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WORLD MARITIME UNIVERSITY

MALMO, SWEDEN

**THE IMPLEMENTATION AND OPERATION OF
THE VTS IN THE TURKISH STRAITS AND SEA OF
MARMARA**

by

Nejat Kamil DENIZLI

TURKEY

A dissertation submitted to the World Maritime University in partial
fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE

in

MARITIME EDUCATION AND TRAINING (Nautical)

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred upon me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University

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ABSTRACT

Turkish Maritime Shipping and Traffic in the Turkish Straits and the Sea of Marmara has been effected due to lack of dissemination of navigational information, traffic monitoring and management during the past. There has always been a need for ships to navigate accurately and safely. This problem has created a number of ship collisions, accidents, fires, deaths and major pollution spills, loss of vessels and cargoes. This lack of proper traffic management has been led to the blockage of Straits by some casualties. These results directly cause harm to both the Turkish economy and environment and also effect other countries which have to use these sea ways.

The paper examine the current traffic situation in the Turkish Straits and the Sea of Marmara and investigates current developments in vessel traffic management systems around the world. An attempt is made to determine how best the new technology can be applied to improve safety and effectiveness in the Straits.

A number of recommendations on how a suitable and practicable VTS system may be successfully implemented in the Straits to fulfill the requirements of this sensitive area are made. To assist the development of a proposed VTS, technical specifications, operational plans, procedures and regulations, as well as training requirements for VTS operators, are recommended.

The paper concludes with some views on the status of the Turkish Straits bearing in mind apparent conflicts between International Legislation.

CHAPTER 1

INTRODUCTION

1.1 Background to the development of Vessel Traffic Services (VTS)

For centuries there has always been a need for ships to navigate accurately and safely. Authorities have provided aids to navigation in and around coastal waters for assisting ships to complete their voyages safely. Some form of traffic control has existed in places for many years. For instance, records show that by the sixth century there existed on the Grand Canal in China a legal system for vessels operating. Later canal systems such as the Suez and Panama Canals like wise necessitated a mandatory system for traffic movement.

However, it was not until after World War II that a system for traffic control started in spite of the grooving urgent requirements. On a worldwide basis it became necessary for four main reasons, namely:

- the rapid increase in seaborne trade,
- the development of VHF radio,
- the development of radar, and
- the development of military systems for operational control.

On the other hand, shipping increased in speed and size and more sophisticated methods of managing vessel traffic became necessary through the introduction of various passive traffic management techniques including:

- the establishment of Traffic Separation Schemes (TSS),
- the establishment of areas to be avoided, precautionary zones, recommended directions of traffic flow and other related routeing measures, and
- the use of speed limits.

The safety of navigation and protection of the environment in most coastal waters were improved by the introduction of these passive traffic management techniques.

However, the increasing number of ships with dangerous cargoes, and the intensive traffic flow in approaches to ports and narrow fairways has increased the complexity of traffic. This of course has led to considerable delays in shipping movements. Therefore, the cost of maritime traffic and port operations has increased together with the probability of accident increased. This situation increases the risk to life, property and the environment. These problems can be overcome by means of monitoring the movements of shipping in sensitive areas.

Furthermore, information, advice and instructions to shipping have been developed. These provide a service, interacts with shipping and organises the flow of traffic in order to maximize the efficiency of the port or harbour. Such a service is called a " Vessel Traffic Service "or " VTS."

In 1946, an International Meeting on Radio Aids to Marine Navigation took place dealing with the importance of radar for shore surveillance purposes as an aid to marine navigation. In 1948, in order to assist ships navigating in a port, the first shore-based radar station and VHF communication network was established. In many European and North American ports and harbours similar system were established during the next 20 years.

In the late 1960s and during the 1970s, several major tanker groundings and collisions occurred in various parts of the world. The resulting oil pollution from these accidents heightened public awareness of the devastating damage to a local marine environment that could result from shipping accidents especially those involving loaded oil tankers. Therefore, questions were asked of maritime authorities concerning what measures could be taken to reduce the risk of such accidents occurring. During the same time VTS systems were expanding with most major ports already operating some form of VTS utilising VHF radio and radar. Some countries were extending their VTS operations along coastlines and into offshore areas.

It is evident that VTS had a major role to play in the overall maritime pollution prevention infrastructure. As a result, VTS continued

It is evident that VTS had a major role to play in the overall maritime pollution prevention infrastructure. As a result, VTS continued to develop and expand into new ports and waterways, not only to enhance the safety and efficiency of shipping but also to exercise its capability of helping to protect the marine environment from pollution.

1.2 Guidelines for Vessel Traffic Services - Resolution A.578 (14)- IMO

These Guidelines describe operational procedures and planning for vessel traffic services(VTS). The Guidelines do not address liability or responsibility. The liability or responsibility of VTS should be considered by the authority establishing a VTS. Nor do they create new rights to enact legislation which impose requirements on shipping.

VTS authorities are urged to ensure that vessel traffic services within territorial seas are operated in accordance with national law and do not prejudice the right of innocent passage through such waters and to ensure that vessels outside territorial seas are able to use, on a voluntary basis, the service provided.

No provision of these Guidelines shall be construed as prejudicing obligations or rights of vessels established in other international instruments.

VTS authorities or those planning VTS are recommended to follow these Guidelines in the interests of international harmonization and improving maritime safety.

The guidelines describe the possible functions of VTS and provide guidance for designing and operating VTS once it has been decided that such a system, whether simple or highly sophisticated, is necessary. They further aim at international harmonization and address the procedures used by VTS taking into account current practice. They are based on relevant recommendations and resolutions adopted by the International Organization,

Chapter 1 - Objectives and procedures

Section 1 Vessel traffic services

- . assistance to navigation in appropriate areas
- . organization of vessel movements in VTS area
- . handling of data relating to ships involved
- . participation in action in case of accident
- . support of allied activities

Section 2 VTS authority

Section 3 Elements of a VTS

- . VTS organization
- . vessels using VTS
- . communications

Section 4 Functions of a VTS

- . data collection
- . data evaluation
- . information service
- . navigational assistance service
- . traffic organization service
- . support of allied activities

Section 5 Procedures

Section 6 Personnel

Section 7 VTS publication for users

Chapter 2 - Planning a VTS

1.3 Purpose and benefits of a Vessel Traffic Services

A VTS is any service implemented by a competent authority. It's first and foremost purpose should be to provide an information gathering service both from the shipping community and the operators of the port. In this way the port's operations can be coordinated to provide for the safe movement of shipping to achieve an optimum use of berth space and ensure minimum delays to ships using the port.

Secondly, having gathered this information together the VTS provides an assistance to navigation in appropriate areas by managing of vessel movements to facilitate an efficient traffic flow and the protection of the environment in the VTS area. This assistance may range from the provision of simple information messages to extensive management of traffic within a port or waterway or VTS area by using a centre which is charged with the system to make the best use of the information.

To achieve real benefit from VTS, a port needs to equip a centre with the means to carry out above functions and having done so make the best use of them across the port's activities. These activities can be summarised as follows;

- The means to receive information from the port community. This may be by telephone, telex or faximile or all three. Whichever is selected, it must be capable of handling, the volume of information generated within the port community.
- The means to store, retrieve and distribute the information. According to the volume of traffic using the area the computer system should be capable of being used by other sectors outside the VTS centre for such functions, so that maximum use can be made of the information stored in the database.
- The means to transmit information to ships and the maritime community. According to the volume of traffic and the number of telephone, telex or on-line computer terminals for the shipping

community, generally this is VHF radio for ships operating on one or two frequencies.

- The means to manage vessel traffic in the port and port area to monitor what is happening. This is normally done by radar surveillance which should cover the port area and approaches to the port.

To ensure true benefits of VTS, many of these functions can be integrated with each other. For example, the radar can be linked to the database to transmit automatically reports to the database on a vessel's progress.

1.4 Functions of Vessel Traffic Services

The VTS functions, which are designed to support vessel traffic with services, can be categorised into main areas which are;

- Collection of data in order to discharge its other functions.
- Allocation of space by time or area to vessels.
- Routine control of vessels, which is the contribution of VTS to the process of navigation on board the vessel, that enables the vessel to avoid collision and grounding.
- Manoeuvres to avoid collisions, which applies only in close and potentially dangerous situations. It should be noted that the VTS provides assistance to the masters involved and it is they who must take the right decisions.
- Enforcement of rules and regulations.
- Remedial actions to reduce the effects or consequences of an incident.

1.5 Factors to be taken into consideration when establishing VTS.

1.5.1 General

In planning the vessel traffic system first it is necessary to forecast vessel traffic demand. Then a feasibility study of such vessel traffic system should be made to consider how the various problems regarding vessel traffic could be solved and what the priorities should be. For this

purpose it is necessary to take into account research developments in the following two fields:

- Techniques for forecasting the demand of vessel traffic.
- Method of evaluating the environment of vessel traffic.

According to the International Association of Lighthouse Authorities (IALA) VTS Manual certain factors need to be considered.

1.5.2 Physical Factors

Local geography:

The local geography will have the determining influence on the size of the area to be covered by a VTS. Some ports are very simple and on the coast protected by breakwater heads, which give direct access to the open sea. Vessels are only restricted when they pass through the breakwater. Other ports are estuarial ports which are often far from the open sea with long approaches obstructed by shallow, shifting sandbanks, sharp turning points and etc.

Local Conditions:

In particular, visibility and wind together with the tidal range and stream may create difficulties on the ability of vessels to navigate safely. Local geography and conditions together may cause navigational difficulties to be encountered by a vessel. An appreciation of these physical factors with local or regional services leads to a first assessment of services to be provided to vessels navigating in the area.

1.5.3 Vessel Traffic

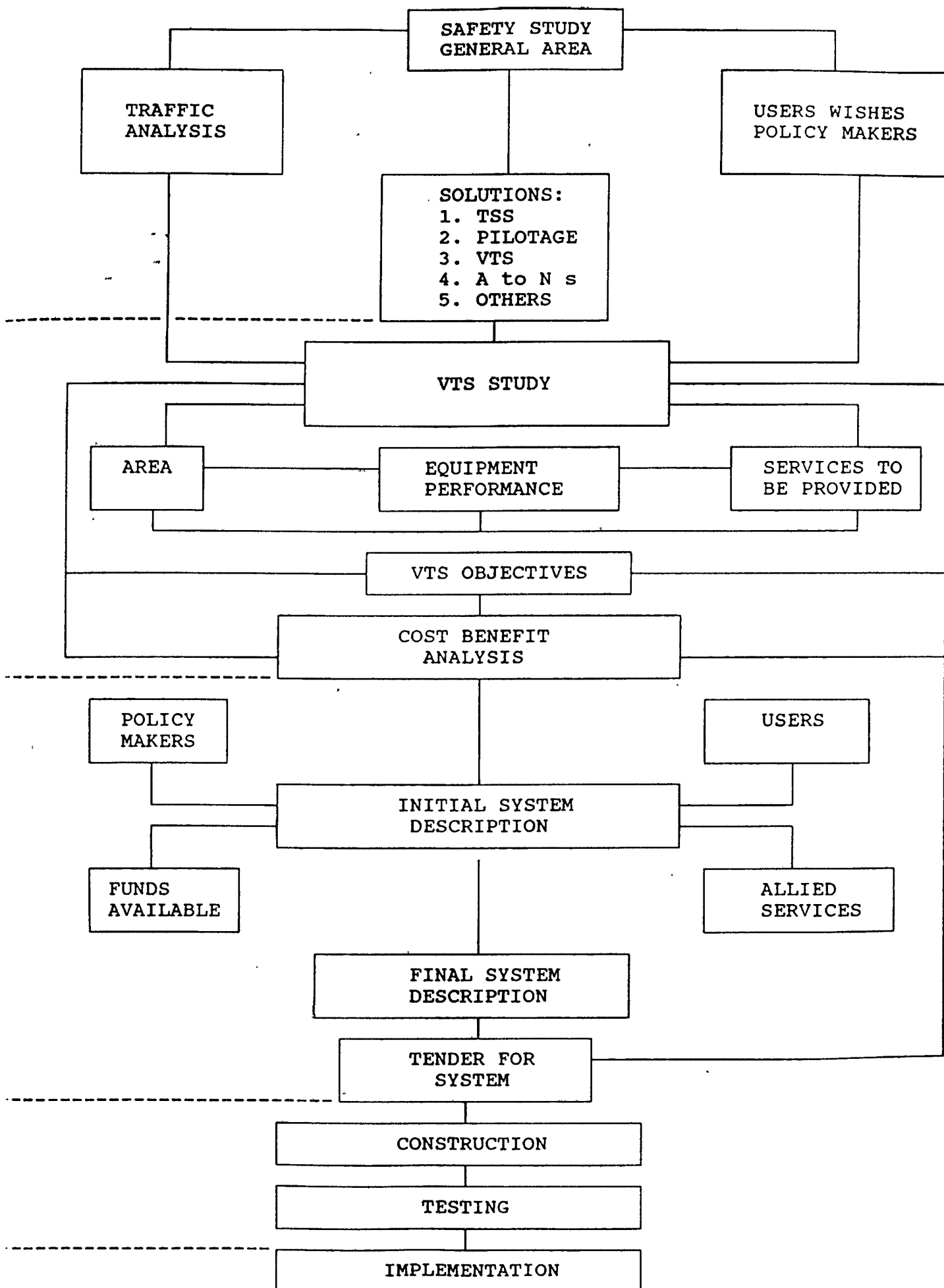
Numbers of vessels and types: This information is very important, especially their size, type, equipment, manoeuvrability and cargo carried so that vessels which require assistance or place constraints on the movement of other vessels can be identified.

Commercial Factors

Any VTS must take measure to deal with potential conflicts. Ports must operate in an efficient and timely manner, and meet the needs of their users. This must be done without compromising the safe operation of the port and waterway. For the port management resources, the

Fig 1

BLOCK DIAGRAM FOR PLANNING OF VTS



distribution of ship arrivals and departures may be an important factor. Inconvenient arrivals and departures can have a considerable and adverse effect on the harmony of the port.

Other Activities

Naval operations, oil and gas production and recreational activities may take place within the area to be covered by a VTS. These activities will also influence the operation of the scheme and must be taken into account.

1.5.4 Environmental Aspects

In recent years some horrible incidents have impacted upon the coastal environment. These have involved large tankers such as the Amoco Cadiz, the Exxon Valdez, the Aegean Sea, the Braer and other vessels carrying dangerous substances.

Due to these incidents, the importance of ship reporting and identification has been highlighted once again. In fact, significant concern has been expressed by the public outside the marine industry for protecting the environment from marine casualties. There are very sensitive areas where it is necessary to take extra safety provisions over those normally applied. These areas must be identified so that the VTS can protect them and play very important role in the protection of the environment through the prevention of accidents.

For the purpose of preventing environment all damage and limiting possible accidents, reporting should be made mandatory in environmentally sensitive areas covered by a VTS and traffic flows in approaches to harbour and/or straits should be carefully managed.

1.5.5 The users and participating bodies

The VTS play an important role in seaborne trade by providing appropriate and timely information to the shipping community, including the shoreside marine industry. Because, a valuable information concerning vessel movement can be gathered and processed by a VTS

and this information can automatically transfer to the users of VTS. Due to this relationship, the benefit for the shipping community is clear and immediate and also for public. The VTS authority must consider the collective and at times conflicting needs of users when designing and operating a VTS.

1.5.6 External Expertise

The competent authority must have sufficient technical competence. Because to undertake the detailed planning of the intended service will be quite difficult if the VTS Authority does not have such competence, external expertise should be used in such a case. The persons and companies involved should be independent and impartial.

Generally the expertise can be considered under the three categories;

- clarifying the objectives of system
- describing the system
- supervising construction of the system plus effective quality control.

1.6 Legal Considerations

General

A competent authority defines the need to establish and operate a vessel traffic service within a port, harbour or waterway. This authority must undertake responsibility for the proper and professional conduct of the VTS's operation. The areas of VTS jurisdiction and persons or vessels subject to its authority must be pictured and identified by the competent authority. In addition, the authority must clearly describe the responsibilities of the VTS personnel. Three legal issues arising from the implementation of a VTS must be taken into consideration.

1- The enforcement of VTS regulations regarding control over vessels.

2- The relationship between vessel traffic centre personnel and ship masters or pilots operating in VTS waters.

3- The determination of liability in the event of an accident involving a vessel participation in the VTS.

1.6.1 Authority

According to Resolution A. 578 (14) (Chapter 1) the VTS authority is the authority operating a VTS and it could include a governmental maritime administration, a single port authority, a pilotage organisation or any combination of them.

That necessary powers will be given by the government for improving safety and efficiency of traffic and the protection within the area of its jurisdiction is the foundation for a vessel traffic service.

These statutory processes are generally granted by laws which is formulated by government taking into consideration international and national legislative measures relevant to the provisions of VTS. These laws are created to establish a means of increased supervision of vessel and port operations in the interest of safe and efficient navigation and to protect property and the environment.

In many cases, laws are established to authorise the control of vessel traffic in hazardous areas, under unsafe circumstances, in reduced visibility, adverse weather, vessel congestion etc. Under the provisions of these laws which authorise operation of a VTS and may specify the appropriate vessels to utilise the VTS, some specified navigation communications and other safety equipment may be required.

Degrees to which this authority can be exercised and should be clearly established in the law, and may include the authority to:

- specify times of entry, movement or departure
- establish traffic routing schemes
- establish vessel size, speed and draft limitations and vessel operating conditions
- restrict operations to vessels having particular operating characteristics and capabilities and
- instruct vessels to behave when justified in the interest of safety.

The rights of innocent passage and free navigation are very important for shipping in international activity. Therefore, statutory instruments establishing a VTS authority should recognised and parallel

international rules and standards. There are several divisions of the sea which are international waters, territorial waters, contiguous zone, archipelagic waters, exclusive economic zone and the high seas. A coastal state describes the limits of its authority ranging from the coastal line to the high seas. With regard to VTS authority, a state holds the right to control its internal waters and all vessels which are subject to the state's jurisdiction. Within its territorial sea, a coastal state may utilize its full authority subject to the right of innocent passage.

However, when it takes into consideration the jurisdictional situation of straits used for international navigation a VTS authority cannot reduce the innocent passage of a vessel. In this case, a state should endeavour to enter into agreements with maritime nations to agree on standards of conduct for vessels operating in these waters. These standards may include provisions for participation in a VTS. IMO should be urged to adopt the provisions as an international convention.

1.6.2 Relationship between VTS and vessels

It is necessary to develop a systematic relationship to ensure the safe movement of marine traffic between the VTS operator, the ship's master and pilot of a vessel. This concept plays a key role. In confined waters, the decisions concerned with vessel manoeuvres are based on information provided by the VTS and the final decision taken by the master of the vessel. For carrying out these manoeuvres as a general rule, experience and training and also good relationship in engine and rudder orders are important.

VTS legislation should provide sufficient authority to manage the waterways. In spite of the location or authority of a VTS, it is generally true that VTS functions, as an informative information, are very useful for marine safety in the event of a danger and the vessel's master or pilot will take the necessary specific actions. Therefore, there are times when a VTS needs to be more directive in communicating with a vessel for its location at a specific time and place.

Vessels are firm that decisions concerning the actual navigation and the manoeuvring of the vessel remain with the master. Care should be taken that VTS operations do not interfere with the masters responsibilities for the safe navigation of his vessel, and the traditional relationship between the master and the pilot.

Depending upon the governing rules and regulations, participation in a VTS can be mandatory or voluntary. All participants in the VTS, whether mandatory or voluntary, must fully understand their role. The instructions of the VTS operations should be issued by the competent authority for mariners who will comply with these instructions for the safety of their ships and take into account the safety of other vessels and the protection of the environment.

1.6.3 Liability

Having chosen, trained and certified personnel to operate a VTS, the VTS Authority must take into account further responsibilities of these persons.

In regard to vessel movement within the VTS areas, whether VTS participation is mandatory or voluntary, the VTS centre has given an instruction to a vessel, the question arises: who would be liable in case of an accident where the VTS played a role?

According to ~~the~~ some VTS authorities there is no liability for the consequences of VTS messages. In fact, the Convention on the Law of the Sea gives the right to a coastal state to take measures to protect and preserve the marine environment in its exclusive economic zone. But the Convention states in its Article 211 that those measures concerning ships are to be taken in accordance with internationally accepted rules and standards.

This clearly means that while the Convention establishes general principles, the implementation of these principles is an international responsibility. Therefore, coastal states have no rights regarding shipping in their EEZ, except for certain rules which have been established under

the auspices of IMO. This is also true for straits within territorial waters used for international navigation where ships exercise the right of transit. It is difficult for coastal states to establish legislation. Because, they are very limited by Article 42 of the Convention. In particular as regards the protection of the marine environment, the state is limited to enforcing the relevant international rules.

On this point, it appears that no legal instrument to deal with liability in cases where a VTS is involved in proportion to how much its actions contributed to the incident.

CHAPTER 2

THE VESSEL TRAFFIC SYSTEM IN THE TURKISH STRAITS AND SEA OF MARMARA

2.1 General information

The process of developing Vessel Traffic Services for the Straits of Turkey is a further endeavour to promote the safety of navigation of vessels and to improve the protection of the marine environment.

The density of merchant vessels of large tonnage using the Turkish Straits is progressively increasing. The Turkish Straits, consisting of the Straits of Istanbul (Bosphorus), the Sea of Marmara and the Strait of Canakkale (Dardanelles), are very complicated and narrow waterways connecting the Black Sea to the Mediterranean Sea. The very narrow and winding shape of the Straits is more like that of a river. It is an established fact that the Turkish Straits is one of the most hazardous, crowded, difficult and potentially dangerous waterways in the world for mariners. Navigation in the Straits is highly congested by merchant traffic, coasters, fishing vessels and local traffic. All the dangers and obstacles characteristic of narrow waterways are present and acute in this critical sea lane.

The increase of traffic density using these waterways together with the high volume of dangerous cargo that is carried by large vessels which are represent a significant risk to the inhabitants of the densely populated banks of the Turkish Straits, as well as its environment.

2.2 The Justification

Although the Bosphorus, the Sea of Marmara and the Dardanelles are within Turkish territorial waters, they should be considered an international seaway because they form a connection between of the Black Sea ports to the international ports. Because of this reason, thousands of foreign and Turkish vessels use these waterways every year

The number and the tonnage of the vessels which use these waterways increase every year in connection with the great increase of the worldwide marine trade.

In spite of these facts, the geographical structure of the Bosphorus and the Dardenelles presents some very serious difficulties for the navigation of vessels which sail in these areas. Among these difficulties are the strong currents and counter currents, the hills surrounding the coasts of the Bosphorus, several shallow places and insufficiency of visibility because of the weather conditions.

The investigations made in relation to the reasons for the sea accidents which have taken place in the Bosphorus and the Dardenelles shows that five main points can be taken into consideration regarding the causes of these accidents.

1. The unfavorable natural conditions such as fog, snow, storm, strong currents and counter currents.

2. The defectiveness, deficiency or failure of the technical equipment of the vessels involved.

3. The deficiency of the regulations and rules for safety of vessels at sea and the lack of control and compliance with the present rules and regulations.

4. The deficiency of the auxiliary navigational systems in the surroundings area for providing the necessary information for safe and orderly navigation.

5. The ships masters being unaware of the local geographical and environmental conditions, and sailing without pilotage assistance despite the presence of these conditions.

The sea accidents which have happened to date in these waterways, have caused fires, deaths, pollution, destruction of historical and new buildings on the shores, the loss of vessels and cargoes and finally the blockage of sea traffic. These results have caused direct harm to the Turkish economy and also to the economies of the other countries which use these waterways.

According to the investigations carried out into a few of the above mentioned sea accidents, it is clear that it is necessary to organise the transit of vessels during bad weather conditions; to prevent the entrance of improperly equipped vessels until deficiencies are corrected; to give the necessary information to masters about the environmental conditions; to encourage the inexperienced masters for the pilotage assistance in order to prevent the probable sea accidents in the Bosphorus, the Marmara Sea and the Dardenelles.

In order to provide safe passage through these difficult navigational conditions which are the main cause of many accidents in the area then it is need to expand navigational assistance and the existing traffic management system in traffic control. Procurement of a VTS system will improve the situation as it has shown its effectiveness when acquired in other similar international waterways particularly the English Channel.

2.3 Incidents

During the period 1952 to 1991 there occurred 444 major incidents in this area associated with the following locations:

Bosphorus	-	332
Dardenelles	-	81
Sea of Marmara	-	31
Total	-	444

**Marine Pilots' Association
Istanbul, 1st May 1994**

For the forty year period this gives an average of 11 incidents per year, however traffic flow over this period has not been linear, in fact statistics show that 35% (155) of the incidents have occurred since 1988, as seen below:

1988	-	7
1989	-	16
1990	-	38
1991	-	57
1992	-	37
Total	-	155

**Marine Pilot Association
Istanbul, 1st May 1994**

Table 2-1 Some major Incidents in Turkish Straits

No	Date	Cause of Incident	Place of Incident	Flags of Vessels
1	1982	Collision	Kandilli	USSR
2	1982	Grounding	Karaburun	Greek
3	1982	Collision	Bebek	Romania-Italy
4	1982	Grounding	Yenikoy	Cyprus
5	1983	Collided into quay	Bebek	Panama
6	1983	Collided into quay	Arnavutkoy	India
7	1984	Collided Shore house	Emirgan	Malta
8	1984	Collision	Pasabahce	Turkish-USSR
9	1985	Collision	Buyukdere	USSR-Italy
10	1985	Collision	Rumelifeneri	Bulg-Roumania
11	1986	Grounding	Selviburnu	Panama

12	1986	Grounding	Bebek	Yugoslavia
13	1986	Collision	Kanlica	Turkish-Turkish
14	1986	Collision	Bebek	China-Greek
15	1987	Collision	Buyukdere	Turkish-Panama
16	1987	Collision	Pasabahce	Turkish-Cyprus
17	1988	Collision	Buyukdere	TurkishRoumania
18	1988	Grounding	Bebek	Egypt
19	1989	Collision	Bebek	Ahirkapi
20	1989	Collision	Bebek	Turkish-Romania
21	1990	Grounding	Selviburnu	Cyprus-Greek
22	1990	Collision	Hamsiburnu	China-Iraq
23	1991	Collision	Tarabya	Turkish-Italy
24	1991	Collision	Anadoluhisari	Lebanon
25	1992	Collision	Kavak	Greek-Bulgaria
26	1992	Collision	Ahirkapi	USS
27	1992	Grounding	Buyukliman	Greek
28	1993	Collision	Ahirkapi	Syria
29	1993	Grounding	Kizkulesi	Russia
30	1994	Collision	Buyukliman	Cyprus-Cyprus

**Marine Pilots' Association
Istanbul, 1st May 1994**

On 13 March 1994, a 66,822 gross ton Greek Cypriot oil tanker, the Nassia and a 14,826 gross ton Greek Cypriot cargo vessel, the Shipbroker, collided inside the Northern approaches of the Istanbul Strait (Bosphorus).

The collision and subsequent explosion in the tanker led to a conflagration in which both ships were enflamed. Of the 29 crew members of the Nassia, six were reported missing; 20 seamen of the Shipbroker died in the accident, while six were missing and three saved. The captain of the Shipbroker was among the missing. This collision was the worst accident in the Straits since the collision between the Romanian tanker Independenta and Greek cargo vessel Evriali in 1979 in which 43 seamen died. The full investigation has not yet been completed.

Analysis of all the collisions concluded that:-

- (i-) 75 % of the collisions occurred with no pilot onboard.
- (ii-) 24 % of the collisions occurred when only one vessel employed a pilot.
- (iii-) 1 % of the collisions occurred when both vessels employed a pilot.

2.4 The Functions

The functions of the Bosphorus, the Sea of Marmara and the Dardenelles Vessel Traffic System are as follows:

2.4.1 To organise the movements of the vessels in order to achieve a safe, regular and fast and good traffic flow in the region

The VTS should organise the vessel's movements according to the relevant international and national rules and regulations in order to procure a safe, fast and orderly sea traffic flow in the region. It should control the vessels sailing in the region by ensuring that they comply with the above mentioned regulations and to take the necessary measures to make sure that they meet the mentioned rules.

For organising and controlling the traffic an identification and tracking system is essential. Progress can be provided by ships reporting the position through radio communication, but independent controlling and monitoring needs radar, VHF DF, closed circuit Tv and visual observation from shore side.

2.4.2 To assist the navigation in the Region

- To carry out the necessary operations in order to prevent the meeting of vessels in the dangerous zones and to assist them their navigation.

- To provide the necessary safety warnings to vessels which are in danger of colliding and grounding for their safety.

- To assist the vessels in the entrance and the exit from the Region.

- To assist the vessels while entering and the leaving the quays and anchorage places.

- To provide the necessary information's to the vessels about the fog and visibility conditions in order to assist them their navigation.

- To control the movements and the manoeuvring of the vessels in connection with the national and international regulations in the Region.

2.4.3 To collect, evaluate and distribute information about the sea traffic in the Region

- To collect and evaluate related information's about the traffic situation, the auxiliary navigation system, meteorological and hydrologic conditions in the region.

- To take the reports submitted by the masters, the agents and the shipowners.

- To collect information's about the hull, engines, equipment, outfittings, navigation equipments, the crew and cargo dangerous for human health or the environment or both.

- To analyse the traffic situation and its development in the region.

- To arrange for the exchange of information between the participants and to distribute the information to the relevant organizations.

- To collect statistical data in the region.

- To submit the necessary documents in the case of any accident.

- To assist all vessels in the region of the VTS System including the small vessels having communication equipment by maintaining listening watch and broadcasting information about the movement of traffic, the visibility, the speed and the direction of the currents, and the movements of the ships manoeuvring.

- To exchange information with the masters of the vessels about relevant safety subjects.

- To warn vessels about the obstacles to safe navigation on the sailing routes such the wrecked ships, fishing boats, small marine vehicles and especially tasked vessels, and to inform the vessels about the alternative navigational routes.

2.4.4 To intervene effectively in case of any accident, pollution problem or any other extraordinary event

- To take necessary and effective action by setting in motion all the relevant units in case of an accident, pollution problem or other extraordinary event. Moreover, it should provide co-ordination and assistance between the related units in order to intervene effectively according to the contingency plans determined in advance.

2.4.5 To support the related activities

- To support the below mentioned administrations which render services to the vessels which are the transient passing entering, berthing or departing to/from the ports, by providing them with the necessary information. These administrations are:

- the Management of the Istanbul District of the Ministry of Transport
- the Harbour Master of Istanbul .
- the Health Management of the Borders and the Coasts
- the Pilotage and Towing Departments
- the Coast Security Management
- the Customs
- the Sea Police - the Coast Security Guard.
- the units related with the environmental pollution
- the Ship Salvage and Rescue Management
- the port administrations
- the owners
- the agents

CHAPTER 3

THE GENERAL SITUATION AND SEA TRAFFIC IN THE REGION OF THE TURKISH STRAITS AND SEA OF MARMARA

3.1 Traffic flow assessment

Transit traffic

The entrance, transit and exit vessels through the Turkish Straits and Sea of Marmara forms the main density of traffic flow in this region. Besides that, vessels calling or departing to or from one of the ports in the Sea of Marmara adds significantly to this traffic density. With a transit traffic of average 35 000 vessels per annum, Turkish Straits may be considered as the most critical waterway of the world.

As a result of rapid development of modern technology and with the increase in the international marine trade, the tonnage of the vessels which pass most of them through the Turkish Straits has increased dramatically. This trade development is more significant than the increasing number of vessels passing through.

Local traffic

Due to Asia and Europe being separated by the Turkish Straits, it is necessary to use either the two suspension bridges in Istanbul or local small vessels in the seaway between the two continents for passengers and cargo transportation. Considering that about 10 million people live around the Strait of Istanbul, it is easy to understand the dimensions of the local marine traffic. As well, local sea traffic between the two sides is further enhanced by the operation of the Gelibolu-Lapseki and Canakkale-Eceabad ferryboat lines.

