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UPDATING OF SIGNS AND SIGNALS ON INLAND WATERWAYS (SIGNI)

Transmitted by the Danube Commission

Note: The secretariat reproduces below extracts from the Danube Commission's Instruction on the installation of signs and marking on the Danube of 23 April 1991.

INSTRUCTION ON THE INSTALLATION OF SIGNS AND MARKING ON THE DANUBE

I. GENERAL

In terms of the objective pursued, the marking of the Danube comprises two categories of signs:

- signs used to regulate navigation on the waterway, set out in Annex 7 to the Basic Provisions relating to Navigation on the Danube (hereinafter the DFND, publication by the Danube Commission, Budapest, 1991), and
- signs and signals on the water and bank marks marking the sides of the fairway and navigational hazards, set out in Annex 8 to the DFND.

The signs set out in Annex 7 to the DFND are prohibitory, mandatory, restrictive, recommendatory or informative signs and additional signs.

In accordance with article 5.01 of the DFND, boatmasters shall obey the requirements and take account of the recommendations or indications brought to their attention by these signs.

The signs and signals on the water and bank marks of Annex 8 of the DFND are used to indicate the limits, the direction and the depth of the waterway and, in addition, are used to mark obstacles and permanent structures in the fairway or in its vicinity.

The number of bank marks and signs and signals on the water and the plan for their on-site location shall meet the requirements of navigational safety.

The choice of the mark and the establishment of their number depends on the local characteristics of the waterway and the function of the mark. Their installation shall be effected in such a way as to ensure visibility from one to the next.

The luminous range of lights is established by the competent authorities of the respective countries in terms of local navigational conditions. In calculating the luminous range, the atmospheric transmission coefficient 0.6 should be used over a distance of 1 nautical mile.

In principle, the colours of lights should be in keeping with the recommendations of the International Commission on Illumination ("Colours of light signals", in ICI publication No. 2.2 (T.C. 1.6) 1975).

The marks shall be installed by the competent authorities of the Danube countries and by the special river administrations which:

- (a) regularly observe the state of the bed of the river and the changes taking place in it and, on the basis of the results of these observations correct the positioning of the signs and marks and, where necessary, add to them so that they will indicate the fairway dimensions set out in the corresponding recommendations of the Danube Commission or those published in the notices to boatmasters;

- (b) regularly measure the depth and the width of the marked fairway and provide boatmasters with the necessary information concerning minimum channel depths and widths and the river level regime;
- (c) establish the plan for the installation of signs and marks in their respective sectors and establish the type and number of signs and signals on the water and bank marks to be used, in terms of the requirements of navigational safety and local conditions;
- (d) ensure the uninterrupted operation of all signs and signals on the water and bank marks;
- (e) ensure that the bottom of the fairway is obstacle-free, mark uncovered obstacles, take the necessary measures to remove such obstacles and to carry out work on deepening and cleaning the bottom of the river bed; they should also submit proposals concerning the work to be done on regulation over sills and in other places where navigation is obstructed;
- (f) inform boatmasters in good time of the date of the installation and removal of signs and signals, of all alterations to their number, type, positioning and lighting, and the rules they establish permitting the passage of vessels in restricted sections where meeting and passing are prohibited.

II. REQUIREMENTS TO BE MET BY SIGNS AND MARKS AND THE PLAN FOR THEIR INSTALLATION

In principle, marking shall be in operation uninterruptedly (by day and by night) all along the navigable section of the river, as from when the waterway is free from ice until the ice appears; it shall be corrected as changes occur in the level and in the fairway.

During periods of high water and when debris is being carried down, the regular marking removed to preserve it from possible damage shall be replaced, as far as possible, by marker posts and spars the topmarks and colours of which shall correspond to those adopted for the respective side of the fairway.

The bank marks and the additional signs and signals on the water shall if possible operate until navigation becomes completely impossible because of ice, so that vessels still under way can reach their wintering quarters or the nearest harbour.

The positioning of the signs shall, as already said, be effected so as to ensure day and night visibility from one sign to the next. Moreover, if the local conditions of the river bed so permit, the navigable channel shall be marked such a way that vessels proceeding downstream can use sections of the river where current speed is greatest, and vessels proceeding upstream can use sections of the river with a lower current speed (calm water).

Signs and signals on the water shall be installed so as to ensure the safety of vessels on the fairway.

Buoys shall be unsinkable and shall remain unsinkable in all storms, and their main body shall therefore be watertight; they shall not only float but also be stable, i.e. conserve a vertical position as far as possible and not be tipped too much by waves and wind.

The basic condition which the plan for the installation of the signs and marks shall meet is to ensure the safety of the fleet and the continuity of traffic, by day and by night, throughout the sailing season and to give boatmasters clear and unambiguous indications concerning the direction and the limits of the fairway.

