The Need and Necessity for the M/S Sigyn's Advanced Communication and Navigation Systems, Adapted for Marine Transport of Radioactive Materials

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INTRODUCTION

As far back as 1978, the Swedish Nuclear Fuel and Waste Management Co, SKB, decided to design and develop an integrated marine transport system, ISTS, a system that would meet the transportation needs of the Swedish nuclear power plants for the present and for the future, a system that would satisfy all the requirements and expectations that the principals, public authorities and the general public could have in respect of SKB.The system as conceived was at that time, and is still today, unique. Despite the fact that the highest safety standards were applied, it was completed, though not entirely finalized, in 1982.

Pending completion of the central interim storage facility for spent fuel, CLAB, some shipments were sent during the years 1983-1984 to the reprocessing plant at La Hague in France, but from the summer of 1985, when CLAB was ready for operation, the fuel shipments have mainly been to Swedish facilities. Since the final repository for low- and intermediate-level waste was commissioned in the spring of 1988, the entire transportation system has been finished and operational. The principle transport routes for M/S Sigyn are shown in figure 1.

The ISTS consists of a specially designed ship, M/S Sigyn, ten transport casks for spent fuel, two casks for core components and five terminal vehicles for local transport at CLAB, reactor sites and SFR. Specially designed containers are used for the transport of reactor waste from the reactor sites to SFR. The ISTS is now in routine operation with about 30 trips with M/S Sigyn every year. On the average, 15 of these are used for fuel and the rest for ILW container shipments.

M/S SIGYN

M/S Sigyn was designed by Salen Tecyhnologies AB (Saltech) and built by the French shipyard Societe Nouvelle des Ateliers et Chantiers du Havre, ACH. She was ordered in January 1981 and delivered in October 1982.

She is specially designed for transport of spent fuel and radioactive waste and meets IMO regulations for type I ship. Accordingly, she has a double bottom and a double hull, Machinery and electrical equipment are duplicated. The ship is a combined roll-on/roll-off and lift-on/lift-off vessel.

Normally the roll-on/roll-off system is used. The fuel casks and waste containers for ILW are to be secured to the deck of the cargo hold by means of simple and robust locking devices.

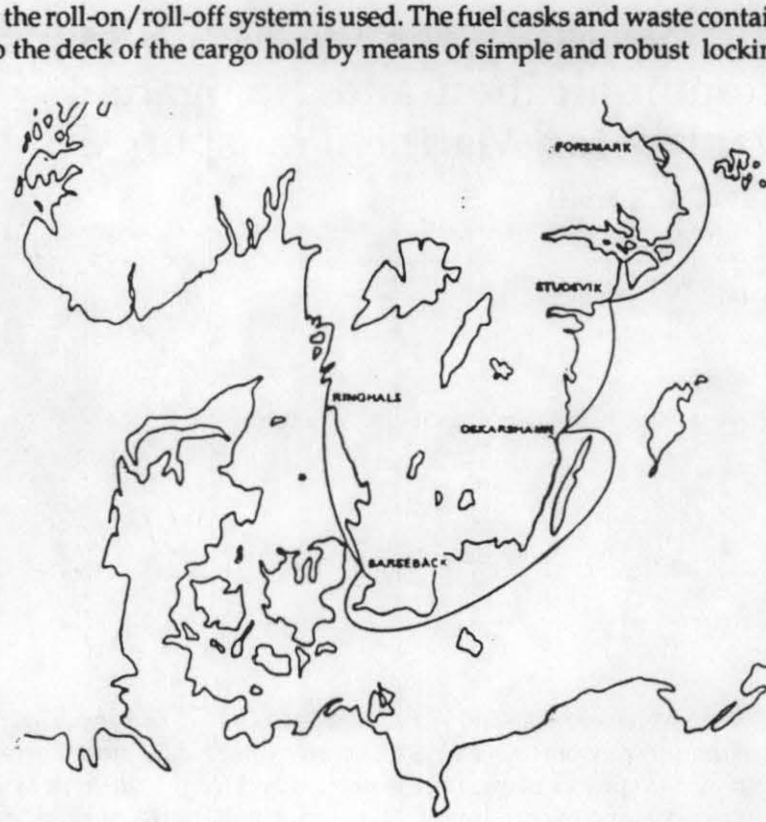


Figure 1. Principle transport routes for spent fuel and radioactive waste.