Traffic Statistic - Merchant Shipping

Table 3-4 shows that there is an approximate annual increase of more than 3 % in the number of vessels using the Turkish Straits of size

greater than 250 GRT. An annual increase in the order of 1.2 % can be taken into account in the Strait of Canakkale.

3.2 Main Traffic Routes

Figure 3-1 shows the traffic flow between the Black Sea and the Aegean Sea with flows to the internal ports in the Sea of Marmara.

Entrance of the Strait of Istanbul - Black Sea

Four major routes are identified which converge to the Strait of Istanbul:

Shipping to / from

Bulgarian and Romanian ports

Odessa and the Crimea ports

Northeast Russia ports

Northern Turkish ports

In addition, sand barges operate in the Northern Black Sea Coast.

Entrance of the Strait of Canakkale - Aegean Sea

Three major traffic lanes converge at the entrance of the Strait of Canakkale:

Shipping to / from

Greece

Mediterranean ports

Aegean ports

Entrance to Strait of Istanbul from Sea of Marmara

Four major routes converge at the southern portion of the Strait of Istanbul:

Traffic to / from

the Strait of Canakkale

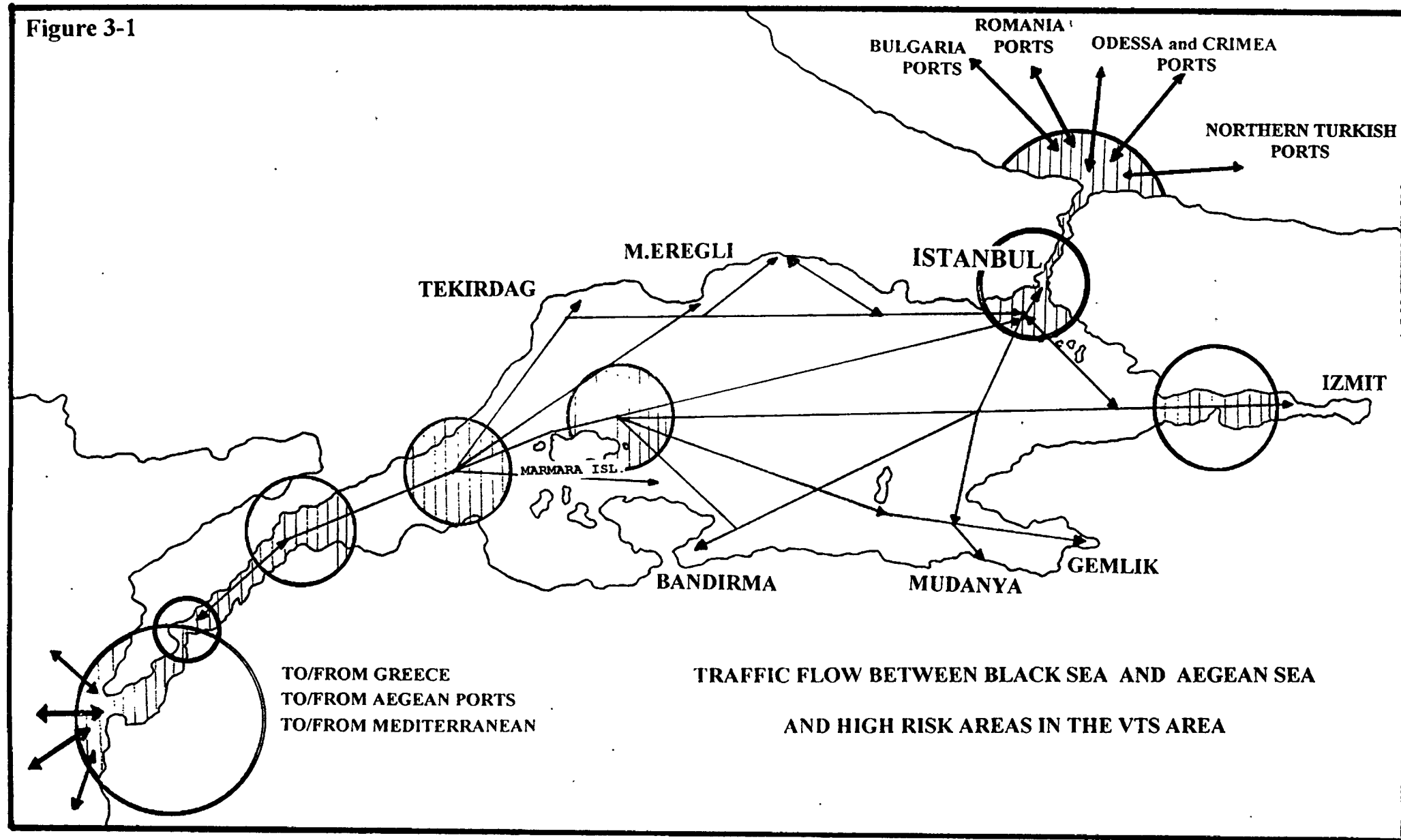
ports of Bandirma, Gemlik and Mudanya

Izmit Bay

Ambarli and Silivri

Figure 3-1

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3.3 Types of cargoes in the traffic flow

The types of cargoes which are being transported by vessels using the above mentioned sailing routes. They carry a high volume of dangerous goods in packaged form, liquid and solid substances and gases carried in bulk. The cargoes carried by the shipping in the region are as follows:

- Oil and chemical tankers transit the Strait of Istanbul
- Chemical tankers to / from Yalova
- Ammonia tankers to / from Gemlik
- Fuel tankers to / from Ambarli
- LNG tankers to / from Marmara Ereğlisi
- Sand barges in the Northern Black Sea Coast
- Ferry and cruise ships cross the region

It is recommended that the transport of dangerous substances in the Turkish Straits must be controlled and as soon as possible very effective measurements must be taken to ensure the safety of people and protection of environment in the region. A VTS must include the proper procedures and equipment to enable effective management of this type of shipping.

3.4 The physical features of the Straits and Sea of Marmara

3.4.1 General

The Turkish Straits include the Canakkale, which links the Aegean Sea in the north-eastern part of the Mediterranean Basin to the Sea of Marmara, and the Istanbul, which links the Sea of Marmara to the Black Sea, as shown in **Figure 3-1**. The approach to the Canakkale from the west is between islands of the Aegean Sea. The distance of the nearest of these islands to the entrance of the Canakkale ranges from 12 to 25 n.miles. The total navigable length of the straits from Cape Kumkale, at the entrance of the Canakkale from the Aegean Sea, to Rumelifeneri, at the exit of the Istanbul Strait to the Black Sea, is about 160 n.miles.

3.4.2 The Strait of Canakkale

It is located between north latitude $26^{\circ} 10' 30''$ and $26^{\circ} 42' 0''$. The length of the Canakkale Strait between Cape Kumkale and Gelibolu is about 38 miles. The width at the entrance is two and one-half miles. About five miles within the strait, the passage widens to four miles and then is again restricted to one and one-half miles, about eight and one-half miles beyond the entrance. The passage extends northwards for about six and one-half miles, with average widths of one to two miles and a minimum width, abreast of Canakkale, of about three-quarters of a mile. The breadth near the northern end of the strait is one mile. As the passage tends north-eastwards to the Gelibolu for about 16 miles, it has a minimum width of one and one-half miles and a maximum of three miles.

The Canakkale Strait are deep, averaging 55 meters, with a maximum of 91 meters. There are two major currents. The surface current which flows from the Black Sea towards the Aegean Sea, and the more saline undercurrent, which flows in the opposite direction. There are also other local currents of limited intensity that run through the strait.

Vessels in general keep to the middle to avoid the current that runs from about one to two knots except in some narrows where the rate may be up to four-five knots/hour. As is usual in confined channels, cross currents must be expected near the sharper bends. There are numerous lights to assist navigation at night. A speed restriction is enforced through the Canakkale Strait.

3.4.3 The Sea of Marmara

The Sea of Marmara can be considered as part of the straits connecting the Aegean Sea to the Black Sea. It has a two layer current system in which the upper Black Sea waters flow south to the Aegean Sea and the lower Mediterranean waters flow north. Surface currents are not as fast as in the straits and vary from half to two knots/hour at the entrance to Canakkale Strait.

Navigation through the Sea of Marmara presents no great difficulty. There are no navigational dangers, with the exception of some

detached shoals lying up to a mile offshore at the south-western end of the approach to the Canakkale Strait, and a bank with less than nine meters over it, and projecting about a mile from the Asiatic side of the approach to the Istanbul Strait. There are ample navigational lights to assist night passage. The route most usually followed is that north of Marmara Island. The general direction of the current the sea is from east to west at rates varying from one-half to one knot.

3.4.4 The Strait of Istanbul

It joins the Sea of Marmara to the Black Sea. It tends in a north-easterly direction, with its southern entrance considered as a line connecting Sarayburnu on the European territory of Turkey to Moda Burnu on the Turkish Asiatic shore about two and one-quarter miles south-eastward. Its northern entrance lies between Rumelifeneri and Yum Burnu about two and one-half miles eastward. The strait looks something like a river, being narrow with sudden and angular windings and a strong current.

The length of the strait is about 19 miles. Just inside the southern entrance of the strait on the European side is the Golden Horn. The width at the southern entrance is two and one-quarter miles abreast of the southern entrance to the Golden Horn, the breadth of the strait is rather less than a mile and the entrance to the Golden Horn narrows to about a quarter of a mile. The strait then narrows further and about five and one-quarter miles from Istanbul, near Rumelihisari, it reaches its minimum of 750 meters. The strait then tends north-westward for about two and one-half miles, with an average width of about three quarters of a mile. It turns in a north-easterly direction for about six miles to its northern entrance.

The depths in the main channel of the strait are deep, from 36 to 124 meters. The rapid currents present difficulties that call for a pilot's help. In fact, the fast surface current may be observed as it is formed by the waters of the rivers that flow into the Black Sea and through the Istanbul Strait to the Sea of Marmara. An opposite undercurrent containing salt water moves to the Black Sea through the strait. These currents flow depending on the wind's strength.

3.5 Risk Assessment and Recommendations

Identifying the risks associated in a waterway and then examining methods to reduce those risks is the principle employed to ensure that the needs have been met.

For along time the Istanbul District of the Ministry of Transport has performed an initial assessment of navigational risks as encountered in the Turkish Straits. In the assessment, the factors examined by the authority were as follows:

- 1- Type of vessels and cargo
- 2- Encounter characteristics
 - meeting/passing in open sea
 - meeting/passing in narrow channels
 - meeting/passing in bends
 - crossing traffic
 - marging traffic
 - speed of encounters
- 3- Width of channels
- 4- Weather characteristics
- 5- Number of passenger vessels
- 6- Effect of potential disasters on the environment.

The situation analysis has identified the following specific areas in the Turkish Straits which can be classified as having either high or moderate marine risk.

3.5.1 Risk Areas

High Risk Areas

- Northern and southern entrances of the Istanbul Strait from the Black Sea and the Sea of Marmara
- The Istanbul Strait at selected locations
- North of Marmara Adasi
- Entrances to the Canakkale Strait from the Aegean Sea and the Sea of Marmara
- Within the Canakkale Strait at Nara Burnu

- Approaching to Marmara Ereğlis LNG terminal.

Other risk areas

- Entrance to İzmit Bay
- Small chemical tanker traffic to Yalova
- Ammonia traffic to Mudanya, Gemlik and Bandırma
- Gas, fuel and chemical tankers to/from Ambarlı margining with traffic at the southern portion of the Istanbul Strait.

These risk areas are identified in **Figure 3-1**. As can be seen, significant risks to navigation exist within the waters of the Turkish Straits and Sea of Marmara.

Risk Areas within the Strait of Istanbul

This strait presents the highest risks to navigation because of the following factors:

- narrow channel with reduced manoeuvring
- heavy currents
- sharp bends
- fishing traffic
- ferry traffic
- ferry traffic crossing the main channels
- reduced visibility due to fog, rain, snow, and sudden and angular windings. High risk area is shown in **Fig 3-2**

3.5.1.1 Description of major risk areas - The Strait of Istanbul

Area 1- Entrance from the Sea of Marmara

This risk area as shown in **Fig 3-2** is a major focal point. At this location, the following types of traffic are encountered:

- tanker traffic to/from İzmit Bay
- ammonia tankers from Mudanya
- main traffic from the Strait of Çanakkale
- fuel tankers from Ambarlı
- passenger ferries to/from the Princess Islands
- passenger ferries to/from both side of the strait.

Major course alterations are required for traffic transitting the region. Stone breakwaters exist in this region which reduce the manoeuvring capability of vessels. The area is subject to low visibility. Therefore, traffic from the anchorage moves in and out of the traffic lanes. Visibility is restricted during manoeuvres. Pilot boarding an anchorage area exists in this area. Vessels slow down for pilot boarding/disembarkation, hence creating additional risks.

Recommendations

1- A TSS should be implemented in this region. The focal point in the traffic scheme should be relocated further south of the entrance of the Strait of Istanbul to reduce the density of traffic merging at this area.

2- Pilot boarding/disembarkation should be moved to approximately 7 miles south of the present pilot boarding region.

3- A traffic lane should be established for vessels entering/leaving the anchorage region for the main channels. Vessel movements from the anchorage should be known with at least 12 hour advance notification.

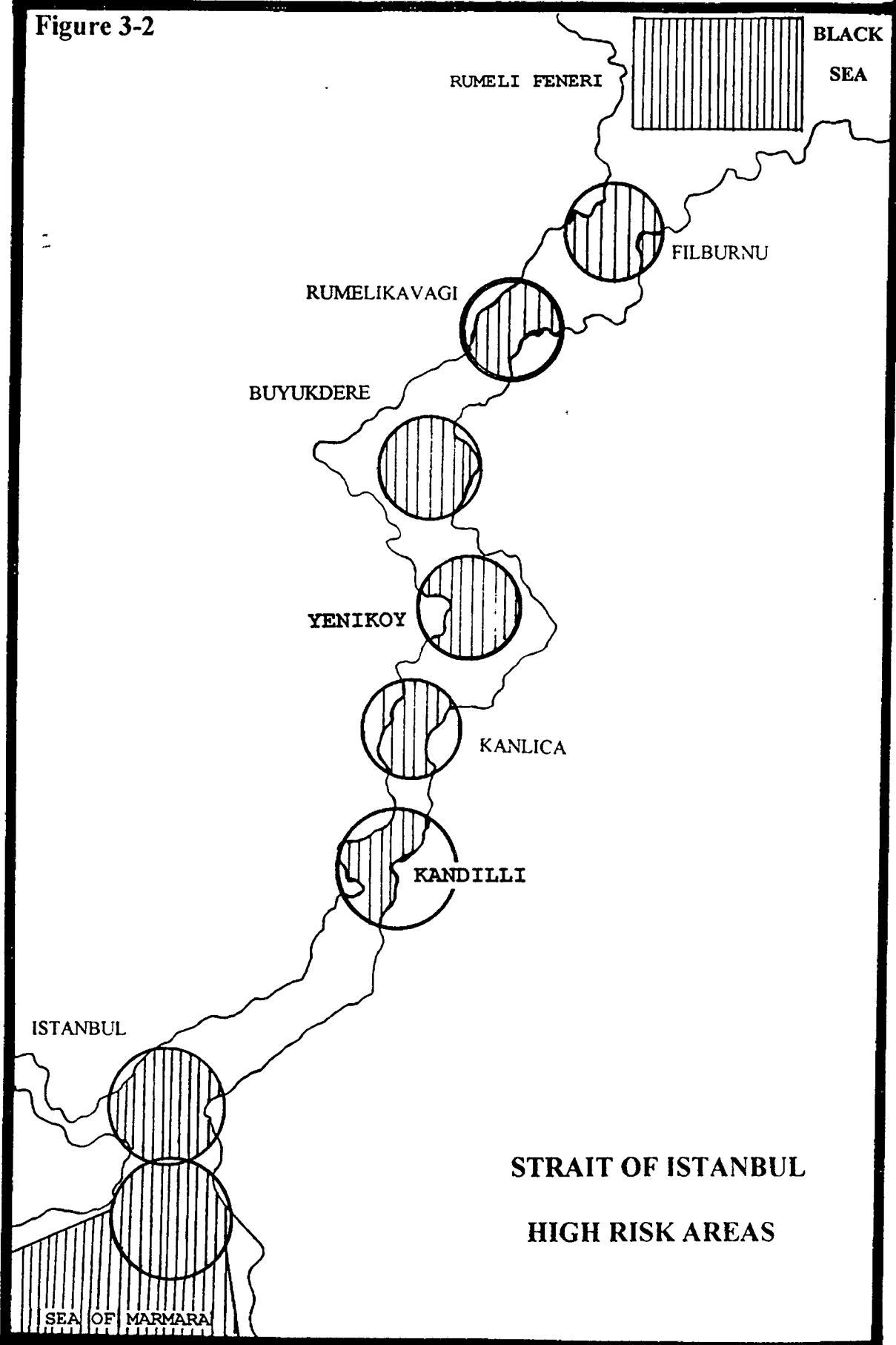
4- A VHF reporting point should be established for all vessels entering/leaving the strait within the 10 nm. radius of the new pilot station at Bakirkoy.

5- All critical points and reporting points in the proposed TSS should be clearly marked with navigations aids. The revised procedures should be implemented by regulations and notices to mariners.

6- A VTS for this region, when properly equipped and operated, will complement the TSS therefore enhancing the overall risk reduction potential.

To effectively manage the risks in this conflict area and to provide the necessary information services, a potential VTS must be equipped with radar, VHF communications and VHF DF. Visibility and wind sensors are a requirement to inform mariners of expected meteorological conditions as well as planning and scheduling of ship movements. The VTS shall also be equipped to monitor all vessels within the anchorage area. Any movement of vessels within the anchorage area shall generate an audible alarm. Drift or swing of a vessel at anchor should also be detected.

Figure 3-2



Area 2 Kadikoy-Karakoy Region

This area of the strait requires a major course alteration for traffic . Due to the course alteration, on-coming traffic is not visible. In addition, passenger ferry traffic continuously transits this region between the banks of the strait. Small fishing craft and pleasure boats are concentrated in this region. **Table 3-5** shows the routes and number of ferry trips.

Recommendations

The region from the Istanbul Bridge to the entrance from the Sea of Marmara should be monitored and controlled under all weather conditions. Ferry traffic should be closely monitored and be in VHF contact with the VTS before and during movements. The VTS should be equipped with Closest Point of Approach projection vectors together with the traildots so that proper management of the ferry movements can be accomplished to reduce potential collisions involving a ferry. Fishing boats should be monitored closely on radar and must be regulated to stay out of the main channels. The VTS must have effective communication with the authorities responsible for ensuring that fishing boats do not violate the rules.

Area 3 Kandilli

This area is one of the highest risk areas in the strait. In this region, the strait narrow down with a sharp curve requiring major course alterations. In addition, the surface current is high; poor visibility conditions contribute towards accidents in this region.

The main current in this region reverses direction and whirls in the bay and then joins the main stream flow. Therefore, a vessel manoeuvring is subject to different current speeds and direction between the fore and aft sections on the ship's hull. This causes the bow of the vessel to shift laterally, throwing the vessel off course. In order to prevent an accident with an on-coming vessel or to prevent a grounding, the vessel must have the proper speed in the water. Regulations governing the Port of Istanbul require that vessels should not sail with a speed in excess of 10 knots. However, if the current is 7 knots, then the effective speed of the vessel is

3 knots. This speed together with the individual structural and response characteristics of the vessel may not be sufficient to prevent drifting.

Recommendations

The regulations for speed within the straits should be flexible without compromising the safety of shipping. Current measuring devices, visibility and wind sensors at Kandilli will enhance operations. This information should be transmitted to all users of the system. A proper communications system and data distribution with a vessel traffic environment will ensure the information is properly distributed. Vessels sailing under 10 knots should be prevented from entering the strait if current at Kandilli exceeds 5 knots. A manned control station of the VTS should monitor this region continuously under all weather conditions. This control station should have the capability to provide advanced information for all vessels which will pass this region at least 10 minutes in advance. Meeting/passing reports should be generated and vessels scheduled so that there is no overtaking of vessels. On-coming traffic should be regulated so that only one vessel at a time is allowed to perform a manoeuvre in this region.

Area 4 and 5 Kanlica and Yenikoy

These risk areas are characterised as narrow channels with major course alterations, hence the vessels slow down to negotiate the turns. Heavy currents cause manoeuvring of large vessels difficult and with the reduced speeds drifting occurs. In addition, there is limited visibility for on-coming traffic. Low visibility is experienced due to the environment and fishing boats use this region even though it is against regulations to fish in the main channels.

Recommendations

A manned control station at Yenikoy must monitor the movements of all vessels in this area. On-coming traffic should be determined at least 10 minutes in advance on the meeting / passing reports predicting the times of encounters. Vessels should be scheduled to minimise vessel encounters at the turns. The system should be able to detect when fishing boats enter into the channel areas. Adequate communication facilities

shall be provided so that a VTS operator can inform the appropriate authorities.

Area 6 Buyukdere

The Buyukdere region is a turn area which requires major course alteration. Limited visibility for on-coming vessels exists hence vessels must slow down to negotiate the turns. A temporary anchorage area exists and vessels may be required to cross the main channel when entering or leaving the anchorage.

Recommendations

Two manned control station, which will be located at Yenikoy and Tellitabya, must monitor the movements of all vessels in this region. On-coming traffic should be determined at least 10 minutes in advance with meeting / passing reports predicting the time of encounters. In addition, the anchorage area must be monitored continuously. Any movement within the anchorage shall generate an audible alarm.

Area 7 Kavak Burnu

This channel narrows at Kavak with a small course alteration. Small fishing boats using nets are encountered in the main channel. The narrowing of the channel together with the intrusion of fishing vessels main accidents can occur since the manoeuvring capability of the vessel is reduced. In addition, pilots are located at the pilot station for boarding and disembarkation of vessels.

Recommendations

This region must be monitored continuously under all weather conditions. The Tellitabya and Rumelifeneri vessel traffic control station should be capable of detecting small fishing boats and monitor for intrusions into the main shipping channels. Any such intrusion shall generate an alarm. The VTS operator should be equipped with adequate communications facilities to inform the proper authorities of violations by fishing vessels. Furthermore, direct communication between pilot stations

and ships for pilotage assistance should be co-ordinated from a central authority preferably 24 hours in advance of the vessel entering the strait.

Area 8 Filburnu

The traffic lane narrows at Filburnu with a minor course alteration. In this area, the vessels slow down and in some cases come to a full stop for independent pilot boarding as well as for sanitary control purposes. Boarding activities between pilotage and sanitary control are not able to co-ordinate under unfavourable weather conditions and dense traffic.

Recommendations

This area should be monitored at all times under all weather conditions. Pilot and sanitary control boarding of vessels should be carried out simultaneously and at the same location. It is further recommended that boarding of vessels be conducted before a vessel enters the strait , preferably in the Black Sea. The implication is that larger vessels capable of operating in the Black Sea environment will be required. However, vessels will not be required to slow down or stop in the strait.

The VTS should be capable of providing advanced information to both the pilots and sanitary control so that both activities can be planned and co-ordinated, and pilot and sanitary control boats can be detected by the VTS operator.

Area 9 Entrance to the Strait of Istanbul

Four major course converge / diverge at the northern entrance of the strait.

- 1- Shipping to/from the Northern Turkish ports.
- 2- Shipping to/from the North-eastern Russian ports.
- 3- Shipping to/from Odessa and Crimea ports.
- 4- Shipping to/from Bulgarian and Romanian ports.

Sand barges transit the coastline between the entrance of the Strait of Istanbul. High winds and waves are encountered in this area and low

visibility is common. In addition, vessels entering the strait do not voluntarily report their movements and hence authorities are not aware of a movement until the vessel is in the strait. The traffic converging in this area gives rise to a focal point with a relatively high density and therefore danger of collision exists.

Recommendations

It is recommended that traffic lanes be separated to minimise the incidence of collisions. The simplification of the traffic flow through the use of a round-about is recommended with a precautionary area clearly established. This precautionary area can be located approximately 6 miles within the territorial waters of Turkey and through regulations all vessels should be required to report to a central co-ordinating authority.

With the introduction of a VTS system, the central co-ordinating function could be performed by the VTS operator. It would be desirable for the VTS to be able to monitor and communicate with all vessels approaching the Strait of Istanbul as far as possible from the entrance to the strait so that advanced notification can be achieved.

It is recommended that a long range radar system capable of operation under all weather conditions be equipped to monitor all shipping beyond the territorial waters of Turkey. The VTS should be equipped with proper communications equipment and facilities to allow pre-screening of vessels for type of cargo, defective or deficient equipment and pilotage requirements. Availability of Lloyds shipping information will enhance operations.

The minimum information required for pre-screening vessels according to IMO recommendations is as follows:

- name of vessel and date and time of arrival,
- the correct technical name of the substances, the flashpoint or flashpoint range and the quantity,
- whether a valid certificate of fitness is held for the cargo,
- stowage of the dangerous goods on board indicating if any undue hazard is likely to arise,
- any known defect which may substantially affect the safety of navigation, and

- pilotage requirements.

3.5.1.2 Risk Areas Within the Strait of Canakkale

Risk regions within the Strait of Canakkale are identified in **Fig 3-1** These are as follows:

- the region north of Marmara Adasi
- entrance from the Sea of Marmara
- at Nara Burnu
- entrance from the Aegean Sea

Risk at the region north of Marmara Adasi are primarily due to vessels transiting too close to the land. The traffic lane should be reorganised in this region. In addition, it should be monitored by radar under all weather condition. Risks at the entrances of the Strait of Canakkale can be reduced through proper traffic separation with VHF call-in points and radar monitoring. Risks at Nara Burnu and Canakkale are due to the narrow channels, strong currents and limited manoeuvring capability within the region. Passenger ferries also transit the waterway. Through radar monitoring, the risks in the strait can be significantly reduced. As in the Strait of Istanbul additional risks are created due to vessels slowing down for pilot boarding and sanitary control. These service should be co-ordinated and ideally, boarding of vessels should occur before the vessel is allowed to enter the strait.

General Recommendations

A properly implemented Traffic Separation Scheme will contribute significantly towards reduction of risks in the Turkish Straits. As a part of implementing the traffic scheme, traffic lanes could be reorganised to minimise the number of encounters. In addition, appropriate navigational aids must be placed to mark critical points within the channels.

With the introduction of the Traffic Separation Scheme (TSS) areas of risks will change but would be contained through the use of clear procedures. A VTS conjunction with the TSS will further reduce the risks to navigation in the Straits.

3.5.1.3 Risk Areas Within the Sea of Marmara

The major risk areas are identified in **Fig 3-1**. Risks in the Sea of Marmara can be reduced significantly through the introduction of proper traffic separation lanes and reorganisation of traffic flow. All other risks can be contained by monitoring vessels within the region.

3.6 Meteorology

The climate in the area is influenced by the sea. Wind currents to and from the sea create mild winter and summer seasons. Precipitation is usually in the form of rain, whereas in winter short duration snowfall occurs. These factors contribute toward reduced visibility for navigation.

3.6.1 Rainfall

The mean annual precipitation over the area varies from 500 mm to 1000 mm with approximately 85 percent of the total rainfall falling between September and May. **Table 3-1** shows 48 year average precipitation for the Istanbul region.

Table 3-1

<u>MONTH</u>	<u>PRECIPITATION mm</u>
January	86
February	69
March	61
May	30
June	33
July	28
August	41
September	51
October	62
November	102
December	122
Yearly Average	726

Meteorology Institute-Istanbul

3.6.2 Temperature

The average temperature over the area is approximately 14 C. The temperature falls below 0 C for short durations. Freezing of above-ground unprotected equipment can be expected. Table 3-2 shows average temperatures in the area.

<u>MONTH</u>	<u>MEAN</u>	<u>EXTREME MIN.</u>	<u>DAYS BELOW C</u>
January	5.5	-13.9	-
February	5.3	-16.1	5.5
March	6.9	-11.1	4.5
April	11.3	- 1.1	0.2
May	16.2	2.8	-
June	20.7	7.1	-
July	23.2	10.5	-
August	23.4	10.2	-
September	19.6	6.0	-
October	15.6	6.0	-
November	11.8	-7.2	0.2
December	8.0	-10.8	2.3
Annual Average	14.0	-16.1	20.8
Lowest	-	-16.1	-
Total No. Days Below 0 C			20.8

Table 3-2

Meteorology Institute-Istanbul

3.6.3 Wind Velocities

The wind conditions of the region are moderate. The maximum hourly average wind speed recorded was 17 m/sec and the maximum peak wind speed was 32m/sec. Within the Sea of Marmara the probability of a storm with an average wind speed of 8 m/sec or higher is 16 percent. Peak wind speeds of 15 m/sec can be expected. Table 3-3 shows average wind velocity for the Istanbul region.

Table 3-3

<u>MONTH</u>	<u>VELOCITY m/sec</u>
January	2.4
February	2.6
March	2.4
April	2.3
May	2.0
June	2.3
July	2.5
August	2.5
September	2.3
October	2.0
November	2.1
December	2.5

Meteorology Institute-Istanbul

3.6.4 Humidity

The average annual humidity is approximately 75 %.

TABLE 3-4

YEAR	ISTANBUL		CANAKKALE	
	No of Vessels Over 250 GRT	Net Tonnage in Thousand	No of Vessels Over 250 GRT	Net Tonnage inThousand
1982	25,255	116,730	23,565	144,644
1983	26,475	135,801	23,641	143,810
1984	30,300	153,548	27,171	168,830
1985	34,048	150,022	25,834	161,627
1986	35,836	153,698	25,007	167,376
1987	32,560	150,833	27,371	169,42

PROJECTED VALUES

1988	34,655	156,051	26,676	169,993
1989	35,632	159,204	26,987	172,670
1990	36,609	162,357	27,299	175,347
1991	37,586	165,510	27,610	178,024
1992	38,563	168,663	27,921	180,701
1993	39,540	171,816	28,232	183,378
1994	40,517	174,969	28,544	186,055
1995	41,494	178,122	28,855	188,732
1996	42,472	181,275	29,166	191,409
1997	43,448	184,428	29,478	194,086
1998	44,425	187,581	29,787	196,763
Annual Growth		Annual Growth	Annual Growth	Annual Growth
= 3 %		= 2 %	= 1.2 %	= 2 %

(Ministry of Transport of Turkey)

Table 3-5

FERRY TRAFFIC STATISTICS - MONDAY TO FRIDAY
Southern part of the Strait of Istanbul

	Scheduled Time in Minutes	Total # of Trips
Karakoy-Kadikoy	15	35
	20	17
	30	9
Kadikoy-Karakoy	15	37
	20	20
	30	7
Uskudar-Eminonu	10	22
	15	15
	20	26
	30	6
Eminonu-Uskudar	10	20
	15	14
	20	26
Uskudar-Besiktas	15	32
	20	29
	30	7
Besiktas-Uskudar	15	30
	20	28
	30	7
Sirkeci-Harem	20	50
Harem-Sirkeci	20	50

CHAPTER 4

IMPLEMENTATION AND OPERATION OF THE VTS IN THE TURKISH STRAITS AND SEA OF MARMARA

4.1 System Objectives

The objectives of Istanbul, Canakkale and Sea of Marmara VTS system can be summarised as follows:

- To carry out detection, surveillance and control of the traffic within the designated VTS area.
- To avoidance of accidents.
- To prevent environmental pollution.
- To produce evidence in case of accidents.
- To provide ship-ship and ship-shore communication.
- To provide harbour management with high efficiency.
- To predict traffic density.
- To storage ship data and ship's movement information for statistical purposes.
- To control of Search and Rescue activities.
- To provide meteorological / hydrological information and predictions

These objectives will be supported by the VTS administration and rules and regulations.

4.2 System Tasks

The Istanbul, Canakkale and Sea of Marmara VTS System will provide the following operational and functional features:

- Automatic tracking, monitoring and tracking of all radar targets within defined acquisition areas.
- Simulation and Dead Reckoning of targets which have not yet entered the radar coverage area.
- Identification of each tracked target.
- Warning for ships on collision course.
- Warning when anchored vessels or navigation aids come into drift.
- Special extra control on ships with dangerous cargo.

