vom Unterfeuer	19520	Rohrleitung, Kopf s-g-s. Stahlpfahl (10 m) mit ⬦ am Auslauf einer Abwasserleitung 53° 26' N 008° 13' E

Combining Topmarks vs. Precomposed symbols

In some current fonts topmarks exist not as overlays (combining marks) but precomposed into the symbol. Because neither topmarks nor base symbols for aids to navigation exist in the standard, it would theoretically not violate the stability guarantees if both the combining marks, as well as the precomposed symbols were to be encoded.

However, we feel this would constitute an entirely unnecessary complication and that converting between legacy practice and a simple sequence of base shape plus topmark is not a showstopper in terms of migrating legacy to Unicode. Unlike combining accents used with a variety of letters, the base shapes for use with topmarks all have consistent metrics and don't require any fancy layout technology to result in good quality output.

Symbols Derived from a Dotted Circle

In the Unicode Standard, combining marks are conventionally shown with a dotted circle which gives a rough indication of the location of the base character relative to the combining mark. Among nautical symbols, the dotted circle has a different significance. It encloses symbols for rocks and other obstructions that are found outside their depth area. In other words, they rise significantly above the surrounding sea floor.

In column xxA in the attached summary of the proposed repertoire, all the dotted circles are part of the actual symbol and do not represent place holders.

Enclosed Digit Sequence

Obstructions are indicated as a series of up to three slanted digits enclosed in a dotted envelope. The subscripted digits indicate an amount in the secondary unit, which is not always decimal. Soundings on charts may use meters and decimeters or fathoms and feet. Obstructions deep enough to require more than three digits are not particularly relevant for surface navigation.

Examples:

$$2 \qquad 2_5 \qquad \overline{12} \qquad 15_5 \qquad 120$$
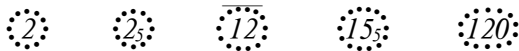
In the notational system realized in nautical charts, slanted digits are used to indicate depth, whereas upright digits are used to indicate elevation (e.g. the height of a light house). These slanted digits therefore represent the same kind of semantic distinction that is already encoded with the series of styled digits in the Mathematical Alphanumeric Symbols block.

NOTE: The following list three alternatives in rough order of descending preference)

ALTERNATIVE 1:

The examples above and below were laid out without any specialized software support with one of the existing fonts that are used to publish Notices to Mariners. There are three sizes of dotted outlines,

conceptually similar to a combining mark spanning one, two or three digits. The following table lists each of the possible combinations that occur in practice together with the pattern that produces it, where D is a large digit, d a small digit and O_n one of the outlines.

Example	Pattern
$\vdots 1 \vdots$	$D\ O_1$
$\vdots 2_1 \vdots$	$Dd\ O_1$
$\vdots 12 \vdots$	$DD\ O_2$
$\vdots 12_3 \vdots$	$DDd\ O_2$
$\vdots 123 \vdots$	$DDD\ O_3$

As implemented in the legacy font all patterns must be preceded by some amount of white space because they overhang to the left of the first digit by a certain amount.

In terms of Unicode encoding, O_3 could be defined unambiguously as a combining character spanning three base characters (DDD). The other two enclosing outlines are more challenging, because they appear to have a variable number of base characters. However, this can be formally accounted for by assuming that the digits in the first and third examples above are preceded by a space character and including that character in the number of characters spanned. With that O_1 can be defined as a combining character always spanning two base characters (either SPACE + D or Dd), and O_2 as a combining character always spanning three base characters (either SPACE + DD or DDd).

ALTERNATIVE 2:
The examples above were laid out without any specialized software support with one of the existing fonts that are used to publish Notices to Mariners. There are three sizes of dotted outlines, conceptually similar to a combining mark spanning one, two or three base characters. Logically this type of composite symbol behaves like a series of conjoining characters according to this regular expression:

$$D\ \{\ D\ |\ d\ \}^*O$$

where D is a large digit, d a small digit and O one of the outlines.

As implemented in the existing fonts, this feature does not require special support by the layout software. Even though it seemingly represents a complication of the encoding model, there is no associated burden to implementations that simply wish to migrate from the existing system. From a processing point of view, the most useful support would be the prevention of unsuitable line breaks. This can be easily accomplished in the existing framework of UAX#14, and does not require the dotted overlay characters to formally be combining marks.

ALTERNATIVE 3:

The examples above and below were laid out without any specialized software support with one of the existing fonts that are used to publish Notices to Mariners. There are three sizes of dotted outlines, conceptually similar to a combining mark spanning one, two or three base characters.

Treating these as single, double and triple combining character in Unicode has the advantage of simplicity, but the disadvantage that it does not reflect how these symbols are used in practice.

For example, compare ⊙*2i* from Alternative 1, with ⊙ *2i* . The latter is the result of using the second outline form with a **Dd** pattern. Clearly the spacing looks better when the **Dd** pattern is surrounded by the smaller outline. Because the inclined digits allow the subscripts to "tuck in" rather closely, the **Dd** pattern ends up as much more similar in width to a **D** rather than a **DD**.

Overall, it would seem preferable in this situation to simply use the existing character sequence and outline design, rather than forcing a different model that introduces additional complexities, just because it seems more attractive or more systematic on some purely abstract level.

If these characters are encoded as proposed here, existing implementations can migrate to the new Unicode encoding for these symbols by simply remapping character codes and fonts, there would be no requirement to change anything in the character sequence or to provide any specialized layout support. Generic support for character clusters in Unicode-based application would do the "right thing" out of the box.

Because of the limited number of patterns, requiring sophisticated layout support (full cartouching) would be overkill and would merely result in an unnecessary obstacle to migration. Treating the existing font that contains these symbols as a compatibility character set for this purpose would be the preferable approach.