The plan for the installation of the signs and marks shall be prepared in such a way as to permit a rational combination of bank marks and signs and signals on the water. When the plan is drawn up, it should be based on the conditions of navigation, and specific hydrographic and hydrometeorological conditions, the need to ensure the established dimensions of the fairway and create the necessary conditions for the safety and continuity of navigation of all river vessels and, where necessary, of seagoing vessels.

Bank marks serve to guide boatmasters and to indicate the direction of the fairway. Signs and signals on the water supplement bank marks in sectors where, in order to ensure the safety of navigation, it is essential to indicate not only the direction of the fairway but also its limits, and to mark places where there are obstacles.

The marking plan comprises permanent marking and additional signs; the first is used for average and low water, and the second for low water. An appropriately scaled map is used for this purpose.

In preparing the plan for the installation of signs and marking the following requirements should be taken into account:

(a) only the signs set out in Annexes 7 and 8 of the DFND are to be used to mark the fairway and regulate navigation; in exceptional cases special additional bank marks may also be used, provided, however, that the marks are not in contradiction with those contained in the DFND;

(b) the dimensions of the marked channel shall correspond to the dimensions established by the Danube Commission and approved by decisions taken at the XVIIIth, XXth, XXIst, XXXIIIrd, XXXVIIth and XLVth sessions or the dimensions published by the competent authorities;

(c) it is recommended that the minimum dimensions set out in the "Recommendations relating to the establishment of dimensions for fairways and water supply engineering and other structures on the Danube" should be taken into consideration only at critical points for navigation (rocky banks, sills, sections in which there are sunken vessels, etc.). In all other cases, it would be useful for fairway dimensions to be greater than those set out in the above-mentioned Recommendations;

(d) the choice of where the signs are to be placed shall be based on the most recent measurements, acquired experience and available data on the state of the fairway, critical points, water levels, etc.;

(e) signs and marker lights shall be visible whatever the level of the water, at all points of the fairway and as long as may be necessary for the guidance of boatmasters;

(f) over the entire width of the channel marked with the corresponding signs and signals on the water, the depth shall not be less than the effective minimum depth published by the competent authorities in the notifications to boatmasters.

All the signs and signals on the water and bank marks comprising the marking of the sector in question shall be set out in a consolidated table attached to the marker installation plan. Each mark shall be preceded by the kilometre point at which it is placed.

At the start of the sailing season, after the ice has gone and before the marks are installed, soundings shall be taken on the sections where the bed is liable to deformation and the marking plan corrected on the basis of these soundings.

If there is a subsequent drop in level, reconnaissance soundings shall be taken on some sections of the river in order to check whether the positioning of the signs is adequate and to establish whether the marking needs to be supplemented by new signs.

The frequency of these soundings shall be determined by changes in water level. The more rapid the drop in levels, the more frequent the soundings need to be.

III. VISIBILITY OF SIGNS AND LIGHTS

Whatever the position of the vessel in relation to the sign or the marker light, the characteristics of the sign or light shall remain unchanged. For daytime signs, these characteristics are: the form (topmark) and the colour; for signs and signals at night: the type and colour of the lights.

The forms and the colours of the topmarks and the types and colours of the lights are set out in detail in Annexes 7 and 8 of the DFND.

Sketches of the signs are given in Annexes 1 and 2 of this Instruction. The numbering of the sketches corresponds to the numbering of the signs given in Annexes 7 and 8 of the DFND.

(a) Conditions of visibility and dimensions of signs

The basic requirement to be met by signs and marking is the guarantee of good visibility of all signs and signals by day or night.

There are three degrees of visibility of signs and signals:

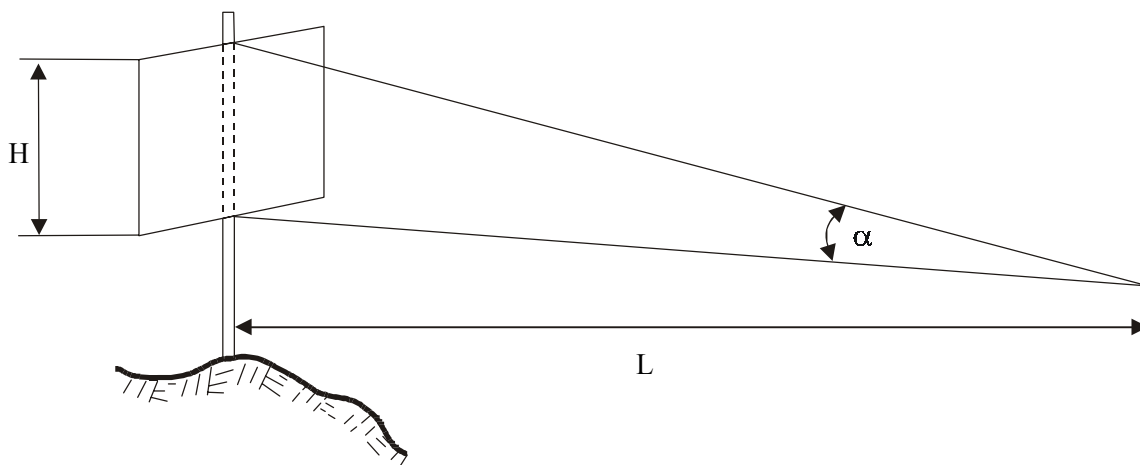
1. When, because of the distance, the sign is no more than a blotch on the background and neither shape nor colour can be distinguished (dotted outline);
2. When the sign is visible and its shape and outline can be seen, but the colour remains unclear;
3. When the shape and colour of the sign can be seen distinctly.