- Continous recording of the traffic situation. (Data recording-handling system and Voice communication-Voice recording)
- VHF communication facilities with multi channel capabilities.
- Patching of VHF Radio Calls with Public Telephone Network.
- HF or MF communication.
- Provision of a comprehensive Data Information System featuring Ship's Information, Ship Movement and Sailing Plans, Berth Availability Information, Statistical Evaluations and Traffic Density Prediction.
- Collection, evaluation, recording and prediction of weather information with remotely located sensors.

4.3 System Plan

By taking into consideration the traffic situation, traffic flow and risk areas associated with safety of navigation, the defined VTS area, which extends from Rumeli Lighthouse - North entrance of Strait of Istanbul- via Sea of Marmara to Mehmetcik - entrance of Strait of Canakkale from Aegean Sea, can be sectorized into three distinct areas. Each area according to geographical conditions has Region Traffic Centre(s) (RTC). In order to ensure a safe and expeditious traffic flow in this densely populated area the Main Traffic Centre (MTC) located in Istanbul will co-ordinate the operations of the six Region Traffic Centre.

Area 1 Istanbul Vessel Traffic System

This area will be controlled by the new Istanbul VTS which extends from 45 kilometres off the north entrance of Strait of Istanbul to 45 kilometres off the south entrance of the Strait of Istanbul. In order to obtain the best results from information gathered, this area will be divided into three regions as it is shown in Fig 4-1.

Region 1

Lying between $41^{\circ} 40.0'$ and $41^{\circ} 07,4'$ N
 $28^{\circ} 45.0$ and $29^{\circ} 15.0$ E

AREA 1 AND AREA 2 RADAR COVERAGE

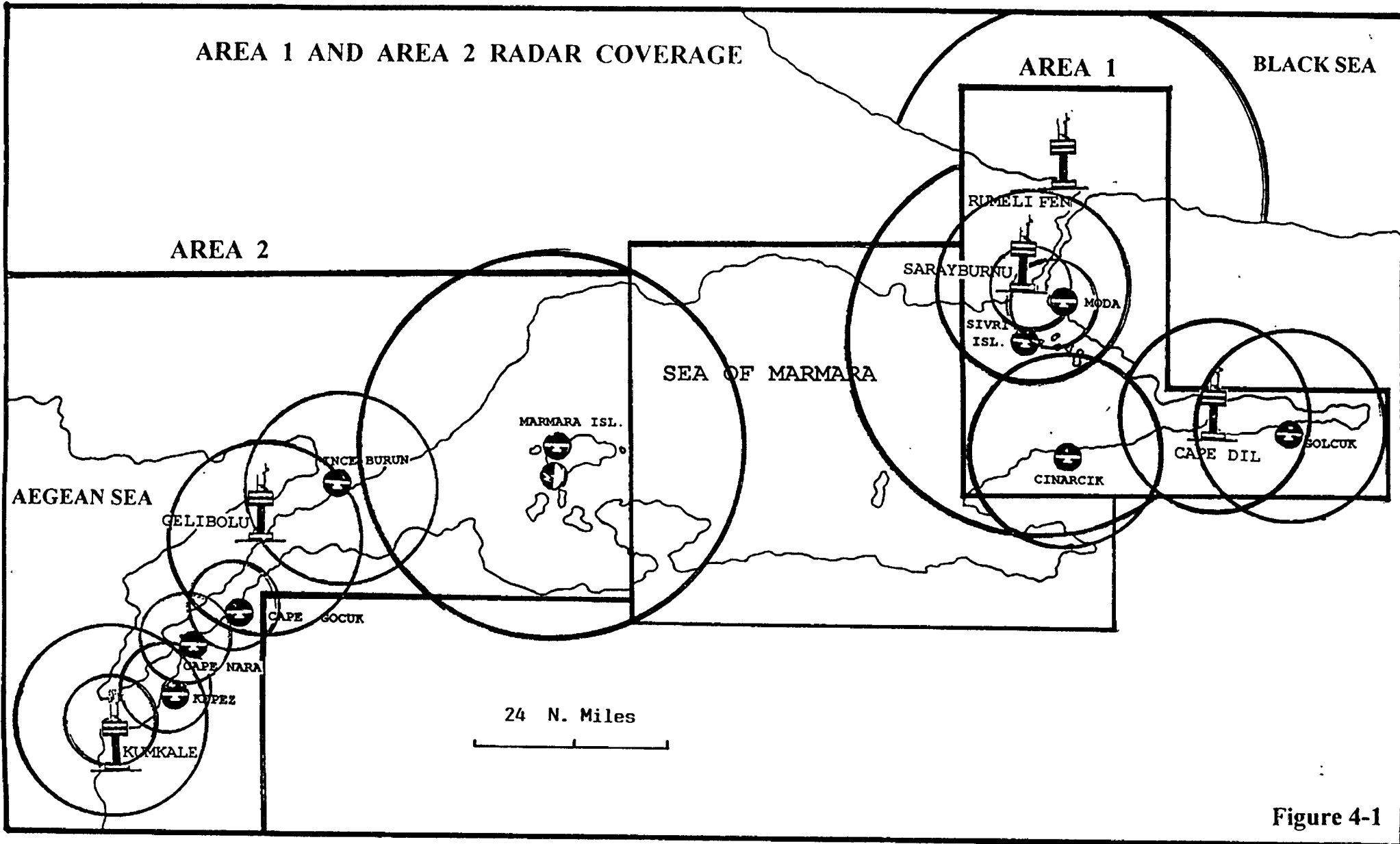


Figure 4-1

Region 2

Lying between 40° 45.0' and 41° 07.4' N
28° 45.0' and 29° 15.0' E

Region 3

Lying between 40° 32.0' and 40° 49.0' N
29° 15.0' and 30° 00.0' E

Each region will have a traffic centre manned by VTS operators. Two of the regions have a subsidiary centres which mainly control shipping in the strait. Each region will be divided into a number of sectors.

The locations of these three region control centres are recommended to be as follows:

Region Traffic Centre No 1

At the Rumelifeneri - 41° 14.0' N 29° 06.8' E - This will be used to monitor vessel movement to and from the Black Sea and the north entrance of the Strait of Istanbul.

Region Traffic Centre No 2

At the Sarayburnu - 41° 05.0' N 28° 59.2' E - This will be used to control shipping to and from The Sea of Marmara and Bay of Izmit.

Region Traffic Center No 3

At the Cape Dil - 40° 44.0' N 29° 35.0' E - to control shipping to /and from Sea of Marmara.

Subsidiary radar and control facilities will be established at :

Site	1	Tellitabya	- manned
	2	Yenikoy	- manned
	3	Kandilli	- manned
	4	Moda	- unmanned
	5	Sivri Island	- unmanned
	6	Cinarcik	- unmanned
	7	Golcuk	- unmanned

Figure 4-2

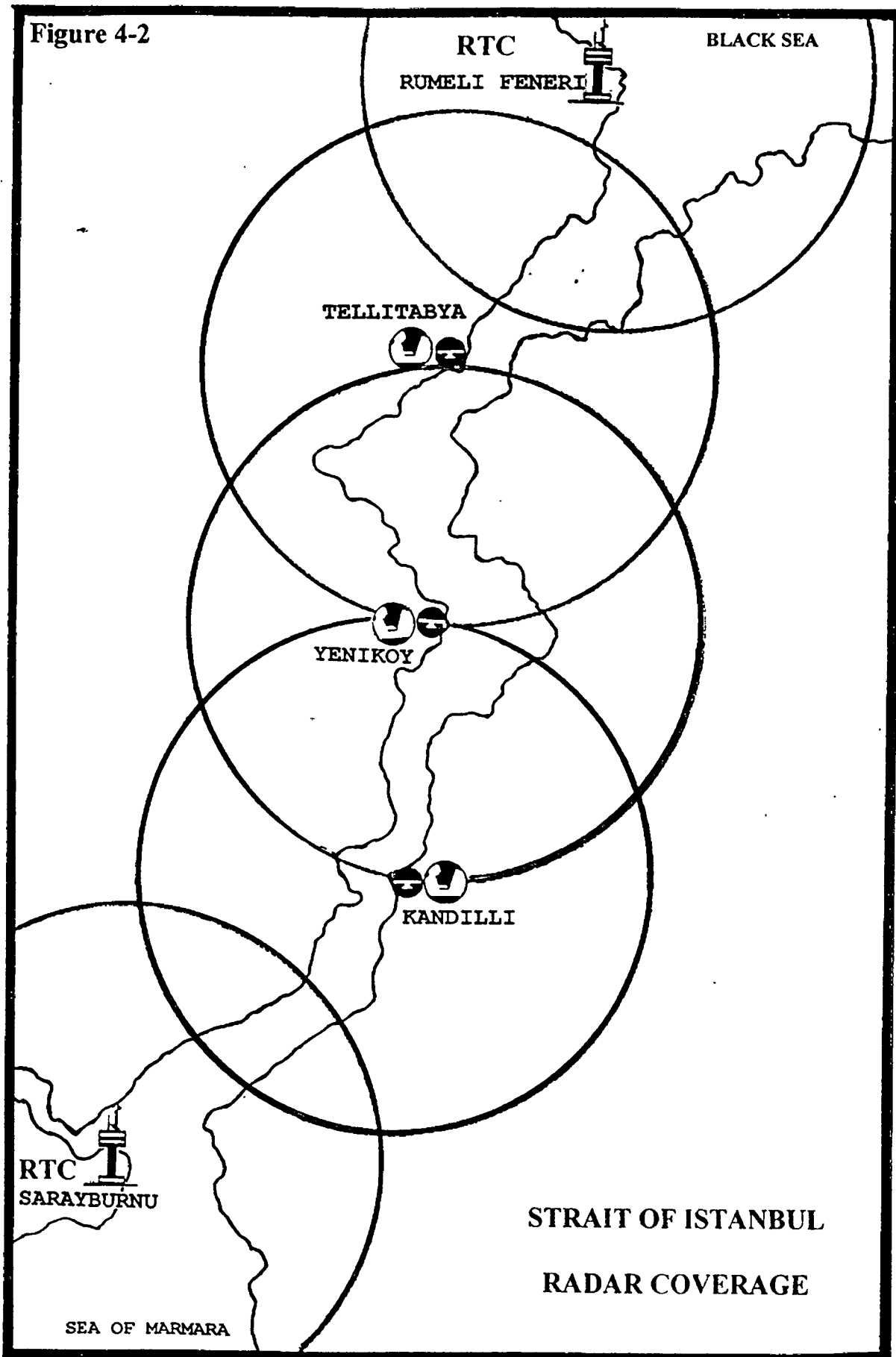
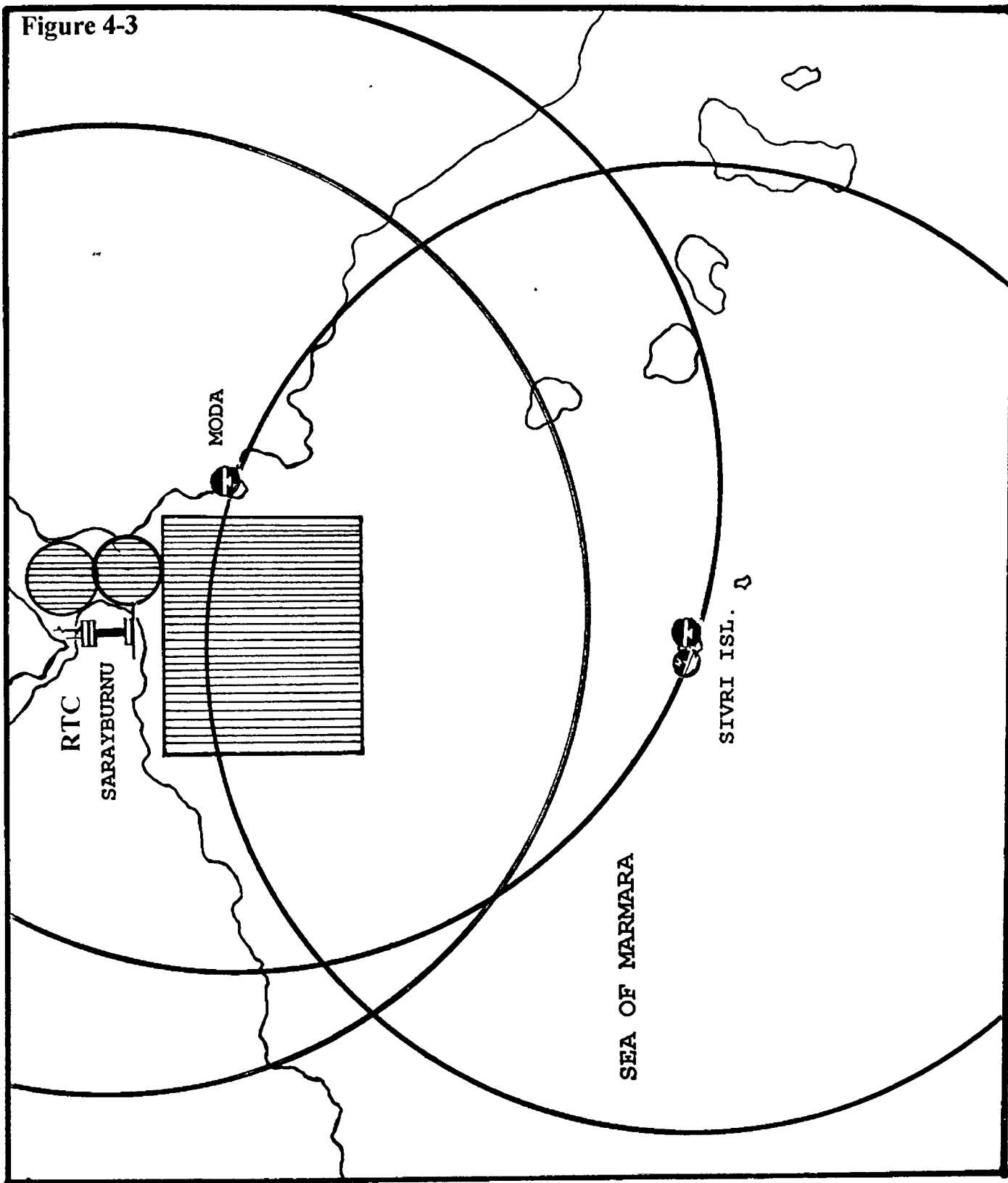


Figure 4-3



STRAIT OF ISTANBUL SOUT APPROACH RADAR COVERAGE

The above seven radar stations will provide the best radar coverage and minimum radar shadow areas. Inside the Strait of Istanbul especially, a chain of manned short -range radar stations are to be established to monitor visually the traffic along the channel and some high-risk areas .

Radar total coverage for Area 1 and the expected radar coverage along the Strait of Istanbul are given in Fig 4-1, 4-2 and 4-3.

Area 2 Canakkale Vessel Traffic System

This area provides total radar coverage stretching from the East of Marmara Island ($27^{\circ} 50.0' E$) to the entrance of Strait of Canakkale from the Aegean Sea (East of $25^{\circ} 50.0' E$ longitude) and distance of about 160 kilometres. This area is divided two regions as follows:

Region 1

Lying between $41^{\circ} 00.0'$ and $39^{\circ} 50.0'$ N
 $26^{\circ} 24.0'$ and $27^{\circ} 50.0'$ E

Region 2

Lying between $41^{\circ} 00.0'$ and $39^{\circ} 59.0'$ N
 $25^{\circ} 50.0'$ and $26^{\circ} 24.0'$ E

Each region has a traffic centre manned by VTS operators and two regional control centres are recommended as follows:

Region Traffic Centre No 4

At the Kumkale - $40^{\circ} 00.0'$ N $26^{\circ} 12.0'$ E - This will be used to control shipping from the Aegean Sea to Cape Nara or vice versa.

Region Traffic Centre No 5

At the Gelibolu - $40^{\circ} 25.0'$ N $26^{\circ} 40.0'$ E- This will be used to control shipping from the Sea of Marmara to Cape Nara or vice versa.

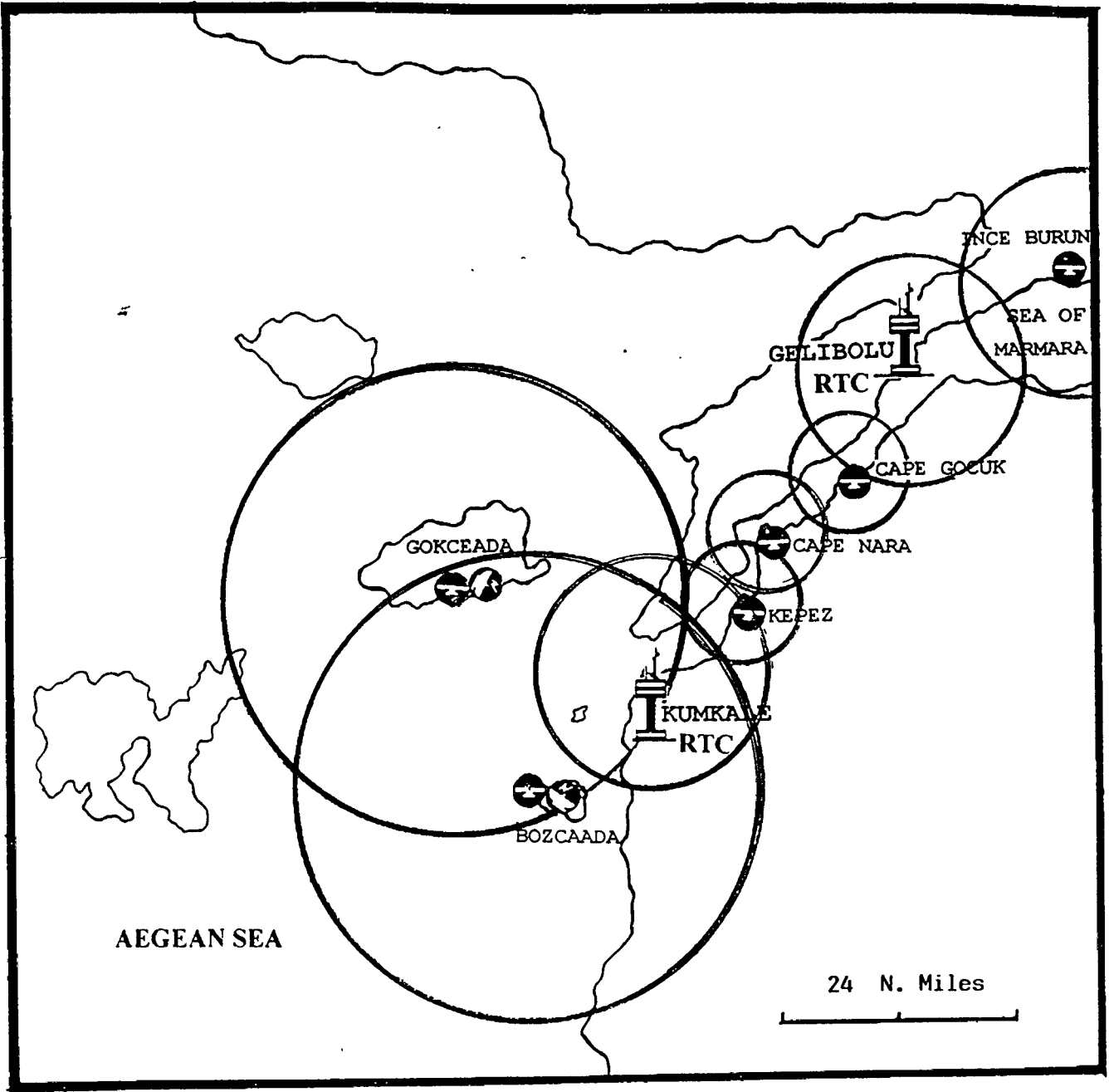


Figure 4-4 STRAIT OF CANAKKALE SOUTH-EAST APPROACH
RADAR COVERAGE

Subsidiary radar and control facilities may be established at :

Site :	8	Marmara Island	- unmanned
	9	Cape Gocuk	- unmanned
	10	Cape Nara	- unmanned
	11	Kepez	- unmanned
	12	Gokceada	- unmanned
	13	Burgaz	- unmanned
	14	Inceburun	- unmanned

The overall radar coverage for Area 2 is given Fig 4-1 and Fig 4-4.

Area 3 Sea of Marmara Vessel Traffic System

One control centre and three unmanned radar sites are proposed in order to provide complete coverage within the Sea of Marmara for safe and effective LNG transport via Strait of Canakkale to Eregli Port, which is a very important LNG unloading terminal, visual observation is an important requirement and this type of transportation has significantly increased of the risk factor in the Strait of Canakkale and Sea of Marmara.

Region Traffic Center No 6

At the M.Eregli - 40° 58.0' N 27° 57.0' E - This will be used to control LNG traffic to/from the Strait of Canakkale

Radar sites are identified by the following general locations:

Site :	15	Imrali	- unmanned
	16	Kapidag	- unmanned
	17	Cape Degirmen	- unmanned

The overall radar coverage for Area 3 is shown in Fig 4-5 and 4-5.

AREA 3 RADAR COVERAGE

BLACK SEA

AREA 3



M. EREGLI

CAPE DEGIRMEN

SEA OF MARMARA

AEGEAN SEA

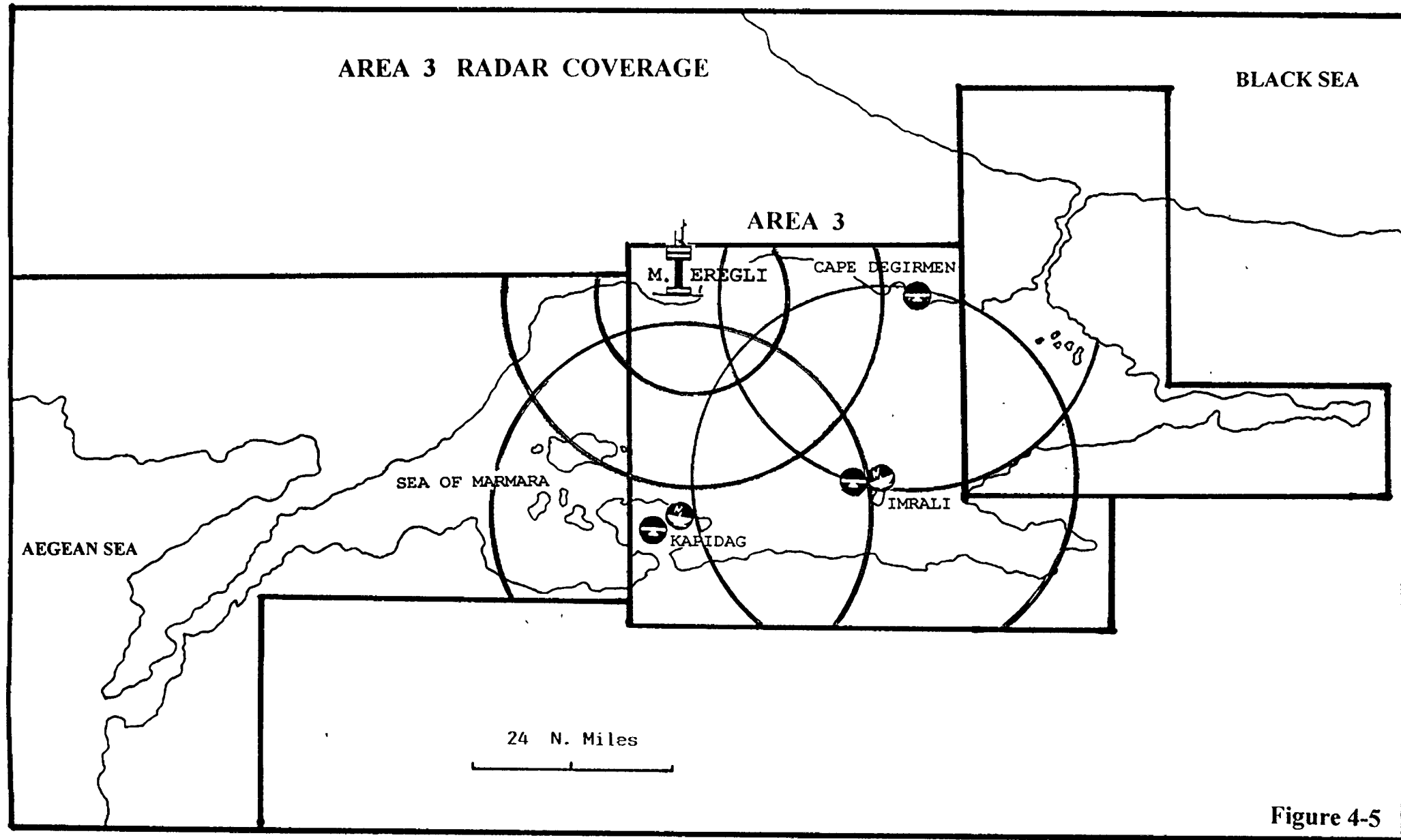
KAPIDAG

IMRALI

24 N. Miles

Figure 4-5

54



4.4 System Components

4.4.1 Sensors

4.4.1.1 Radar

Due to the geographical situation of the high risk areas in the Straits of Istanbul and Canakkale, and the importance of monitoring both entrances to the straits from the Black Sea and Aegean Sea, and the Sea of Marmara respectively, the VTS radars will have to cover the entire VTS areas in particular Area 1 and Area 2. Several factors must be taken into consideration such as several sharp bends in the straits, which affect the line-of-sight of the radars, the very small size of some targets such as pleasure craft or small fishing boats and the width of the straits which restricts the passing distance between the ships when they encounter each other. Confined waters like the Turkish Straits requires highly accurate radar bearing and ranging to obtain the best position of the target and also an efficient radar data processing and ship information processing system.

To fulfil these requirements, the following VTS radar specifications are proposed:

For each Region Control Centre and unmanned station a dual X-Band / S-Band configuration can be proposed, which is able to cope with the large variety of the weather conditions. While X-Band radar has excellent resolution characteristics, the S-Band radar has superior performance in strong rain conditions with respect to range coverage and detection capabilities.

Another reason for proposing a dual radar configuration is the increased system availability which is achieved by the redundant implementation of antennas and receivers. Therefore, a continuous operation of each centre and unmanned station is guaranteed even in the case that one of the radar subsystem components fail.

An outstanding performance of the dual system is achieved by a high receiver sensitivity. This approach should be chosen by the authority rather than increasing the output power because high output power values especially in the short range areas, often causes adverse effects such as ghost echoes, multi path reflections and receiver saturation. Additionally,

low power consumption leads to increased reliability due to lower requirements to the high tension power circuitry.

In order to avoid interference with other radar equipment e.g. radars on ships or adjacent radar sites, the transceiver must be equipped with a sweep stagger function, that random varies the pulse repetition frequency (PRF). Both X-Band and S-Band antennas must be high quality slotted waveguide antennas. Additional in order to eliminate undesired video returns from land areas which are of no importance for the traffic management such as shore buildings and no traffic areas, a receiver blanking map must be implemented which is used to turn the radar off when the antenna is facing the land. This is used to minimise the risk of radiation to people living in the region.

The S-Band antenna with a length of 6.7 m. provides superior quality under adverse weather and wind conditions. The 4.3 m. X-Band radar antenna is especially designed for shore based installations, its small horizontal beamwidth of approximately 0,4 is especially suited for VTS installations with their high resolution requirement. To achieve the required performance in slotted waveguide antennas two waveguides are needed, one for horizontal, the other for vertical polarisation. In order to minimise interference, vertical polarisation is used in VTS radars. The details for selection shore-based radar antennas are provided in **Appendix 1**.

4.4.1.2 CCTV

Closed-circuit Tv cameras are also used for surveillance of traffic through critical passages where radar may not be effective. The following purposes are provided by the CCTV camera subsystem.

- Supervision of port areas
- Supervision of waterways in the vicinity of control centres and in some of the critical regions of the strait.
- Identification of ships with all the details.

For these purposes a video camera unit should have a high sensitivity colour daylight camera and low light level night vision camera. Both cameras are installed in a weatherproof unit with heating and

windscreen wipers. The wipers and camera are remotely controlled by the VTS centre operators.

This camera unit should allow for the surveillance of a 5 to 10 kilometres distance around its situated position and a large zooming factor of up to 20 times should be able to facilitate recognition of even detailed images. Each unit will be mounted on a remote controlled adjustable platform which allows turning 270° in the horizontal plane and 90° in the vertical plane which can be operated from the operation room in the RTC No 1 and No 2 and manned control stations along the Strait of Istanbul. Additionally, the camera videos can be transmitted via microwave link and/or cable to the RTC No 1 and No 2. These centres must have a video recorder which should allow to recording up to 480 hours continuously.

The probable places in the Strait of Istanbul for the installation of the video cameras are:

- RTC No 1- Rumelifeneri
- Yenikoy
- Kandilli
- Istanbul Bridge-just bottom side
- RTC No 2- Sarayburnu
- Moda
- Ahirkapi Lighthouse

The CCTV capacity should allow for the connection of additional video camera to the existing system if necessary.

4.4.1.3 Meteorological and Hydrological Equipment

With the meteorological and hydrographic equipments the following purposes are fulfilled:

- Measurement of all relevant meteorological / hydrological information
- Storage of weather information for statistical evaluations
- Assistance in establishing local weather forecast
- Data supply to national meteorological institutes.

Sensors supplying meteorological data may be integrated with the VTS to provide a centralised display or printed copy of weather data. The stations may be placed at the control centres or at remote sites. If a remote site is selected, the data from the different sensors is combined in a signal multiplexer and transmitted to the MTC for presentation.

Examples of such information are as follows:

- Wind direction
- Wind speed
- Temperature
- Atmospheric pressure
- Humidity
- Visibility
- Direction and speed of the current
- Water level
- Wave height

4.4.2 Displays

Display devices for the presentation of sensor information are used as the principal man-machine interface. Displays provided are of the colour daylight viewing type and can be used in the high-glare environment such as harbour and/or region control tower. The display should be provided in workstations which has been designed ergonomically to suit the requirements of the VTS operators.

The following entities should be available for displays.

- System boundaries
- Coastlines and islands
- Map text
- Navigational points
 - .radar sites
 - .buoys
 - .beacons
 - .reference points
 - .waypoints
 - .the latitude and longitude of any point
- Polygons

- .anchor zones
- .restricted/prohibited areas
- .channel and waterways
- Shoal and depth contours
 - Several levels of depth may be shown and colour filled.
- Miscellaneous lines
 - .leading lines
 - .pipelines
 - .underwater cables
 - .territorial boundaries
 - .piers and bridges
- Recommended routes
 - Each have the following attributes:
 - .waypoints
 - .each route segment may have an associated speed limit
- Area of possible strong radar interference for the tracking devices
- Acquisition zones
- Range rings
- Anchor area and associated swing circle (Radius and centre may be altered by the operator).
- Transmission Blanking Sectors
- Receiving Blanking Map
 - A map for each radar site
- Bearing lines
 - Used when range and bearing measurement functions are active.
- Number of Alerts
 - .speed limit
 - .collision danger
 - .target loss
 - .passage tracking
- Navigational information of vessel
 - .route, speed
 - .distance from a reference point
 - .closest point of approach-CPA
 - .Time to CPA

In addition, the status display must provide a complete status summary of the system configuration. This must include the radars, operator workstations, recording system and other subsystem.

4.4.3 Communications

A communication system in a VTS is the principal tool used by the VTS operator to communicate with shipping and is the link between the VTS and its users. Without it, the VTS control centre's task will be reduced to merely observing events. A basic system consists of VHF transmitter/receiver equipment, with remote control facilities. The present available switching technology allows for flexibility and user friendliness. Operator units may occupy any channel within the system through various remoting techniques, connecting with other switches at other locations is possible.

The International Telecommunication Union (ITU), a member of the United Nations Organisation, has issued detailed recommendations concerning what portions of the radio spectrum and which frequencies within them should be used for each type of application. Today, practically every country in the world abides by these recommendations and enforces them within their territory.