Letters Enclosed in Diamonds

Capital letters enclosed in a diamond (or lozenge) outline signify reference locations for tidal current data or other data that must be charted. The IHO suggests a limit of no more than 20 in any single chart, the current proposal provides for the 16 found in actual fonts used for the purpose of printing notices, plus the ten that would extend them to the full alphabetic set needed if these are to be used outside the

nautical context as well, which would seem likely. These characters should therefore be encoded as general purpose enclosed letters and placed in an appropriate block.

While there is an existing combining character 20DF ENCLOSING DIAMOND, its use for this purpose is not proposed. The primary reason is that the precedent for other enclosed letters has been to encode them as single code points, and an additional reason is that using simple combining overlay without glyph substitution will not yield the correct appearance – for the letter shapes are smaller and are raised from the baseline.

Names and Naming Conventions

In the context of the Unicode Standard, there is a precedent for naming symbols by their shape if they can have many different meanings in different contexts. However, most nautical chart symbols have very specific shapes that do not lend themselves to re-use in other contexts.

Therefore, this proposal provides names for nautical chart symbols that are derived from their description in chart INT 1 as far as possible. It is common practice in nautical charts to use symbols for a variety of related functions, the precise nature of the feature being indicated by a label placed next to it in the charts or following it in text. In that case, the character names proposed in this proposal reflect the meaning of the unannotated symbol.

Many symbols exist in a filled in and hollow form, for which the Unicode Standard has the convention of adding BLACK or WHITE to the character name. It is understood that the actual colors of the navigational mark would be indicated by an explicit label anyway.

Topmarks are named in this proposal by shape on paper and not by their function in the IALA system. This allows a consistent convention for naming whether any given topmark is part of the IALA system or not. This does not mean that all topmarks should be considered general purpose geometrical shapes. Most configurations would seem fairly specialized and would only ever occur in a nautical context.

The names in this proposal abbreviate the typical Unicode names for triangular shapes by shortening "up-pointing" to "up" and so on, in an attempt to make the names for topmarks less unwieldy.

It should be noted that the actual shapes for topmarks on buoys by necessity are three dimensional, rotationally symmetric bodies so that they exhibit the same aspect from all directions. Therefore, what the names for the proposed characters call triangles, are in actuality cones, circles are balls, and squares, cylinders. Where appropriate, such information has been added to the nameslist as suggested annotations.

What IHO documents call a diamond shape is not in fact a turned square, so it might be preferable to call the corresponding enclosing shape a "lozenge".

In some cases, there's evidence in IHO publications, such as S-57, for a name for a symbol distinct from what it symbolizes. The prime example is the POSITION CIRCLE signifying a *fixed position*.

4. References, Authors, Sources

The Authors

Asmus Freytag, Ph.D. (asmus@unicode.org) is a contributing editor to ISO/IEC 10646 and former Technical VP of the Unicode Consortium.

Michel Suignard is VP and Secretary of the Unicode Consortium, Project Editor of ISO/IEC 10646 and representing the Script Encoding Initiative (SEI) (http://linguistics.berkeley.edu/sei/).

Prof. Dr. Eberhard R. Hilf is CEO of the Institute for Science Networking Oldenburg (ISN) (http://www.isn-oldenburg.de/).

Dipl. Inform. Karl Pentzlin is a member of the DIN committee for character coding.

References and Organizations

IHO: International Hydrographic Organization (http://www.iho.int)

Examples of national publications of chart INT1 defining the symbols in chart INT1 together with national symbols used in charts by the issuing authority.

- Chart No. 1, United States of America, *Nautical Chart Symbols, Abbreviations and Terms*, Eleventh Edition November 2011 (http://www.nauticalcharts.noaa.gov/mcd/chart1/ChartNo1.pdf)

- Service hydrographique et océanographique de la marine, Ouvrage 1D, INT 1, S*ymboles, abréviations et termes utilisés sur les cartes marines,* Édition n° 4 – 2006 http://www.shom.fr/fr_page/fr_prod_ouvrage/og_num/1D_4.001_28112006.pdf

- (excerpt only) BSH, *Kartenzeichen und Abkürzunge für Sportbootkarten,* http://www.bsh.de/de/Produkte/Infomaterial/Kartenzeichen_und_Abkuerzungen/Kartenzeichen.pdf

Some countries do not publish their own version of the INT 1 chart, for example New Zealand just references the publications by BSH and UKHO and simply states that they cover all the symbols in use for New Zealand.

Cross reference from INT 1 to Document S-57, which gives extensive notes on the intended use for many of these symbols as well as documenting the notational conventions established by the IHO.

- www.iho.int/iho_pubs/standard/S-57Ed3.1/s57int1_xref.zip and http://www.caris.com/S-57/frames/S57catalog.htm

Examples of the use of nautical chart symbols in running text can be found in the Notices to Mariners by different issuing authorities. The following is a non-exhaustive sampling of such publications:

- http://www.ukho.gov.uk/ProductsandServices/MartimeSafety/WeeklyNms/30snii11_Week30_2011.pdf

- http://www.bsh.de/de/Schifffahrt/Sportschifffahrt/Berichtigungsservice_Karten/Sammelberichtigungen/gebiet21/krt0049.pdf

- http://www1.kaiho.mlit.go.jp/TUHO/tuho/html/tuho/pdf/2012/suiro_eg/2012-01.pdf

AHS, Australian Hydrographic Service (http://www.hydro.gov.au)

BSH: Bundesamt für Seeschiffahrt und Hydrographie (http://bsh.de)

IALA: International Association of Marine Aids to Navigation and Lighthouse Authorities (http://www.iala-aism.org)

LINZ, Land Information New Zealand (http://www.linz.govt.nz) Publishes Notices on behalf of the New Zealand Hydrographic Authority.