In order for boatmasters to find their true bearings, second and third degree visibility must be ensured, where shape and colour can be seen distinctly. The types and dimensions of signs and marking shall be established taking these requirements into account.

The degree of visibility of a sign, as of any object, depends primarily on the size of the angle of sight, the colour contrast, the contrast in luminance and weather conditions.

In order to ensure first degree visibility (dotted outline) it suffices in daytime to see the sign with an angle of the order of 1 minute and by night with an angle of the order of 10 minutes. The details and colour of the sign (second and third degree visibility) can only be distinguished with a larger angle of sight and in terms of specific characteristics.

According to research data, the limit of the angle of sight for signs with simple shapes (circle, square, triangle, etc.) is between 3.5 and 5 minutes in daytime and for signs with complex shapes (figures, letters, etc.) between 5 and 8 minutes. In order to permit boatmasters to identify what the signs or marks (board, buoy, etc.) mean with the naked eye at corresponding distances and conditions of visibility, the following formula can be used to calculate the dimensions:



$$H = L \cdot \tan \alpha \quad \alpha \cong L \cdot \sin \alpha$$

Where H = height (size of the sign in M)
 L = observation distance in m
 α = angle of sight in minutes

The numerical values of H (in m) are given in the following table:

	α	Distance - L in metres			
		1 000	2 000	3 000	4 000
For signs with simple shapes (circle, square, triangle, etc.) ...	3'	0.87	1.74	2.61	3.48
	4'	1.16	2.32	3.48	4.64
	5'	1.45	2.90	4.35	5.80

It emerges from this table that at a distance of 1 km ($L = 1,000$ m), with a sufficient angle of sight of 4' it is possible to see an ordinary board approximately 1 m in size ($H = 1$ m); a board of approximately 2 m in size ($H = 2$ m) can be seen at a distance of 2 km ($L = 2,000$ m), etc.

As a rule, signs should have the following minimum measurements:

(a) for boards carrying signs which regulate navigation on the waterway (Annex 7 of the DFND), the minimum measurements are given in cm in Annex 1 to this Instruction;

(b) for signs and signals on the water marking the sides of the fairway and navigational hazards (Annex 8 of the DFND, section A):

(i) The minimum measurements for the topmarks of light buoys and unlighted buoys shall be:

- upstream from Gönyü: height - not less than 0.6 m, width - not less than 0.35 m, distance from the water to the upper edge of the topmark - 1 m;
- downstream from Gönyü: height - not less than 0.8 m, width - not less than 0.55 m, distance from the water to the upper edge of the topmark - 1.2 m;

(ii) the minimum measurements for the topmarks of additional marks (spars and marker posts) are given in cm in Annex 2 of this Instruction;

(c) for bank marks marking the sides of the fairway and navigational hazards (Annex 8 of the DFND, section B):

- (i) minimum height, from the lower edge of the topmark to the base of the sign: 3 m. In navigable high water, this height above the water shall not be less than 1.5 m;
- (ii) the minimum measurements of topmarks and boards are given in cm in Annex 2 of this Instruction.

As regards the signs and signals of Annex 8 of the DFND, unlighted buoys and unlighted bank mark boards shall be covered with reflective material. Light buoys and lighted bank mark boards may also be so covered. The colours of these materials shall correspond to those established for the buoy lights or the boards.

In order to ensure that bank marks are clearly visible, their dimensions shall be determined in terms of their purpose, the distance between the fairway and the banks, the nature of the region and the characteristics or other specific conditions of the sector in question.

In many cases, the contrast between the luminance of the sign or signal and the background has an important role to play in terms of good visibility. For example, of two boards, one red and the other white, positioned one beside the other against a light background, the red board will be more visible and visible at a greater distance than the white board while, in contrast, the white board will be easier to see than the red board against a dark background. These circumstances shall also be taken into consideration in choosing a site for signs and signals.

The visibility of signs and signals regulating navigation on the waterway shall be ensured at night by lighting them with fixed directional white lights, operating uninterruptedly and so positioned that the light does not incommode the boatmasters.

If electric lighting cannot be used, the sign boards shall be covered with reflective material of a corresponding colour on which the symbol shall be clearly visible to vessels.

