Part III - Ch 5 Traffic management

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5 Traffic management

Along with the increase of waterborne transport, the necessity of traffic management has increased, especially in coastal seas, harbour access areas and inland waterways. Whereas aboard the vessel, the captain was and is responsible for safe navigation, parties ashore have an interest in safe arrival and therefore provided aids to navigation. Management applies methods such as signalling, traffic separation, Fairways Information Services (FIS) and Vessel Traffic Services (VTSs). In this chapter we will give a brief summary of each of these methods.

5.1 Aids to navigation (buoys, beacons and traffic signs)

Signalling is the oldest means of traffic management. This first known lighthouse, for instance, the Pharos of Alexandria, Egypt, was built as early as 300 BCE and the oldest existing one, in La Coruña, Spain, dates from 20 BCE. Buoying systems have alo been in use for centuries. Until the seventies of the last century, over twenty different systems were in use worldwide, often conflicting with each other. It took a series of disasters to change this situation. In 1976 the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) came up with a uniform system (System A) that was agreed by the IMO. Introduced in 1977, its use has gradually spread throughout Europe, Australia, New Zealand, Africa, the Gulf and some Asian countries (together called Region A; see Figure 5.1). For the rest of the world (Region B, comprising the Americas, South-Korea and Japan; see Figure 5.1) the rules were completed in 1980.

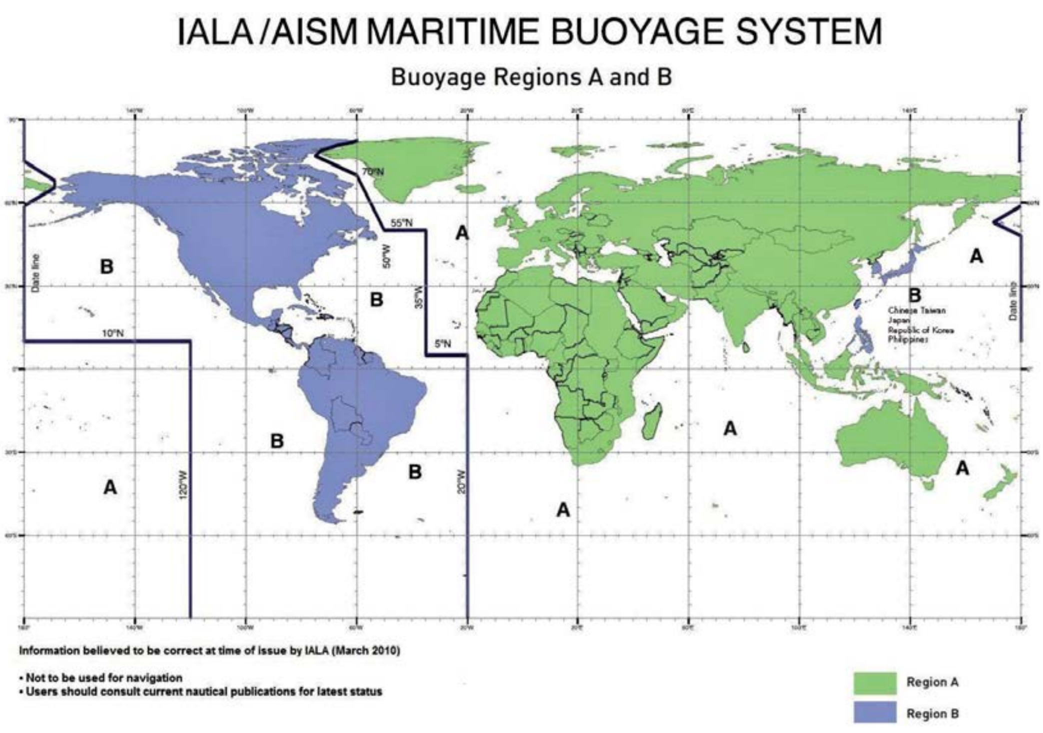

Figure 5.1: Worldwide distribution of buoyage systems. Image by IALA Navguide 2018 (reproduction for training or education purposes permitted, provided the attribution is mentioned).

The principal difference between the two systems are the lateral marks: red at port side and green at starboard side in Region A and conversely in Region B (see Figure 5.2). The other rules are so similar, that they have been laid down in 1980 in a single combined system, the IALA Maritime Buoyage System (MBS). In 2010, this system was extended by including other aids to navigation, to yield the IALA Marine Aids to Navigation System for fixed as well as floating devices (IALA, 2018).