The single hold is 57 m in length with a free breadth of 10 m and a free hieght of 5.6 m and can accommodate 10 fuel casks or 10 ILW containers or a combination of fuel casks and ILW containers. 10 ISO containers with low level waste can also be transported at the same time in the aft of the hold.

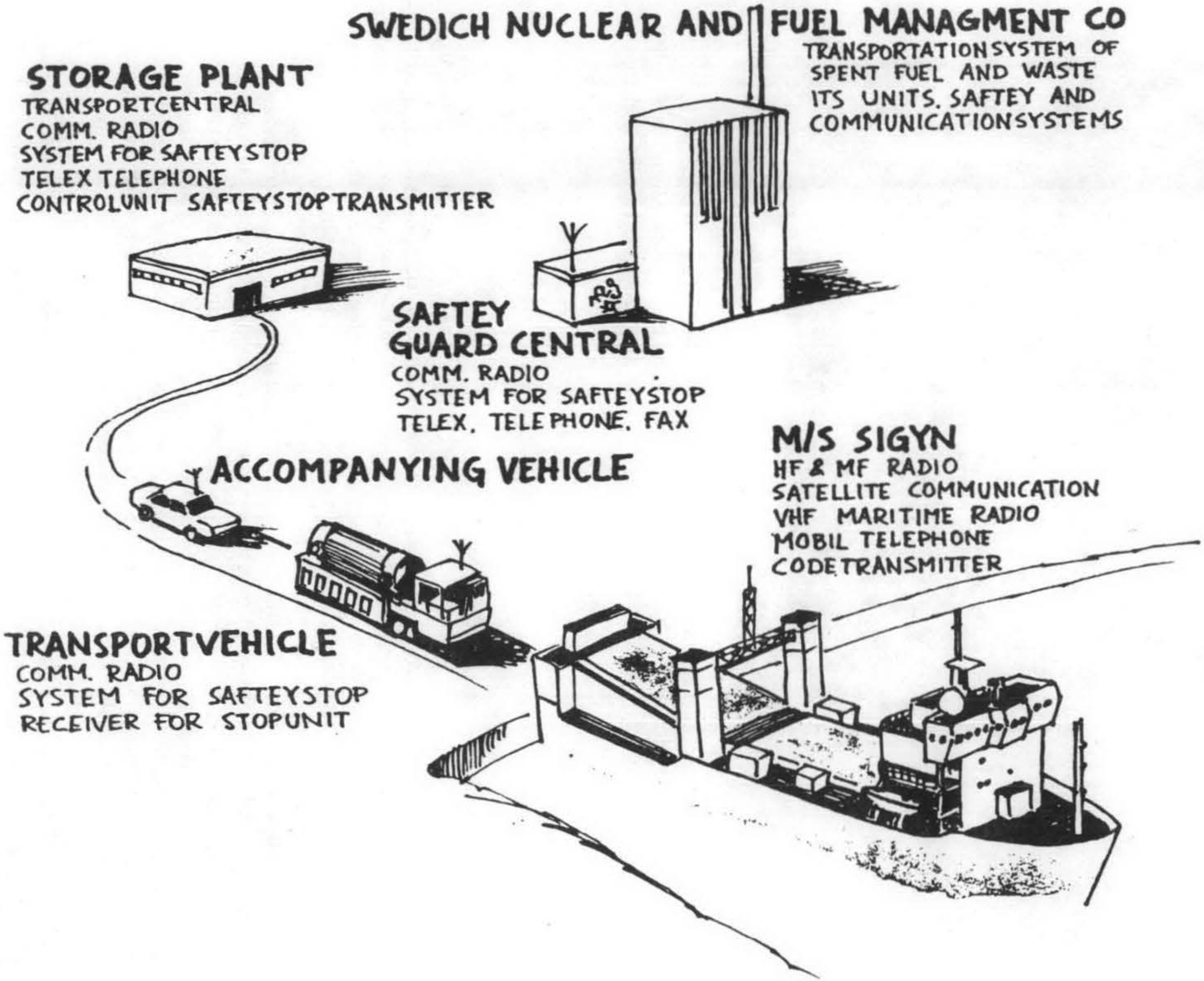
Main data for M/S Sigyn are given below:

- Overall length	90.60 m	- Dead weight, max	2 044 tonnes
- Length	82.07 m	- Cargo capacity	1 200 tonnes
- Breadth moulded	18.00 m	- Machinery output	2 x 1 170 kW
- Draught fuel loaded	4.00 m	- Speed	12.5 knots
- Depth moulded	6.65 m	- Cruising range	23 days or 6 000 nautical miles

Designing for anticipated disturbances and accidents has been a very important aspect in the design of the differnt parts of the transportation system. The aim has been to minimize the impact on the overall safety of the system by means of e.g.

- light buoys
- pingers
- lifting devices
- stop radio function (on vehicles)

The transportation system for spent fuel and waste-its units, safety and communication system are shown in figure 2. M/S Sigyn is shown in figure 3.


SWEDICH NUCLEAR AND FUEL MANAGMENT CO
TRANSPORTATION SYSTEM OF SPENT FUEL AND WASTE ITS UNITS, SAFTEY AND COMMUNICATIONSYSTEMS
STORAGE PLANT
TRANSPORTCENTRAL
COMM. RADIO
SYSTEM FOR SAFTEYSTOP
TELEX TELEPHONE
CONTROLUNIT SAFTEYSTOPTRANSMITTER
SAFTEY GUARD CENTRAL
COMM. RADIO
SYSTEM FOR SAFTEYSTOP
TELEX, TELEPHONE, FAX
M/S SIGYN
HF & MF RADIO
SATELLITE COMMUNICATION
VHF MARITIME RADIO
MOBIL TELEPHONE
CODETRANSMITTER
ACCOMPANYING VEHICLE
TRANSPORTVEHICLE
COMM. RADIO
SYSTEM FOR SAFTEYSTOP
RECEIVER FOR STOPUNIT