Luminance and its regularity are also important from the point of view of the visibility of signs and signals. When boards are lighted, it should be ensured that the shade of their colour is unchanged. The luminance of the sign or signal perceived, like that of any object, depends not only on the lighting but also on the capacity of the surface of the sign to reflect the light waves falling on it. This shall be taken into consideration when the signs are painted; this shall be done in such a way that the surface of the sign is smooth and reflects the light properly and is not dull and covered with an uneven coat of paint.

(b) Conditions for the visibility of lights

The visibility of lights is determined by their strength and by weather conditions.

The equation set out in Annex 5, point 4 of the DFND may be used to establish the minimum luminous intensity required to obtain the desired visibility.

Since the luminous intensity of coloured lights - obtained by using various filters - needs to be greater, the strength of their light source must also be increased. The following table sets

out the data on the strength of the light source (electric lamp) needed to obtain the main signal lights visible at different distances.¹ These data have been calculated for 7th degree conditions of atmospheric visibility (slightly foggy).

Luminous range of light	Intensity of light	Intensity of light source in cd		
in km	in cd	white light	red light	green light
0.5	0.06	0.06	0.4	0.6
1	0.25	0.25	1.7	2.5
2	1.40	1.40	9.3	14.0
3	4.20	4.20	28.0	42.0
4	9.80	9.80	65.0	99.0
5	20.00	20.00	133.0	200.0

As has already been pointed out in the first part - General - the colours of the lights shall, in principle, conform to the recommendations of the International Commission on Illumination ("Colours of light signals", in ICI publication No. 22 (T.C. 1.6) 1975).

Marking lights are fixed or flashing lights. The luminous range of flashing lights is less than that of fixed lights with the same luminous intensity. Flashing lights can nevertheless be seen more easily and attract the boatmaster's attention more readily, especially when the lights of neighbouring localities are all around.

The duration of the flash of a signal light shall not be less than 0.5 seconds. Shorter flashes, even if they are frequent, are tiring on the boatmaster's eyes and hinder orientation. Long and infrequent flashes on the other hand also hinder orientation, since while waiting for the next flash the boatmaster cannot be sure that he is still proceeding in the desired direction.

Details of the characteristics of signal lights used on the Danube can be found in Annex 8 of the DFND.

(c) Obligation not to hinder road and rail traffic

Signs and marking shall be installed in such a way that their lights do not hinder the movements of other modes of transport if the road runs close to the river.

In a sector in which a road or a railway runs close to a river, the installation of all the above-mentioned signs and signals shall be carried out in consultation with the respective competent authorities.

¹ The data are taken without perspective and with an average coefficient (0.6) for atmospheric transmission.

V. INSTALLATION OF SIGNS AND MARKING (ANNEX 8 OF THE DFND) IN CHARACTERISTIC SECTIONS OF THE RIVER

1. Principles to be complied with in the installation of signs and signals on the water and bank marks

The use of a particular sign or signal on the water or bank mark and how it is installed depends on the one hand on the local features of the river (speed of current, variation in levels, meanders, width of the bed, existence of sills, branches, islands, etc.), and on the other on the density of traffic in a given sector and the form and size of convoys.

The position of each sign or signal on the water indicating the side of the fairway shall be determined on the basis of the marking installation plan based on the results of measurements. Depths within the limits of the width of the marked fairway shall under no circumstances be less than the minimum depth reported for the sector in question.

When signs and signals are installed on the water, it is essential to take the direction of the current into account. If the current flows in the direction of an obstacle, the sign or signal shall always be placed a long way from the navigational hazard (obstacle); if, on the other hand, it flows in the opposite direction, the sign or signal shall be placed nearer.

In order to check whether a lighted or unlighted sign or signal on the water is in its assigned position, two pairs of marker posts or targets on the bank and a goniometer are used.

Obstacles on the sides of the fairway are always marked with signs or signals on the water. When the obstacle is indicated by a single sign, it shall be placed on the downstream extremity of the obstacle, on the channel side (Annex 3, figure 1-b).

As a rule, light buoys or unlighted buoys shall be used to mark the upstream and downstream extremities of sills, banks which narrow the channel, alluvial channels, banks protruding into the channel, piles of stones, reefs, water supply engineering structures, and underwater hazards or obstacles (sunken vessels, anchors, etc.).

Marker posts and spars shall be used as additional signs supplementing buoys in order to give a clearer indication of the limits of the fairway over difficult sills and in order to mark underwater obstacles. In some cases and in some sectors, buoys may be replaced by marker posts or spars.

In order to avoid damage to buoys during the period when ice is carried down, they shall be replaced by spars or marker posts.

On sectors of the river where there is day and night navigation, forks, junctions and the centreline of the fairway along with obstacles to navigation lying within the fairway shall be marked by light buoys or bank lights. Signs and signals on the water shall be installed at such a depth and at such a distance from the obstacle that the safety and ease of movement of vessels shall be guaranteed at night and in poor visibility.