PBO: Practical Boat Owner, http://www.pbo.co.uk

SHOM: Service hydrographique et océanographique de la marine (http://www.shom.fr)

UKHO: The United Kingdom Hydrographic Office (http://www.ukho.gov.uk)

Sources
A detailed list of notes on individual characters can be found at
http://unicode.org/~asmus/ChartSymbolsInRunningText/Notes.pdf

5. Proposed Repertoire

The following pages contain a listing of the set of nautical chart symbol characters proposed for encoding. Most of the symbols in the table are contained in fonts distributed by issuing authorities for the purpose of publishing text documents for chart updates, and are shown with actual glyphs from these fonts, where available. Because of they occur in the font collections created for showing nautical symbols in Notices to Mariners, all characters in these font collections are presumed to be occurring regularly in running text.

An extensive survey was nevertheless carried out, reviewing the Notices to Mariners for several national authorities in Europe, the Americas and the Far East for the latter part of 2011 and the early part of 2012. It was established that the repertoires contained in the fonts mentioned line up nicely with the categories of symbols used in actual notices. This survey also netted a number of additional symbols used by countries that do not release the fonts they use for publication. Negotiations to acquire fonts from these sources are underway.

The proposed repertoire of symbols is listed with glyphs and accompanying identifying information ("names" as well as annotations) in the familiar code chart and names list layout. The symbols have been roughly sorted according to their classification in chart INT1. All duplicates between source sets have been removed, except where there are national variations in shape for certain symbols.

Cross reference information to existing characters has been collected, usually in form of a cross reference to the Unicode characters that are most similar. However, the number of characters where a full unification seems possible is very small, and there are several characters that, despite superficial similarities, seem distinct enough in size, stroke width or position to warrant separate encoding (see Section 3, *Encoding Consideration*).

Code location

It is anticipated that the code locations for digits and enclosed letters will be changed to one or more different blocks during the encoding process, so they are shown as here as separate blocks.

NOTICE ABOUT PRESENTATION CONVENTIONS SPECIFIC TO THIS Proposal DOCUMENT:

In the summary of the proposed repertoire, code positions for proposed characters are shown relative to the beginning of a block using an xxFF notation. Some glyphs have been replaced by temporary bitmaps until they can be fixed in the font collection.

Many combining marks are shown on a white spherical buoy symbol ⌓ (gray or dotted) or the white beacon ⌂ and not on the standard dotted circle. This makes it much easier to visualize the intended result for purposes of review (see discussion in the text). The symbols at xx05 ⌓ and xx0D ⌂ are the stand-alone versions of these characters, all other instances of those shapes in the "Chart Symbols" block are placeholders.

Where dotted circles indicate combining characters, they have been grayed somewhat to distinguish them from characters where the dotted circle is part of the design, such as xxA0, xxA2, xxA5 and xxA7.

	xx0	xx1	xx2	xx3	xx4	xx5	xx6	xx7	xx8	xx9	xxA	xxB	xxC	xxD	xxE	xxF
0	xx00	xx10	xx20	xx30	xx40 (B)	xx50 (B)	xx60	xx70	xx80	xx90	xxA0	xxB0	xxC0	xxD0		
1	xx01	xx11	xx21	xx31	xx41 (G)	xx51 (G)	xx61		xx81	xx91	xxA1	xxB1	xxC1	xxD1		
2	xx02	xx12	xx22	xx32	xx42 (Or)	xx52 (Or)	xx62	xx72	xx82	xx92	xxA2	xxB2	xxC2	xxD2		
3	xx03	xx13	xx23	xx33	xx43 (R)	xx53 (R)	xx63	xx73	xx83	xx93	xxA3	xxB3	xxC3	xxD3		
4	xx04	xx14	xx24	xx34	xx44 (W)	xx54 (W)	xx64	xx74	xx84	xx94	xxA4	xxB4	xxC4	xxD4		
5	xx05	xx15	xx25	xx35	xx45 (Y)	xx55 (Y)	xx65	xx75	xx85	xx95	xxA5	xxB5	xxC5	xxD5	xxE5	
6	xx06	xx16	xx26	xx36	xx46 (BY)	xx56 (BY)	xx66	xx76	xx86	xx96	xxA6	xxB6	xxC6	xxD6	xxE6	
7	xx07	xx17	xx27	xx37	xx47 (GRG)	xx57 (GRG)	xx67	xx77	xx87	xx97	xxA7	xxB7	xxC7	xxD7	xxE7	
8	xx08	xx18	xx28	xx38	xx48 (BRB)	xx58 (BRB)	xx68	xx78	xx88	xx98	xxA8	xxB8		xxD8	xxE8	
9	xx09	xx19	xx29	xx39	xx49 (RW)	xx59 (RW)	xx69	xx79	xx89	xx99	xxA9	xxB9		xxD9	xxE9	
A	xx0A	xx1A	xx2A	xx3A	xx4A (YB)	xx5A (YB)	xx6A	xx7A	xx8A	xx9A	xxAA	xxBA		xxDA	xxEA	
B	xx0B	xx1B	xx2B	xx3B	xx4B (BYB)	xx5B (BYB)	xx6B	xx7B	xx8B		xxAB	xxBB	xxCB	xxDB	xxEB	
C	xx0C	xx1C	xx2C	xx3C	xx4C (YBY)	xx5C (YBY)	xx6C	xx7C	xx8C		xxAC	xxBC	xxCC	xxDC	xxEC	
D	xx0D	xx1D	xx2D		xx4D (RGR)	xx5D (RGR)	xx6D	xx7D	xx8D		xxAD	xxBD	xxCD	xxDD	xxED	
E	xx0E	xx1E	xx2E				xx6E	xx7E	xx8E		xxAE	xxBE	xxCE	xxDE	xxEE	
F	xx0F	xx1F						xx7F	xx8F			xxBF	xxCF	xxDF	xxEF	