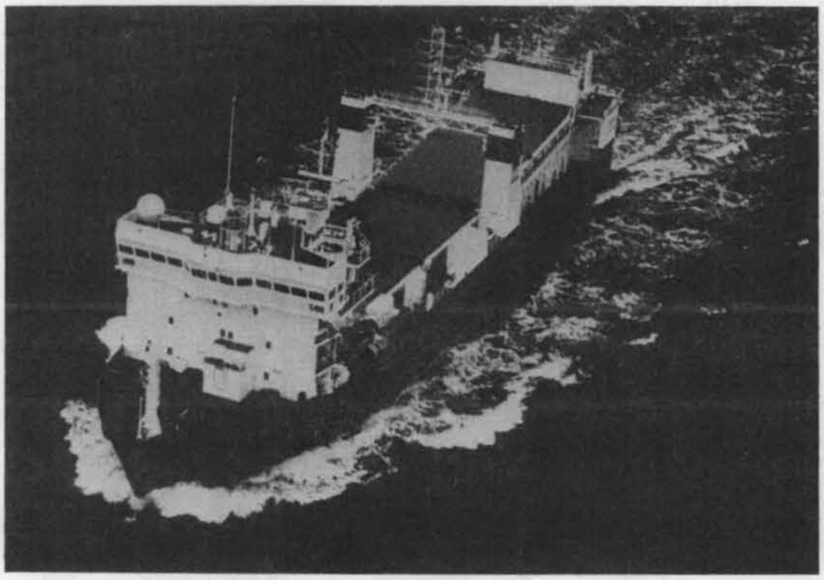


Figure 3 M/S Sigyn

COMMUNICATTION SYSTEMS AND ROUTINES

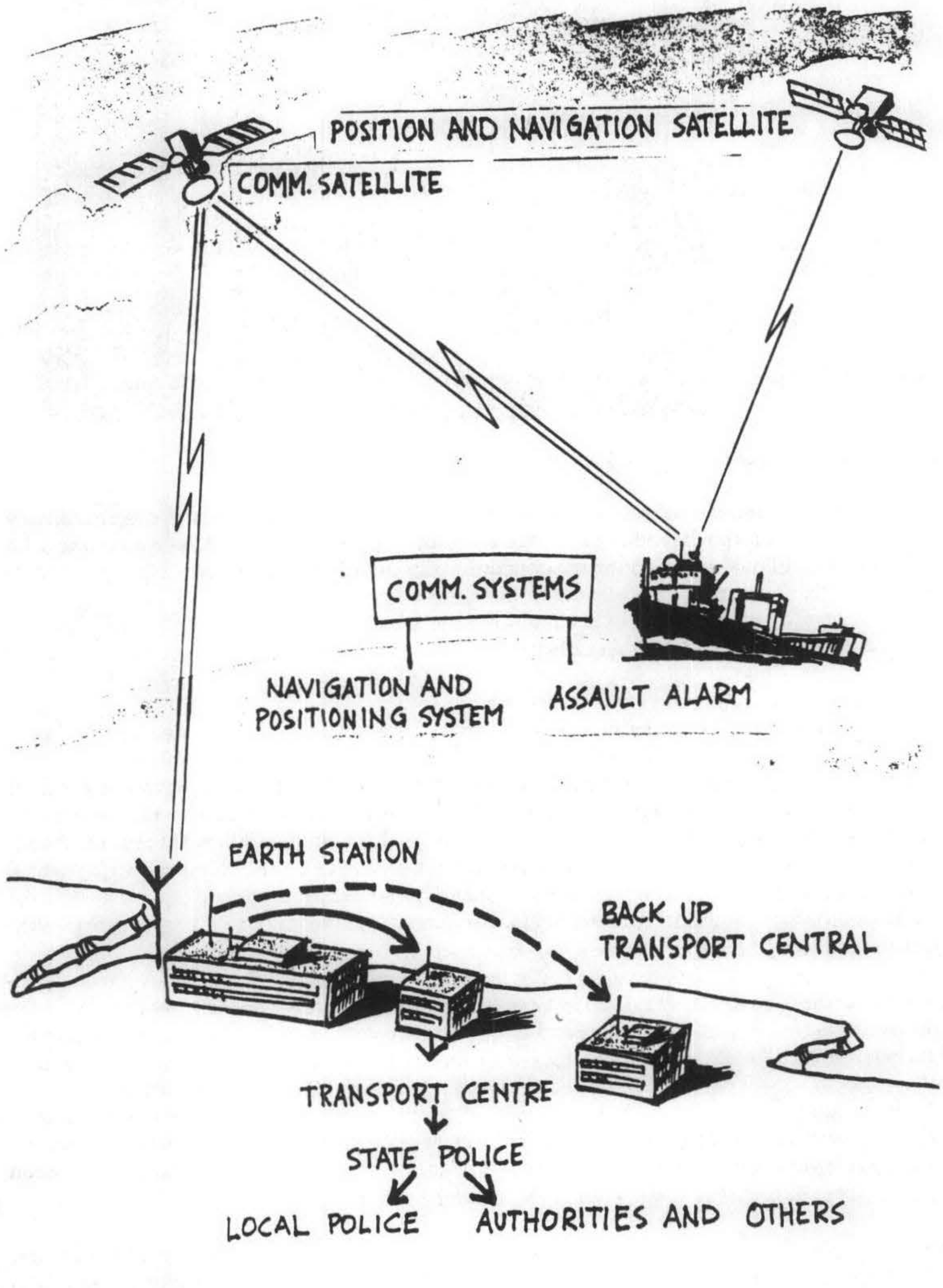
Many events can cause delays during a transport. These events do not have to be dramatic in any way, but can easily be perceived as such if the correct equipment is not available and established routines are not followed. The performance of the communications equipment is of crucial importance here. What I mean by performance in this context is:

- immediate access to the public network
- simplicity of use
- very high accessibility
- facility for private communications

Satellite communications system have all these characteristics, and such a system is used for around 95% fo the communications between M/S Sigyn and concerned parties, which in this context will be the transport control centres, the security guards and the owners of the ship. Today, when technology, and in particular electronics, are being developed and refined at an incredibel speed, there is an inherent hazard in the use of such expressions as "advanced equipment". Still, I don't hesitate to claim that the communications equipment we are using on M/S Sigyn is highly advanced even though it has been in use for several years. Allow me to outline briefly how the equipment works, with the aid of figure 4. On board the ship, the satellite transmitter and receiver constitute the main unit, by which text, data and speech are conveyed. Transmission takes place from the ship's unit via communications satellite to a land-based station, which relays the message to the subscriber. Reception takes the reverse course. By menas of this communications unit we transmit and receive all messages concerning loading and discharging of the cargo we transport.

As soon as loading or discharging is completed, the control centre and SKB are informed of the position in which the cargo unit has been placed. This is of interest in the event of a salvage operation and in matters of responsibility, and it is also required by the IAEA's regulations.

Before departure from the reactor site harbour, the control centre is contacted concerning a suitable departure time. Mostly this is done via the public network, and we also provide information on our route and port of destination. Immediately after departure, ATD and ETA are transmitted to the control centres at the relevant ports.


POSITION AND NAVIGATION SATELLITE
COMM. SATELLITE
COMM. SYSTEMS
NAVIGATION AND POSITIONING SYSTEM
ASSAULT ALARM
EARTH STATION
BACK UP TRANSPORT CENTRAL
TRANSPORT CENTRE
STATE POLICE
LOCAL POLICE
AUTHORITIES AND OTHERS

Throughout the entire trip, the ship's position, course and speed are reported at predetermined intervals to the control centres. Should any major deviation from the agreed route occur, this is also reported to the control centre.

In order to prevent incorrect information from being perceived as correct, each message in classified. At certain passages along the coast carry, the ship must report to the Coast Guard, which can follow the trip through its radar equipment.

Before arrival, the ship requests permission to enter from the harbour master at the port of destination. After this has been granted, the ship begins its entry. On arrival, the exact time of arrival is reported to the control centre and SKB. These routines would seem to satisfy whatever rrequirements are made on ships carrying cargo classified according to the IMO code. Unfortunately, at most places in the world here are no requirements whatsoever to report.

Frequent reports and tansmissions create familiarity with the use of equipment, and this familiarity is necessary in the event a difficult situation should arise. It also gives the reporting party access to information from the control centre. This could be of great value for the safe conduct of the ship.

THE IMO

IMO frequently issues resolutions concerning the safe conduct of ships, but these can hardly acquire the status of any more than the advice and recommendations they are, unless national regulations based on these recommendations are imposed on carriers and cargo owners.

At sea, a legal duty to report does not have to be burdensome to either party. Reporting systems and control centres whose main purpose is to improve marine rescue services already exist all over the world today.

IMO member countries shall extablish marine reportring systems whereever necessary and pratcical to facilitate sea rescue operations. Ships carrying certain kinds of cargo should also be covered by these rules. The primary aim of the existing systems of position reporting is to increase marine safety. An additional effect is that one gets at an early stage reports concerning other risks so that action can be taken to avoid them. Tow different systems: JASREP and SISCONRAM are in use and they cover areas of considerable size and varying character.

It is up to IMO as an international agency to issue advice and recommendations for safe transport at sea.

It goes without saying that it is up to us to comply with such recommendations, but I believe and hope that the level of ambition in this industry "when it comes to safety" is so high that it can serve as an example to others.

Some people may feel that we should not overdo safety routines when transporting radioactive materials, but keep them at a normal level. However, self-interest does not lead to safe transport. ***High safety standards permit normal transports.***

INTERGRATED COMMUNICATION SYSTEMS

General

New ships of all sizes often have high-tech equipment, expensive to acquire and advanced in many ways. New technology for a new generation is an excellent thing. However, the most important thing is what use is made of the technology. This is what is interesting from a safety point of view.