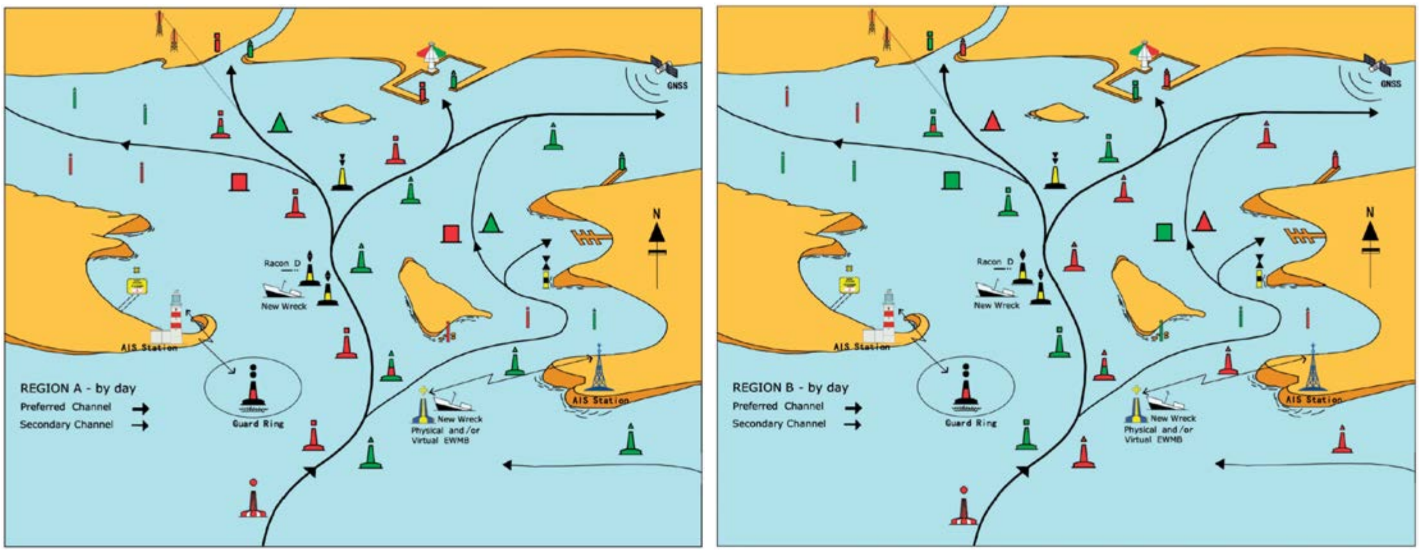

Figure 5.2: Worldwide distribution of buoyage systems, left: Region A, right: Region B. Image by IALA Navguide 2018 (reproduction for training or education purposes permitted, provided the attribution is mentioned).

The Marine Buoyage System encompasses six types of marks:

1. *lateral marks* – denoting the port and starboard sides of a navigation channel, each with a different colour (red or green, depending on the region, as described above); at bifurcations, a modified lateral mark may be used to indicate the preferred route designated by the competent authority; lateral marks are general numbered, with even numbers on the red buoys and odd numbers on the green ones; numbers increase in shoreward direction.
2. *cardinal marks* – indicating that the deepest water is at the named side of the mark; to that end, these marks have an agreed colour and flashlight code indicating whether this is the north, east, south or west side of the mark;
3. *isolated danger marks* – placed on, or near to a danger that has navigable water all around it; for the nature and extent of the danger, reference is made to nautical charts and publications; isolated dangers marks are clearly distinguished from cardinal marks by colour codes and flashlights;
4. *safe water marks* – have navigable water all around them without marking a danger; they may be used as fairway, mid-channel of landfall marks;
5. *special marks* – (always yellow) are used to indicate a special area or feature whose nature may be apparent from reference to a chart or other nautical publication; they are not generally intended for situations where the MBS provides suitable alternatives;
6. *new danger marks* – for newly discovered hazards that may not yet be shown in nautical documents and publications; until the information is sufciently promulgated, they should be indicated by using an Emergency Wreck Marking Buoy (EWMB), or deviating the traffic using appropriate means such as lateral, cardinal and isolated danger marks.

Apart from these marks meant to indicate navigable channels, there are marks meant to aid the mariner navigating, such as lighthouses, lightvessels, beacons, sector lights and leading lines, as well as port or harbour marks, such as breakwater lights, quay/jetty lights, traffic signals, bridge markings and inland waterways.

For further reading about the Maritime Buoyage System and the Marine Aids to Navigation System, we refer to the IALA Navguide 2018.

For inland waterways, the Economic Committee for Europe of the United Nations has issued the European Code for Navigation on Inland Waterways (CEVNI). Apart from sections on general conduct, rules and regulations, documents and onboard signs and signals, it gives and overview of waterway signs and markings, encompassing prohibitory, mandatory, restrictive, recommendatory and informative signs plus a number of auxiliary signs. Furthermore, it describes the buoyage of inland waterways, in line with the IALA Maritime Buoyage System.