The most widely used ITU recommendations concerning marine radio communications are contained in Appendix 18 to the Radio Regulations, Geneva, 1959 entitled 'Table of Transmitting Frequencies in the Band 156 - 174 Mhz for Stations in the Maritime Mobile Service', which identifies 56 channel designators or "Marine VHF Channels".

In the light of the ITU recommendations the objectives of the Turkish VTS in terms of radio communications should be set up. The main purposes of the VHF system are to provide:

- The practical day to day use of marine VHF channels for traffic regulating
- The monitoring of emergency and distress calls and the co-ordination of search and rescue operations
- Voice communication with the maritime traffic on multiple VHF channels

- Voice recording of all voice communication
- Communication between multiple parties on different channels
- Broadcast communication for maritime information to all vessels concerned
- Telephone communication with vessels.

This type of communication can be performed by using the following equipment:

- public telephone lines
- private telephone lines
- telex
- telefax
- radio telephony and microwave links
- automated data transfer system.

The internal communication within the VTS is of the utmost importance. If there is more than one VTS centre it is necessary that the operators in one VTS centre can communicate easily with operators in other centres so that traffic information can be passed on from one operator to another with the minimum of delay. In order to cover the three areas in the Turkish Straits and the Sea of Marmara as large as possible the VHF base stations should be located on:

RTC No 1-	Rumelifeneri	Area 1
RTC No 2-	Sarayburnu	Area 1
RTC No 3-	Cape Dil	Area 1
RTC No 4-	Kumkale	Area 2
RTC No 5-	Gelibolu	Area 2
RTC No 6-	M.Eregli	Area 3

4.4.4 Automatic Tracking and Data Processing

A VTS operator can easily and efficiently observe multiple marine targets through automatic tracking and data processing facilities. On the operator's display, each vessel is automatically tagged and tracked with course and speed information. The system can provide prediction reports consisting of :

- Closest point of approach (CPA)
- Time to CPA
- Estimated time of arrival at specific locations
- Meeting/passing reports
- Intended destination or port of call within the straits system
- Dimensions of the ship underway
- Nature of cargo

Each radar has its own tracking system, consisting of a chain of three computers: the video extractor, the plot processor and the track processor. At the radar site the video extractor masks non-relevant areas from the received raw and digitises this video. The digitised video is processed in the plot processor, which detects targets in the video. For each target the plot processor determines position, dimensions, orientation and echo strength. These target characteristics are transferred via telephone line and / or microwave link system to the track processor in the control centre as target reports. The track processor executes two main functions: automatic tracking by correlation of incoming target reports to existing tracks; and automatic initiation of new tracks, based upon non-correlated target reports.

All local tracks from the radars in a region come together in the multi radar track processor. This processor compares the tracks received and makes a selection of the tracks. Because the main fairway and the most important harbour basins have double radar coverage particularly in the Strait of Istanbul, the multi radar track processor can reduce ghost echoes to a large extent. A ghost echo or reflection will not be detected by two radars at the same time in the same position. Because of the double coverage, shielding effects can also be eliminated.

Within the multi radar track processor the available data of a vessel from the data handling system(name, dimensions, category of vessel, destination, etc.) will be coupled to a track by the operator when identifying a vessel on his screen. The system tracks are transferred to the radar screens. Track information on the screen stems from all relevant radars in the region, giving a total traffic picture. To ensure double radar coverage for the multi radar track processors in the boundary area

between two regions, and also to maintain ships' identities when crossing this boundary, the multi radar track processors exchange track information with each other from the radars near this boundary.

All system tracks are stored in the multi radar track processor for 1 hours continuously and are then removed. Track information from the last 1 hours and the track information for the coming 1 hours is then stored and can be replayed afterwards, either for training or for legal purposes. Every minute the multi radar track processor sends the system tracks to the data handling system where they are processed to produce lists of vessels sailing in a certain area and calculate expected times of crossing certain boundaries, for instance the next sector.

4.4.4.1 Ship Database Processing System

This system can assist the competent authority in the data management functions and improve productivity of the Turkish Straits and ports. Through the information provided by this system, the authorities involved can obtain sufficient data in a timely manner to assist in the co-ordination of pilotage assistance and health inspections. The overall result could be a faster turn around of vessels using the various ports as well as more expeditious transit through the straits.

The System provides database facilities for:

- General ship information form
- Movement plan
- Movement list form
- Sailing plan form
- Ship at anchor
- Ship at berth
- Anchored ship statistics
- Berthed ship statistics
- Historic list of Arrivals / Departures
- Ship accidents form
- Non compliance with regulation list
- Aids of navigation
- Arrival and Departure statistics-Tonnage

- Arrivals and Departures-Nationality
- Arrived ships-Ship type and tonnage
- Departed ships-Ship type and tonnage
- Weather form
- Weather statistic

4.4.5 Radio Direction Finders (RDF)

The International Maritime Organization (IMO) recommends that VTC be equipped with RDF equipment in order to identify vessels approaching the surveillance area and for search and rescue purposes. This equipment operates in the VHF radio range. It has an antenna, a receiver and a data link. The receiver antenna combination determines an azimuth vector to pre-defined VTS radio frequency in use by a vessel.

Usually the signal is initiated when the VTS operator contacts a vessel's radio operator on a defined channel. The RDF is set to that channel, and when the radio operator keys his microphone the RDF calculates the azimuth angle from the RDF antenna to the ship's radio VHF antenna. Since the position of the RDF antenna will be precisely known, the resulting line-of-position to the vessel can be determined. This vector data can be sent by data interchange format message via a radio data link to the VTS sensor processor and then drawn on the radar situation display as a line -of-position vector. If there are two or more RDF sensors in the same area and each is set to the same channel at the same time, one can obtain intersecting lines-of-position locating the vessel in question. Sometimes the radio direction finder is used to detect targets in the clutter, when the radar is not to produce tracks of, for instance small vessels. The accuracy is better than one degree. The distance from which signals are picked up depends on the height of the RDF antenna, the height of the ship's antenna and VHF power. For normal seagoing vessels the RDF range is about equal to the radar range.

For optimum performance, RDF equipment should not be located with the VHF radio transmitters/receivers, but rather at least several hundred metres away from any fixed transmitter operating in the 156 MHz marine band. Direction information can be integrated on the regular display by providing a strobe on the bearing of a received radio

transmission. In VTS applications, RDF equipment has proven to be an effective tool in search and rescue operations.

A total of 5 automatic RDF units should be used in the Strait of Istanbul VTS system two of which can be installed at the Black Sea entrance of the strait-probably at the Rumeli Lighthouse and Anadolu Lighthouse- and the other three in the Sea of Marmara entrance of the strait -probably at the Ahirkapi Lighthouse, Sivriada and in the vicinity of Moda.

For the Strait of Canakkale, a total of three automatic RDF units should be used, two of which can be installed at the Aegean Sea entrance- probably Cape Mehmetcik and Cape Kumkale- and the other one at the Gelibolu Lighthouse.

Typical data of RDF equipment:

- Frequency range, 155,5 - 163,550 MHz / 121 MHz
- Number of frequency channels, 99 including all marine channels
- Frequency scanning, up to 64 channels
- Channel separation, 25 KHz
- Accuracy of RDF equipment +/- 1 degree with 8 element antenna
- Bearing speed 0,5 sec.
- Bearing procedure, measuring of phase difference.

4.4.6 VTS Recording Processor

The digital recording and replay function is implemented in the recording processor which is a workstation server interconnected to the tracking system and display processor via a network.

4.4.6.1 Operational features

- Comprehensive on-line recording features and components
- Simultaneous replay and recording
- Replay at any selected console providing extensive replay features
- Continuous recording of at least one day time
- Access to recorded data for replay
- Protection of recorded data for archiving
- Archiving of files to tape
- Retrieve files from archive tapes

4.4.6.2 Recording components

- Digital radar plots from all radar processor
- System tracks, including their associated data
- Operator actions
- Bearing lines from the RDF
- System status, including alerts.

4.4.6.3 Replay features

- Free selection of any geographical area within the system boundaries
- Zooming and panning features as in traffic mode
- Range and bearing measurement
- Fully functional alert window
- Close control on tracks and points
- CPA / ETA calculations.

4.4.6.4 Recording

A high capacity disk can be provided to record all data which is recorded in predefined time intervals and placed. Recording is automatically initiated although a supervisor may have manual control under password protected functions. All recorded information is time stamped with the current recording time, and placed in hourly files. Storing the radar video with other recorded data digitally together in one file ensures an accurate and efficient reconstruction of events during replay.

4.4.7 Transmission Facilities

The main purpose of transmission facilities is to transfer radar related information from the remote radar site to the control centre. Independent of the transmission media used, the aim is to give the traffic operator the necessary navigational information required to safely survey a busy port or a coastal area or straits.

There are in principle four different ways of transporting a radar signal from the remote site to the control centre. Either by microwave link, fibre optical cable, telephone line or coaxial cable for short distances. Each alternative has different capabilities and advantages. The

choice is usually the result of consideration of geographical constraints such as distance and topography, weather conditions, existing infrastructure, local authorities, technical requirements and price.

Brief descriptions of the different transmission lines are:

Microwave Link

Where possible, the use of microwave link equipment is preferable, this is usually dependent on the requirements of the VTS system and budget limitations. Through the use of such link equipment the raw video signals are transferred to the control centre.

Analogue

The transfer of radar and other data may be performed over an analogue link. Signals are usually multiplexed together such that all information may be transferred simultaneously, i.e. control, status and equipment warning signals. Analogue links are rather expensive compared to other transmission means, and also require allocation and permission from telecom authorities for their use.

Digital

Digital link equipment is a recommended alternative. This equipment is less expensive than its analogue counterpart, and is more flexible when more than one remote site is to be connected to the control centre. The raw radar signals have to be converted to digital signals and then reconverted at the control centre. With today's technology, this conversion process provides signals at the control centre with little difference compared to analogue links.

Fibre Optic Cable

It provides a relatively inexpensive method of transferring signals from remote sites. However, the laying of the cable can be expensive and even impossible over certain areas. In controlled areas i.e. within the confines of a port this is the best available means of linking the control centre to a remote site.

Telephone Line

The transfer of data via a telephone line is possible through the use of either remote extraction techniques or if very high speed lines are available, through the use of similar conversion systems as for the digital microwave link. The most usual means for utilising a telephone line is with remote extraction. Dependent on the quality of the telephone lines available, the remote extractor may transmit either tracked targets only, or tracked targets and plots. Control and status signals to the remote site are also sent via the remote extraction device.

Coaxial Cable

It is used for transmitting the raw radar video from a radar site of not more than 100 metres distance from the control centre. In addition, the control signals are sent on a separate cable to/from the site.

4.4.8 Power system

Primary or standby power systems may be required to ensure a high operational availability of the system. Auxiliary equipment consisting of fire-suppression equipment, air conditioning/heating may be required.

4.4.9 System control and data acquisition

Monitoring and control of equipment at remote sites can provide security monitoring as well as equipment status monitoring from the control centre. This system reduces the need for providing 24 hour maintenance service at the remote equipment site.

4.5 System Configuration

4.5.1 Configuration of MTC

Telephone Line link system with RTCs

Reception from RTCs:

VTs tracks

VHF voice channels

CCTV information

Transmission to RTCs:

VHF voice channels

- 2 Large screen displays for display of maps and tracks
- 2 Traffic displays
- 2 VHF control consoles
- 2 Ship database with 2 displays
- 2 CCTV monitors

4.5.2 Configuration of RTCs

- 2 Traffic Displays
- 2 VHF Control Consoles
- 1 Voice Recorder
- 1 Tracking System
- 1 Vessel Traffic Management System
- 1 VTS Recording System
- 1 Ship Database Slave Display
- 1 CCTV Camera (only for RTC No1 and No2)
- 1 CCTV Monitor (only for RTC No1 and No2)

4.5.3 Sensors at RTCs :

- 1 Radar X- Band
- 1 Radar S- Band
- 2 Microwave Link System for RTC No 2
Site 4 and 5
- 2 Microwave Link System or Telephone Line for RTC No 3
Site 6 and 7
- 3 Microwave Link System or Telephone Line for RTC No 4
Site 10, 11 and 12
- 3 Microwave Link System or Telephone Line for RTC No 5
Site 8, 9 and 10
- 3 Microwave Link System for RTC No 6
Site 13, 14 and 15

4.5.4 Configuration of unmanned Sensor Sites for RTC No 2, 3, 4, 5, and 6

- 1 Radar X - Band (for Site 4, 5, 6, 7, 8, 9, 10, 11, 12)
- 1 Radar S - Band (for Site 5, 6, 8, 12, 13, 14, 15)
- 1 Microwave Link System or Modem for Telephone Line
Transmission to RTC:
Raw Radar Video Signals

Status Information of Sensors

VHF Voice Channels

Reception from RTC:

Remote Control of Sensors and VHF Base Stations

VHF Voice Channels

3 VHF Base Stations

4.5.5 Configuration of manned Sensor Sites (1, 2, 3)

Short Range X- Band radar and display

VHF radio communication facilities

Direct communication with adjacent sectors and RTC No 1 and 2

Emergency power generating system

Voice and video recording facilities

Vessel traffic management system

Visibility meters, current and wind sensors

CCTV Camera

CHAPTER 5

VTS ORGANISATION AND SERVICES

5.1 Competent Authority

The Ministry of Sea will be responsible for the management of the whole VTS system. Its major tasks will be policy-making for the VTS system, administration of the system and establishing close co-operation with other organisations such as port authorities, navigational aids services, emergency services, etc. which are related to the VTS operation. The VTS will become a central co-ordinating authority for all shipping services within the areas under concern. It is evident that the system administration should be co-ordinated with the VTS activities.

5.2 Director of VTS Organisation

The Director of the VTS organisation must have a statutory responsibility for the safety of navigation within the VTS area and this should be derived from both existing Acts and national rules and regulations and new legislation if required, taking into consideration the international agreements. The tasks and responsibilities should be well defined in adequate regulations, together with the necessary legal powers. Staff adequate in qualification and number, technical equipment as required by the scope and tasks of the VTS systems and a supporting budget should be provided. These will provide the Director of the VTS organisation with powers to give instructions to vessels for the purposes specified in the rules and regulations thus ensuring the safety of navigation. Navigation in this sense refers to all its aspects, and includes also the movement of dangerous substances. The Director should exercise his powers concerning the safety of navigation being able to make both general and special instructions to through traffic, by exercising the powers vested in him. The Director should act on behalf of the Ministry of Sea. ✓

It is important that the statutory rules and regulations authorise the Director to implement new or more stringent operational rules or to deviate from the regulations in one way or another. The rules and regulations should provide for such necessities and give the necessary power to the Director. Due to this concept the Director must have an indepth knowledge of all safety aspects under his authority and to be prepared to take more responsibility than other people in the VTS.

The Director should have high quality so that he is able to give advice to the rule-ratifying body when he wants to improve VTS rules, regulations and procedures and also should be able to judge and propose the necessary steps. To be able to do so, he has to keep himself informed about all international, national and local developments in this field of work and responsibility and has to have close contacts with the various shipping, commercial and scientific institutions and the authority responsible for developments.

5.1.2 Main Traffic Centre (MTC)

Main Traffic Centre is the central operational point of the system, primarily concerned with the overall traffic controls within the operational area of the VTS system. Therefore, its main tasks are:

- the collection of information from all vessels within and entering the VTS area,
- control of admittance of vessels,
- overall traffic evaluation,
- co-ordination of operations of regional traffic centres,
- broadcasting information and issuing navigational warning to all vessels, and
- interfacing with other organisations concerned such as port research planning.

5.1.3 Head of MTC

The Head of MTC should be an experienced and qualified seafarer with necessary background in English language, together administrative

experience, adequately familiarity with the functions and procedures of the VTS and a capable of managing VTS equipment.

The major responsibilities of the Head of MTC are as follows:

- to monitor the VTS areas (Areas 1, 2, 3),
- to get required information via RTCs regarding ships which are moving in both directions from/to the Black Sea and the Aegean Sea through Turkish Straits and/or to Turkish ports in the Sea of Marmara,
- to co-ordinate information regarding the scheduling of ships with other relevant authorities through the Co-ordination and Co-operation Service,
- to inform RTCs about possible ship movements in the VTS area together with associated scheduling programs,
- to prepare contingency plan for required precautionary measures and urgent preventative action against possible incident and to inform as quickly as possible all appropriate civil and military authorities,
- to provide and distribute required publications especially World VTS Guide to vessels and other national and international organisations involved,
- to prepare daily working schedule of the organisation staff, and
- to report to the Director of Organisation about work being carried out.

5.1.4 Regional Traffic Centre (RTC)

The whole operational area of the VTS will be divided into six regions, each having one RTC which is responsible for traffic control within the region. It will be managed by the VTS operators and they should have a license as master (unlimited) and sufficient knowledge as indicated in Chapter 6 - Training for VTS Operators.

The major tasks of the operators in the RTCs are as follows:

- to acquire, designate and keep track of any kind of vessels in the VTS area using tracking systems,
- to monitor ship movement,

- to identify and inform vessels which are in possible collision situation or any other danger situations,
- to monitor and control aids to navigation within the area,
- to establish communications with ships in order to ensure necessary information about:
 - . dangers to navigation
 - . the traffic situation in the area
 - . the position of ships engaged in special operations in the area
 - . any required advice, recommendations, warnings and instruction to ships
 - . co-ordination with pilot and tug master
- to operate the data handling system, and
- to participate to the Search and Rescue operation, pollution control and other emergency cases and to reduce the number of messages transmitted on VHF radiotelephones to an acceptable level.

5.1.5 Movable Control Units

Control vessels will be referred to as Floating Traffic Control Units in the VTS system. Their main function is to maintain close cooperation with the RTCs in order to monitor vessels for compliance with the regulations related to safety of navigation and pollution prevention, and to assist in the maintenance of advice given by RTCs. In addition, in the case of an incident the Floating Traffic Control Units will provide assistance.

5.1.6 Maintenance Department

It will be necessary to develop a maintenance team for regular and successful support operations to all installed equipment used by the VTS system and ensure a smooth and economical operation of the data processing equipment and other technical facilities of the VTS system, by taking operational requirements and technical possibilities into account. Technical facilities are, for example, shore-based radar, VHF direction finding, signal transmission, VHF radio communication as well as control and energy supply equipment.

The basic requirement for a uniform on-the-spot maintenance of the systems is the comprehension of the system configuration (system status of hardware and software), of arising problems (e.g. hardware and software errors, operational malfunction) and user's requests for changes due to modified or new operational requirements.

5.2 Services

5.2.1 Information Service

Information service is a service to ensure that essential information is in time available to the on board navigational decision making. This information would be concern:

- Vessel traffic with respect to positions, identities, intentions and destinations, or
 - The VTS area regarding amendments or changes to promulgated information on boundaries, procedures, radio channels or frequencies,
 - Exchanging information with vessels on all relevant safety matters;
 - . notice to mariners
 - . status of aids to navigation
 - . meteorological and hydrological information
 - Exchanging information with vessels on relevant traffic conditions and situations, movements and intentions of approaching traffic or traffic being overtaken.
 - Warning vessels about hindrances to navigation such as;
 - . hampered vessels
 - . concentrations of fishing vessels
 - . small craft
 - . other vessels on special operations
 - Giving information on alternative routing(outside of the Straits)
 - Repeat of current urgent messages (navigational warnings) previously broadcasted.
 - Pilotage and tug service details such as;
 - . availability, suspension, meeting point etc.
 - Berthing and anchoring information

This information is to be made available in good time to the shipboard navigational decision making process and should be clearly published in relevant nautical publications with account being taken of the transmission times of neighbouring services. The broadcasts should be drawn up in a standard format.

Broadcasts will be made in Turkish and English. All vessels must maintain a continuous listening watch on the proper VHF channel or any other channel as advised by the competent RTC involved or by the pilot. In addition, a continuous listening watch must be maintained on VHF channel 16, whenever the vessel's equipment so permits.

5.2.2 Navigational Assistance Service

The following information has been taken from the IALA/IAPH/IMPA World VTS Guide (September 1994 - NAV 40).

Navigational Assistance Service is a service to assist the on board navigation decision making and to monitor the effects, especially in difficult navigational or meteorological circumstances or in case of defects or deficiencies. This service consists of navigational information relating to a particular vessel and may include warnings and navigational advice, as long as, it is not the intent to direct the course to be steered or engine manoeuvres to be executed. The VTS can participate in the on board decision making process by giving:

- Navigational information relating to course made good and speed made good of a vessel; position relative to fairway axis and way-points, or the positions, identity and intentions of the surrounding traffic.
- Warnings to prevent collisions and groundings.
- Navigational advice relating to tracks and routes to be followed.

The competent authority should be aware of the distinction between navigational information and navigational advice and should determine whether navigational advice can and may be given from the shore, and if so, under what circumstances, by whom and to what extent. Navigational assistance is given at the request of the vessel or if deemed

necessary by the VTS and can only be given if positive identification has been established and can be maintained during the process.

The exchange of this information is interactive and the validity of the information supplied by this service can normally be judged by the vessel concerned.

The communication should be conducted in accordance with the established operational procedures which should include fall-back procedures in case of disrupted communication. Messages should be sent and updated at appropriate intervals of time.

Any request for navigational assistance should include:

- . vessel's name, call sign and nationality
- . vessel's current position
- . vessel's size and draught
- . vessel's gross tonnage.

5.2.3 Traffic Organisation Service

The following information has been taken from the IALA/IAPH/IMPA World VTS Guide (September 1994 - NAV40).

Traffic Organisation Service is a service to prevent the development of dangerous situations and to provide for the safe and efficient movement of traffic within the VTS area. Traffic organisation concerns the forward planning of movements and is particularly relevant in times of congestion or when the movement of special transports may effect the flow or other traffic. Monitoring the traffic and enforcing adherence to governing rules and regulations is an integral part of traffic organization.

The service may include establishing and operating a system of traffic clearances in relation to the priority of movements, the allocation of space, mandatory reporting of movements, establishing routes to be followed, speed limits to be observed or other appropriate measures which are considered necessary by the VTS authority. Where the VTS is

authorised to issue instructions to vessels, the instructions should be result oriented only, leaving the details of execution to the vessel.

5.2.3.1 Sailing Plan

The following information has been exhortated from Guidelines for Vessel Traffic Services - IMO Resolution A.578(14) and Draft VTS Guidelines IALA September 1994-NAV 40.

Sailing plans are an instrument of traffic organisation and as such are a major source of information to the VTS. A sailing plan normally consists of the estimated time of arrival in the VTS area or departure from a berth or anchorage in the VTS area. The VTS authority should specify the additional information required in the sailing plan for all ships or for special ships according to local circumstances. In exceptional circumstances the sailing plan may be amplified at the request of the VTS centre.

The VTS centre may advise changes to the sailing plan to take account of the traffic situation or special circumstances. After the sailing plan is agreed between the vessel and the VTS centre the vessel is permitted to participate in the VTS and should, as far as practicable, try to maintain the plan. If special circumstances or the safety of traffic so require, the VTS centre may request the vessel to follow a changed sailing plan, indicating the reasons for its request. Such changes should be limited, as far as practicable, and may include:

- . extra position reports,
- . a new destination,
- . remaining at a specified location,
- . request not to enter the VTS area,
- . request to stay alongside the berth and
- . request to follow a certain route.

If the sailing plan cannot be maintained the vessel should send a deviation report to the VTS centre and an amended sailing plan should be agreed between the vessel and the VTS centre. The vessel should send a

final report when leaving the VTS area or arriving at its berth or anchorage in the VTS area.

5.2.3.2 Traffic Separation Scheme (TSS)

The high risk to navigation in the Turkish Straits can be significantly reduced through the implementation of a Traffic Separation Scheme. Main objectives for the implementation of a TSS in Turkish Straits are as follows:

- to reduce the dangers of collision between crossing traffic,
- to separate the opposing streams of traffic in order to reduce potential head-on encounters,
- to simplify patterns of traffic flow in focal points or converging areas, and
- to suggest a routing system which will ensure a safe passage of vessels without restriction of the legitimate rights and practices of the users.

The details of TSS in the Turkish Straits and Sea of Marmara are provided in **Appendix 2**.

5.2.4 Co-operation with Allied Services and other parties

In order to increase the safety and efficiency of the traffic, the protection of the environment and the effectiveness of the VTS, it is essential to develop the cooperation of other services in the VTS organisation. This service will provide data exchange and information flow between parties such as pilotage services, port services, maritime safety etc.

Co-operation is a vital continuous process and therefore procedures for the best co-ordination should be established among parties. In addition, co-ordination with port operations is another important factor which plays an active role in establishing a sailing plan and is both safety and efficiency orientated. It should always be borne in mind that for an effective search and rescue operation and pollution control, co-operation and co-ordination should be created in accordance with pre-established

contingency plans which ensure the most efficient use of equipment, materials and services of the organisations involved and the maintenance of good communications.

5.2.5 Ship Data Collection and Distributing Service

The main objective of this service is to provide a link between sovereignty tasks of the Turkey and the economy's state and private sector. Its main purpose will be to precipitate clearance via such information in good time for imminent ship arrivals thus increasing the attractivity and competitiveness of all ports in the VTS area. In order to have this kind of information on call for all the port enterprises (brokers, shipowners, ship suppliers etc.) the data concerning ships navigating within the Turkish waters and the VTS area will be recorded, processed and reported to the economy's state and private sector.

The necessary reports will be sent to this service by computer-assisted means or by phone, fax or telex. The ships' masters and/or officers will report their positions and passage times in accordance with individual agreements reached with customers. Details of unscheduled measures affecting a ship's passage such as anchorages, reductions in speed, engine problems, accidents or other reasons should be immediately passed on to the ship's broker, the main port office pilots and the cargo handling firms. The rapid, routine, reliable exchange of information between a ship and all land based services using this service information network will be a vital factor in providing an optimisation of costs while ships are passing through recommended VTS areas.

5.2.5 Search and Rescue Service

This centre will be established in a separate room in the Main Traffic Control Centre for the meeting of the search and rescue personnel around a chart table in order to be able to command an operation using a radar display for viewing the all the area, conducting communication with other organisations involved, and target tracking facilities. This service will coordinate marine SAR activities within the VTS area in

cooperation with Turkish Air and Navy forces and provide dedicated marine SAR vessels in strategic locations.

This centre will be staffed 24 hours a day. In addition, Marine Rescue Sub-Centres will be formed at Canakkale and Eregli to coordinate local marine SAR operations. Where an emergency situation develops at sea in or near the VTS area the relevant centre could initiate the SAR action. An advantage of a VTS regional centre is that it will have the area under radar coverage and may be in contact with all or most of the tracked vessels in the designated area. It ensures that the movement of vessels in and out of the VTS area is carried out safely. In a SAR situation, a vessel traffic service is an important safety facility during such operations.

5.3 The pilotage and Its Function within the VTS

It is obvious that a VTS can only be operated if there is close co-operation between all land and sea based parties and of course most especially between the VTS operators and the pilots. Pilots are the direct link between the VTS centre and the vessels, and they are fully proficient with the local rules, regulations and procedures. Therefore, pilotage is an important element in the VTS particularly since the pilot will usually be first person the ship's master meets before entry to the confined waters.

However, traditional pilotage no longer satisfies the demands of shipping and ports with respect to safety and economy against the developments of VTSSs. Before the introduction of shorebased radar advice in connection with information services, larger vessels had to drop anchor in case of restricted visibility. This often caused an additional danger situation especially in confined waters. With the existence of modern radar and computer assisted VTS systems, pilotage can now be divided to three systems:

- . traditional pilotage- compulsory or not
- . pilotage in connection with a VTS controlled area
- . shore based pilotage

Traditional pilotage:

It is nautical advice to the master given by a pilot, who is physically onboard ship, with or without receiving information from shore while navigating in the approaches to the port and/or navigating in straits in the limited possibility. This system is no longer acceptable to guarantee maximum safety or to prevent accidents in busy ports and areas.

Pilotage in connection with a VTS controlled area:

In this system traffic flow under difficult conditions can be largely operated and delays in arrivals or departures also avoided. Nevertheless, the safety factor for vessels navigating in confined waters under difficult conditions must be controlled by pilot being physically onboard ship and using advice and navigational assistance from shore given by the VTS operator.

It is evident that the introduction of compulsory pilotage should become an additional safety factor and in future will be very useful in connection with the VTS in the Turkish Straits. It cannot be expected that masters of vessels, navigating in relatively unknown narrow straits should have to concentrate on the nautical stresses and at the same time listen to the continuously broadcasted traffic information by the VTS. Different systems in different areas make this more difficult as well as having insufficient knowledge of languages. Therefore, masters are often unable to follow traffic information and to take all reasonable measures for safety.

Shore based pilotage:

In this system navigational advice is given from shore by a licensed pilot. Pilotage is carried out by communication and radar observation without the presence of a pilot aboard a vessel entering or leaving a port. Remote pilotage is only possible since the introduction of sophisticated VTS. It is evident that the aim is to keep traffic moving under safe conditions even under unfavourable situations. Of course the achievement of shore based pilotage service depends mostly on the standard of qualification of the operators and skilled and confident shipmasters.

It is quite clear that this is a very extreme form of pilotage system for the Turkish Straits because geographical factors do not allow vessels to operate easily using such a system within the straits. This may be acceptable in outer areas of the straits and provides a safe possibility to guide a vessel for approaching under controlled conditions in the restricted visibility. The acceptance of this system does not change the responsibility of the master. In general, the master will receive nautical information and advice but not instructions from the VTS.

5.4 Rules and Regulations

It is obvious that the rules and regulations should cover the whole VTS area and give details of its use by any ship or floating object as well as providing the basic principles of operation for all users in the Turkish Straits and the Sea of Marmara in order to navigate in that specific area for the purpose of safety of navigation and environmental protection. Entry permission, use of the traffic area, special rules on navigation if necessary, use of tugs and/or pilots, fire prevention, reporting of accidents, pollution prevention, special regulations for tankers and dangerous substances etc, should be included. These rules and regulations should be as close as possible to international and national law, regulations and recommendations and only deviate from them if the local situation so requires.

5.4.1 Legal Regulations

The rules and regulations in force in Turkish Straits are contained in three major international agreements.

5.4.1.1 Montreux Convention

It was signed on 20 July 1936 and recognises and affirms the principle of freedom of transit and navigation in the straits by day and by night under any flag and with any cargo, without any formalities, except medical inspection of merchant ships at the entrance to the straits. According to the convention pilot and tow charges are to be levied only if the services are provided upon request of the master or the ship's agent.

5.4.1.2 International Regulations for Preventing Collision At Sea

The International Maritime Organization has specified International Regulations for the Prevention of Collision at Sea. Thirty-eight (38) rules have been defined by the IMO and apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels. All of the IMO's rules should be enforced for shipping within the territorial waters of a nation state. Rule 9- Narrow Channels and Rule 10- Traffic Separation Schemes are directly applicable to the problems of shipping in the Turkish Straits

5.4.1.3 IMO Recommendations on the Safe Transport, Handling and Storage of Dangerous Substances in Port Areas

These recommendations adopted by the Maritime Safety Committee in December 1980 and subsequently amended in 1983 define the procedures which must be followed by the national, regional or local authority empowered to make regulations in respect of the port area and having powers to enforce regulations. These recommendations provide for the Turkish authorities to prepare and implement regulations for advance notification, inspections and direct communications with all vessels and does not violate the Montreux Convention.

5.4.2 Necessities of the New Rules and Regulations

From the beginning of July 1994 the Turkish Government introduced new regulations for navigation of the straits which has had a settling in period of just over three months. It has raised the hires of several Montreux Convention signatories who claim the regulations impose restrictions of passage, forbidden under the convention during peacetime and therefore, contravenes its meaning. In fact, on a practical level current international safety standards must be incorporated within the agreement to reflect the physical constraints imposed by the size and number of vessels wishing to use these restricted waterway.