On sectors where the bed is narrow, preference shall be given to marks on the banks.

Each sign or signal on the bank shall be established following reconnaissance of the area and selection of the most appropriate site. The need to ensure the visibility of the sign whatever the level of the water should be taken into consideration.

Where it is necessary to ensure good visibility of the symbol on the sign over a long distance, both for vessels proceeding upstream and vessels proceeding downstream, two boards may be installed on the sign pole at an angle to each other, one pointing upstream and the other downstream.

In selecting the site of a sign or signal on the bank, account shall be taken of the need to ensure easy maintenance and to protect it against ice and flooding.

Before a bank sign or signal is installed, the depth in the area in front of it and in the direction it indicates shall always be measured.

As a general rule, the objective is that only the network of signs and signals on the bank shall provide an uninterrupted indication of the position of the channel, while the signs and signals on the water shall help boatmasters to determine the limits of the fairway.

2. Marking of alluvial channels

(a) Installation of cross-channel fairway signs and bank lights

Cross-channel fairway signs and bank lights may be used in alluvial channels in order to indicate that the fairway crosses over from one bank to the other (signs featured in B.1, B.2, B.3, B.4 in Annex 8 of the DFND).

Alluvial channels are marked by bank lights and cross-channel fairway signs when the fairway is sufficiently broad, its safety is ensured, and when the direction only requires to be indicated approximately.

Bank lights and cross-channel fairway signs shall be selected in such a way as to differentiate cross-channel fairways in terms of their length, in other words in terms of the distance between two neighbouring signs. The length of the cross-over is relative, since it depends on the width of the channel.

The maximum range of the cross-channel fairway sign is 3 km. On sections of this length it is possible to install such signs (without using signs and signals on the water) provided that the width of the channel is more than 2 to 3 times or more the minimum width for the given sector.

If, however, the width of the channel is less than twice the minimum planned width, the cross-channel fairway signs (without using signs and signals on water) may be installed at a maximum distance of 1-1.5 km from each other.

If the distance between two such signs is greater than the calculated visibility distance, and if the curve of the bank followed is such that a straight line between the signs installed at either end of the section goes beyond the edges of the fairway, bank lights shall be installed between them in order to indicate the lie of the channel (Annex 3, figure 2-a).

Bank lights shall also be installed in sectors where there are alluvial channels in cases in which, at the end of the cross-over, the channel passes close to the bank as far as the next marker post or cross-channel fairway sign (Annex 3, figure 2-b).

Bearing in mind the local conditions of the given sector, it is possible to indicate by means of signs and signals on the water (Annex 3, figure 3) the presence of cross-currents, strong side winds, etc., and the limits within which vessels may safely diverge from the cross-over line.

(b) Installation of marker posts

When the channel follows the middle of the river bed over a long distance or when it crosses abruptly from one bank to the other, its centreline may be indicated by marker posts (B.5 and B.6) which give a more exact indication.

On straight sections more than 5 km long where, because of the presence of navigational hazards, the width of the channel is less than double the minimum width planned, it is also preferable to install marker posts. If the layout of the banks permits, the marker posts shall be placed at the two ends of the line of alignment (Annex, figure 4).

Even where the channel is narrowed because of stones, rocks or other hazards to navigation close to the fairway, preference shall be given to the marker posts, irrespective of the dimensions of the river and the length of the fairway section marked by these signs.

In sectors of alluvial channels where the fairway, after moving to the opposite bank, abruptly crosses to the other bank which shall also be marked in this section, triple marker posts shall be installed (the first sign shall have 2 boards; see Annex 3, figure 5). In this case, the lights of the rear marker posts shall be oriented strictly on the line of the fairway, one upstream and the other downstream.

Special formulae are applied for an accurate calculation of alignment more than 4 km long.

The data (in m) for the shortest alignments, in normal conditions of visibility, can be found in the table below.

L	d	h_o	a	2a	L	d	h_o	a	2a
200	17	8.50	2.6	5.0	1 000	83	9.60	13	26
300	25	8.70	4.0	8.0	1 500	125	10.25	19	38
400	33	8.85	5.2	10.5	2 000	166	10.90	26	52
500	42	9.00	6.5	13.0	2 500	207	11.50	33	66
600	50	9.10	8.0	16.0	3 000	250	12.15	39	78
700	58	9.20	9.0	18.0	3 500	290	12.75	46	92
800	67	9.35	10.0	20.0	4 000	330	13.40	52	104
900	75	9.50	12.0	24.0	4 000	760	14.20	25	50