Buoys, Beacons and other marks

Mooring buoys have a ring on top

xx00		BLACK CAN BUOY
xx01		WHITE CAN BUOY
xx02		BLACK NUN BUOY
xx03		WHITE NUN BUOY
xx04		BLACK SPHERICAL BUOY
xx05		WHITE SPHERICAL BUOY
xx06		MULTICOLOR SPHERICAL BUOY
xx07		BLACK PILLAR BUOY
xx08		WHITE PILLAR BUOY
xx09		MULTICOLOR PILLAR BUOY
xx0A		BLACK SPAR BUOY
xx0B		BLACK BEACON
xx0C		BLACK TOWER BEACON
xx0D		WHITE TOWER BEACON
xx0E		LATTICE BEACON
xx0F		SUPER BUOY
xx10		SUPER MOORING BUOY
xx11		BLACK BARREL BUOY
xx12		WHITE BARREL BUOY
xx13		BLACK BARREL MOORING BUOY
xx14		WHITE BARREL MOORING BUOY
xx15		BLACK LIGHT FLOAT
xx16		WHITE LIGHT FLOAT
xx17		LANBY

xx18   LIGHTED BEACON
- there are two forms, with the star and the hollow star, hollow seems to be more standard

xx19   LIGHTED BEACON ALTERNATE
- there are two forms, with the star and the hollow star

xx1A   BLACK DIAMOND SYMBOL FOR BUOY
= used in US charts for buoys independent of shape

xx1B   WHITE DIAMOND SYMBOL FOR BUOY
= used in US charts for buoys independent of shape

xx1C   MULTICOLOR DIAMOND SYMBOL FOR BUOY
= used in US charts for multicolored buoys independent of shape

Marked Submerged Rock

The two black balls conform to IALA convention for isolated danger and the usual convention about floating and fixed marks (inclined or upright symbol) apply

In principle only the base characters would have been needed, but the inclined symbol is more strongly inclined at 45° and the full set of topmarks is not needed in this context

xx1D   BEACON ON SUBMERGED ROCK
xx1E   SPAR ON SUBMERGED ROCK

Leading Beacon

xx1F   LEADING BEACON
- a pair will indicate a leading line
- more prominent circle than std. beacon at xx0B and more squat
- → F363 ǂ leading line

Combining Topmarks for Buoys

These are topmarks for floating structures and therefore drawn inclined

xx20   COMBINING BUOY TOPMARK TWO BLACK TRIANGLES UP
= North

xx21   COMBINING BEACON TOPMARK TWO BLACK TRIANGLES DOWN
= South

xx22   COMBINING BUOY TOPMARK TWO BLACK TRIANGLES UP ABOVE DOWN
= East

xx23   COMBINING BUOY TOPMARK TWO BLACK TRIANGLES DOWN ABOVE UP
= West

xx24   COMBINING BUOY TOPMARK TWO BLACK CIRCLES
= isolated danger mark

xx25   COMBINING BUOY TOPMARK WHITE CIRCLE
= safe water mark

xx26   COMBINING BUOY TOPMARK X
= special mark

xx27   COMBINING BUOY TOPMARK WHITE SQUARE
= single white can topmark

xx28   COMBINING BUOY TOPMARK BLACK SQUARE
= single black can topmark

xx29   COMBINING BUOY TOPMARK WHITE TRIANGLE UP
= single white cone topmark

xx2A   COMBINING BUOY TOPMARK BLACK TRIANGLE UP
= single black cone topmark

Combining National Topmarks for Buoys

xx2B   COMBINING BUOY TOPMARK WHITE TRIANGLE DOWN
= used in French and German charts

xx2C   COMBINING BUOY TOPMARK WHITE TOP HALF CIRCLE
= used in French charts
- glyph is incorrect, should be the top half of a white circle

xx2D   COMBINING BUOY TOPMARK FISH
used in German charts

xx2E   COMBINING BUOY TOPMARK WHITE FLAG
used in German charts

Combining Topmarks for Towers and Beacons

These are topmarks for land-based structures and therefore drawn upright

xx30   COMBINING TOWER TOPMARK TWO BLACK TRIANGLES UP
- North

xx31   COMBINING TOWER TOPMARK TWO BLACK TRIANGLES DOWN
- South

xx32   COMBINING TOWER TOPMARK TWO BLACK TRIANGLES UP ABOVE DOWN
- East

xx33   COMBINING TOWER TOPMARK TWO BLACK TRIANGLES DOWN ABOVE UP
- West

xx34   COMBINING TOWER TOPMARK TWO BLACK CIRCLES
= isolated danger mark

xx35   COMBINING TOWER TOPMARK WHITE CIRCLE
= safe water mark

xx36   COMBINING TOWER TOPMARK X
= special mark

xx37   COMBINING TOWER TOPMARK WHITE SQUARE
= single white can topmark

xx38   COMBINING TOWER TOPMARK BLACK SQUARE
= single white cone topmark

xx39   COMBINING TOWER TOPMARK WHITE TRIANGLE UP
= single black cone topmark

xx3A   COMBINING TOWER TOPMARK BLACK TRIANGLE UP
= single black can topmark

Combining National Topmarks for Towers and Beacons

xx3B   COMBINING TOWER TOPMARK WHITE TRIANGLE DOWN
= used in French charts

xx3C   COMBINING TOWER TOPMARK WHITE TOP HALF CIRCLE
used in French charts
• glyph is incorrect, should be the top half of a white circle

Combining Colors

These designate the actual color of a buoy or floating mark. In following the inclined depiction of these marks, the color labels are drawn oblique and shifted to the left so they align with the small circle.