In conformity with an earlier version of CEVNI, Rijkswaterstaat issued in 2008 the 'Richtlijnen Scheepvaarttekens', the Navigation Signs Directive (RST 2008), which apply to inland navigation in the Netherlands (Brolsma et al., 2008). They include chapters with specifications for traffic signs, light signals, Dynamic Route Information Panels (DRIPs) and fairway buoyage. Figure 5.3 gives a number of examples of traffic signs. At passings with a limited headway and a variable water level, such as fixed river bridges and bridges over tidal waters, skippers need to be informed of the actual headway. This is indicated by scales mounted on one or more bridge piers (Figure 5.4).

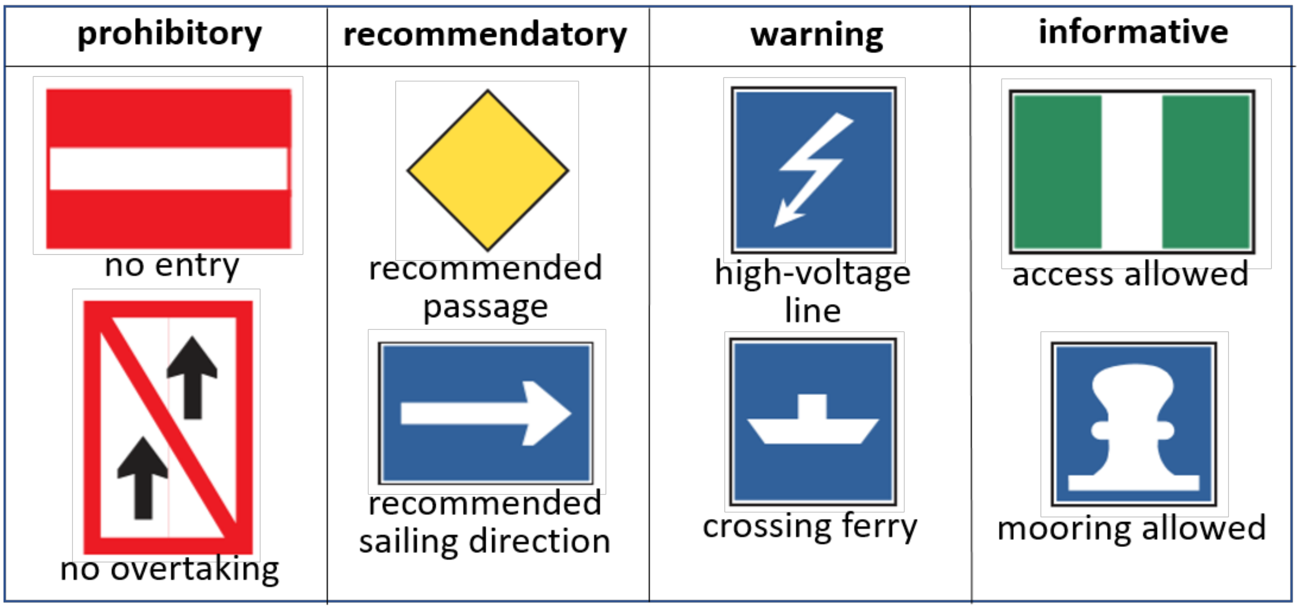

Figure 5.3: Examples of traffic signs for inland waterways (from Brolsma et al., 2008, Rijkswaterstaat).