Where

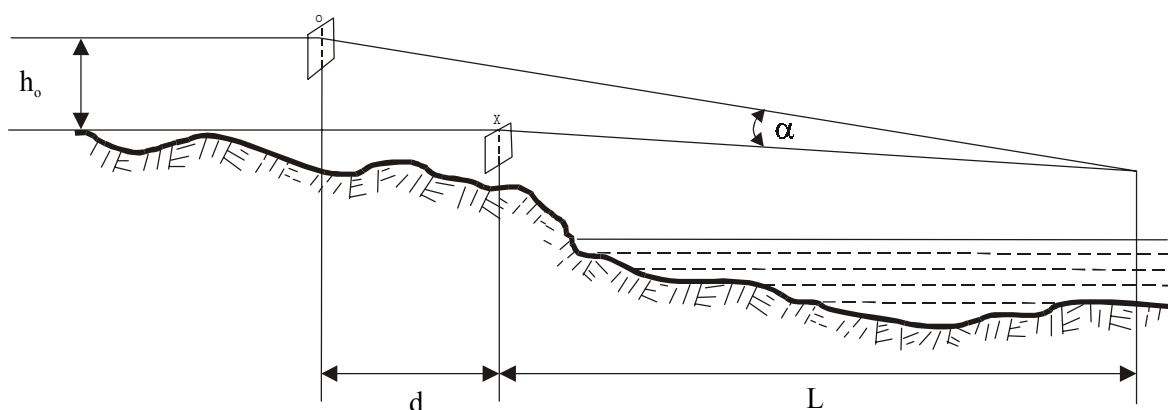
L = length of maximum distance over which marker posts may be efficiently used.

d = distance between the front and the rear markers (= at approximately 1/12 of L).

h_o = distance in height between the lights of the front and rear marker is.

a = approximate distance over which the vessel may diverge to right or to left before realizing that it is no longer following the layout of the alignment.

The table has been prepared on the assumption that the observer's eye is at a height of 5 m from the surface of the water and that the light of the marker post (front marker) is 8 m from the surface of the water.



The value “a” in the table describes the precision of the alignment. The value is very important when the vessel passes through a narrow channel. As a rule, the precision increases the closer to the marker post.

In order to ensure that marker posts - and their lights during the night - are visible from the start of the line of sight, the front and rear lights shall be set up in such a way that the angle of sight (α) between them is at least 4° in relation to the vertical.

(c) Installation of signs and signals on the water

In sectors of alluvial channels, where the channel passes along the middle of the river bed, or along the bank or passes slowly from one bank to the other, signs and signals on water are used to mark formations in the river bed or obstacles, both natural and artificial, on the sides of the channel (banks, shores, islands, stones, sunken vessels, wrecks of bridges, etc.), when these obstacles protrude into the channel and reduce its width to less than twice the minimum width for the sector in question (Annex 3, figure 6).

These underwater obstacles are marked in sectors of alluvial channels by signs and signals on the water if, within the limits of width indicated above, the depth of water over such obstacles does not exceed the minimum depth reported for the sector. If the obstacle is not very wide a light signal shall be installed on the water on its upstream section. A marker post or a spar may be installed on its downstream section, depending on its length.

The signs and signals on the water marking underwater obstacles of considerable length are so installed that the parts situated closest to the channel are marked by light signals between which unlighted signs are placed, thus enabling a given obstacle to be marked completely (Annex 3, figure 7).

In the part of the river bed where the shore opposite that followed by the channel is bordered by an inshore bank which favours upstream navigation in calm water, the bank is marked by signs and signals on the water independently of the width of the bed.

In sectors of alluvial channels, the bank marking system in periods of high water generally remains the same as in periods of lowest water level, except in sectors where, when water levels are high, it is advisable to find another channel with better navigational features. In this case, the selected channel shall be marked appropriately.

3. Marking of sills

In the case of both sills and alluvial channels, the principle of the continuous marking of the direction of the channel, i.e. from one sign to the next, by means of the network of signs and signals, should be observed. The channel over sills may be marked by marker posts, cross-channel fairway signs, bank signs and signals (lights) and signs and signals on the water, depending on the type of sill.

Stable sills, where the channel is straight and sufficiently wide, may be marked by marker posts (Annex 3, figure 8).

Since cross-channel fairway signs only give an approximate indication of the direction of the channel and do not mark its limits they are generally used on sills together with signs and signals on the water (buoys, marker posts, spars) (Annex 3, figure 9).

If the channel over a short-crest sill is straight, the entrance to and exit from the deep-water pool shall be marked by at least two main signs on the water - a sign on the upstream bank and a sign on the downstream bank (Annex 3, figure 10).

If the channel winds within the pool, additional signs shall be positioned on the water to indicate where the channel turns (Annex 3, figure 11).

If on difficult sills there are very strong cross-currents, additional signs may be installed on the water at the entrance to and exit from the sill to indicate the area surrounding it.

If it is impossible to use bank signs (marker posts or cross-channel fairway signs), the fairway across the sill shall be marked by double or single signs on the water depending on its width and taking hydrological factors into account.

4. Marking of the vicinity of bridges and passages through bridges

The navigation of vessels and towed or pushed convoys in the vicinity of bridges and through bridge passages requires particular attention and precautions on the part of boatmasters because of the narrow channel. These sections must therefore be marked with the greatest care.