In 1936, the largest vessel likely to transit the straits was about 18,000 dwt. Today there are over 100 daily non-local transits including

laden VLCCs passing through the centre of Istanbul without any requirement to carry a pilot or maintain valid P&I insurance. At its narrowest point the deep water channel is only 380 m. wide leaving little room for either manoeuvring or error for the VLCC master whose ship's length is up to 340 m. Considered in conjunction with a six knot current speed and a minimum of seven course changes through the middle of a city, the likelihood of a dangerous situation arising can be understood. In addition, the current development of the Caspian Sea oil fields and proposed pipeline terminal at Batumi in Georgia would increase the traffic considerably with up to 750 additional VLCC transits per year (Turkish Chamber of Shipping).

As quickly as possible international solutions must be found. Therefore, the Turkish Government asked the Maritime Safety Committee of the IMO to review the lack of safety considerations within the Montreux Convention and to recommend amendments to the 50 year old rules. New IMO rules for the Straits of Istanbul and Canakkale as approved by the IMO Maritime Safety Committee on 25 May 1994 and effective as of 24 November 1994 are briefly as follows:

- Adherence to traffic separation scheme (TSS) is obligatory
- One way traffic to be used if large vessels cannot comply with the TSS
- Vessels are strongly recommended to comply with Turkish Marine Environment Protection Association (TUBRAP) reporting system
- Vessels are strongly advised to give authorities cargo details
- Vessels are strongly recommended to use pilots
- Vessels over 200 m. loa. and/or 15 m. draft are advised to transit in daylight
- Towage within the straits restricted to suitably equipped tugs

5.5 Procedures

5.5.1 Operational Procedures

IMO's guidelines for Vessel Traffic Services describe traffic organization as a main task which is considered to mark a turning point

in the reduction of risks to navigation. The execution of traffic organization should be based not only on nautical and operating experience but also on basic physical features in order to establish objectively proper operational procedures. Such procedures may be the final result of the correlation between safety to traffic including the determination of risk levels and the efficiency of the VTS technical equipment.

A ship's visit should be notified at least 24 hours in advance by the agent and/or by ship's master who sends information which has to be addressed to the Main Traffic Control Centre in writing (telegram, telefax or telex will be accepted) comprising the ship's particulars as follows:

- The name of the ship
- The radio call-sign
- The position, course and speed
- Ship's particulars and characteristics
- The estimated time of the ship entering the designated VTS area
- The estimated time of the ship arriving at the given destination if it is going to Turkish ports
- Cargo details
- Request for pilot, tug or any other relevant port and allied services
- Request for anchorage

It is suggested that some necessary additional reports should be given at any time when a ship is in or about to enter VTS area, making a report immediately giving its name and position in the following circumstances:

- The occurrence of a fire on board the ship obstruction to safe navigation
- The involvement of the ship in a collision, grounding or striking an obstruction
- Any defect in the ship's hull, main propulsion machinery, steering system, radar, compasses, anchors and cables, obstruction to safe navigation.

At least six hours before entering to the Turkish Straits from the Black Sea or the Aegean Sea, the master of the ship should send an ETA via the coastal radio station to the MTC. When within the VHF range, the master should contact the RTC in order to give an updated ETA and other particulars. The ship is then identified on the radar screen by means of the RDF and subsequently labelled by the VTS operator.

The pilot boards the vessel at the entrance of either the Strait of Istanbul or Canakkale and the pilot will give an ETA to the next RTC. This time is important for the other RTC because of one way traffic restrictions on passage which is necessary for safety reasons. This will almost certainly be the case for the passage of all large tankers and vessels.

Prior to entering the VTS area, departing the VTS area or proceeding within the VTS area especially within the straits, a ship must obtain a traffic clearance from the VTS operator. Also a ship shall not proceed unless it can maintain direct radio communication with the VTS operator. The master shall take all reasonable measures to communicate with the operator as soon as possible if a ship cannot maintain direct radio communication with the operator. This problem could occur under conditions of extreme radio interference or in the case of radio failure.

It will be required to maintain a continuous listening watch on the designated VTS frequency when a ship is underway, moored to a buoy or at anchor in the VTS area. There would be occasions when a ship switched to another VHF channel or upon entering a VTS area failed to switch to the designated VHF channel. Therefore, it could be necessary for the operator to contact the ship on another available channel such as channel 16 and will request the ship to standby on the VTS area VHF channel allocated.

5.5.2 Communication Procedures

It is quite clear that in order to support operational procedures and to transmit necessary information, an effective communication procedure should be created. Because communications the basic link between VTS

and the user, communication must be clear and simple and should contain only necessary information in order to avoid imposing an undue burden on masters, officers and pilots.

Communication should be conducted in conformity with the IMO Resolution A 648 (16) on Ship Reporting, using message markers in accordance with IMO Resolution A 380 (x) on the use of Standard Marine Vocabulary (SMV), and ITU (International Telecommunication Union) communication procedures. In doing so, it is therefore suggested that:

The communication frequencies used between participating vessels and the RTCs throughout the VTS area of responsibility must be specified.

- The language used should be English.
- The Standard Marine Navigation Vocabulary should be used.
- In anchorages or approaches to the VTS area the necessary instructions about the VHF watchkeeping must be pre-notified.
- The first reporting area should be provided.
- Retransmission from ashore of all duplex communication

CHAPTER 6

TRAINING FOR VTS OPERATORS

6.1 Introduction

The need for further improvement of the efficiency and safety of maritime traffic because of higher traffic density, more complex traffic situations, and larger ships carrying greater commodities of noxious and dangerous cargoes, has been one of the reasons, among others, to establish a modern and effective VTS system at Istanbul and Canakkale Straits and Sea of Marmara.

It is evident that, in order to achieve efficiency and safety of maritime traffic, the VTS operator plays very a important role. This role has evolved over the last fifteen or twenty years and varies considerably from one port to another. The content of any particular operator's task depends on the type of operation, the age, scope and sophistication of the equipment in VTS. In some ports the individual is only expected to communicate information to ships, in others he is expected to act as a traffic manager. At some ports the nature and sophistication of operator's equipment encourages to operator to become involved in the navigation of ships.

In spite of these various tasks, many VTS operators are working with no clear guidance. One of the anomalies in the present system is that an air traffic controller has an internationally recognised qualification. Although the work of the VTS operator is highly specialised, he has not officially needed a recognised qualification. In order to have a nationally and internationally recognised qualification as a VTS operator, a standard is required. This standard must be recognised by all VTS authorities.

The International Maritime Organisation (IMO) Resolution A. 578 (14) Guidelines for Vessel Traffic Services states that

"A VTS is any service implemented by a competent authority, designed to improve safety and efficiency of traffic and the protection of the environment. It may range from the provision of simple information messages to extensive management of traffic within a port or waterway " and

"The VTS authority should ensure that VTS operators have the qualifications and have received specialised training appropriate to their tasks within the VTS and meet the language requirements mentioned in paragraph 3.4. in particular with regard to VTS operators authorised to issue traffic instructions or to give navigational assistance ".

This is the old VTS Guidelines definitions which is still valid. Nevertheless, there are some amendments and changes according to new Draft VTS Guidelines which has been approved by the IALA VTS Committee and the IALA Council and was submitted to IMO in September 1994, and discussed, but was not accepted. Because a number of countries representatives had some remarks and has been working on Draft Guidelines. Having made some minor amendments and changes, there will be another meeting in September 1995, and most probably this Draft Guidelines will become official VTS Guidelines. The IALA is strongly advising to all its members that in order to set a VTS or do anything with respect to VTS, this Guidelines should be used. The details of Draft VTS Guidelines are provided in **Appendix 3**.

Before examining the basic abilities, background, qualifications and training necessary to become an effective VTS operator, the functions of a Vessel Traffic Service must be briefly identified.

According to the IMO in its " Guidelines for VTS " these functions are;

i) Data Collection

- ii) Data Evaluation
- iii) Information Service
- iv) Navigational Assistance Service
- v) Traffic Organisation Service
- vi) Support of Allied Activities.

Other work has been done by the International Association of Lighthouse Authorities (IALA) VTS Committee, particularly their paper on "Recruitment, Qualifications and Training of VTS Operators (Guidelines) " which give basis defined the tasks, skills and knowledge required by an effective VTS operator. These are;

- i) Acquisition of data
- ii) Allocation of space
- iii) Routine control of vessels
- iv) Manoeuvres to avoid collisions
- v) Enforcement functions
- vi) Remedial functions.

There are of course various levels of VTS and this is one of the problems in developing suitable, standardised training courses. In addition to the various levels of VTS, differences must be considered in VTS systems which are;

- Coastal VTS
- Estuarial VTS
- Port VTS.

These various levels and types of VTS have special and differing operational and training requirements. As indicated above a competent authority should establish appropriate qualifications and training requirements for VTS operators taking into consideration the type and level of services to be provided by the VTS.

6.2 VTS operator levels

The three levels of VTS operator can be considered as to the basic types of qualification appropriate to the job as explained below.

Level 1 - Advanced Operator

Operators allowed to deal with navigational matters. They are generally recruited from a professional marine background, most often with the equivalent of a Master's licence. This level may include the provision of navigational advice when specialised local knowledge and recent extensive ship handling experience may be required.

Level 2 - Standard Operator

Operators normally carrying out communications with ships and giving general information either by broadcast or on request. They generally are recruited having some marine or communications background with a qualification similar to radio officer. They may be experienced Level 3 personnel who have undergone additional training or planned experience on the job.

Level 3 - Assistant Operator

Personnel carrying out the routine work of the VTS. In particular exchange of information by telephone or telex, recordkeeping, ancillary tasks such as ordering pilots or tugs and dealing with ships agents. They do not normally communicate by radio except for routine broadcasts. These personnel will normally have a good general standard of education.

6.3 Basic Abilities and Suitability for VTS operators

It is evident that technical and organisational developments in VTS systems has been effective for the levels of knowledge and skills required of the VTS operators. Therefore, operators should have the general knowledge areas necessary against the various VTS functions outlined by the IMO guidelines.

- 1 - Knowledge and use of English language
- 2 - General nautical knowledge
- 3 - Specific nautical knowledge
- 4 - Equipment handling
- 5 - Legal knowledge
- 6 - General education
- 7 - Local geographical knowledge.

The VTS authorities which identified and considered these areas, recognised that the levels of skill required to implement these knowledge areas in the VTS context would vary according to the level and type of activity of an individual VTS.

6.3.1 Levels of Skill Required

The areas of knowledge can separate into three levels of skill, as follows.

1 - Knowledge and use of English language

Low - Ability to read simple English

Medium - Able to communicate and converse at Seaspeak/IMO Vocabulary level

High - Can converse freely on technical matters

2 - General nautical knowledge

Low - General description of ship's main features

- Different categories of ships (oil tankers, LNG carriers, car carriers etc.) and their general outline.

Medium - Same as Low, plus some seafaring experience

High - Same as Low, plus:

- Seafaring experience and ability to navigate seagoing vessel.
- Familiarity with use of shipborne navigational equipment.

3 - Specific nautical knowledge

Low - Knowledge of existence of constraints for some categories of vessels(VLCCs, LNG and LPG carriers, car carriers, etc.)

Medium - Good knowledge and experience of ship behaviour and nautical constraints.

- Effect of wind, current, shallow water on different types of vessels.
- Influence of tide on the navigation of vessels in the area.
- Squat
- Turning capacities of vessels.
- Stopping capacities.

High - Same as Medium, plus:

- Extensive practical knowledge of handling all types of ships in the area.
- Extensive knowledge of all the effects that may influence the behaviour of the different types of vessels in the whole area.
- Capacity to assess the possibilities of any type of vessel in present circumstances;
wind, current, tide, depth of water, squat, safe minimum speed, available space, location and orientation of berth

allocated, position of other vessels, tugs available, estimated or known capabilities of vessel and crew.

4 - Equipment handling .

Low - Use of telephone, telex, telefax etc.

Medium - Use of VHF, radar, automatic plotting , computer storage, etc.

High - Great familiarity with all sophisticated radar equipment and interpretation of display.

5 - Legal knowledge

Low - Familiarity with local bylaws and harbour/port regulations, etc.

Medium - Knowledge of the responsibilities of the VTS personnel

High - Thorough familiarity with the legal status of the VTS, all harbour rules, COLREGs, etc.

6 - General education

Low - Educated to school leaving standard.

Medium - Education to pre-university / higher education standard.

High - Further education or technical training, Nautical School, etc.

7 - Local geographical knowledge

Low - Familiarity with configuration of area

coastline, channel, berths, swinging areas, anchorages.

- Positions of lights, buoys, sensors and aids to navigation, obstructions, etc.
- Ability to identify all fixed objects on radar.
- Reporting points.

Medium - Good knowledge of area as described in Low, plus:

- Characteristics of aids to navigation
- Tidal conditions
- Currents
- Prevailing winds
- Positions of points or lines which must not be passed in the case of denial of clearances.

High - Same as Medium, plus:

- Depths of water at some important places in the VTS area
- Configuration and design of straits
- Points of no return for deep draught vessels
- Possibility of anchorage for vessels of different types and loading conditions.

The above subjects are almost self evident and necessity for VTS operators to have a good basic general knowledge background, as well as further skills.

For a modern system, the following skills are essential.

The ability

i) to communicate clearly, briefly, effectively and correctly using VHF equipment. This is a key requirement of an effective VTS.

ii) to use and understand radar tracking information clearly and correctly and to realise the limitations of radar surveillance equipment.

iii) to understand the problems of the mariner navigating within VTS area- the pilot/Master/VTS relationship.

iv) to develop co-operation between the shore-based operator and the Master/officer onboard ship and to ensure that mariners in the VTS area are conscious of the VTS and its purpose to improve navigation safety.

v) at the same time to find proper solutions for problems arising in a VTS area.

vi) as quickly and effectively as possible to reply to developing situations.

vii) to be conscious of the legal implications of VTS.

In order to meet these requirements nowadays, candidates are come from widely experienced mariners. The others are trained communicators or radar operators and air traffic controllers. It is obvious that these differences among candidates create some difficulties in setting up proper training programmes.

On the other hand **the suitability** defines how well an individual can carry out specific tasks. The application of knowledge and skills in the performance of the duties of the any position of job personal suitability and traits play a very important role.

In this case, personal suitability can include ;

- comprehensive skills; analysis, synthesis, interpretation and evaluation.
- social skills; communication and discussion.
- language capability.
- problem solving.
- work; under pressure.
- responsibility.
- ability of decision making.

6.4 Entry Qualification

In recent years, there has been a rapid expansion in Vessel Traffic Services. This expansion has led to important increases in the number of VTS operators required world-wide. The services given by vary considerably from country to country. Unfortunately there are no internationally recognised qualifications for VTS operators. Furthermore, in order to achieve their role in the provision of safety and efficiency services to shipping and in the protection of the environment, the standard of training necessary has never been fully defined on a worldwide basis.

In general, a VTS operator must have a good appreciation of a maritime environment and the ability to understand the problems of the mariner under many and varying pressures and to solve problems and to absorb information from a variety of sources.

Accordingly, according to the MSC / Circ.578 paragraph 5.2.1 which states that:

Authorities should establish entry standards for new VTS operators coming into the system in terms of prior skills, knowledge, and personal suitability characteristics relevant to the tasks or functions they will be required to perform. These skills and knowledge may in part be assessable through existing qualifications (e.g. master or pilot`s license).

and paragraph 5.3.1 states that:

Authorities must be able to determine what competencies a VTS operator must possess to carry out assigned functions in order to establish the combination of prior qualification and subsequent training required to ensure that VTS operators in a VTS are competent.

Therefore, flexibility is required and it is also reasonable to assume that VTS authorities will continue to recruit operators across a wide range of individual qualifications and experience.

6.5 Vessel Traffic Service Training

The training scheme should be in a modular form structured on a national basis and is governed by the following principles:

- i) It should be flexible taking into consideration the different levels of experience of recruits.
- ii) There should be a curriculum which covers the principles of VTS and relevant IMO guidelines.
- iii) According to the scope of the VTS the level of vessel traffic and the equipment in use, the training programme should be able to train VTS operators to differing levels as required.
- iv) It should include refresher or continuation training at regular intervals for qualified VTS operators.
- v) It should include simulator based training.
- vi) It must have a formal certification system.

A training programme for VTS operators should preferably consist of the following elements:

- Basic training
- Initial VTS training
- On the job training
- VTS training- Simulator based VTS management course
- VTS assessment
- An appropriate certificate.

6.5.1 Basic training

Basic training should be given prior to specialised VTS training. In this case the candidate hasn't had instruction on aspects of basic training in the previous occupation. The minimum objectives of basic training are as follows:

6.5.1.1 Communication

- . English- grammar, vocabulary, speaking and listening.
- . Voice communication procedures
- . Distress, urgency and safety communication
- . Standard marine navigational vocabulary
- . Information broadcasting

6.5.1.2 Maritime

This aspect of training can apply for candidates with little or no navigation background.

- . Basic coastal navigation
- . Passage planning
- . Bridge teamwork
- . Ship handling- co-ordination of the task run by the Pilot and Master

6.5.1.3 Radar

- . Shore based radar and tracking system
- . Radar presentation- synthetic coastline, symbols and information
- . Identification and tracking targets
- . Radar performance- tracking capability and limitation
- . Errors, accuracy and reliability
- . Interpretation, evaluation and analysis of information for prediction and decision making

The candidate must reach the required standard prepared by competent authority according to level of VTS system and demonstrate the ability to evaluate information presented by radar tracking equipment.

6.5.1.4 Equipment

- System configuration
- Start up, operate, adjust, test, maintain the equipment and perform minor repairs

6.5.1.5 Meteorology

- . Meteorological terms and definitions
- . Preparation of weather forecast message

6.5.2 Initial VTS training

Having finished basic training which is required for VTS the operator will attend a VTS " Familiarisation Course ". This is designed to provide VTS basic operating procedures as recommended by IMO and to give an overall assesment of the task of a VTS operator.

The objectives of the training are:

- . the review of radar theory
- . the review of radar plotting
- . the review and study of communication procedures
- . to ensure that participants can evaluate data presented by shore based radar surveillance system
- . the application of safe VTS operating procedures
- . to examine the role of the mariner and encourage co-operation between the mariner and VTS operator.

The aim of the this training in particular is for more qualified candidates who may enter the training programme at this point. This is mainly simulator based. The main part of this training is to make up and use the various radar, VTS simulators for further training as a follow up to the basic training.

6.5.3 On the job training

For a long time a professional and functionally oriented on the job training programme, has been used with success in some important industries, especially in airline industry, firstly is an understudy role and finally as a junior operator under supervision in real life situation.

This "on the job training" for a VTS operator is only possible when VTS consoles in a VTS centre are not used for informing and advising marine traffic. This situation has great consequences for the duration of the training programme. In this case, the use of simulators can reduce training periods without reducing the effectiveness of the training.

However, the most important condition is that where the operator's own port must be simulated. This is rarely the case because of cost and enough trainees to make up a feasible course for one VTS authority alone.

On the job training should include:

- Familiarisation with
 - i) radar surveillance equipment.
 - ii) communication equipment.
 - iii) other data acquisition and storage facilities.
 - iv) the geographical area.
 - v) the system of allocation of pilots and pilot launches, tugs and mooring gangs.
 - vi) Understudying experienced operators in all their roles.
 - vii) During pilotage and coastal passage to observe the task and problems of the pilot, ship master and bridge team.
 - viii) Basic knowledge of the business structure of the port.

The length of "on the job training" may change according to the VTS operation level but it is suggested that a period of six months be considered as minimum.

6.5.4 Simulator based VTS Management training

Having completed the initial on the job training programme, this simulator based training is designed for a VTS operator. Furthermore, it is also suitable for the experienced VTS operator. He/she may wish to improve their experience in VTS techniques and in dealing with the unexpected situation.

The objectives of this training are:

- i) To review rules and regulations.
- ii) To be able to evaluate data presented by shore based radar surveillance systems through sailing plan, traffic situation and navigational conflicts.
- iii) To continue to develop safe VTS operating procedures in order to avoid delays to shipping,
 - . monitoring, routine control and addressing
 - . navigational assistance
 - . providing position fixing, course and speed
- iv) To be able, as quickly as possible, to respond effectively to hazardous and emergency situations.
 - . distress, urgency and safety radio watchkeeping
 - . Search and Rescue
 - . medical assistance
 - . salvage operation
- v) To examine the legal implications of the VTS and the legal position of the VTS operator.

Applications of these objectives are generally achieved by using the simulator to run a traffic intensive exercise within an operator's own port and its surround. Many factors of VTS operations, in which the port approaches include traffic separation schemes and areas of difficult navigation, are very important during the time exercises are tested and examined.

6.5.5 VTS Assessment

On completion of the training, assessment of VTS personnel is a very important and necessary requirement. The procedure of assessment will depend widely on local requirements. An important part of the assessment is to take into consideration their performance when they perform tasks allocated to them. One of the important factors in this field is decision making.

At the beginning of selection tests and interviews, qualities and aptitudes of candidates are not always discernible. In this case on the job training and the use of simulator play an important role. In order to get real outcomes, assessment should not stop after training, and training should not stop once VTS operators are qualified. They will need continuation training in order to be able to maintain allocated tasks to them when new equipment or procedures are introduced and they are to accept higher posts and responsibilities.

Nevertheless, during the training programs the main problem areas and the common error areas will have been observed by supervisors namely:

- i) Poor VHF- Communication procedures.
- ii) Difficulty in dealing with several problems at one time.
- iii) Potentially dangerous errors in principle when using shore based radar surveillance- particularly when giving navigational assistance.
- iv) Lack of awareness as to the limitations of radar.
- v) Uncertainty for VTS operators actual duties and obligations.

Some examples of common error areas are as follows:

Failure to

- i) use the standard marine vocabulary as recommended by IMO.
- ii) understand the difference between heading and ground track.
- iii) understand that information on heading cannot be obtained from a shore based ground stabilised radar.

- iv) identify targets correctly.
- v) intervene when necessary.
- vi) maintain a continuous radar watch when radar surveillance is an integral part of the system.
- vii) dangerous involvement in anti-collision situations.

6.5.6 An appropriate certificate

On successful completion of the training, a candidate should be graded as a "VTS operator" and awarded a certificate signed on behalf of the VTS authority.

6.6 Training of experienced VTS operator

The VTS simulator is used in maintaining a high level of skill and to obtain the necessary attitude of active VTS operators in order to enhance efficiency and safety of marine traffic. Their skills can be measured step by step using different approaches, and changes in rules and regulations, new equipment, new concepts, new developments and techniques used in a VTS can be given by preparing refresher and updating training courses over a period of 3-5 days every year.

6.7 Simulator training or on the job training

In comparison on the job training, simulator training provides a safety working situation to learn new concepts. Safety for people, equipment and environment and also physical safety for the candidate which causes the required learning climate. It is evident that to get the needed skills and necessary attitudes for the job, a VTS simulator provides good working environment. In addition, a simulator provides possibilities for experiments during the training.

CHAPTER 7

CONCLUSIONS

7.1 As a result of the sharp increase in maritime trade, the shipping industry has expanded dramatically and this has led to the introduction of different types of vessels and the transportation of many commodities, resulting in denser marine traffic in waterways and harbours. This has created risky and hazardous conditions for navigational safety and traffic efficiency as well as threatening local environmental. The rapid increase in traffic density in special waters has caused critical concern among many countries due to a series of spectacular incidents. Therefore, Vessel Traffic Services is now being increasingly introduced in such special areas in order to facilitate and protect both the traffic flow and the environment.

7.2 Setting up the measures for maritime traffic management by the use of VTS will be a topical subject in Turkey due to recent maritime accidents that involved oil-tankers, producing extremely severe damage to the local environment and the local economy. These events have drawn the attention of the Turkish government to the need to workout an effective solution to the problems in the Straits of Istanbul and Canakkale, and the Sea of Marmara where seas and coasts are particularly exposed to the risk of accidental marine pollution due to dense maritime traffic.

7.3 The Vessel Traffic Service (VTS) will play a more important role in the evolution of the transportation system and this evolution will be logically ecologic and economic at the same time. On the one hand direct sea-shore interaction with maritime traffic and the exchange of information with ships will allow an increase in safety levels to be achieved, and therefore protection of the coastal and marine environment. On the other hand, linked VTS systems will allow to arrive to the desired informative support for the application of interrelated network for

the improvement of the maritime transportation system. For an interrelated system in the District of Marmara, the management of maritime traffic will have a special economic meaning especially where the VTS will be used not only to manage the traffic as regard ships routes, but also to schedule as well.

7.3.1 The Turkish Straits and the Sea of Marmara VTS system should connect to the European VTS data base computer with the port and shipping information services to make the VTS system more efficient and it would be very useful for the shipping business to have such an information service. ☆

7.4 For the implementation of the Turkish Straits and the Sea of Marmara VTS , the functions, organisation and operation of the system are proposed as simple as possible. When it is fully established, it should run on a trial basis for one or two years. During this period, ships would participate in the VTS on a voluntary basis until VTS has gained experience and made the corrections, improvements that may be necessary. When VTS can be run properly and smoothly, VTS participation of all ships on a compulsory basis will be applied. 12

Therefore, a research plan will be necessary in order to achieve a reduced level of risk for any specific context, and should include both accident prevention measures and remedial measures to limit any damage that will happen notwithstanding the actions taken.

7.5 It can be concluded that the implication of applying a VTS system in the Turkish Straits and the Sea of Marmara will be in response to the following general requirements:

7.5.1 The need to reduce the risk in navigation and to the environment in the Turkish Straits. The risks to which navigation in the Straits is exposed come from the following factors:

- The morphological and physical structure of the Straits, the narrowness of the navigable area, the sharp turns and shallow submerged wrecks

- Interference with transit vessels proceeding from north to south and from south to north inside the Straits due to intra-city ferries and other shuttle boats crossing between the two sides of the Straits

- Adverse meteorological conditions especially such as:
 - . reduced visibility due to fog or sleet
 - . unpredictable changes in the velocity of current and countercurrents

- The lack of sea/shore based navigational assistance and difficulties encountered in the transfer of information regarding traffic flows

7.5.2 Provision of specific services capable of reducing the aforementioned risks, to be implemented for future maritime activities in the area without any negative consequence.

7.5.3 Capability to operate in the specific juridical environment where defined measure will be applied.

7.6 The consequences of introducing VTS in such areas are the diverse views that have arisen as the legal responsibility for safety and environmental policies under VTS. Under the definition of "international" the Turkish Straits are deemed to be an international waterway. Recognition of freedom of transit and navigation for the vessels in a strait however does not in the view of the author make it international waters.

From the point of view of international law the seas are classified as follows:

- . high seas
- . international waters
- . territorial waters
- . archipelagic waters

There are specific rules which govern each category. As mentioned above, in view of the lack of a generally recognised definition of "international waters" as a legal term, to define Turkish Straits as such is

not at all appropriate, and therefore the Turkish Straits is a waterway through which foreign flag vessels have special permission to pass.

7.7 As to the VTS regulations and procedures, they should be improved so as to provide suitable measures to monitor, supervise and manage the navigation in the Straits and the Sea of Marmara. b

To reach a desired level of safety and efficiency of navigation and protection of the environment, the role of the VTS operator is critical. Because they have to solve problems caused by traffic situations and face the difficulty of dealing with particular conflicts between users about navigational decisions, issues of authority and responsibility and questions of liability, VTS operators must be highly qualified, and well-trained. Turkish VTS operators should be dispatched to well-known training centres to be educated.

Finally, it can be said that the present methods of managing shipping in Turkey will change as a result of the implementation of a Vessel Traffic System, and that the high risk to navigation and environment in the Turkish Straits can be significantly reduced. Its necessity has to be recognised at the international level by all the authorities concerned.

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APPENDIX 1

SHORE BASED RADAR ANTENNAS

A GUIDE TO THEIR SELECTION FOR PORT, RIVER, COASTAL AND SECURITY SURVEILLANCE

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CHAPTER ONE - INTRODUCTION AND BACKGROUND

The overall performance of a radar is rarely completely predictable. The interaction of particular targets, local site terrain and weather can only be approximately allowed for according to the mountain of both empirical and theoretical knowledge that has been built up over the last fifty years.

With unlimited design and development resource good predictions are possible. Unfortunately, for most VTS and similar civil radars, such luxury is not available. The antenna heads the list of those components that can be a trap for the unwary. Problems which have been attributed at least in part to poor choice of antennas include:-

- Inability to see targets at both long and short range
- Displays so cluttered that targets can't be seen
- Tracking algorithms becoming confused
- Large targets suddenly disappearing and re-appearing
- Tug towed barges "losing" the tug on the display
- Targets lost in heavy rain
- Poor detection of small targets
- Targets merging

These pitfalls apply equally to apparently simple, low cost installations and to large multi site projects. Correct choice of antennas and related RF electronics can help in all these areas.

It is the purpose of this guide to help in the correct antenna selection. In the recent years major advances have been made in antenna design and manufacturing, through the use of powerful computer analysis and modelling techniques. This has enabled a high level of performance to be achieved at low costs.

Table 1.1 gives an indication of some of the applications of shore based surveillance radar. The most striking feature is their variety.

For the less demanding of these applications the antenna is often regarded as a standard, off-the-shelf, catalogue item requiring only limited consideration in its specification and selection. This is unfortunate. Given the diversity of terrain, environment and wide differences in required system performance, correct choice of antenna is vital if the desired performance is to be achieved. To do this, the radar system engineer needs to seek the advice of a specialised antenna engineer.

These guidelines, then, have been written to address the relevant questions regarding antenna performance and cost. In a necessarily brief document it is only possible to indicate some of the answers, but it is hoped it will help guide the system designer and user to the correct selection of antennas.

Table 1.1

APPLICATIONS	TYPICAL REQUIREMENTS
Coastal VTS	Small target/long range detection and resolution, long and short range cover, weather clutter, sea clutter, cost
Port VTS	Resolution, long and short range cover, sea clutter, large and small detection, cluttered sites, cost
River VTS	Resolution, sea clutter, weather clutter, aesthetics, cost
Coastal Surveillance	Small target detection, weather clutter, long & short range detection, air and sea cover
Anti-pollution Surveillance	Target clutter, all weather performance, sea clutter
Offshore Installation Protection	Short and long range, small target detection, small size, air and sea cover
Drug Interdiction Anti-terrorist	Small target detection. All weather performance, sea clutter, semi covert, air and sea cover
Search and Rescue	Small target detection, all weather performance, air and sea cover

CHAPTER TWO - ANTENNA TYPES

There are many things which affect the antennas' transmission and reception of signals. According to the requirements set by the radar user, some of these factors will dominate, others will be less critical but if ignored may have unexpected and unfortunate consequences.

Table 2.1 (overleaf, pages 9 & 10) provides a list of parameters to be considered.

Practical constraints, at least in the civilian field, will usually prevent a full and detailed analysis of every parameter. Selecting a best approach in such circumstances is similar to other engineering decision processes; there may be several options of apparently equal merit and the selection is not always obvious nor easy. In particular, the choice of antenna has as much or more influence on the performance of the total system as any other single hardware sub-assembly. It is also the component whose role is most sensitive to site factors.

In practice, for VTS, coastal and similar shore based surveillance radars, the current choice of antenna type is restricted to:-

Commercial Slotted waveguide array

Custom Slotted waveguide array

Front fed shaped parabolic reflector

Parabolic cylindrical reflector with line feed

These are shown diagrammatically in Figure 2.2.

Antennas incorporating electronic scanning, although technically feasible and well proven in military systems, are still far too high in cost to be considered in most civilian applications.

In general choice depends on application:-

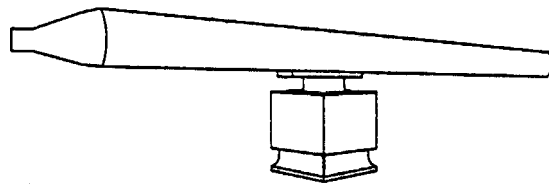
Commercial Slotted Waveguides are generally built in considerable numbers for shipboard applications and are therefore low in cost. They are not, however, designed for the VTS environment. They provide relatively low gain, only moderate control of sidelobes, and are unable to use clutter reduction techniques such as polarisation switching. Commercially, most ship-borne sizes are limited to about 3.7m maximum width with 2m and 2.4m sizes more common.