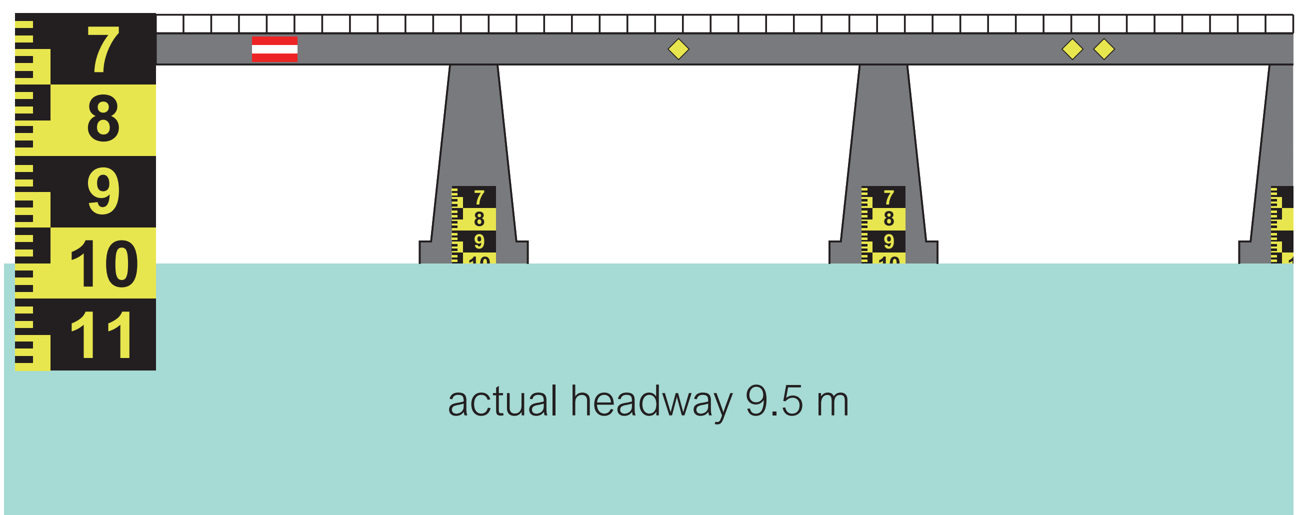

Figure 5.4: Use of scales to indicate the actual headway of a bridge (reworked from http://www.zeilvertrouwen.nl by TU Delft – Ports and Waterways is licenced under CC BY-NC-SA 4.0).

Fixed signal lights are used to arrange the passing of structures such as locks and movable bridges:

- two red lights indicate that the structure is permanently blocked and no passing is possible;
- a single red light indicates that the lock or bridge is in operation, but passing is not allowed now;
- a red-green light indicates that passing is about to be allowed;
- one green light means that passing is allowed;
- two green lights mean that passing is allowed and that the bridge is unattended, or the lock is open at either side.

Lights are also used to guide traffic in darkness. Figure 5.5 gives a schematic of how to illuminate a bridge passage. DRIPs give information referring to the actual situation on the waterway. Figure 5.6 shows an example.

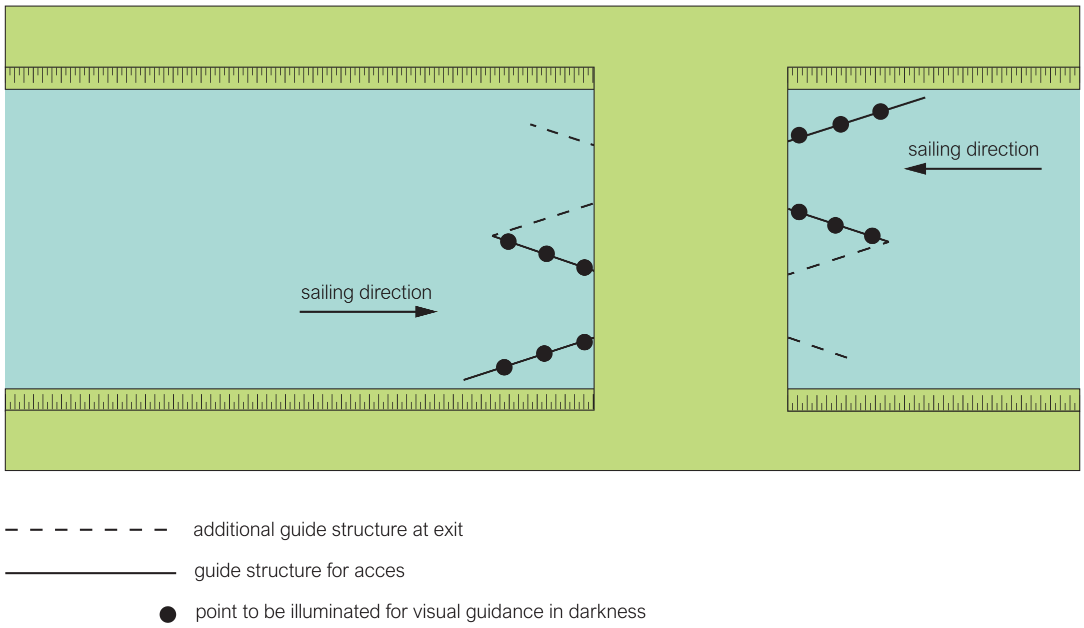

Figure 5.5: Illumination of a bridge passage (reworked from Brolsma et al., 2008, by TU Delft – Ports and Waterways is licenced under CC BY-NC-SA 4.0).

Figure 5.6: Example of a DRIP, saying: 'Bridge closes' (image from Rijkswaterstaat).

Fairway buoyage on inland waterways is quite similar to that at sea, except that that the numbering of the buoys runs seawards from inland. In tidal waters the numbers increase in the direction of the ebb current, in harbours they increase from sea to land. In the Dutch Western Scheldt, however, the IALA system is used. Left and right are always defined looking in the direction where the numbers increase.

In the SIGNI/CEVNI system for inland waters, red buoys and lights are on the right side of the fairway and green ones on the left side. Figure 5.7 gives an schematic of buoyance in a river section.