With optimum safety as a goal, the position, navigation, alarm and computer equipment on the M/S Sigyn has been integrated with the communications equipment, creating a new capability to transmit automatically at preselected intervals information on position, speed and course to the appropriate control centre, and the capability for authorized persons to access this information at will.

Computerized alarms function with smart feedback. So we see here that a well-balanced integrated communications system provides broad application potential.

The accessibility of these systems is very good in my opinion. Rarely if ever do technical faults occur. Those that do occur are more often than not caused by the operatior. The system is forgiving to a certain extent, but as I mentioned beforde, experienced operators are always of great value.

Practice and training

An unexpedted event does not have to be and should not be unplanned. Therefore, frequent parac-tice involving all equipment connected to communications part is a permanent feature of duty on board. Those parties on shore whose duty it is to pass on information and data to authorities and decision-makers on shore must also have training. To practice these routines at regular intervals, it is necessary to be able to handle an unexpedted event.

Accident probabilities

There is always a risk that a ship may be involved in some incident, great or small, during its lifetime.

Grounding, collision with another ship and fire are the most common incidents. In order to limit the consequences of these accidents as far as possible, M/S has built-in technology taht fulfills by a wide margin the IMO safety standards for this type of ship, type 1.

Calculations of the probabiliteis of the kinds of incidents I mentioned earlier can be carried out, as data is available for several years back. But, certain hazards seem to loom year by year, such as extortionist threats and terrorism. Just how likely it is that such means of pressure will be applied to us is hard to tell.

On M/S Sigyn we are prepared, however, with a very sophisticated alarm system. One of the features of this alarm is that once it is initiated, it seeks under all circumstances to establish contact with a control centre.

We consider the capacity to advise security and control staff ashore of the situation of the unit to be of the greatest value, Training and education of staff in leading positions, who are the potential victims of this type of incident, we also consider necessary. To avoid misunderstandings in an alarm situation or in any other communications, the messages are classified. Prearranged codes are also used as a way to eliminate unauthorized use of the communications unit.

M/S Sigyn is, of course, also equipped with several redundant communication units for the most common marine systems. As a result, the ship will never be isolated for technical reasons.

FUTURE

You may have received the impression that we are complacent with our integrated system and our various communication facilities, but this si not the case. We strive towards improvement at all levels. The spectrum of available technology is wide and rich. It is up to us to draw on our experience and prudence in order to achieve a safe, practical and reliable level.

What is next?

As we all know, computer technology has been undergoing a dramatic development for several years. I believe we are on the brink of a new "space age" for the marine industry that will result in dramatic improvemetns in the operation and navigation of ships.

The ongoing launching of new satellites is giving us new marine systems to improve:

- Ship-to-Shore Communications
- Accuracy of position determination.

Progress in computer technology is brining considerable improvements in:

- Shipboard Radar
- Traffic Surveillance Systems.

For some years we have seen and experienced how the Inmarsat Services have improved and became necessities to that we can hardly live without today. The third generation of ship-earth stations is amassing an excellent record of reiability.

The Global Positioning System, GPS, that has been planned for many years will, we are told, be fully operational worldwide for merchant marine application in early 1990.

GPS entails a tremendous step forward for safety in ship navigation and will replace the old Transit Satellite navigation system, along with traditional radio navigation systems. GPS permits excellent continuous positions determination.

When it comes to radar, the new technology has great potential, and many military research projects concerning radar technology are being conducted today, ensuring further improvements that will soon reach the marine radar market. Present-day marine radar technology is just the first generation of radar based upon this new concept.

This new radar technology will, of course, also give rise to systems for marine traffic surveillance of, for example, ships carrying dangerous goods.

Progress in computer technology will also soon result in systems that can receive and interpret a wide range of verbal instructions. Speech synthesizers that can deliver messages of reasonable quality already exist today. It will not be long before the master of a ship will be able to talk to the mainframe computer for communication in his new integrated navigation system and expect to get an intelligent answer.