Custom Slotted Waveguides offer much better performance but at high cost. These designs provide narrower beamwidths, and some elevation pattern shaping. Generally they retain the limited gain and lower weight of their low cost cousins. It is possible to integrate clutter reduction techniques, but cost is high as two slotted waveguides must be used.

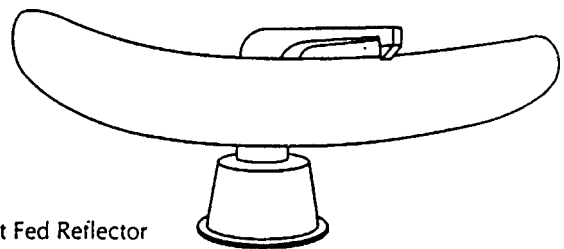
Front Fed Reflectors offer performance in excess of that of custom slotted waveguides and are generally lower in cost for narrow beamwidths. They also have a wide flexibility in tailoring the performance to suit particular requirements. They are well suited to clutter suppression techniques such as polarisation switching and frequency diversity and offer high gain with good sidelobes (to -30dB peak).

Line Fed Reflectors offer performance as good as the front fed reflector in most parameters and better in some. Weight is comparable with front fed reflectors. Cost is very high due to the feed network required.

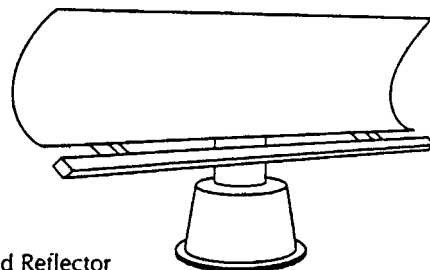
Figure 2.2 ANTENNA TYPES



Slotted Waveguide



Front Fed Reflector



Line Fed Reflector

TABLE 2.1 - COMPARISON OF IMPORTANT ANTENNA PARAMETERS

PARAMETER	COMMERCIAL END FED SLOTTED WAVEGUIDE		CUSTOM BUILT SLOTTED WAVEGUIDE		FRONT FED SHAPED REFLECTOR		PARABOLIC CYLINDRICAL REFLECTOR LINE FED	
Gain for given azimuth beamwidth. Actual gain depends on beam shape/ antenna aperture.	Poor to moderate 28 to 33 dBi X band		Moderate 30 to 35 dBi X band		Good to very good 35 to 47dBi X band		Good to very good 35 to 47 dBi X band	
Azimuth beamwidth	Min beamwidth at X-band = 0.4° Min beamwidth at S-band = 1.25°	Limited by max antenna length of 5.4m	Min beamwidth at X-band = 0.265° S-band not available	Limited by max antenna length of 9.5m. Lengths greater than this not practicable	X-band beamwidth at 8m = 0.28° S-band beamwidth at 8m = 0.84°	Reflector and pedestal progressively more costly above approx 8m width	X-band beamwidth at 8m = 0.28° S-band beamwidth at 8m = 0.84°	Reflector and pedestal progressively more costly above approx 8m width
Elevation beam shape	Fan Beam	Very limited availability of beam shapes, not optimised for VTS etc.	Fan or inverse cosec ²	Moderate flexibility to provide desired beam shape	Inverse cosec ² pencil or fan	Excellent flexibility to provide desired beam shape	Inverse cosec ² or pencil	Excellent flexibility to provide desired beam shape
Dual Beams	Not practicable		Not practicable	Requires two co-mounted antennas	Yes	Convenient, requires separate feed	Yes	Difficult, requires separate line feed
Sidelobe Levels	Poor to moderate -23 to -28dB peak	Difficult to control esp. off axis	Good -25 to -30dB peak	Moderate flexibility to control sidelobes, but limited capability off axis	Good to very good -25 to -35dB peak	Good flexibility to control sidelobes especially off axis	Very good -25 to -35dB peak	Good flexibility to control sidelobes particularly azimuth
Azimuth beam near to far transition	Fixed	Cannot be optimised to site	Fixed	Cannot be optimised to site	Not fixed	Can be optimised to site	Not fixed	Can be optimised to site

Table 2.1 continued

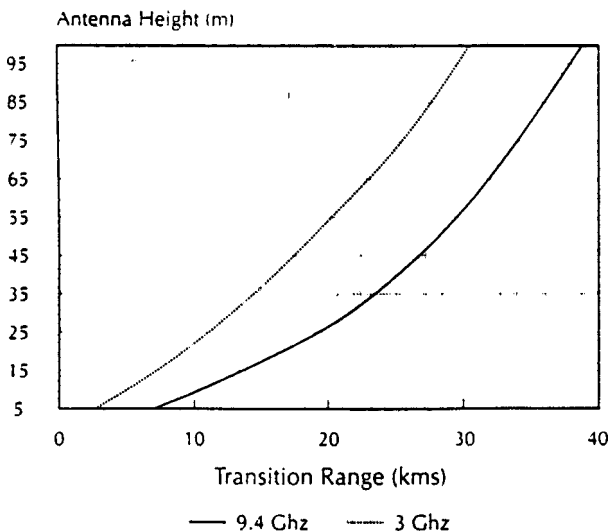
PARAMETER	COMMERCIAL END FED SLOTTED WAVEGUIDE		CUSTOM BUILT SLOTTED WAVEGUIDE		FRONT FED SHAPED REFLECTOR		PARABOLIC CYLINDRICAL REFLECTOR LINE FED	
Polarisation Diversity	Single polarisation only	Normally linear	Available using two co-mounted antennas	Difficult but, diversity in single antenna possible	Readily Available	High or low speed switching	Available	Difficult but possible. High or low speed switching
Frequency/Bandwidth	Single band	Dual band operation not possible	Single band	Dual band operation not possible	Wide Bandwidth	Dual band operation possible	Wide bandwidth	Dual band or frequency diverse operation difficult
Boresight shift with frequency	Yes	Requires use of signal processing to compensate for beam squint if frequency diversity used	Yes	Requires use of signal processing to compensate for beam squint if frequency diversity used	No	Very simple to implement frequency diversity - no need for extra signal processing	No	Very simple to implement frequency diversity - no need for extra signal processing
Short pulse operation	Restricted	Wide antennas not suited to short pulses	Restricted	Wide antennas not suited to short pulses	No Restriction		No Restriction	
RF Power Handling	Low, <100kW		Moderate <200kW peak		High >600kW		Moderate high 100 - 200kW	
RF Pattern Tests	Not individually fully tested		Individually fully tested		Individually fully tested		Individually fully tested	
Wind loading/weight	Low		Low		Moderate to high		Moderate to high	
Power Requirements	Low		Low		Moderate to high		Moderate to high	
Custom Designs Available	No		Yes		Yes		Yes	
Cost	Low		Moderate to very high		Moderate		Very high	
Availability	Very Good		Extended delivery		Good		Very extended delivery	

CHAPTER THREE - ELEVATION BEAM SHAPE

VTS type radars require mounting on a tower, cliff or other elevated site to achieve long range. The height required is not the optical horizon - the radar range is altered by reflected signals from the sea surface. For the radar to cover short distances as well, the antenna must provide enough energy below the horizon to cover a range of elevation angles. This coverage zone will depend on the application, but can be approximated as given below.

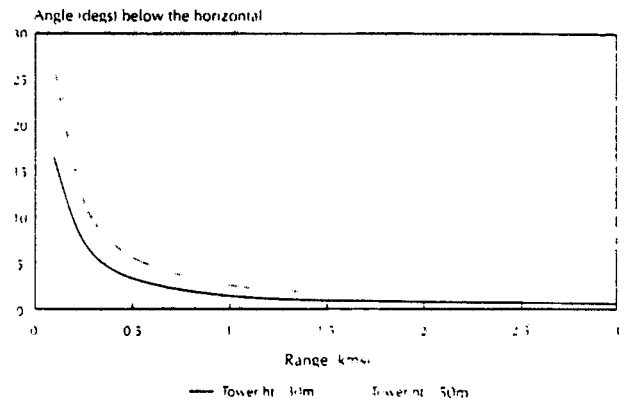
The long range performance of any sea surveillance antenna depends on its height amongst other factors. For guaranteed performance, the target should not be further away than the transition range. This is the point where, for perfectly calm sea, the reflected wave from the sea surface still substantially adds to the direct wave from the antenna (i) (ii). This is an approximate guide as the sea surface is rarely smooth. Nor should it be assumed that beyond the transition range the radar won't detect - it will, but will exhibit large nulls and peaks. For interest, transition range versus antenna height is shown in Figure 3.1, assuming a smooth spherical earth model and a target 5m above mean sea level. Results are shown for radars operating at 9.25GHz and 3GHz.

Figure 3.1 TRANSITION RANGE AS A FUNCTION OF ANTENNA HEIGHT



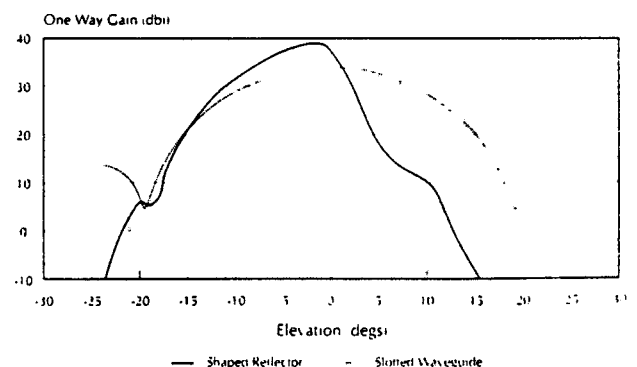
Inspection of the graph shows why VTS antennas are often tower mounted to get reasonable range. Of course, if the antenna is elevated, at short ranges the target is substantially depressed in elevation angle (Figure 3.2). This, then, is the compromise. To achieve long range requires elevated sites, but requires wide angle coverage from the antenna.

Figure 3.2 RANGE .v. DECLINATION



It should be noted that the situation is worse at 3GHz as tower heights get higher for long range operation. To achieve optimum results at any frequency requires elevation beam shaping, with the well known inverse cosec² shaping often specified to give approximately constant field strength whatever the range (Figure 3.3).

Figure 3.3 ELEVATION BEAMSHAPING
5.4m APERTURE ASSUMED



(i) Williams, PDL: "Limitations of radar techniques for the detection of small surface targets"; *The Radio and Electronic Engineer*, Vol 45, No 8, August 1975

(iii) Rohan, P: "Surveillance Radar Performance Prediction"; Peter Peregrinus, 1983

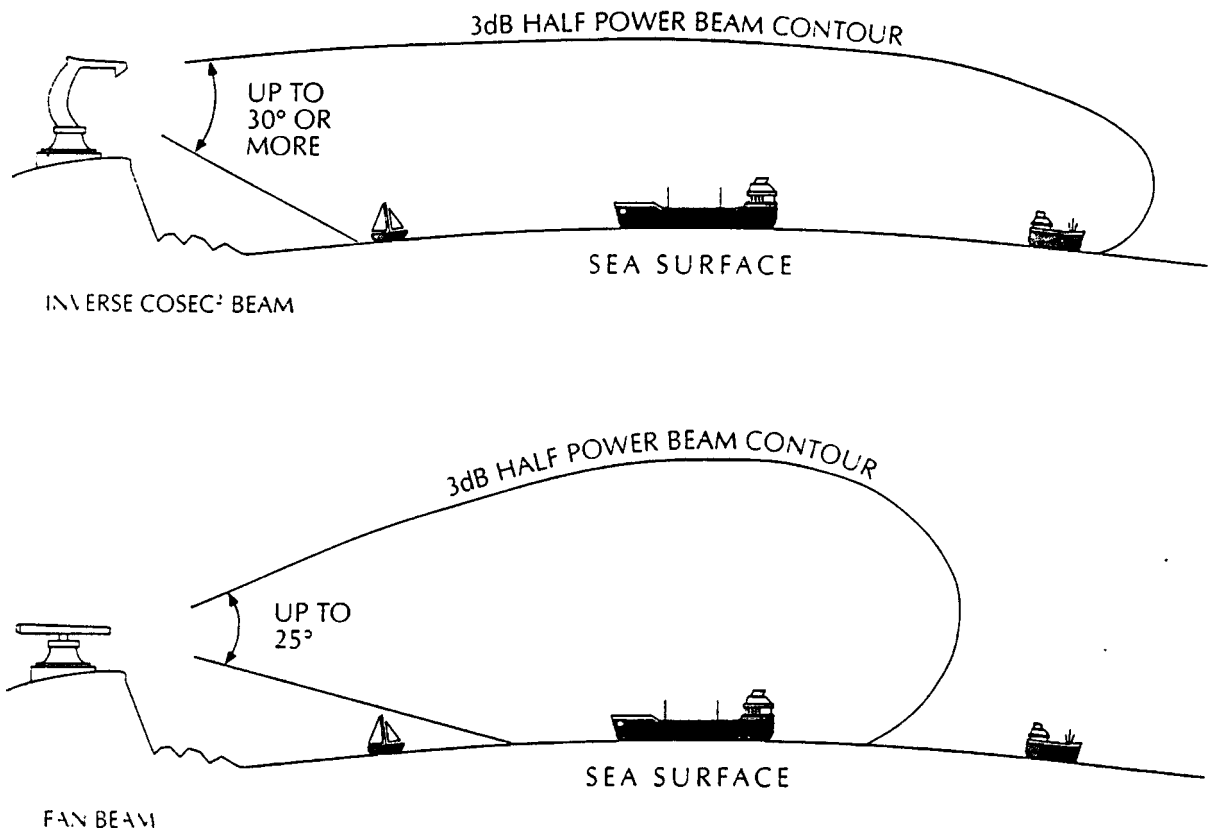
RADAR ANTENNA GUIDE

However, getting significant power on target (antenna gain) is not enough. The antenna elevation beam shape is also dependant on the sidelobe level requirements as perceived by a target moving towards the antenna. This is discussed in Chapter 5.

With reflector antennas designs can achieve good results in elevation beam shaping. (Figure 3.4). In this example the antenna is configured for an

elevated site, where the operational requirement calls for good detection capability of small surface targets both at a long range and close-in to the base of the antenna tower. The beam pattern is shaped at its upper or skyward edge to give a sharp cut-off so reducing rain clutter (see Chapter 8). The antenna type and physical constraints of size, primarily vertical aperture, determine the elevation arc over which the inverse cosec² relationship can be achieved.

Figure 3.4 TYPICAL ELEVATION BEAM PATTERNS FOR VTS/COASTAL SURVEILLANCE



Also shown is a typical slotted waveguide pattern of an antenna of identical width (5.4m). This beam has reduced gain and is symmetrical about its axis.

Most slotted waveguide antennas are based on those developed for shipboard use in navigation and collision avoidance. In this application, and taking into account the ship's motion in terms of roll and pitch, the symmetrical fan beam is adequate. This may cover an elevation arc of typically 25° depending on make and model,

giving coverage to nominally 10° below the horizon, (Figure 3.4). Simple slotted waveguides of this type are not designed to provide inverse cosec² shaping. More sophisticated designs of slotted waveguide are available which have been developed specifically for VTS and coastal applications. These are provided with optimised flared sides or extensions to the antenna which are capable of providing approximate inverse cosec² beam shaping to an elevation angle typically of -15°.

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Reflector antennas provide greater flexibility than slotted waveguide antennas for elevation beam shaping. A reflector of relatively small vertical aperture can provide inverse cosec² beam shaping over an arc of 10° to 15°. This can now be achieved with a vertical aperture little more than that of slotted waveguide varieties, with resulting savings in cost, size, wind resistance and motor power over more traditional designs, whilst maintaining good radiated power density (ie, antenna gain).

Further improvements to close-in performance can be provided by an inverse cosec² elevation shaping over larger angles. Examples of use include some cliff-top applications. Up to -35° or -40° of inverse cosec² coverage can be provided with practical designs of reflector antennas by using a large vertical height, but such coverage is not feasible with slotted waveguide antennas.

If the site terrain and antenna location permit the use of a narrow elevation beam, for example, if the site is a few hundred metres inland from the water's edge, the elevation beamwidth can be reduced. This improves the performance against small targets and helps to minimise sea and land clutter returns. Such a beam is known by the general description of "pencil beam", although it is normally shaped to give a broader pattern in elevation than it does in azimuth. Improvements in gain from the use of pencil beam shaping are dramatic, up to 7dB compared with inverse cosec² coverage from the equivalent aperture.

Less sophisticated antenna designs yield spurious lobes in the elevation beam pattern, as found in many slotted waveguide varieties designed for shipboard use. The effect of such lobes can give unexpected results. For example, this can produce a strong echo from a nearby helicopter which, if at the same range, may be difficult to distinguish from a close-in sea surface target.

CHAPTER SEVEN - SEA CLUTTER REDUCTION

Sea clutter is caused by reflections from the sea surface. These literally "clutter" the display. Simple filtering techniques on the display can produce a clean picture but targets, particularly small ones, in the clutter will then often disappear. What is needed is to enhance the wanted signal power received and to reject the clutter. This is done both by reducing the patch of sea illuminated and by averaging the signals. In this latter case, by varying frequency and polarisation on different pulses, the sea clutter received will vary in a random way and be averaged to a lower level, decorrelating the clutter. As the wanted signal does not substantially vary the signals are additive over the pulses used. Thus the signal to clutter ratio is improved.

These techniques assume sufficient gain exists in the system for detection of targets at particular ranges (see Chapter 6). It is inevitable that some sea clutter will be received by the system¹⁰, and often it is the wanted signal to clutter ratio which is the dominant factor in system design. If this is the case, sea clutter can be reduced by a number of techniques including:-

Reduction of the range length of the clutter cell by using short pulses

Reduction of the azimuth width of the cell by minimising antenna beamwidth

Use of diversity techniques ie:-

- Frequency diversity
- Polarisation diversity

In addition, multiple antennas can be used to give spatial diversity. This is not discussed in this document as it is more a question of radar system architecture.

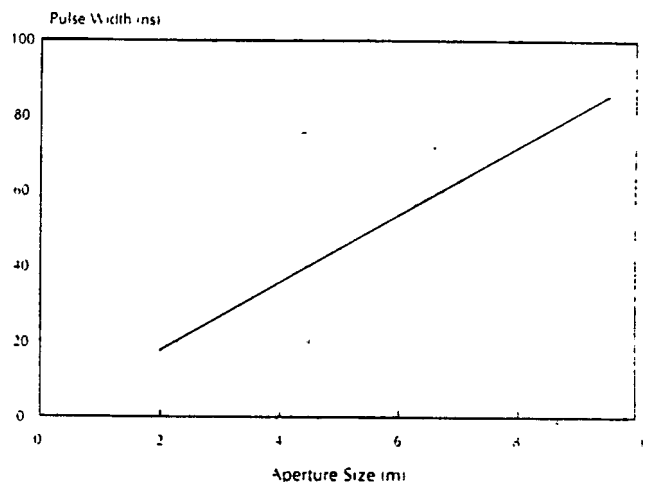
Range Cell Reduction

In order to reduce the total clutter, the range cell should be reduced as far as is possible by using short pulses. This has two effects. Firstly, for the same pulse repetition frequency and radar parameters the energy incident on the target is reduced, and hence the signal to noise ratio degraded. This can be recovered using higher antenna gain, which is best obtained through

elevation beam shaping, or through improved transceiver performance.

A more serious problem is that of waveguide dispersion. Provided the waveguide from the transceiver is kept clean and in good condition, short pulses will pass through the waveguide without substantial degradation, although it is advisable to keep waveguide runs short. However, if a long slotted waveguide antenna is used with short pulses then major degradation to the signal can occur. This is due to the serial nature of the slots; the signal must be sufficiently long to ensure all the slots radiate the same time. Figure 7.1 generated from data given by Hansen¹¹ illustrates this problem.

Figure 7.1 MINIMUM PULSE WIDTH v. ANTENNA LENGTH (SLOTTED WAVEGUIDE)



Such problems do not exist with parallel feed arrays, as are commonly used in line fed reflectors, or in conventional reflector antennas; so that pulse width is purely limited by the transceiver and ultimately the waveguide run.

Resolution Cell Reduction

In order to reduce overall clutter the azimuth width of the resolution cell should be reduced as much as feasible. This requires as narrow an azimuth beamwidth as can be provided, given the practical and cost constraints of any particular system ensuring any sidelobes illuminating the sea surface are minimised as far as possible.

Frequency Diversity

With frequency diversity more than one frequency is used through the same antenna to de-correlate the clutter. Authorities differ as to the difference in frequency required for de-correlation, and how many frequencies should be used.

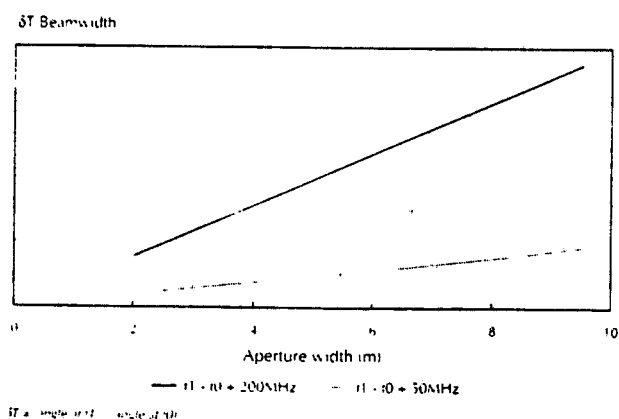
In a typical case presented by Hamer and Speckter⁽ⁱ⁾, two frequencies separated by 200MHz at approximately 9GHz are used. They note that this type of clutter reduction is available at practically no increase in system cost. This is because most systems have a main and standby transceiver for reliability reasons. By having them tuned to different frequencies, frequency diversity is obtained. In the event of failure of one transceiver, the diversity element is lost, but the system is still capable of running in reduced capacity until repairs are effected.

Actually, this zero cost element is only true in most systems if the antenna does not squint with frequency.

Beam squint is the change in direction of the beam with respect to its nominal pointing angle, the change being as a consequence of variation in frequency. Beam squint occurs in end fed slotted waveguide antennas; it does not occur in point fed shaped parabolic reflectors.

If this squint does occur, the frequencies used will give different beam pointing directions. The differential squint can be removed by suitable signal processing but this can be a costly provision unless already available. End-fed slotted waveguides by their nature squint with frequency. Figure 7.2 illustrates this for two frequencies 200 MHz apart and 50MHz apart. The figure shows change in beam pointing angle, or squint, as a

Figure 7.2 BEAM SCANNING IN SLOTTED WAVEGUIDES



fraction of beamwidth based on 9GHz centre frequency. This shows that for long slotted waveguide antennas, the beam squint over 200 MHz, for example, is equivalent to several beamwidths.

An extreme form of frequency diversity is the provision of dual bands through the same antenna, say, 9.5GHz and 3GHz. This can be implemented by stacking two slotted waveguides antennas, by fitting two back-to-back, or by a dual band feed in a reflector antenna.

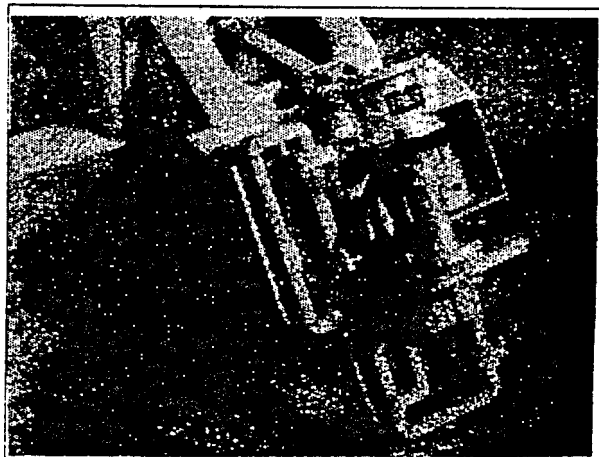
Polarisation Diversity

For sea clutter reduction, pulse-to-pulse linear to horizontal polarisation switch networks have been implemented⁽ⁱⁱ⁾.

In terms of antenna technology, this calls for the provision of a high speed switch, switching between two linear polarisations. Depending on power level, the switches can either be PIN diode or ferrite type. Switching can occur either on the rotating antenna platform, or by use of a dual channel rotating joint, at some point below the antenna.

Linear polarisation switching can be implemented in either slotted waveguide or reflector type radars. To achieve the required performance in slotted waveguide antennas normally incurs high costs as two waveguides are needed, one for horizontal, the other for vertical polarisation. The reflector, by its nature, can readily incorporate polarisation switching in the feed system (Figure 7.3).

Figure 7.3 POLARISATION SWITCHING UNIT



(i) Hamer K.H. and Speckter E.R: "Experience with computer assisted shore-based radar systems", XII IALA Conference, Holland, 1990

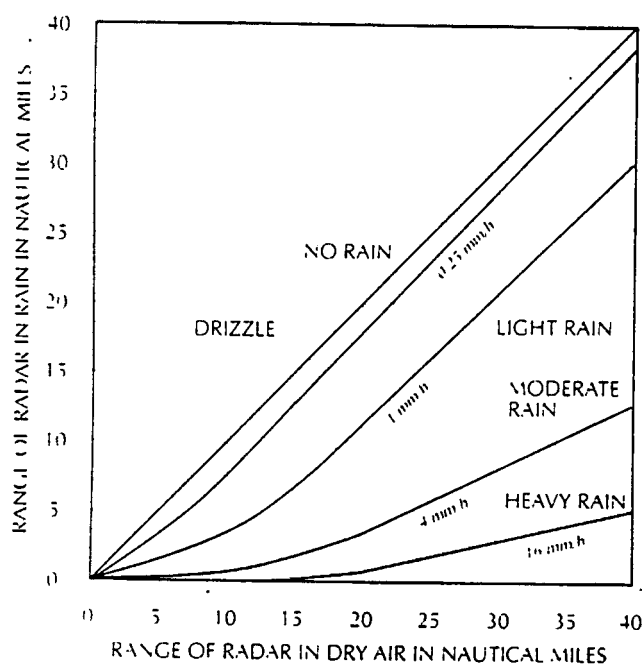
(ii) Hansen, in "Handbook of Antenna Design" ed. Rudge et al., Peter Peregrinus Ltd. 1982

CHAPTER EIGHT - POLARISATION AND RAIN CLUTTER REDUCTION

Rain, particularly at X-band, can cause major difficulties in radar systems. Reflections from the rain may mean the radar cannot "see" the targets. Displays can become cluttered with returns from the rain. As in the case of sea clutter, simple filtering can help clean the display but only at the price of losing targets in the clutter.

The effective reduction of clutter from rain is fundamental to radar performance. Figure 8.1 derived from Hovanessian¹, shows the effect of rain on detection range for a typical system.

Figure 8.1 EFFECT OF RAIN ON RANGE FOR TYPICAL SYSTEM



1. Hovanessian, "Radar System Design & Analysis", Artech House, 1984.

Rain clutter can be reduced in three ways:-

- Use of small resolution cell size
- Signal processing to improve signal/clutter ratio
- Use of circular polarisation

These approaches are complementary one to the other, and for maximum rain clutter reduction all three will be used. Minimising of the resolution cell size by means of a small azimuth beamwidth and short pulse length has already been referred to (Chapter 7). Signal processing methods in general are outside the scope of this guide, but it may be remarked that simple filtering techniques

are ineffective where the echo signal is dominated by clutter returns. To be effective, signal processing methods of clutter reduction must be of a reasonably sophisticated nature and therefore have significant cost implications - it is easy to remove clutter from the displays but difficult to stop this also removing wanted targets.

It is usually cost effective to improve the signal to clutter ratio within the antenna. A powerful tool in this battle is the use of polarisation.

Fixed circular polarisation has been used for over forty years to reduce rain clutter. It works on the principal that reflections from rain drops return to the antenna in the opposite hand of polarisation to the transmitted signal, hence the received signals are rejected by the antenna. The rejection is not complete, largely as rain drops are not truly spherical, also the precise polarisation of the transmitted signal cannot be optimised for the transient propagation conditions encountered at any particular moment. However, a rain clutter cancellation of approximately 18 to 20dB is a typical figure quoted by several researchers in this field^{2,3,4}.

Unlike raindrops, the wanted target is usually complex in shape and will scatter the signal into both hands of circular polarisation, so that an echo can be received by the radar.

The amount of clutter introduced by rain is dependant on the frequency of the radar signal together with beamwidth, gain, pulse length, as well as the rain density and droplet shape.

Schneider and Williams⁵, and others, show that whilst there is generally a reduction in target cross section of some 3dB when circular polarisation is used in clear air as compared to the use of linear polarisation, this is not always true and there are circumstances when circular polarisation gives a greater value of apparent radar cross section than linear polarisation. Practical observations carried out by Williams and others confirm that circular polarisation generally improves signal to noise ratio in rain by some 13dB at 'X'-band on average.

This result is typical. However high side winds, and other environmental factors affect the circularity of the raindrops and hence the improvement in performance. Further improvements can be found using true polarisation

adaptive radars. These have not, to our knowledge, been implemented in commercial radars due to high costs. Alternatively, manually changeable elliptical polarisation can be provided. This is not generally liked due to the need for operator intervention. Overall, circular polarisation is a good compromise in rain conditions.

The following Tables 8.2 to 8.5 compare the effect of horizontal and circular polarisation in free space without rain and at 4mm/hour and 16mm/hour of rain. Here it may be commented that 50mm/hour of rain is frequently encountered in tropical coastal regions during monsoon conditions and this intensity may extend for some miles at any one time. The tables assume a 10m² target with 25Kw peak power and 6dB noise figure at X-band, 50Kw and 6dB at S-band, and that the rain extends to the extent of the radar range. The average figures given by Williams for clutter reduction are assumed. These assumptions are not always correct, but the calculations nevertheless provide a valid comparison.

It is of interest that, as the tables show, 'S'-band radar performance can also be significantly affected by rain.

Having discussed the advantages of circular polarisation in rain, most of the time it does not rain and linear polarisation will give stronger target echo returns. For this reason it is generally advantageous, subject to cost constraints, to provide for polarisation switching. This can be done most economically by manually switching from one polarisation state to another, using a simple switching circuit. Up to four polarisation states may be required, for example left hand circular, right hand circular, horizontal linear, and vertical linear. The switching may be done by the operator in order to select the best polarisation for the prevailing conditions.

Alternatively, polarisation switching may be carried out on a high speed pulse-to-pulse basis by the radar itself. This is discussed more fully in Chapter 7.

It is more economic to carry out the pulse-to-pulse switching between the two states of linear polarisation only; or between left and right hand circular polarisation, rather than between all four polarisation states. There is little reason to switch on a pulse-to-pulse basis between circular polarisation and linear polarisation. This is because when rain is present linear polarisation may fail to produce useful echoes from a given

target when circular polarisation does so. Conversely, in clear conditions a small target at long range may not be seen by circular polarisation even though it is detected by linear polarisation. Therefore a sophisticated system having pulse-to-pulse polarisation switching may nevertheless utilize slow, manual, switching between circular and horizontal polarisations.

Although both reflector and slotted waveguide antennas can be manufactured to operate on any fixed state of polarisation, circular polarisation is not commonly available on commercial slotted waveguides. Also polarisation switching is not available from simple slotted waveguide antennas, although by using two such antennas it can then be provided (See Chapter 7).

Reflector antennas can be conveniently designed for either manual polarisation switching, carried out locally to the antenna, or remotely. A reflector antenna, can equally be designed for high speed pulse-to-pulse switching, the pulse-to-pulse switching being controlled by the transmitter.