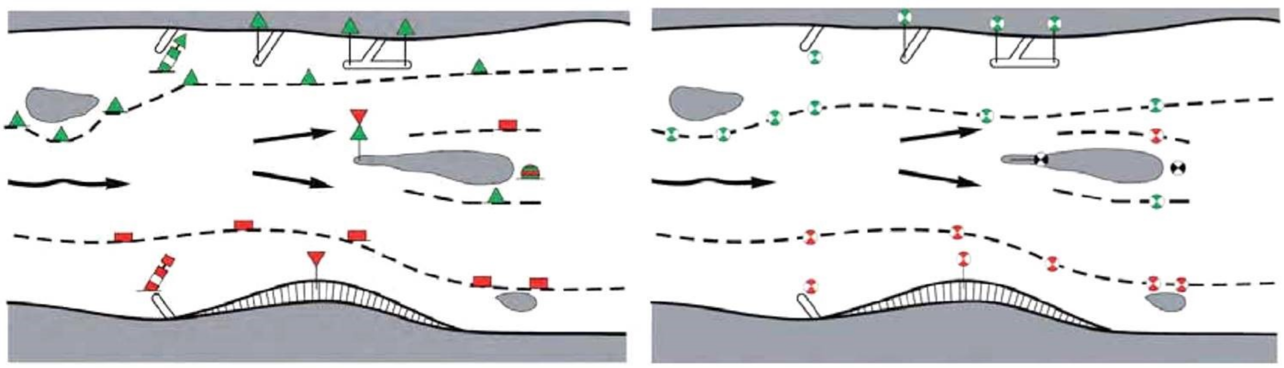

Figure 5.7: Schematic of SIGNI/CEVNI buoyance in a river (from Brolsma et al., 2008, Rijkswaterstaat).

For further details of inland waterway marks and signals, we refer to the latest revision of the CEVNI-code Inland Waterways.

5.2 Traffic Separation Schemes (TSS)

In order to improve safety in heavily navigated or congested seas, confined waterways and around capes, the IMO has introduced marine route systems (IMO Routeing Schemes) separating opposing traffic flows. The objectives of these schemes are:

- to help reduce and manage head-on situations for opposing traffic streams,
- to facilitate the safe crossing of traffic in the vicinity of a port,
- to keep traffic at a safe distance from facilities for offshore activities,
- to provide safe routes for deep-draught vessels,
- to avoid traffic in areas designated by the competent administration, and
- to better manage inshore traffic zones, fishing zones and areas with isolated dangers or shoal patches dangerous to navigation.

These Traffic Separation Schemes (TSS) designate traffic lanes, such that ships navigating in a lane all travel in the same direction, or they cross the lane at an angle as close to 90° as possible. In order to make this work, there must also be separation zones where no traffic is allowed and roundabouts where traffic flows can safely cross. Furthermore, a TSS may include precautionary areas, where navigation requires particular caution, and areas to be avoided by all ships. TSS rules are incorporated in the International Regulations for Preventing Collisions at Sea (COLREG). Figure 5.8 shows an example of a TSS.

The North Sea is not only heavily navigated, but also used for so many other purposes (e.g. hydrocarbon mining, windparks, nature reserves, fisheries), that a certain degree of spatial planning is needed (see, for instance, the North Sea 2050 Spatial Agenda of the Netherlands Ministry of Infrastructure and the Environment). In the North Sea, a distinction is made between route-bound and non-route bound shipping. The latter category includes short-sea, Ro-Ro ferries, work boats, fishing vessels and yachts that are all allowed to sail outside the TSS. The TSS implemented in the North Sea (see Part I –Figure 1.7) is therefore not only meant to make traffic safer, but also to confine it to certain zones.

Traffic separation by designated lanes is not common in inland waterways. Instead, traffic rules, regulations from police or waterway authorities, aids to navigation (also see Section 5.1) and Vessel Traffic Services (see Section 5.4) are the principal tools for traffic regulation. In general vessels pass each other at portside of the vessel, but this is not always possible. In river bends, for instance, deep-draught vessels may have to take the outer bend and pass at starboard-side of the encountering vessel, because the inner bend is too shallow.