The basic condition to be met to ensure safe passage through bridges is the marking of the direction of the fairway and also, where necessary, its sides. Signs and signals on the water and on the banks may be used in addition to boards and lights for marking the navigable passage through bridges.

The choice and positioning of the signs depends in each case on local conditions in the bridge section.

As a general rule, the installation of marking signs in the vicinity of bridges and the buoying of navigable passages shall comply with the following conditions:

- (a) in order to indicate permission to use the navigable passage of a bridge, only signs A.10, D.1 or D.2 in Annex 7 of the DFND shall be used;
- (b) the installation of marking signs shall be based on depth and current direction measurements, both in the immediate vicinity of the bridge and in the approach sections;
- (c) the positioning of the signs installed in the vicinity of a bridge shall be modified in due course, as conditions of navigation change;
- (d) if, when approaching the bridge or in the navigable passage the direction of the current forms an angle with the bridge, giving rise to eddies around the pillars of the bridge, the signs on the water shall be so installed as to indicate the direction of the eddies.

Signs and signals may be installed on the water at the approach to the navigable passage to give an exact indication of the position of the channel.

The following examples illustrate the use of these signs on the water or on the banks:

(a) if the bridge is located on a winding section of river where it is more appropriate to use bank signs to guide boatmasters, bank lights may be installed on the right or left (Annex 8, B.1, B.2). The position of the light on the bank and its distance from the bridge shall be established by the competent authorities, on the basis of the need to ensure safety and ease of passage of vessels in the sector in question (Annex 3, figure 12).

(b) where it is not possible to use the bank marking mentioned above because the channel is winding or for other causes which are the result of local conditions, signs and signals on the water (buoys or spars) may be used to ease the progress of vessels through the navigable passage. These signs shall be so installed that the channel marked in the direction of the bridge corresponds to the direction of the current (Annex 3, figure 13).

(c) if the bridge is located in a sector of the river where the direction of the current on approaching the bridge forms an angle with the line of the navigable passage, thus causing eddies round the bridge pillars, marking upstream from the bridge may comprise two pairs of buoys. The pair of buoys installed nearest the bridge shall be placed at 100-200 m from it, and the second pair 400-700 m from it. The second pair of buoys shall be so installed that the layout of the channel they indicate with the first pair corresponds to the direction of the current. Convoys will thus be able to align their units in the space between the two pairs of buoys and navigate the navigable channel strictly following the centreline. Another pair of buoys may be installed 100 m downstream from the bridge (Annex 3, figure 14).

5. Installation of signs and signals on the water restricting anchoring points

The increased intensity of the fleet's activity, the growing number of vessels and the substantial accumulation of vessels in the inner harbour basins of various Danube ports has made it necessary to install signs and signals on the water in addition to signs on the banks in order to restrict berthing places.

A.5 type light buoys on the right, marking berthing points in relation to the right hand side of the fairway, are basically intended to prevent excessive narrowing due to the presence of anchored vessels and to establish a succession in order of anchoring.

A.6 type light buoys on the left mark berthing points in relation to the left hand side of the fairway.

6. Installation of signs and signals marking dangerous points and obstacles

The signs C.1, C.2 and C.3 in Annex 8 are used as additional signs for the purpose of marking dangerous points, structures of all kinds in the river bed (dikes, groynes, etc.) and also jutting projections covered during high water.

These signs are installed on the bank, fixed to the ground, and inform boatmasters of the position of the structure in the river bed.

The sign C.3 is installed at the head of an island where it divides the bed into two navigable branches, and also on the bank at the mouths of canals and navigable tributaries.

VI. INSTALLATION OF RADAR REFLECTORS ON MARKING SIGNS AND SIGNALS

River vessels increasingly use radar in order to ensure their orientation in conditions of poor visibility (fog, overcast weather, snow, showers, etc.). These installations, generally with the addition of a compass and echo-sounder, are of great importance for the safety of navigation, particularly in autumn and winter.

The experience of vessels navigating with the help of radar shows that signs and signals on the water which are not equipped with radar reflectors do not have a sufficiently strong reflection to be clearly seen on a radar screen. It is important to equip signs on the water and on the banks with radar reflectors to ensure their visibility.

When marking signs equipped with radar reflectors are installed, account must be taken of the furthest distance between the vessel and the sign in terms of the perception of the sign on the radar screen. This distance is not always the same, but depends on the technical characteristics of the radar equipment, the radar reflectors and the specific conditions of the river and the height of the antenna installed on the vessel, as well as the height of the radar reflector in relation to the water. Experience shows that since the Danube is a very wide river, the outside limit is approximately 1-5 km.

Vessels and other objectives and objects floating on the surface of the water can be perceived and distinguished on a radar screen as clearly separate from each other depending on the technical characteristics of the radar equipment, the distance to the objective, the distance between objectives, etc. Generally speaking, at a distance of 1 km two objects are perceived as clearly separate from each other when there is approximately 15 m between them.