Only a limited number of color designations are used.

xx40   COMBINING COLOR BLACK BELOW
xx41   COMBINING COLOR GREEN BELOW
xx42   COMBINING COLOR ORANGE BELOW
xx43   COMBINING COLOR RED BELOW
xx44   COMBINING COLOR WHITE BELOW
xx45   COMBINING COLOR YELLOW BELOW
xx46   COMBINING COLORS BLACK AND YELLOW BELOW
xx47   COMBINING COLORS GREEN RED GREEN BELOW
xx48   COMBINING COLORS BLACK RED BLACK BELOW
xx49   COMBINING COLORS BLACK RED WHITE BLACK BELOW
xx4A   COMBINING COLORS YELLOW AND BLACK BELOW
xx4B   COMBINING COLORS BLACK YELLOW BLACK BELOW
xx4C   COMBINING COLORS YELLOW BLACK YELLOW BELOW
xx4D   COMBINING COLORS RED GREEN RED BELOW

Combining Colors Alternate

These are color designators for land-based structures and therefore drawn upright and centered.

xx50   COMBINING COLOR BLACK BELOW ALTERNATE
xx51   COMBINING COLOR GREEN BELOW ALTERNATE
xx52   COMBINING COLOR ORANGE BELOW ALTERNATE

xx53   COMBINING COLOR RED BELOW ALTERNATE
xx54   COMBINING COLOR WHITE BELOW ALTERNATE
xx55   COMBINING COLOR YELLOW BELOW ALTERNATE
xx56   COMBINING COLORS BLACK AND YELLOW BELOW ALTERNATE
xx57   COMBINING COLORS GREEN RED GREEN BELOW ALTERNATE
xx58   COMBINING COLORS BLACK RED BLACK BELOW ALTERNATE
xx59   COMBINING COLORS RED WHITE BELOW ALTERNATE
xx5A   COMBINING COLORS YELLOW AND BLACK BELOW ALTERNATE
xx5B   COMBINING COLORS BLACK YELLOW BLACK BELOW ALTERNATE
xx5C   COMBINING COLORS YELLOW BLACK YELLOW BELOW ALTERNATE
xx5D   COMBINING COLORS RED GREEN RED BELOW ALTERNATE

Lights

xx60   MAJOR LIGHT
• looks like a small hollow star, but sits lower
→ 272B ☆ open centre black star

xx61   MINOR LIGHT
• sits lower than the black star
→ 2605 ★ black star

xx62   PILE
= light
• similar dot is used on some charts for lights (with a light cone)
• When used in documents this and the preceding two characters are centered on a line slightly above the baseline, as are the position circles, glyphs in font may need adjustment

xx63   LEADING LIGHTS
• two lights lining up at the bearing indicated in the charts
• character has no semantic connection to 2260 ≠ not equal to and is only superficially similar in appearance
→ 2260 ≠ not equal to

Combining Light

Both orientations exist

xx64   COMBINING LIGHT CONE BELOW LEFT
• indicates a lighted navigational mark

xx65   COMBINING LIGHT CONE BELOW RIGHT
• indicates a lighted navigational mark

Sound and Light Features

These symbols indicate additional equipment on buoys

xx66   LIGHT CONE
xx67   HORN
= fog horn
xx68   FLOOD LIGHT
xx69   STRIP LIGHT
xx6A   RADAR REFLECTOR
• this is a stand alone symbol. Used when denoting the presence of a radar reflector as such in text

xx6B   RADAR REFLECTOR ALTERNATE
- this deeper variant covers 180°, French usage
- this is a stand alone symbol, used when denoting the presence of a radar reflector as such in text

xx6C   COMBINING RADAR REFLECTOR
- left above
- used to show the presence of a radar reflector on a buoy as part of a symbol composed from a combining sequence

xx6D   COMBINING FLOOD LIGHT
- left below

xx6E   COMBINING HORN
= fog horn
- right above

Landmarks

xx70   APPROXIMATE POSITION
= SMALL-ish white circle
- need to check whether alignment relative to baseline is compatible with 26AC ○
→ 26AC ○ medium small white circle

xx71 "   <reserved>

xx72   POSITION CIRCLE
= fixed point
- the nature of the fixed point is giving by a label
- the position is plotted accurately
- this is the smaller variant, dot floats just above base line

xx73   LARGE POSITION CIRCLE
= fixed point
- the nature of the fixed point is giving by a label
- the position is plotted accurately
- unlike 2299 ⊙ circle dot operator F373 ☉ descends below base line
- this is a larger variant of the preceding, but contrastively used
- see also discussion on Unification in proposal document
→ 2299 ⊙ circled dot operator
→ 2A00 ⨀ n-ary circled dot operator

xx74   CHIMNEY
xx75   RADIO TOWER
xx76   RADIO MAST
xx77   WATER TOWER
xx78   TOWER
xx79   FLAG POLE WITH WHITE FLAG
- as a nautical chart symbol, this symbol has a baseline with a small circle marking the position. It cannot be unified with any representation lacking these features
→ 2690 ⚐ white flag

xx7A   MONUMENT
- keyhole shape with diagonal hatching

xx7B   MONUMENT ALTERNATE
- truncated cone shape, narrower than beacon tower

xx7C   WINDMILL
xx7D   WINDMOTOR
- [sic]

xx7E   DISH AERIAL
= satellite dish tower

xx7F   TANK
- glyph is hashed circle larger size than white circle

xx80   MAST

National Landmarks

xx81   RADIO MAST ALTERNATE
- national symbol SHOM

xx82   BLACK CHIMNEY
- this glyph is black, national symbol SHOM

Offshore Installations

xx83   WIND TURBINE
xx84   WIND FARM
xx85   WIND TURBINE ALTERNATE
- alternate symbol, source UKHO

xx86   OFFSHORE PLATFORM
- glyph is a square with dot, sitting on, or slightly below the baseline
→ 22A1 ⊡ squared dot operator
→ 1F771 🝱 alchemical symbol for urine

xx87   MARINE FARM ALTERNATE
- used on small scale charts

xx88   MARINE FARM

Ports

xx89   DEVIATION DOLPHIN
xx8A   TIDE SCALE
xx8B   ANCHOR BERTH MARK ROUND LABEL
xx8C   ANCHOR BERTH MARK RECTANGULAR LABEL
xx8D   FISHING PORT
xx8E   MARINA
xx8F   SEA PLANE ANCHORAGE
- the symbol may also be used to designate sea plan operating area