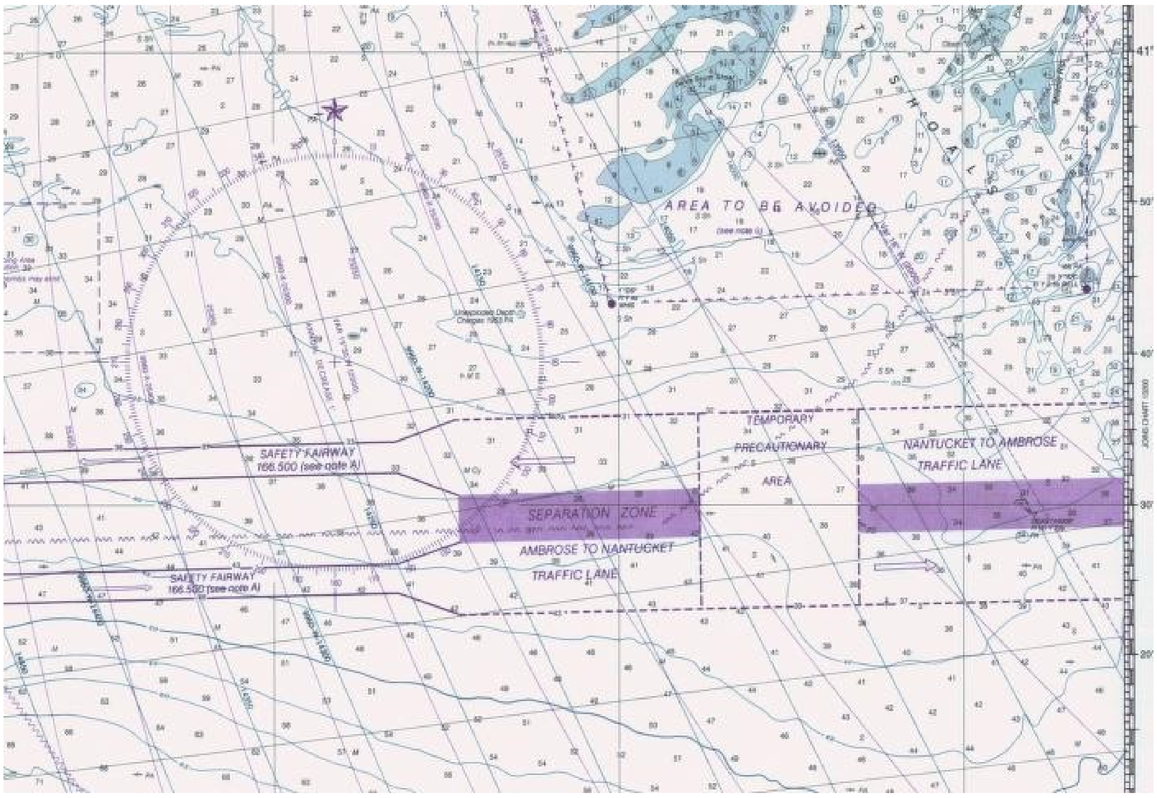

Figure 5.8: Example of a TSS (Chart1 by Wikimedia commons is licenced under CC0 1.0).

5.3 Fairway Information Systems (FIS)

River Information Services (RIS) use information technology to support traffic and transport management in inland navigation, including interfaces with other modes of transport, so as to improve the safety, efficiency and sustainability of inland shipping.

In 2005 the European Parliament and council adopted the River Information Services Directive (DIRECTIVE 2005/44/EC). It encompasses policy development, a legal framework, research and development and implementation monitoring. The Directive requires members states to implement RIS according to certain standards, referring to four key technologies:

- Inland Electronic Chart Display and Information System (Inland ECDIS),
- Notices to Skippers (NtS),
- Automatic Identification System (Inland AIS), based on transponder technology, and
- Electronic Reporting International (ERI).

Technical and operational standards for each of these technologies are defined and continuously updated.

The aims of this standardisation and harmonisation among EU countries are:

- to enhance safety in inland ports and on inland waterways,
- to protect the environment by providing traffic and transport information for effective calamity abatement,
- to enhance the efficiency of inland shipping by enabling information exchange between vessels, locks, bridges, terminal and ports,
- to use inland waterways better and more effectively by providing information on the status of the fairways,
- to enhance the efficiency of the entire multimodal supply chain by providing accurate and timely transport management information, and
- to enhance fuel economy through more accurate travel plans, so as to reduce greenhouse gas emissions.

In the Netherlands, Rijkswaterstaat implemented in 2011 the Fairways Information Services (FIS), in line with the RIS Directive. Via the website https://www.vaarweginformatie.nl it provides the following types of information in Dutch, English, German and French:

- notices to skippers,
- information such as service times and dimensions of bridges and locks, navigable depth of fairways, etc.
- water levels, discharges, headways, etc.
- seasonal information such as ice maps and swimming water quality, and
- electronic charts.

The site also offers downloads, such as a user manual and an overview of all public fairways in the Netherlands.

5.4 Vessel Traffic Services (VTS)

Already in 1968 the IMO issued VTS-guidelines, describing the function, set-up and operation of VTS in coastal waters, access channels and ports. The current version can be found in IMO-resolution A.857 of November 1997.

The IMO gives the following definition:

"Vessel Traffic Services – VTS – are shore-side systems which range from the provision of simple information messages to ships, such as position of other traffic or other traffic or meteorological warnings, to extensive management of traffic within a port or waterway."

Starting from the IMO guidelines, the CCNR has developed the Inland-VTS Guidelines, which are applicable to the waters under the Mannheim Act. As a member of both organisations, the Netherlands shall incorporate this in its legislation, in this case the Scheepvaart-verkeerswet (Vessel Traffic Act).