References

- (i) Hovanessian SA, *Radar System Design and Analysis*, Artech House, 1984
- (ii) Schneider AB, Williams PDL, *Circular Polarisation In Radars*, *The Radio and Electronic Engineer*, Vol 14 Jan Feb 1976

APPENDIX 2

TRAFFIC SEPARATION SCHEMES

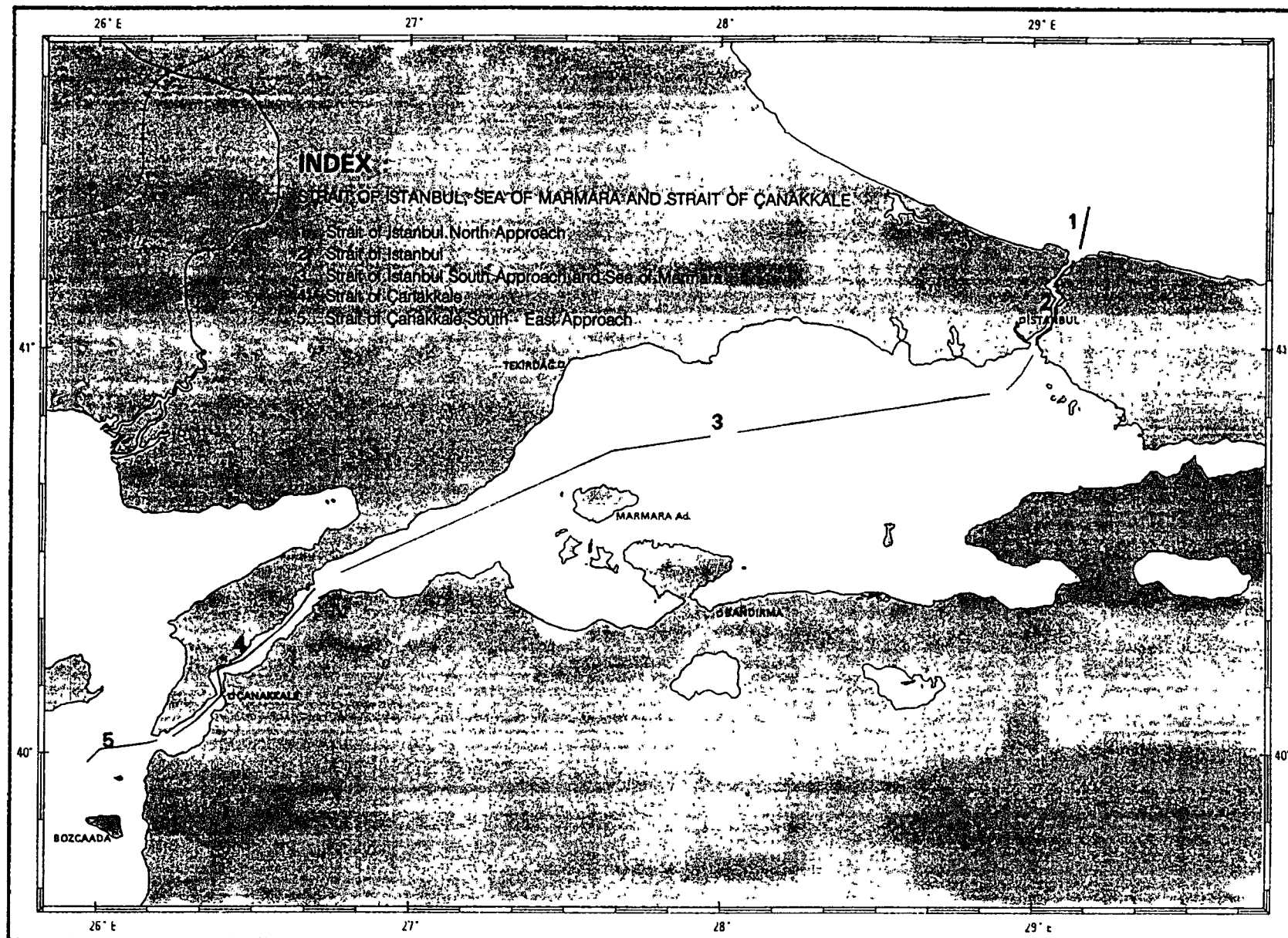
Strait of Istanbul North approach

Strait of Istanbul

Strait of Istanbul South approach and Sea of Marmara

Strait of Çanakkale

Strait of Çanakkale South-East approach



STRAIT OF ISTANBUL SOUTH APPROACH AND SEA OF MARMARA

(Reference charts : Turkish charts 2923 (INT3754) 1991 edition; 293, 1990 edition; 295 (INT3752) 1988 edition).

Note : These charts are based on European Datum

Description of Traffic Separation Scheme :

- a) A line is established as a continuation of the Strait of İstanbul traffic lane centreline :
 - (23) 41°00'.15N., 28°59'.75E
 - (54) 40°59'.53N., 28°59'.73E
 - (55) 40°58'.80N., 28°59'.44E
- b) A traffic separation zone has been established with boundaries defined by the lines joining the following points :
 - (55) 40°58'.80N., 28°59'.44E
 - (56) 40°57'.53N., 28°58'.63E
 - (57) 40°57'.78N., 28°58'.11E
- c) A circular area to be avoided of radius 1.5 cable, is centred upon the geographical position : (58) 40°56'.10N., 28°57'.00E and a precautionary area has been established defined by lines joining the points given below.
 - (71) 40°58'.21N., 28°57'.22E
 - (57) 40°57'.78N., 28°58'.11E
 - (56) 40°57'.53N., 28°58'.63E
 - (81A) 40°56'.83N., 29°00'.06E
 - (81) 40°55'.00N., 29°00'.06E
 - (67) 40°54'.70N., 28°58'.55E
 - (68) 40°53'.78N., 28°57'.15E
 - (76) 40°42'.20N., 27°38'.09E
 - (59) 40°54'.30N., 28°55'.40E
 - (65) 40°55'.58N., 28°54'.82E
 - (71A) 40°56'.83N., 28°54'.23E
- d) A traffic separation zone has been established defined by the lines joining the points given below :
 - (59) 40°54'.30N., 28°55'.40E
 - (60) 40°52'.40N., 28°52'.10E
 - (61) 40°44'.20N., 27°38'.09E
 - (62) 40°26'.00N., 26°45'.25E
 - (63) 40°45'.42N., 27°38'.09E
 - (64) 40°53'.90N., 28°52'.10E
 - (65) 40°55'.58N., 28°54'.82E
- e) A traffic separation zone has been established defined by the lines joining the points given below :
 - (66) 40°51'.50N., 29°00'.31E
 - (67) 40°54'.70N., 28°58'.55E
 - (68) 40°53'.78N., 28°57'.15E
 - (69) 40°51'.95N., 28°58'.00E

f) A traffic lane is established in the Sea of Marmara for traffic bound for the Strait of Çanakkale between the traffic separation zones/lines described in paragraphs (a), (b), (c) and (d) above and the line joining the points given below :

- (53) 41°00'.30N., 28°59'.42E
- (70) 40°59'.50N., 28°59'.39E
- (71) 40°58'.21N., 28°57'.22E
- (72) 40°55'.89N., 28°52'.09E
- (73) 40°47'.40N., 27°38'.09E
- (74) 40°26'.50N., 26°45'.25E

g) A traffic lane is established in the Sea of Marmara for traffic bound for the Strait of Istanbul between the traffic separation zones/lines described in paragraphs (d), (c), (b) and (a) above and the line joining the points given below :

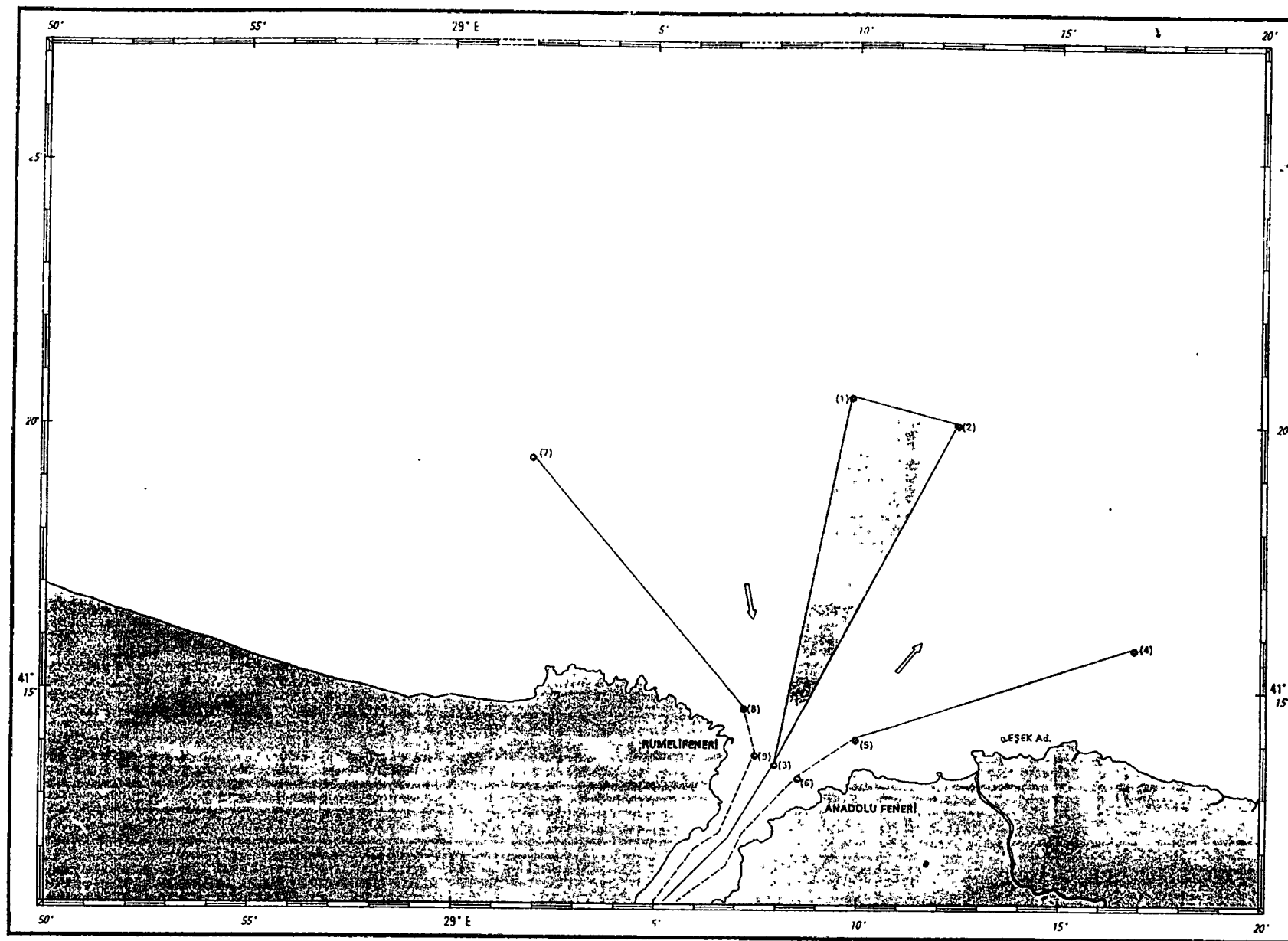
- (75) 40°25'.50N., 26°45'.25E
- (76) 40°42'.20N., 27°38'.09E
- (77) 40°50'.39N., 28°52'.07E
- (78) 40°52'.90N., 28°55'.92E

h) Vessels from the Strait of Istanbul heading for the Gulf of İzmit will follow the Southeast traffic lane which is defined by the traffic lane in paragraph (e), separation zones in paragraphs (c), (e) and (d) above and the line joining the points given below :

- (78) 40°52'.90N., 28°55'.92E
- (79) 40°51'.50N., 28°56'.57E

i) Vessels from the south and southeast of the Sea of Marmara and the Gulf of İzmit, sailing toward the Strait of Istanbul will follow the route between the traffic separation zone in paragraph (e) and the line joining the points given below :

- (80) 40°52'.00N., 29°01'.73E
- (81) 40°55'.00N., 29°00'.06E



STRAIT OF ISTANBUL NORTH APPROACH

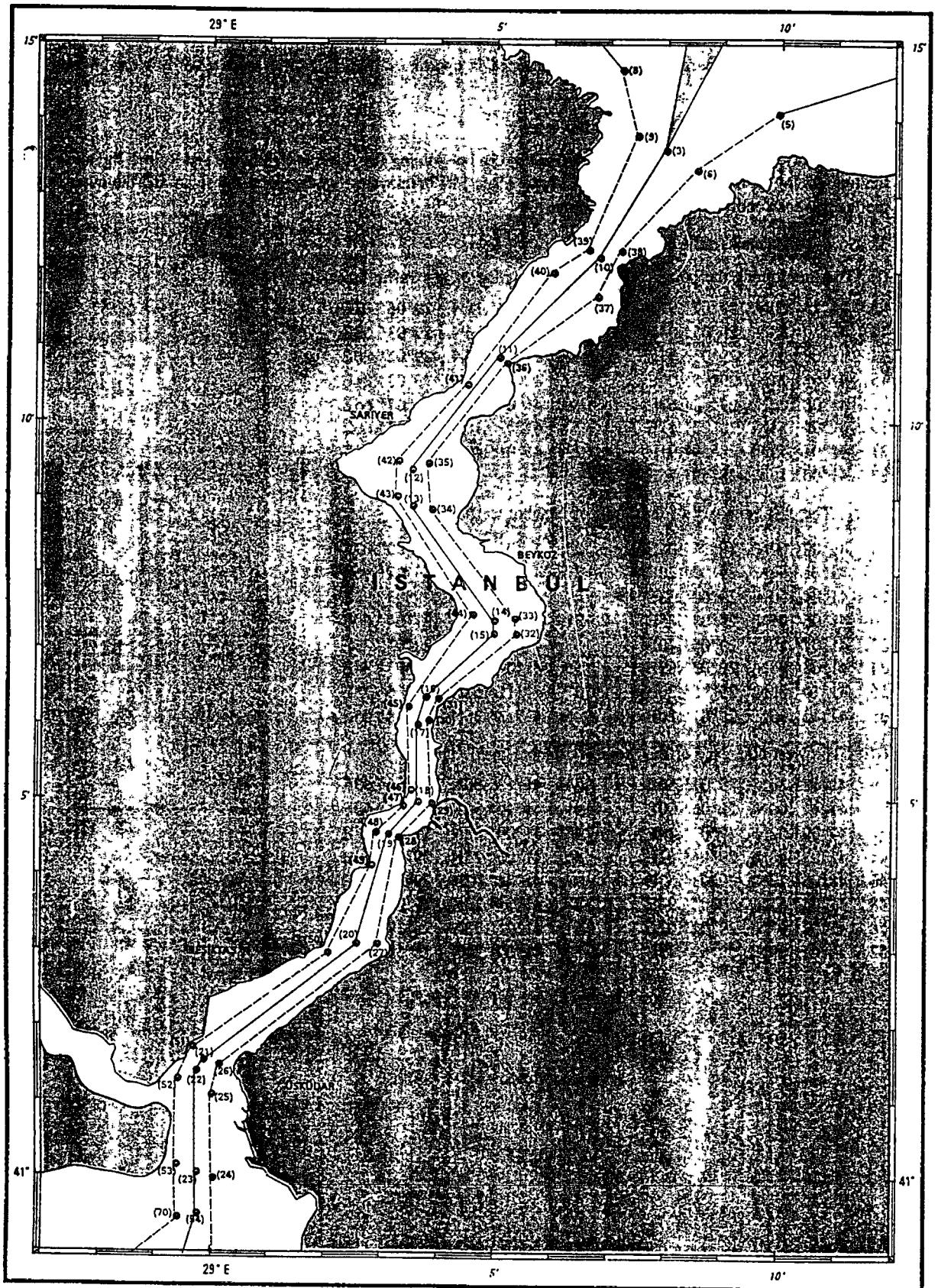
STRAIT OF ISTANBUL NORTH APPROACH

(Reference chart : Turkish chart 1811 (INT3758) 1993 edition.

Note : This chart is based on European Datum.)

Description of Traffic Separation Scheme :

- a) A north-south Traffic Separation Zone has been established with boundaries defined by the lines joining the points given below :
 - (1) 41°20'.50N., 29°09'.90E
 - (2) 41°20'.00N., 29°12'.50E
 - (3) 41°13'.60N., 29°07'.98E
- b) A traffic lane for north-west bound vessels has been established between the zone defined in paragraph (a) and the line joining the points given below :
 - (4) 41°15'.80N., 29°16'.90E
 - (5) 41°14'.10N., 29°10'.00E
 - (6) 41°13'.36N., 29°08'.55E
- c) A traffic lane for south and southwest bound traffic has been established between the zone defined in paragraph (a) and the line joining the points given below :
 - (7) 41°19'.40N., 29°02'.00E
 - (8) 41°14'.70N., 29°07'.20E
 - (9) 41°13'.80N., 29°07'.50E



STRAIT OF ISTANBUL

STRAIT OF ISTANBUL

(Reference charts : Turkish charts 2921 (INT3756) 1993 edition; 2921 A, 1992 edition; 2921 B, 1992 edition.

Note : These charts are based on European Datum.)

1. With the aim of separating transit traffic headed in opposite directions traffic lanes have been established in the Strait of Istanbul.

2. Description of Strait of İstanbul traffic lanes :

The traffic lanes encompass the area defined by the line joining the Anadolu lighthouse and Rumeli lighthouse in the north, the line joining Ahırkapı lighthouse and Kadıköy Cape İnci breakwater lighthouse in the south and the outer boundaries of the lanes whose coordinates are given below :

3. Strait of İstanbul traffic lanes :

(I) The line joining the points below is the centreline of the traffic lanes.

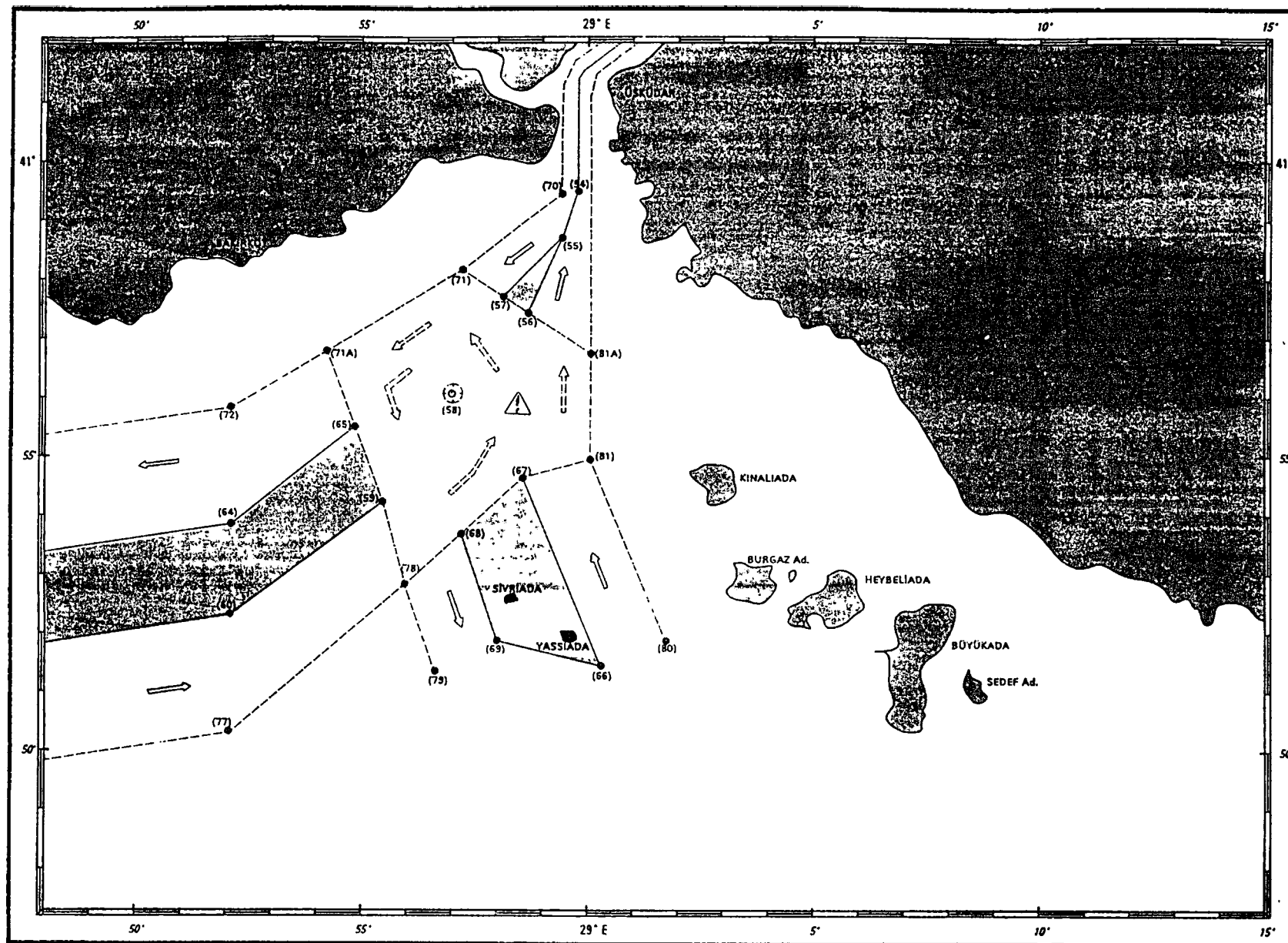
- | | |
|-----------------------------|-----------------------------|
| 3. 41°13'.60N., 29°07'.98E | 10. 41°12'.18N., 29°06'.83E |
| 11. 41°10'.88N., 29°05'.08E | 12. 41°09'.38N., 29°03'.53E |
| 13. 41°08'.92N., 29°03'.53E | 14. 41°07'.38N., 29°05'.00E |
| 15. 41°07'.21N., 29°05'.00E | 16. 41°06'.38N., 29°03'.81E |
| 17. 41°06'.00N., 29°03'.67E | 18. 41°04'.98N., 29°03'.65E |
| 19. 41°04'.53N., 29°03'.17E | 20. 41°03'.10N., 29°02'.60E |
| 21. 41°01'.55N., 28°59'.91E | 22. 41°01'.40N., 28°59'.80E |
| 23. 41°00'.15N., 28°59'.75E | |

(II) The east boundary of the Strait of İstanbul traffic lane.

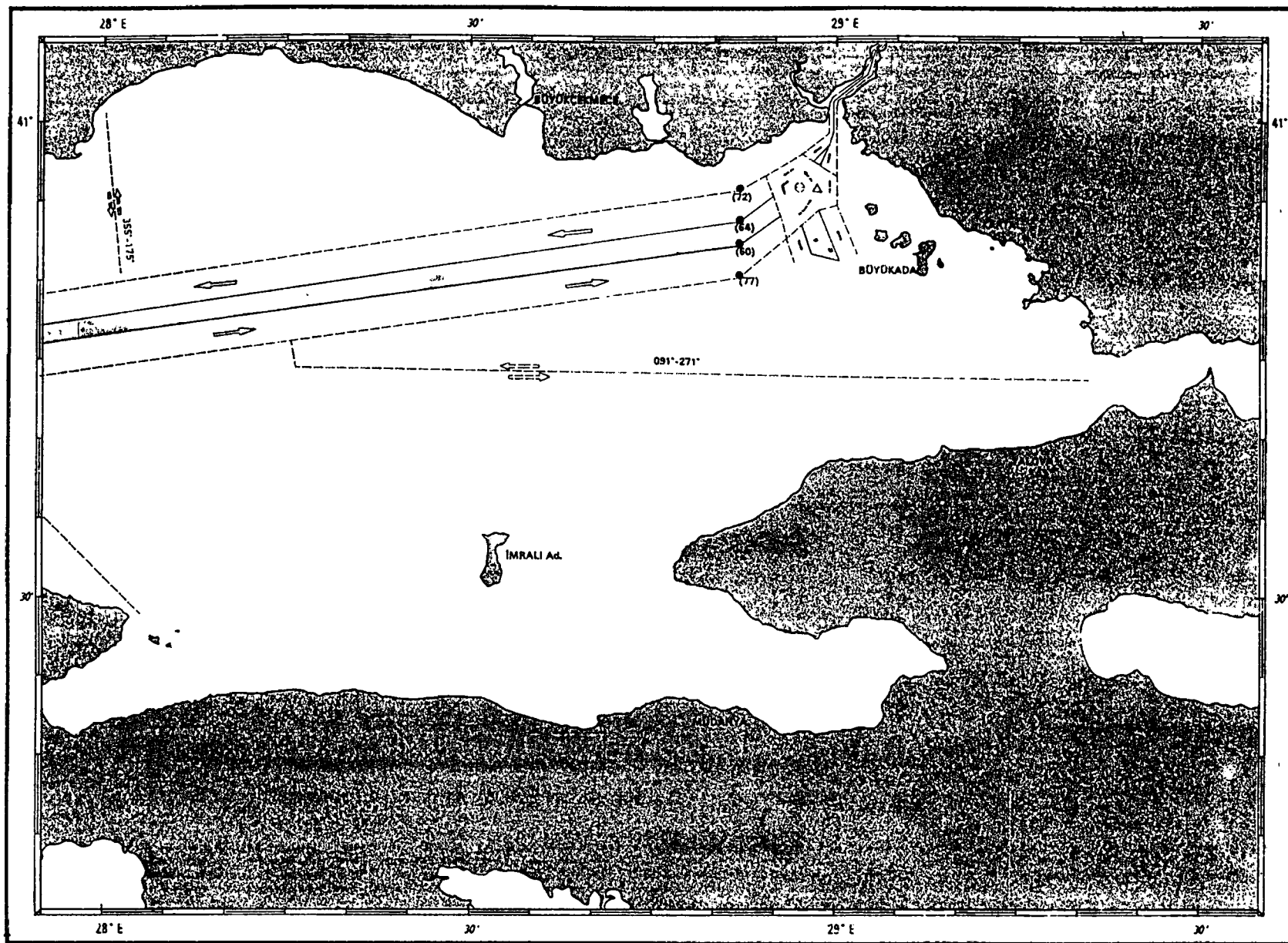
- | | |
|-----------------------------|-----------------------------|
| 24. 41°00'.00N., 29°00'.06E | 25. 41°01'.10N., 29°00'.07E |
| 26. 41°01'.50N., 29°00'.20E | 27. 41°03'.10N., 29°02'.96E |
| 28. 41°04'.50N., 29°03'.33E | 29. 41°04'.97N., 29°03'.92E |
| 30. 41°06'.05N., 29°03'.85E | 31. 41°06'.35N., 29°04'.00E |
| 32. 41°07'.20N., 29°05'.40E | 33. 41°07'.40N., 29°05'.35E |
| 34. 41°08'.85N., 29°03'.89E | 35. 41°09'.48N., 29°03'.84E |
| 36. 41°10'.80N., 29°05'.20E | 37. 41°11'.67N., 29°06'.78E |
| 38. 41°12'.30N., 29°07'.20E | 6. 41°13'.36N., 29°08'.55E |

(III) The west boundary of the Strait of İstanbul traffic lane.

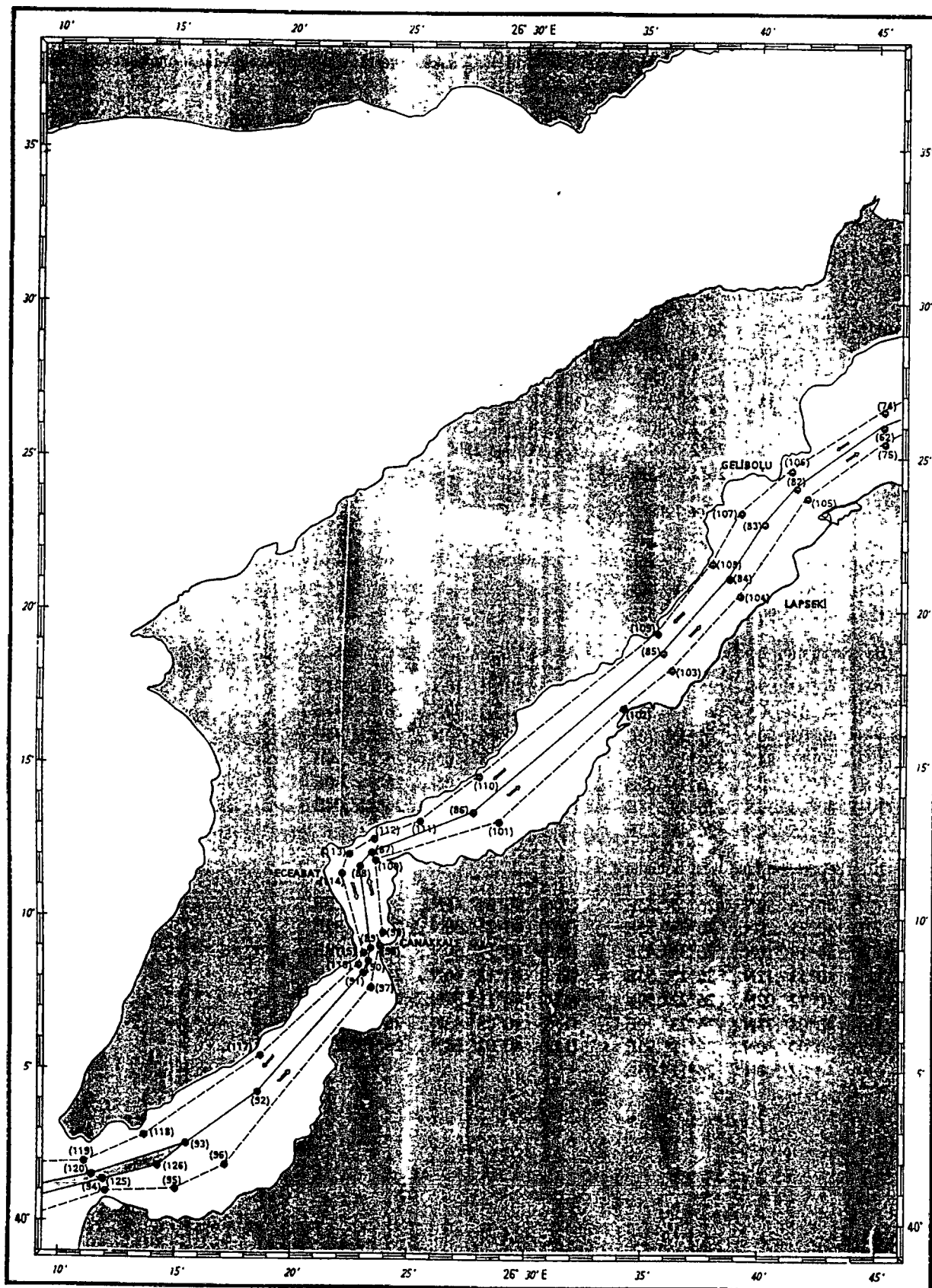
- | | |
|-----------------------------|-----------------------------|
| 9. 41°13'.80N., 29°07'.50E | 39. 41°12'.30N., 29°06'.63E |
| 40. 41°12'.00N., 29°06'.00E | 41. 41°10'.51N., 29°04'.50E |
| 42. 41°09'.52N., 29°03'.29E | 43. 41°09'.03N., 29°03'.27E |
| 44. 41°07'.48N., 29°04'.62E | 45. 41°06'.25N., 29°03'.50E |
| 46. 41°05'.13N., 29°03'.53E | 47. 41°04'.92N., 29°03'.40E |
| 48. 41°04'.57N., 29°02'.94E | 49. 41°04'.13N., 29°02'.85E |
| 50. 41°02'.97N., 29°02'.07E | 51. 41°01'.73N., 28°59'.73E |
| 52. 41°01'.29N., 28°59'.45E | 53. 41°00'.30N., 28°59'.42E |



STRAIT OF ISTANBUL SOUTH APPROACH AND SEA OF MARMARA



STRAIT OF ISTANBUL SOUTH APPROACH AND SEA OF MARMARA



STRAIT OF ÇANAKKALE

STRAIT OF ÇANAKKALE

(Reference chart : Turkish chart 212 (INT3750) 1991 edition.

Note : This chart is based on European Datum.)