Overlays for Obstructions

Used with Nautical Oblique Digits indicating the depth

xx90   OBSTRUCTION OVERLAY-1
- used to overlay 1+ up to one subscript digit

xx91   OBSTRUCTION OVERLAY-2
- used to overlay 2+ up to one subscript digits

xx92   OBSTRUCTION OVERLAY-3
- used to overlay 3 digits

Combining Mark

xx93   COMBINING SWEPT BY WIRE DRAG OR DIVER-1
- spans 1+ digit

xx94   COMBINING SWEPT BY WIRE DRAG OR DIVER-2
- spans 2+ digits

xx95   COMBINING SWEPT BY WIRE BELOW-3
- spans 3 digits

Combining Clearance

xx96   COMBINING SAFE CLEARANCE ABOVE-1
- spans 1 digit

xx97   COMBINING SAFE CLEARANCE ABOVE-2
- spans 2+ digits

xx98   COMBINING SAFE CLEARANCE ABOVE-3
- spans 3 digits

Additional Landmarks

xx99   FLARE STACK

xx9A   NOTICE BOARD

Rocks, Wrecks and Obstructions

xxA0   OBSTRUCTION
- this one is not an overlay

xxA1   +   SUBMERGED ROCK
- like the plus sign, this symbol consists of two crossed lines, but has otherwise no semantic connection
- unlike plus sign, glyph descends below baseline
- → 002B + plus sign

xxA2   SUBMERGED ROCK OUTSIDE DEPTH AREA
- glyph has the plus shape for submerged rock surrounded by the dotted circle for obstruction

xxA3   SUBMERGED ROCK WITH BEACON
- a more standard variant would have the two black circles of the "isolated danger" topmark on a a heavier diagonal
- this form is found in the UKHO font

xxA4   ROCK AWASH
- unlike existing dotted cross, glyph descends below baseline
- → 205C □ dotted cross

xxA5   ROCK AWASH OUTSIDE DEPTH AREA
- a rock that's awash at chart datum, but situated in much deeper waters

xxA6   *   ROCK THAT UNCOVERS WITH TIDE
- the glyph has uniform stroke width must not vary with font design
- glyph descends below base line
- → 002A * asterisk

xxA7   ROCK THAT UNCOVERS WITH TIDE OUTSIDE DEPTH AREA
- the term isolated attempts to capture the semantics of this in a shorthand way, but it's not used in the formal legend
- a slightly smaller version of XXXX rock that uncovers with tide, surrounded by a dotted circle

xxA8   PARTIALLY SUBMERGED WRECK

xxA9   SUBMERGED WRECK

xxAA   SUBMERGED WRECK OUTSIDE DEPTH AREA
- an isolated wreck coming much closer to the surface than the surrounding sea bed

xxAB   #   FOUL GROUND
- like the number sign, this consists of two pairs of crossed lines, but the relative line width is narrower and the spacing wider - it would not be appropriate to unify this symbol with 0023 #
- → 0023 # number sign

xxAC   SUBMERGED PILE

Other

xxAD   NAUTICAL SMALL WHITE SQUARE
- off the baseline but sits lower than the existing character
- smaller than offshore platform
- used generically for a mark on land, or dolphin
- → 25FD □ white medium small square

xxAE   □   NAUTICAL WHITE SQUARE
- this sits on the baseline, unlike the existing character, which is centered on math axis
- larger than offshore platform
- used a.o. for square beacon in plan view, leading beacon in US Charts
- → 25FB □ white medium square

Misc Nautical Symbols

xxB0   DIVING PROHIBITED

xxB1   ANCHORING PROHIBITED
- the corresponding ANCHOR SYMBOL can be unified with existing 2693 ⚓
- see also discussion on Unification in proposal document
- = 2693 anchor

xxB2   FISHING PROHIBITED

xxB3   FISH SYMBOL
- this is a n abstract symbol and in design must match FISHING PROHIBITED and FISH HAVEN, FISH FARM
- must not be unified with pictorial fish dingbat
- → 1F41F □□ fish

xxB4   ZONE LIMIT
- delimits zones, such as restricted areas. In text, this extent of the zone would be given with a list of coordinates
- glyph consists of a line of four small T shaped elements

xxB5   PIPELINE
- name not verified
- glyph consists of a line of four small elements shaped approx. like horizontal lollipops.

xxB6   CABLE
- alternated with XXXX power cable marker to indicate a power cable, alternated with XXXX zone limit to indicate a cable zone
- glyph must align with XXXX pipeline and XXXX zone limit, contains four iterations of the wave
- → 3030 〰 wavy dash

xxB7   POWER CABLE MARKER
- glyph must center align with XXXX cable

xxB8   FISH HAVEN

xxB9   BOARDING PLACE
- boarding place for pilot etc.
- glyph is diamond in a circle

xxBA   RESCUE STATION

xxBB · LIGHT HOUSE OR CABLE MARKER
- name not verified
- is that it, or is it the heavy dot for cables?
- glyph looks like a bullet
- → 2022 • bullet
- same size glyph as XXXX dotted circle

xxBC ⬭ MOORED STORAGE TANKER
- direction in which glyph points seems to be arbitrary

xxBD ⬭ RADIO REPORTING POINT WITH DIRECTION OF VESSEL MOVEMENT TWO-WAY

xxBE ⬭ RADIO REPORTING POINT WITH DIRECTION OF VESSEL MOVEMENT ONE-WAY

xxBF ➤ BIRD SANCTUARY

Withies and Perches

These are used for marking shifting channels in sands. The beginning of a channel is marked with a double withy or perch.