VTS systems are meant to improve the safety of navigation and the efficiency of vessel traffic, to protect adjacent communities, infrastructure and the environment, and to support security and law enforcement. They include facilities to interact with traffic participants in the area covered, who report to the authorities in charge.

The principal operational means to achieve this are:

- traffic supervision, aiming at safe and smooth traffic handling by means of personnel and infrastructural facilities,
- information on the status of the fairway,
- tactical information on the actual traffic, enabling immediate navigation decisions,
- traffic directions, binding orders meant to achieve or forbid certain traffic behaviour; a traffic participant must therefore always follow the directions given by a traffic supervisor (who then implicitly assumes the responsibility).

VTS aims at prevention as well as recovery. Traffic supervision is preventive, in that it aims at preventing accidents. This means that VTS operators have to monitor the traffic situation in real time, have to guard agreements for passing between vessels, and have to inform individual traffic participants on the traffic situation. The recovery function of a VTS primarily aims at limiting the consequences of accidents or incidents. This means that, once an accident occurs, the VTS makes an immediate analysis, in order to adequately alert the emergency services. It also informs the other vessels in the vicinity of the traffic and safety problems the accident entails. Furthermore, the VTS should ensure an orderly continuation of the traffic. Apart from this, a VTS can have several additional functions, such as providing lock and harbour information and gathering traffic data.

5.4.1 History

The development of radar technology during World War II offered great new possibilities for monitoring and tracking guidance for navigation traffic. In 1948, the first radar-based surveillance system was established in Liverpool, UK. In 1950, the USA followed with a system in Long Beach, California.

The first real 'traffic post' in the Netherlands was established at Brienenoord in 1966. In contrast to the 'bad weather posts' that existed up to that time, this one provided shipping with continuous radar information. In

1974 the post at Dordrecht was established, which grew into a fully-fledged vessel traffic service in the eighties (Figure 5.9). Since then the network of VTS posts in the Netherlands has been extended to the system shown in Figure 5.10.

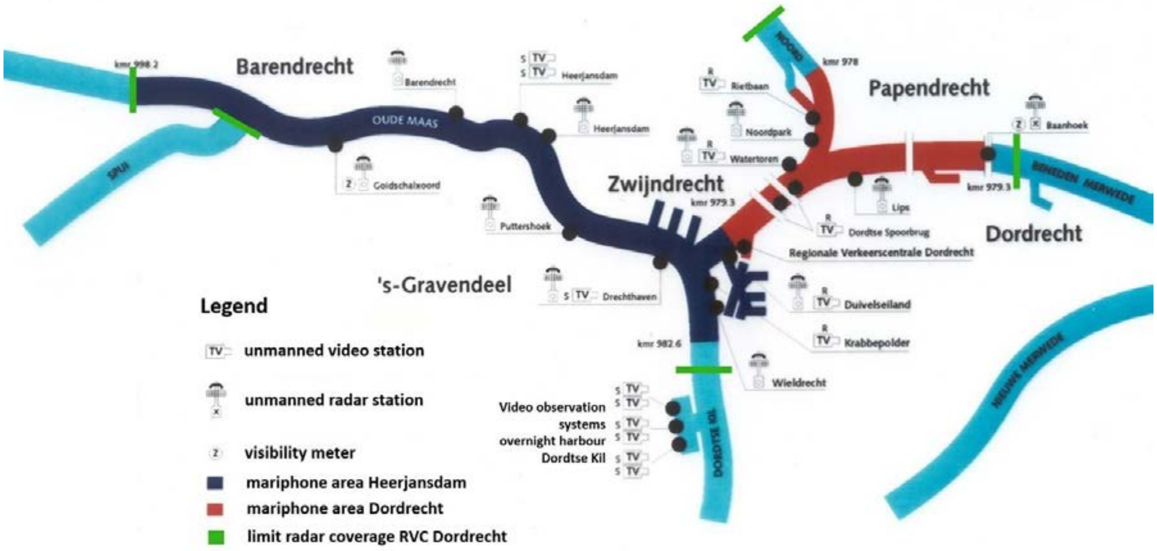

Figure 5.9: VTS-sectors area Regional Traffic Centre (RVS) Dordrecht (image from Rijkswaterstaat).