From experience, bridge passages and pillars are not always sufficiently visible on the screen. In order to ensure danger-free passage through bridges, buoys equipped with radar reflectors should be placed on both sides of the passage, not less than 15-20 metres upstream and downstream from the bridge, or passages through bridges should be marked with radar reflectors installed on the bridge itself.

Since radar reflectors are extremely reliable, every effort should be made to install them by means of supports on the framework of bridges to mark the navigable passage through the bridge.

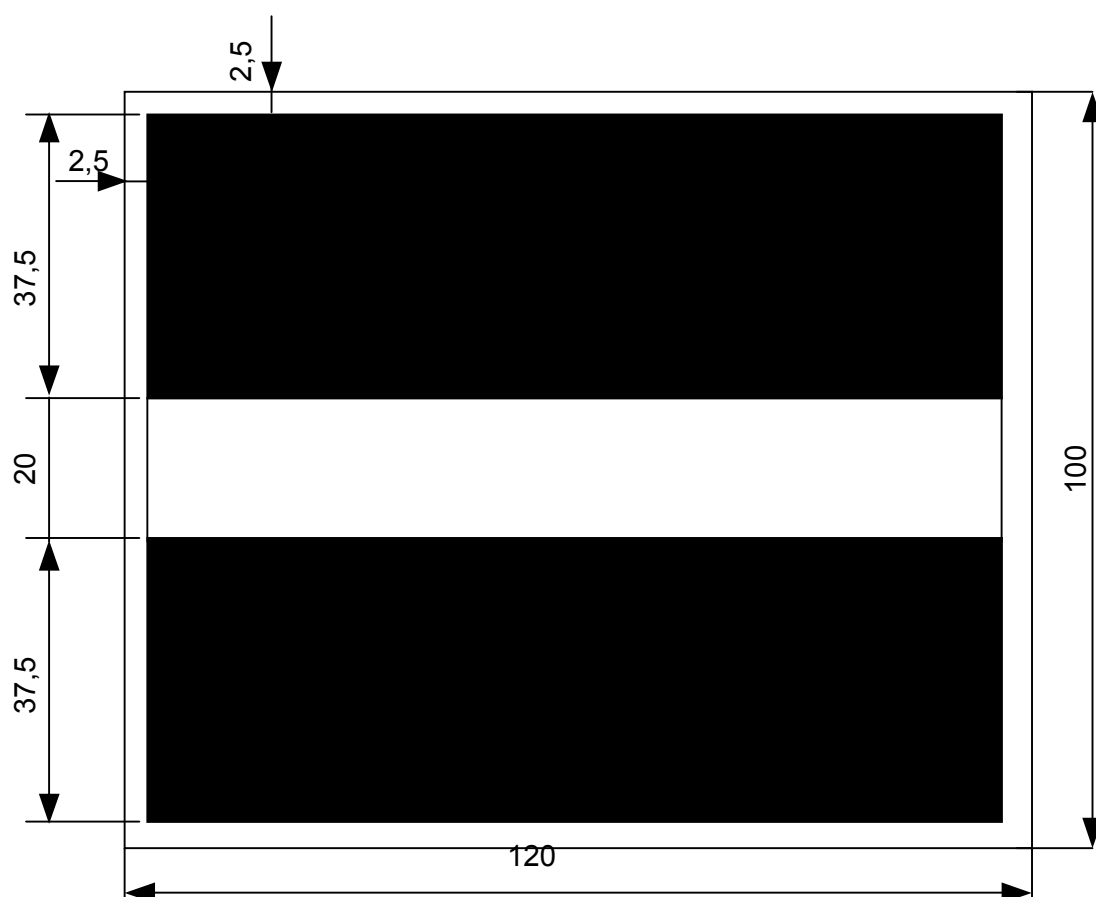
Navigational hazards and water supply engineering structures (sunken vessels, groynes, cross-beams, etc.) located in the river bed may also be marked by signs equipped with radar reflectors. If the groynes or cross-beams marked by radar signals are located along one of the banks while the fairway follows the opposite bank, which is low and flat, the radar reflector signals may also be placed on that bank so as to facilitate the orientation of vessels navigating by radar.

In general, when radar reflectors are used on marking signs and signals on the Danube, the rule that these reflectors shall not modify the form or size of the sign or signal should be observed. Their colour shall also correspond to the colour of the sign or signal in question.

Annex 1**DIAGRAMS OF BOARDS FOR SIGNS AND SIGNALS
APPEARING IN ANNEX 7 OF THE DFND**

In principle, boards may be surrounded with a white strip 25 to 45 mm broad, or a black strip 10 mm broad in order to improve the visibility of the symbols appearing on special bank signs.

Example of the measurements of marking signs A.1 and A.2 (in cm).

A.1.

A. 2.