xxC0 ⵊ PORT HAND WITHY
xxC1 ♯ PORT HAND DOUBLE WITHY
xxC2 ⵊ STARBOARD HAND WITHY
xxC3 ♯ STARBOARD HAND DOUBLE WITHY
xxC4 Ƴ PORT HAND PERCH
xxC5 Ѱ PORT HAND DOUBLE PERCH
- at beginning of channel
xxC6 ⵊ STARBOARD HAND PERCH
xxC7 Ѱ STARBOARD HAND DOUBLE PERCH
- at beginning of channel

Stakes and Poles

xxCB ⟋ DRIFTING STAKE
- name is preliminary - a better option could be "spar"
xxCC ⵗ POLE WITH POSITION CIRCLE
xxCD ⵗ BEACON ALTERNATE
- national form, SHOM
xxCE ⊥ POLE
xxCF ⊥ STAKE WITH WIDE BASE

Radio

xxD0 ◯ RADIO FEATURE
- must match the following in size, line-weight
- line weight for this is often rather light for the size and size is very large. At this state, possible unification with 25EF ○ is still under review, but 25EF ○ does not have design requirement to match any other character.
- → 25EF ○ large circle
xxD1 ◯ COMBINING RADIO FEATURE
- must match preceding in size, line weight. The size of 20DD ☐ may be too small, and it's not matched by design to, say, 25EF ○. Unification would likely break the relation between these two symbols.
- → 20DD ☐ combining enclosing circle
xxD2 ◌ RADIO REPORTING LINE
- glyph should show this as flanked by two dashed lines

Zones

xxD3 ⊷•⊶ RESTRICTED ZONE BOUNDARY

xxD4 ◁▷ CIRCULAR RESTRICTED ZONE BOUNDARY
xxD5 ◁▷ CIRCULAR ZONE BOUNDARY
- e.g. safety exclusion zone etc.
xxD6 LIVE FIRE AREA LIMIT
- usually repeated and / or combined with a dashed line
xxD7 UNEXPLODED ORDINANCE

Tracks and Routes

These symbols are at least 4 em wide

xxD8 VERY LONG RIGHTWARDS WHITE ARROW
xxD9 VERY LONG LEFTWARDS WHITE ARROW
xxDA VERY LONG RIGHTWARDS WHITE DASHED ARROW
xxDB VERY LONG LEFTWARDS WHITE DASHED ARROW
xxDC VERY LONG DASHED LINE
xxDD VERY LONG DOTTED LINE
xxDE FERRY TRACK

Daymarks

Some of these are used as fullsize, non-combining versions of the same shapes as found for topmarks, for use when the shape is discussed in text without a full depiction of the aid to navigation. Typical use would be in description of a daymark shape for beacons. Others may appear in the nautical symbol fonts, but are used in non-nautical ways, such as for text bullets in Notices. All of the latter, but also some of the former, appear unifiable with regular geometric shapes, shown as "bare" cross references here.

- → 25B2 ▲ black up-pointing triangle
- → 25B3 △ white up-pointing triangle
- → 25BD ▽ white down-pointing triangle
- → 25B6 ▶ black right-pointing triangle
- → 25CB ○ white circle
- → 27A4 ➤ black rightwards arrowhead
- → 2605 ★ black star
- → 25CA ◊ lozenge

xxE5 DAYMARK X
- a fullsize X
xxE6 DAYMARK WHITE FLAG
- cannot be unified with the white flag dingbat because that's on a staff
- this glyph clearly shows the flag flying from a flagline
- → 2690 ⚐ white flag
xxE7 ⧩ TWO WHITE TRIANGLES UP ABOVE DOWN
- glyph in source connects triangles with a center stem
xxE8 ⧨ TWO WHITE TRIANGLES DOWN ABOVE UP
- glyph in source connects triangles with a center stem
xxE9 ৪ TWO WHITE CIRCLES
- = two white balls
xxEA ⧩ TWO BLACK TRIANGLES UP
- = North
xxEB ⧨ TWO BLACK TRIANGLES DOWN
- = South
xxEC ⧩ TWO BLACK TRIANGLES UP ABOVE DOWN
- = East
xxED ⧨ TWO BLACK TRIANGLES DOWN ABOVE UP
- = West

xxEE　⦂　TWO BLACK CIRCLES
　　　　= isolated danger
xxEF　▃　HEAVY LOW LINE
　　　　　• not conclusively identified as nautical nor
　　　　　　unified with an existing symbol
　　　　　• included provisionally pending
　　　　　　confirmation of status
　　　　　• source: SHOM fonts
　　　　　→ 2581 ▁ lower one eighth block

	xx0	xx1
0	*0* xx00	*0* xx10
1	*1* xx01	*1* xx11
2	*2* xx02	*2* xx12
3	*3* xx03	*3* xx13
4	*4* xx04	*4* xx14
5	*5* xx05	*5* xx15
6	*6* xx06	*6* xx16
7	*7* xx07	*7* xx17
8	*8* xx08	*8* xx18
9	*9* xx09	*9* xx19
A		
B		
C		
D		
E		
F		

Nautical Oblique Digits

These digits are used for primary units in depth indications (such as fathoms, or meters). They can be in a true italic, that is serif style, or more often, in an oblique sans-serif style.