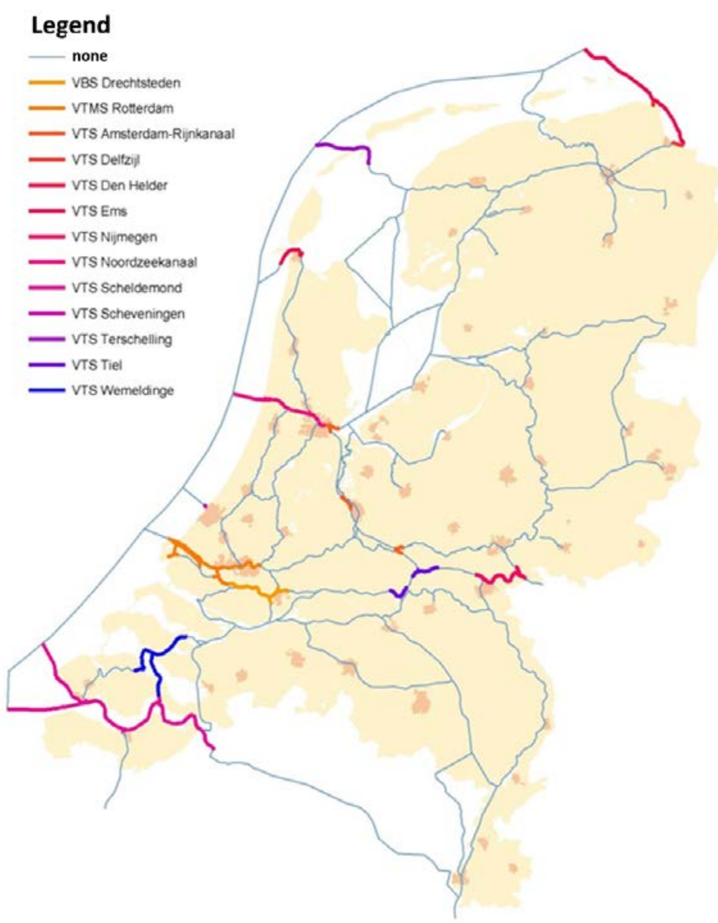

Figure 5.10: VTS-covered fairways in the Netherlands (image from RWS, 2016b, Rijkswaterstaat).

The authorities operate proactively in striving to remedy traffic bottlenecks on waterways. Initially there were more or less continuous proactive patrols by vessels, but the implementation of shore-based traffic posts has made clear that this preventative task can be carried out more cost-effectively from the shore (Figure 5.11).

Figure 5.11: Shore-based traffic supervision; left: traffic post Tiel (VTS monitoring post Tiel by melot001 is licenced under CC BY-SA); right: traffic supervisor (beeldbank.rws.nl, Rijkswaterstaat).

5.4.2 Analysis of the Netherlands' inland waterway transport

The Dutch government has been engaged in analysing the flow of waterborne traffic and transport for many years. Using information and tracing systems, it has attempted to find answers to questions such as: *How is the inland waterway network utilised?* and *Where do what types of ships operate and with what loads and draughts?* Such information enables early identification of bottlenecks and timely measures to avoid them.

In 1994 the 'IVS90' information system was put into operation. This system covered 80% of the Netherlands' main inland waterway network. In 2019 the system was replaced by the technically more advanced and more internationally oriented 'IVS Next', but the Informatie- en Volgsysteem voor de Scheepvaart (IVS) data are still being used for analysis. Ships report in with a set number of data when entering the IVS area and are followed during their journey. Rijkswaterstaat officers at locks and traffic posts also collect IVS data and have access to AIS data. Anonymised IVS- and AIS data are an important source for study and analysis.

This has resulted in a considerable amount of data on waterborne traffic and transport in the Netherlands. This information is used for statistical analysis, e.g. of all journeys in a certain time span, or the traffic intensity in a certain part of the network.

5.5 Safety

The number of accidents in inland transport is very small compared with the number of shipping movements. In total on average about 3000 accidents occur yearly of which about 1000 are registered (RWS, 2016a). Of the registered accidents about 150 are serious accidents with victims/casualties and/or serious damage. These figures have remained more or less constant over the past years. Therefore, the main task of the traffic posts is shifting from supervising and directing traffic to providing skippers and barge captains with information, for instance on the situation at the next lock. Thus the vessel speed can be adjusted, so as to reach the lock at the right moment and to optimise fuel consumption.

The traffic posts are in operation 24/7, with only a few people working in each post. In order to promote safety, traffic post personnel is instructed to be brief, professional and precise in VHF communication, with testing and re-examination of procedures every three years.

Interaction with recreational craft

The number of recreational yachts in the Netherlands is a multiple of the number of commercial vessels. The interaction of barge traffic with recreational cruising is therefore an important issue, requiring special safety measures. Vessels are not obliged to give a call when entering a VTS domain, only if a dangerous situation might occur, for instance if the vessel does not sail at the starboard side of the waterway. Yet, this does not always work in practice, especially not for recreational craft. For the sake of safety, the post nevertheless can provide other traffic participants with details of recreational craft positions on the waterway as far as identified. Also, in order to be understandable to lay people, officers at the post are specially trained to avoid professional jargon in such situations.