1. A traffic lane has been established in the Strait of Çanakkale to separate traffic flowing in opposite directions.
2. Description of the Strait traffic lane :

The Strait of Çanakkale traffic lane is the area between the line joining Cape Mehmetçik lighthouse and Cape Kumkale lighthouse in the south-west, the line joining the Gelibolu lighthouse to the Çardak lighthouse in the north-east and the outer boundaries of the Strait of Çanakkale traffic lane whose coordinates are given below.

3. Strait of Çanakkale traffic lanes :

(I) The separation lane which is a continuation of the centreline and the south exit line.

(a) Centreline of the Strait :

(62) 40°26'.00N., 26°45'.25E	(82) 40°24'.05N., 26°41'.65E
(83) 40°22'.83N., 26°40'.21E	(84) 40°20'.90N., 26°38'.55E
(85) 40°18'.62N., 26°35'.88E	(86) 40°13'.40N., 26°27'.80E
(87) 40°12'.11N., 26°23'.50E	(88) 40°11'.63N., 26°22'.95E
(89) 40°09'.00N., 26°23'.40E	(90) 40°08'.55N., 26°23'.31E
(91) 40°08'.15N., 26°23'.09E	(92) 40°04'.25N., 26°18'.54E
(93) 40°02'.59N., 26°15'.45E	

(b) Traffic Separation Lane :

(93) 40°02'.59N., 26°15'.45E
(120) 40°01'.52N., 26°11'.18E
(125) 40°01'.28N., 26°11'.41E
(126) 40°01'.90N., 26°14'.32E

(II) Separation lane east boundary :

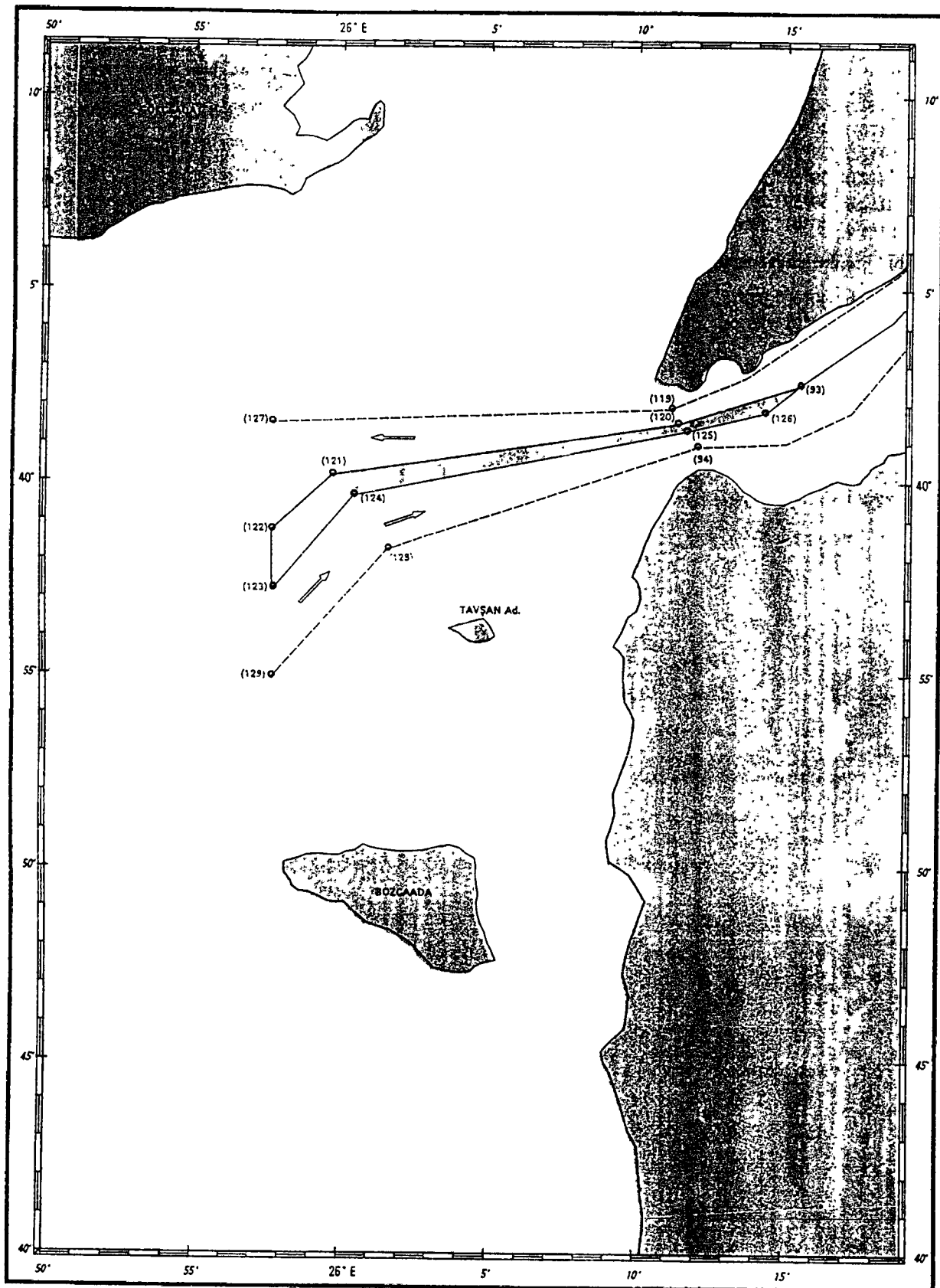
(94) 40°00'.99N., 26°11'.70E	(95) 40°01'.10N., 26°15'.01E
(96) 40°01'.90N., 26°17'.22E	(97) 40°07'.70N., 26°23'.48E
(98) 40°08'.90N., 26°23'.70E	(99) 40°09'.50N., 26°23'.95E
(100) 40°11'.84N., 26°23'.62E	(101) 40°13'.10N., 26°28'.90E
(102) 40°16'.90N., 26°34'.35E	(103) 40°18'.10N., 26°36'.30E
(104) 40°20'.50N., 26°39'.18E	(105) 40°23'.65N., 26°42'.04E
(75) 40°25'.50N., 26°45'.25E	

(III) Separation lane west boundary :

(74) 40°26'.50N., 26°45'.25E	(106) 40°24'.45N., 26°41'.20E
(107) 40°23'.20N., 26°39'.25E	(108) 40°21'.30N., 26°37'.82E
(109) 40°19'.10N., 26°35'.45E	(110) 40°14'.50N., 26°27'.88E
(111) 40°13'.12N., 26°25'.55E	(112) 40°12'.46N., 26°23'.31E
(113) 40°12'.02N., 26°22'.50E	(114) 40°11'.39N., 26°22'.19E
(115) 40°08'.73N., 26°23'.10E	(116) 40°08'.42N., 26°22'.91E
(117) 40°05'.60N., 26°18'.95E	(118) 40°02'.67N., 26°13'.24E
(119) 40°02'.00N., 26°11'.03E	



SEA OF MARMARA (CONT.)



STRAIT OF ÇANAKKALE SOUTH - EAST APPROACH

STRAIT OF ÇANAKKALE SOUTH-EAST APPROACH

(Reference charts : Turkish charts 2134, 1992 edition; 213, 1993 edition.

Note : These charts are based on European Datum.)

(a) A traffic separation zone has been established defined by the lines joining the points given below :

(120) 40°01'.52N., 26°11'.18E

(121) 40°00'.20N., 25°59'.70E

(122) 39°58'.80N., 25°57'.70E

→ (123) 39°57'.20N., 25°57'.70E

(124) 39°59'.70N., 26°00'.40E

(125) 40°01'.28N., 26°11'.41E

(b) For the north boundary of the separation zone given in paragraph (a) the following points need to be joined :

(119) 40°02'.00N., 26°11'.03E

(127) 40°01'.55N., 25°57'.70E

(c) For the south boundry of the separation zone given in paragraph (a) the following points need to be joined :

(94) 40°00'.99N., 26°11'.70E

(128) 39°58'.29N., 26°01'.60E

(129) 39°55'.00N., 25°57'.70E

APPENDIX 3

DRAFT ANNEX VTS GUIDELINES

Part I DEFINITIONS, SERVICES, COMMUNICATION, ORGANIZATION AND USERS

1. DEFINITIONS

- 1.1 A VTS is a service implemented by a competent authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service shall have the capability to interact with the traffic and respond to traffic situations developing in the VTS area.
- 1.2 The competent authority is the authority made responsible, in whole or in part, by the National Administration for the safety and efficiency of vessel traffic and the resulting protection of the environment in the area. Authority can be vested either directly or by delegation. The competent authority should:
 - .1 ensure that a legal basis for the operation of Vessel Traffic Services is in place and that the VTS is operated in accordance with national and international law;
 - .2 appoint a VTS authority and legally empower the VTS authority;
 - .3 set objectives for the VTS,
 - .4 determine the services and the levels to which these are to be provided;
 - .5 delineate the service area, declare it a VTS area and disseminate to mariners full details concerning the area and the scope of the operations;
 - .6 establish appropriate qualifications and training requirements for VTS operators, taking into consideration the type and level of services to be provided;
 - .7 make provisions for the training of VTS operators to the required level;
 - .8 instruct the VTS authority to operate the VTS in accordance with relevant IMO Resolutions, and
 - .9 establish appropriate standards for equipment.
- 1.3 The VTS Authority is the authority operating a VTS. It may include a governmental maritime administration, a single port authority, a pilotage organization or any combination of these. A VTS authority is responsible for:
 - .1 meeting the objectives of the VTS,
 - .2 meeting the standards set by the competent authority for levels of service and operators qualifications and equipment,
 - .4 that the VTS operates in conformity with relevant IMO Resolutions,
 - .5 that the effects of vessel traffic services are fully harmonized with routing measures, aids to navigation, pilotage, and port operations, and that maximum cooperation with these services is realized,
 - .6 that a continuous listening watch is kept and all published services are available during the operational hours of the VTS,A VTS authority should take into consideration:
 - .7 the requirements of participants and user groups, for example, through the installation of an Advisory Committee,
- 1.4 A VTS Operator is an appropriately qualified person performing one or more of tasks contributing to the services of the VTS.
- 1.5 The VTS area is the delineated, formally declared, service area of the VTS.
- 1.6 VTS Centres are centres from which the VTS is operated.
- 1.7 Allied Services are services actively involved in the passage of the vessel through the VTS area.

2. VESSEL TRAFFIC SERVICES

The services of VTS as an organization are directed at the vessel traffic and, in support of this, at shore-based parties having an interest in the safety and efficiency of the traffic, the protection of the environment or other issues of affecting national interest.

Full particulars of the VTS, including the services rendered and the mode and area in which they are available, should be publicized and promulgated. Publications should include all particulars on the classes of vessels which are required or recommended to participate, reporting points, the procedures to be followed and the rules and regulations in force. In this respect, attention is drawn to MSC circular 586, on the IALA/IAPH/IMPA World VTS Guide.

2.1 Information Service is a service to ensure that essential information is in time available to the on board navigational decision making. This information may concern:

- vessel traffic with respect to positions, identities, intentions and destinations, or
- the VTS area regarding amendments or changes to promulgated information on boundaries, procedures, radio channels or frequencies, reporting points etc., or
- variables that influence the navigation of vessels, such as meteo-hydrological information, visibility, notices to mariners, status of nav aids, special transports, traffic congestion or other potential hindrances.

Information is normally provided to the general traffic, by broadcasting at fixed times, at regular intervals or at any other time when deemed necessary by the VTS. Information can also be given to a particular vessel on request of that vessel or when deemed necessary by the VTS. A broadcast will normally contain warnings or other information of importance to all vessels, including small craft or inland traffic participating in the VTS by only keeping a listening watch. Information to an individual vessel is given as needed and will contain aspects relevant to that particular vessel.

2.2 Navigational Assistance Service is a service to assist the on board navigation decision making and to monitor the effects, especially in difficult navigational or meteorological circumstances or in case of defects or deficiencies. This service consists of navigational information relating to a particular vessel and may include warnings and navigational advice, as long as it is not the intent to direct the course to be steered or engine manoeuvres to be executed. The VTS can participate in the on board decision making process by giving:

- .1 Navigational information relating to course made good and speed made good of a vessel; position relative to fairway axis and way-points, or the positions, identity and intentions of the surrounding traffic.
- .2 Warnings to prevent collisions and groundings.
- .3 Navigational advice relating to tracks and routes to be followed.

The Competent Authority should be aware of the distinction between navigational information and navigational advice and should determine whether navigational advice can and may be given from the shore, and if so, under what circumstances,

by whom and to what extent. Navigational assistance is given at the request of the vessel or if deemed necessary by the VTS and can only be given if positive identification has been established and can be maintained during the process. The communication should be conducted in accordance with established operational procedures which should include fall-back procedures in case of disrupted communication. The beginning and the end of navigational assistance should be clearly stated by the vessel or the VTS and acknowledged by the other party. Communications should state whether a message to the ship contains information, advice, or a warning. Messages should be sent and updated at appropriate intervals.

- 2.3 Traffic Organization Service is a service to prevent the development of dangerous situations and to provide for the safe and efficient movement of traffic within the VTS area. Traffic organization concerns the forward planning of movements and is particularly relevant in times of congestion or when the movement of special transports may affect the flow of other traffic. Monitoring the traffic and enforcing adherence to governing rules and regulations is an integral part of traffic organization.

The service may include establishing and operating a system of traffic clearances in relation to the priority of movements, the allocation of space, mandatory reporting of movements, establishing routes to be followed, speed limits to be observed or other appropriate measures which are considered necessary by the VTS authority. Where the VTS is authorized to issue instructions to vessels, the instructions should be result oriented only, leaving the details of execution to the vessel.

Sailing plans are an instrument of traffic organization and as such are a major source of information to the VTS. They should:

- .1 be agreed mutually between the vessel and the VTS;
- .2 contain the ETA at the VTS area or ETD from the berth;
- .3 be adhered to as far as practicable;
- .4 be monitored by the VTS and the vessel during the execution of the plan;
- .5 be promulgated where the general flow of traffic is affected.

With regard to the formulation of sailing plans the VTS Authority should:

- .6 distinguish between those established for efficiency reasons and those established for safety reasons;
- .7 state which categories of vessels are required to submit a sailing plan, specify the information required and state whether additional information is required from special categories of vessels.

The VTS or the vessel may advise changes to the plan to account for traffic situations. In exceptional circumstances, the sailing plan may be amplified at the request of the VTS.

- 2.4 Cooperation with allied services and other interested parties involves the VTS's cooperation with allied services, adjacent VTS and emergency services in order to increase the effectiveness of all the services without adding to the reporting burden of vessels. It may also include the provision of data to parties requiring information related to matters of national interest. This may be achieved through data exchange, common use of databases and action agreements between the parties.

Cooperation with allied services is both safety and efficiency oriented. It should be

a continuous process and is of particular importance in cases where a sailing plan is to be established and action agreements with allied services are required. Procedures for this cooperation between parties should be established. Cooperation with port operations is primarily efficiency oriented but could be an important factor in establishing a sailing plan.

Cooperation between VTSs may concern VTSs with common borders where, if a sailing plan is to be established, an action agreement is essential. If the VTSs are divided by a sea area it should be recognized that the exchange of data between such VTSs could include reciprocal advance notice of arrivals, thus relieving the reporting burden of vessels. It could also provide an administration with valuable information on traffic and cargo flows in the intermediate sea area, which may be useful in preparing for environmental emergencies.

Incidental cooperation with emergency services such as search and rescue and pollution response should be conducted in accordance with preestablished contingency plans in which the procedures for the cooperation are laid down and responsibilities delineated.

Support of national information requirements should be duly authorized and conducted in accordance with preestablished procedures.

3. COMMUNICATION

Communication is the link between VTS and the User. Communication should, for that reason, be clear and simple and should contain only essential information in order to avoid imposing an undue burden on masters, officers of the watch and pilots. Due attention should be given to the character of the message and the mode of transmission. When detailed and extensive information has to be exchanged with one vessel, which is not relevant to other vessels, the VTS may decide to communicate with that vessel using alternative frequencies or methods, providing a continuous listening watch on the promulgated working channel can be maintained.

- 3.1 Reliability of communication and the availability of communication frequencies must be assured. The process of communication in a VTS must under all circumstances be reliable.

Communication should, even under severe weather circumstances, be free from interference from adjacent VTS or other parties using the same frequencies. The number of VTS sectors should be kept to a minimum, taking into consideration the traffic density and the characteristics of the fairway. Every sector should have a communication frequency assigned. If duplex frequencies are used, the VTS authority should consider retransmitting communications from participating vessels, thereby enabling all vessels to update their perception of the surrounding traffic and the fairway situation, the so-called on board traffic image. Fall back procedures in the case of communication breakdown should be established.

- 3.2 Communication should be conducted in conformance with IMO Resolution A 648(16) on Ship Reporting, using message markers in accordance with IMO Resolution A 380(x) on the use of the Standard Marine Vocabulary (SMV), and ITU (International Telecommunication Union) communication procedures.

- 3.3 The VTS and vessels should be alert to the problems inherent in verbal communications. Confirmation should be requested whenever doubt exists with

regard to a vessel's identity or manoeuvres to be carried out. Any VTS message directed to an individual vessel should make it clear whether it contains information, advice or instructions. The language used should enable the VTS and the vessel to understand each other clearly. English, using SMV, should be used in straits used for international navigation and where language difficulties exist, in particular when requested by the master or the VTS operator. In local or inland areas the primary language may be the appropriate working language of the country in which the VTS is situated. The reliability of communications will increase when a pilot is on board the vessel.

3.4 When composing a message, attention should be given to the following elements:

- the addressee or addressees,
- the priority of the message,
- the method of distribution,
- the objective of the message,
- the origin of the message, and
- the repetition rate of messages, whether incidental or periodical.

3.5 At present, VHF telephony is commonly used for VTS communication. VTS authorities should remain alert to the development of modern, non-verbal methods of data transfer which may reduce language difficulties and have great potential for identification, polling, tracking, automatic reporting and reducing the vessels reporting burden. Automated data transfer has the capability to reduce the risks involved with verbal communication and relieve congested VHF frequencies.

4. ORGANIZATION

A VTS is a data-processing system that applies three basic elements; man, machine and method, to perform certain tasks essential to the provision of services. Like all data processing systems, a VTS collects, evaluates and disseminates information. A VTS should at all times be capable of generating a comprehensive overview of the traffic in its service area combined with all traffic influencing factors. The VTS should be able to obtain, either by plotting or by monitoring and labeling, full information about each participating vessel and its intentions. This so-called traffic image is the basis for the VTS capability to respond to traffic situations developing in the VTS area. It allows the VTS operator to evaluate situations and make decisions accordingly. The accuracy and comprehension of the traffic image should be in relation to the VTS services to be provided.

4.1 Tasks to be performed:

4.1.1 Data collection with the main objective to compile the traffic image. This includes:

- data on the fairway situation, such as meteorological and hydrological conditions and operational state of aids to navigation;
- data on the traffic situation, such as vessel positions, movements, identities and intentions with respect to maneuvers, destination and routing;
- data on vessel conditions with regard to cargo carried and the state of hull and machinery, and
- data on equipment and manning.

Data may be gathered by hydro/meteo sensors, remote control systems, radar, VHF, VHF/DF, ships reports, radiotransponders, databases connected to the VTS and from cooperation with allied services and adjacent VTS's. Where automatic tracking facilities are not available, regular position reports may be required from

vessels.

4.1.2 Data evaluation

The assembled traffic image should be evaluated to determine if action from the VTS is required and, if so, to decide on appropriate action.

4.1.3 Data dissemination

Conclusions resulting from the data evaluation will need to be communicated to users. This task requires decisions on the composition and character of the message, the selection of the transmission mode and other decisions aimed at obtaining the desired results.

4.2 Elements

In order to perform these tasks a VTS organisation requires a number of staff, housing, instrumentation and procedures governing operations and interactions between the various elements. The requirements in each field are to a great extent determined by the level of service that is to be provided by the VTS. Additional resources in the fields of management, maintenance, repair and security are required to sustain and maintain the desired level of reliability and availability.

4.2.1 The operator and his level of qualifications and training.

The competent authority should establish appropriate training and qualifications standards for VTS operators in accordance with the objectives of the VTS and the services to be provided. Where navigational assistance service is provided, the VTS authority should take into consideration the extent to which this service can and may be given by the VTS. A distinction should be made between the provision of navigational information, being the relay of information extracted from the VTS sensors and the traffic image, and the provision of navigational advice where a professional opinion is included.

4.2.2 Housing and Instrumentation, including Software

In order to interact with the vessel traffic, the VTS should be equipped with communication facilities appropriate to the size of the VTS area, the density of traffic and the services provided. The VTS should be assigned the necessary number of appropriate frequencies, as prescribed in appendix 18 of the Radio Regulations, including international distress, safety and calling frequencies. Backup communication equipment and power should be installed. In accordance with 3.1 the VTS authority should make provisions for retransmitting communications from vessels when duplex frequencies are in use. In order to have the capability to respond to traffic situations developing in the VTS area, the VTS should be equipped with instrumentation which permits the compilation of a Traffic Image adequate to the needs of the internal decision making.

A database may be considered an essential element of VTS. This database should have the capability to retain, update and supplement reported information. VTS authorities should consider on-line interfaces with allied services and adjacent VTS.

The type and level of service to be provided, especially the navigational assistance service, determines to a great extent the level of accuracy and reliability required

for the compilation of the traffic image as the basis for decision making. In this context, the VTS Authority should consider hardware and software requirements in the fields of: identification, automatic position reporting, plotting/tracking, monitoring, recording communications and radar images, and interfaces with other communication networks.

4.2.3. Operating Procedures

A distinction should be made between internal and external procedures. Internal procedures address operating instruments, interactions among the staff and the internal routing and distribution of data. External procedures govern the interactions with users and allied services. A further distinction could be made for procedures governing the daily routine and procedures governing contingency planning such as search and rescue and environmental protection activities.

All operational procedures, routine or contingency, should be laid down in handbooks/manuals and be an integral part of regular training exercises. Adherence to procedures should be monitored.

5. PARTICIPANTS AND USERS

5.1 Vessels participating in the VTS:

Vessels navigating in an area where vessel traffic services are provided should make use of these services. Depending upon governing rules and regulations, participation in a VTS can be mandatory or voluntary. Within this context participation can take the form of:

- only keeping a listening watch for small craft or inland traffic,
- identification and reporting upon entry and at regular intervals or when passing established reporting points, or
- full participation by calling upon services available.

Vessels are reminded that decisions concerning the actual navigation and the manoeuvring of the vessel remain with the master. Neither a sailing plan, nor requested or instructed changes to the sailing plan can supersede the decisions of the master concerning the actual navigation and manoeuvring of the vessel. Care should be taken that VTS operations do not encroach upon the masters responsibilities for the safe navigation of the vessel, or disturb the traditional relationship between the master and the pilot.

If voluntary or compulsory pilotage exists in the VTS area, pilotage plays an important role in such a VTS. The function of a pilot is to provide the master with:

- navigational advice with respect to the navigation on board;
- assistance in manoeuvring his vessel;
- local knowledge concerning both navigation and national and local regulations;
- assistance with vessel/shore communications, particularly where there are language difficulties, and to provide the VTS with:
- relevant information concerning the vessel and her direct environment.

Communication with the VTS and other vessels should be conducted on the assigned frequencies in accordance with established ITU procedures, in particular where a communication concerns intended manoeuvres. VTS procedures should stipulate what communications are required and which frequencies have to be monitored.

1974 SOLAS Convention vessels that are participating in a VTS will be fitted with navigational and communication equipment in accordance with Chapters IV and V of that Convention, as amended. Depending upon local regulations, additional

equipment for communication, identification and/or tracking purposes may be required or recommended in order for the vessel to obtain maximum benefit from the services provided by the VTS.

Vessels should carry publications giving full particulars on governing rules and regulations regarding identification, reporting and/or conduct on the VTS area to be entered. In this respect, attention is drawn to the IALA/IAPH/IMPA World VTS Guide, as recommended by IMO in MSC circular 586.

Prior to entering the VTS area, vessels should make all required reports, including reporting of deficiencies. During their passage through the VTS area, vessels should adhere to governing rules and regulations, maintain a continuous listening watch on the assigned frequency and report deviations from the agreed sailing plan.

5.2 Shore-based Parties.

Allied services, adjacent VTSs and emergency services may, on a reciprocal basis, have full or restricted access to VTS data. Any exchange or provision of information should be duly authorized, governed by national legislation on privacy if in force and should be conducted in accordance with preestablished procedures. These procedures should include: content, format, data exchange protocols and corresponding technical means. The level of reliability of the information should be in direct relation to the importance of the purpose for which the information is supplied.

Allied services require VTS data for coordinating their actions that are directed at the safe and efficient passage of the vessel through the VTS area and for better resource planning.

The exchange of data with adjacent VTS may be required for the forward planning of movements and may reduce the volume of ship-reporting and relieve congested VHF frequencies.

Emergency services may require VTS data in the event of, or in preparation for, emergency situations.

Under certain circumstances, other parties may request VTS data for reasons of local, national or commercial interest.

II WHEN TO IMPLEMENT VTS

An authority ultimately responsible for the safety and efficiency of marine traffic and the protection of the environment in a certain area, may need to influence the behavior of the traffic or to exercise some form of traffic management. To this purpose, governments have, over the years, developed a number of instruments which can either be categorized as measures or as facilities. Measures tend to be of a restrictive or regulatory nature, in the sense that adherence is mandatory. However, the use of facilities placed at the disposal of the mariner is optional. A great number of measures, covering a wide spectrum of maritime issues, have been internationally agreed and formalized in IMO Conventions, such as SOLAS, COLREG and MARPOL.

Traffic separation schemes (TSS), compulsory pilotage, ship reporting systems (SRS) and other behavioral rules and regulations are examples of measures taken for the express purpose of traffic management. Lighthouses, marine marking systems, information services, voluntary pilotage and radio navigation systems on the other hand should be regarded as facilities that are put at the disposal of the mariner to assist in the on board navigational decision making.

The process of navigation should be regarded as a continuous selection process where one course of action is selected from a number of alternatives. Both measures and facilities aim to influence or contribute to this shipboard decision making process. Measures as well as facilities can be used in isolation or in a certain mix which has been carefully adapted to the local requirements. Local needs for traffic management should be carefully investigated and determined by analysing casualties, assessing risks and consulting local user groups. Where the risks are considered VTS addressable, in cases where monitoring of the traffic and interaction between Authority and User is believed to be essential, the implementation of VTS, as the ultimate traffic management instrument, should be considered.

From this introduction it may be concluded that a VTS is particularly appropriate in the approaches to a port, in its access channels and in areas having one or more of the following characteristics:

- high traffic density,
- traffic carrying noxious or dangerous cargoes,
- narrow channels,
- environmental sensitivities.

Bearing in mind the characteristics of the area under consideration, an Administration may wish to make a distinction in the objectives of a harbour VTS, where both safety and efficiency of the traffic in the harbour approaches may be the prime consideration, or a coastal VTS where the safety of vessels passing through, or past, environmentally sensitive areas is the deciding factor.

III PLANNING A VTS

An Authority considering the implementation of VTS is recommended to follow, to the extent practicable, the following procedures:

1. Identify problem areas in the port, coastal area or waterway through:
 - 1.1 conducting efficiency evaluations,
 - 1.2 analyzing casualty statistics and near-miss reports,
 - 1.3 interviews with involved and affected parties,
 - 1.4 risk assessment techniques or simulation models to augment the above or in cases where previous experience is not available, and
 - 1.5 identifying particularly sensitive marine environments or wildlife habitats.
2. Identify probable cause(s), such as:
 - 2.1 inefficient use of resources,
 - 2.2 complex navigation,
 - 2.3 hydrological/meteorological aspects,
 - 2.4 communication difficulties,
 - 2.5 interactions between vessels or between vessels and other classes of vessels,
 - 2.6 particularly hazardous or noxious cargo,
 - 2.7 congested fairways/cross traffic,
3. Identify parties directly involved with or dependent upon marine traffic, such as:
 - 3.1 port authorities, other government agencies, mariners, pilots, tugs, customs and immigration, health authorities, fishing interests, recreational users, environmentalists, search and rescue organizations, neighboring VTSs, and
 - 3.2 port resources, stevedores, transport and expedition.
4. With input from the affected parties, list possible solutions to the identified problems or deficiencies, estimate the impacts the solutions will have on traffic and on the users, and determine their respective cost. The use of simulation models to verify estimates may be considered.
5. Determine if the identified problems or deficiencies can be reduced to acceptable levels using the traditional traffic management instruments. Analyze the cost/benefit considerations to determine which problems can be addressed by VTS for a reasonable and justified investment.

Determine a source for funding for the initial installation investment and the means to provide funds for the continued operation of the VTS.

The implementation of a VTS is not only a considerable investment, but it is also a time-consuming process requiring expertise in many fields which may not be always available in an operational organization. When the use of external expertise is considered, it is essential that the organizational framework and the operational objectives of the VTS are clearly defined beforehand by the Administration concerned. Once the Administration has reached the decision to implement a VTS, the following steps should be taken:
6. Establish the objectives of the VTS with respect to the class or classes of vessels concerned, and whether the waterway is a port, a coastal zone or an internal transit waterway. Objectives should address the specific problems to be solved or deficiencies to be corrected.

7. Investigate international conventions and national legislation on aspects of:

- 7.1 designating a VTS area;
- 7.2 exercising authority over such an area;
- 7.3 the need for mandatory participation;
- 7.4 accepting liability, especially with respect to the provision of navigational information or advice;
- 7.5 the authority to establish special rules, regulations or carriage requirements, and
- 7.6 qualification and training requirements for the VTS operators.

8. Appoint the VTS authority and consider the extent to which further implementing steps should be delegated.

9. Delineate and establish the service area of the VTS and declare it a VTS area in accordance with national and international law or conventions.

10. Determine the services to be provided and the levels of reliability and availability needed to achieve the objectives.

11. Analyze and describe the tasks to be performed in order to meet the stated service level objectives, maintain consistency and provide the predetermined levels of reliability and availability.

In this respect, the need for supporting activities in the fields of equipment installation and maintenance, management, staffing, training and procedures should be addressed.

12. Determine the optimum siting for the VTS with regard to:

- 12.1 traffic routes, anchorages and port facilities
- 12.2 location of the vessel traffic center(s)
- 12.3 siting of sensors
- 12.4 communication facilities
- 12.5 service areas and sector boundaries

The location of area and sector boundaries should be carefully selected to facilitate safe hand-over procedures between VTS operator positions with minimum distraction to the vessel.

13 Select methods of ship to shore communication, surveillance and data presentation and processing. To the extent possible, acquire exclusive rights to voice and data communication frequencies taking into consideration the danger of interference from frequencies in use at other VTS centers within the reception radius and under extreme weather conditions. Equipment capable of automated vessel identification and tracking should be employed where feasible to minimize the reporting burden on vessels and reduce congestion of radio frequencies. Vessel traffic center hardware and software should be designed to present information to the VTS operator in a manner that is reliable, clearly understood and capable of readily providing data exchange with other parties.

14 Determine the space requirements for the VTS centre with respect to:

- 14.1 the number and configuration of operator positions,
- 14.2 administrative space,
- 14.3 visitors' accommodation,

- 14.4 equipment maintenance,
- 14.5 operators' training,
- 14.6 crew comfort, and
- 14.7 cooperation with allied services, emergency services and support of other parties

- 15. Acquire the necessary real estate and acquire and install hardware and software.
- 16. Staff the VTS with operators, supervisors and support personnel based on the required numbers, qualifications and training necessary to perform the predetermined tasks.
MSC Circular 578 refers
- 17. Establish operating procedures that account for routine and emergency situations. Internal procedures should be promulgated for VTS personnel to assist them in responding to incidents likely to be encountered. External procedures addressing routine and emergency situations should be developed and agreed upon in concert with the individuals and organizations that are likely to be effected by an incident.
- 18. Develop a training doctrine and establish training facilities. It may be appropriate to consider a national VTS training program and setting national qualification and training standards for VTS operators.
- 19. Establish administrative standards and policy.
- 20. Disseminate information concerning the VTS in recognized publications and by all other means available.