xx00	*0*	NAUTICAL OBLIQUE DIGIT ZERO
xx01	*1*	NAUTICAL OBLIQUE DIGIT ONE
xx02	*2*	NAUTICAL OBLIQUE DIGIT TWO
xx03	*3*	NAUTICAL OBLIQUE DIGIT THREE
xx04	*4*	NAUTICAL OBLIQUE DIGIT FOUR
xx05	*5*	NAUTICAL OBLIQUE DIGIT FIVE
xx06	*6*	NAUTICAL OBLIQUE DIGIT SIX
xx07	*7*	NAUTICAL OBLIQUE DIGIT SEVEN
xx08	*8*	NAUTICAL OBLIQUE DIGIT EIGHT
xx09	*9*	NAUTICAL OBLIQUE DIGIT NINE

Nautical Oblique Subscript Digits

These subscripted digits are used for the secondary units of a depth indication (such feet or decimeters). Typically only one digit is used.

xx10	$_0$	NAUTICAL OBLIQUE SUBSCRIPT DIGIT ZERO
xx11	$_1$	NAUTICAL OBLIQUE SUBSCRIPT DIGIT ONE
xx12	$_2$	NAUTICAL OBLIQUE SUBSCRIPT DIGIT TWO
xx13	$_3$	NAUTICAL OBLIQUE SUBSCRIPT DIGIT THREE
xx14	$_4$	NAUTICAL OBLIQUE SUBSCRIPT DIGIT FOUR
xx15	$_5$	NAUTICAL OBLIQUE SUBSCRIPT DIGIT FIVE
xx16	$_6$	NAUTICAL OBLIQUE SUBSCRIPT DIGIT SIX
xx17	$_7$	NAUTICAL OBLIQUE SUBSCRIPT DIGIT SEVEN
xx18	$_8$	NAUTICAL OBLIQUE SUBSCRIPT DIGIT EIGHT
xx19	$_9$	NAUTICAL OBLIQUE SUBSCRIPT DIGIT NINE

	xx2	xx3
0	◇A◇ xx20	◇Q◇ xx30
1	◇B◇ xx21	◇R◇ xx31
2	◇C◇ xx22	◇S◇ xx32
3	◇D◇ xx23	◇T◇ xx33
4	◇E◇ xx24	◇U◇ xx34
5	◇F◇ xx25	◇V◇ xx35
6	◇G◇ xx26	◇W◇ xx36
7	◇H◇ xx27	◇X◇ xx37
8	◇I◇ xx28	◇Y◇ xx38
9	◇J◇ xx29	◇Z◇ xx39
A	◇K◇ xx2A	
B	◇L◇ xx2B	
C	◇M◇ xx2C	
D	◇N◇ xx2D	
E	◇O◇ xx2E	
F	◇P◇ xx2F	

Enclosed Letters

Letters enclosed in diamonds(lozenges?) are used to indicate notes, current information etc. IHO recommends a limit of 20, the UKHO font contains the first 16. The full set A-Z is proposed to make the set usable as general bullet characters.

xx20	◇A◇	LATIN CAPITAL LETTER A ENCLOSED IN DIAMOND
xx21	◇B◇	LATIN CAPITAL LETTER B ENCLOSED IN DIAMOND
xx22	◇C◇	LATIN CAPITAL LETTER C ENCLOSED IN DIAMOND
xx23	◇D◇	LATIN CAPITAL LETTER D ENCLOSED IN DIAMOND
xx24	◇E◇	LATIN CAPITAL LETTER E ENCLOSED IN DIAMOND
xx25	◇F◇	LATIN CAPITAL LETTER F ENCLOSED IN DIAMOND
xx26	◇G◇	LATIN CAPITAL LETTER G ENCLOSED IN DIAMOND
xx27	◇H◇	LATIN CAPITAL LETTER H ENCLOSED IN DIAMOND
xx28	◇I◇	LATIN CAPITAL LETTER I ENCLOSED IN DIAMOND
xx29	◇J◇	LATIN CAPITAL LETTER J ENCLOSED IN DIAMOND
xx2A	◇K◇	LATIN CAPITAL LETTER K ENCLOSED IN DIAMOND
xx2B	◇L◇	LATIN CAPITAL LETTER L ENCLOSED IN DIAMOND
xx2C	◇M◇	LATIN CAPITAL LETTER M ENCLOSED IN DIAMOND
xx2D	◇N◇	LATIN CAPITAL LETTER N ENCLOSED IN DIAMOND
xx2E	◇O◇	LATIN CAPITAL LETTER O ENCLOSED IN DIAMOND
xx2F	◇P◇	LATIN CAPITAL LETTER P ENCLOSED IN DIAMOND
xx30	◇Q◇	LATIN CAPITAL LETTER Q ENCLOSED IN DIAMOND
xx31	◇R◇	LATIN CAPITAL LETTER R ENCLOSED IN DIAMOND
xx32	◇S◇	LATIN CAPITAL LETTER S ENCLOSED IN DIAMOND
xx33	◇T◇	LATIN CAPITAL LETTER T ENCLOSED IN DIAMOND
xx34	◇U◇	LATIN CAPITAL LETTER U ENCLOSED IN DIAMOND
xx35	◇V◇	LATIN CAPITAL LETTER V ENCLOSED IN DIAMOND
xx36	◇W◇	LATIN CAPITAL LETTER W ENCLOSED IN DIAMOND
xx37	◇X◇	LATIN CAPITAL LETTER X ENCLOSED IN DIAMOND
xx38	◇Y◇	LATIN CAPITAL LETTER Y ENCLOSED IN DIAMOND
xx39	◇Z◇	LATIN CAPITAL LETTER Z ENCLOSED IN DIAMOND