ANNEX XIV

TECHNICAL AND INDUSTRIAL DISMANTLING PROCESSES

Annex XIV

Technical and industrial dismantling processes

This annex gives an overview of existing technical and industrial techniques for dismantling ships of metal construction; metal-structured ships account for the immense majority of merchant and government fleets. Various instances and organisations (IMO, Basel Convention, ILO, International Chamber of Shipping …) have looked into the best methods which protect the health of workers and the environment.

As will be seen below, different dismantling modes exist in relation to the local industrial and economic environment, the technical level of available equipment and infrastructures, and the recovery circuits for the materials and secondary raw materials that are collected.

It is to be noted that this comparative inventory does not investigate the dismantling of ships that have sunk or run aground, or of wrecks which require specific processes adapted to the type and final condition of the ship, and adapted to the circumstances and location of the disaster. For these types of operations, the safety of men and navigation and the protection of the environment are of prevailing importance compared with other necessities (technical, economical, operational time) and mobilise purpose designed technologies.

As a general rule, the keystone of any dismantling process heedful of workers and the environment lies in the prior knowledge of and the adapting of the dismantling facility to the type of pollutants and hazardous substances contained on board the ship. It is on the basis of this inventory (e.g. a Green Passport provided by the owner supplemented by the issue of a recycling plan by the dismantling facility) that the dismantling facility will be able to choose and adapt its organisation and pre-existing type-process for demolition, while remaining sufficiently competitive with respect to “type” processes of its competitors.

Schematically, three “type” modes of dismantling can be globally defined, each corresponding to differentiated industrial models:

- **A highly mechanised process using a small labour force, which is found solely in Western countries.**
- **A non-mechanised process using a strong labour force, which is found in the Indian subcontinent.**
- **An intermediate process using some equipment but still maintaining a significant labour force, which can be found in Turkey, China or even at some dismantling facilities in the United States.**

Each of these “type” processes varies locally in relation to secondary characteristics as regards infrastructures and outlet markets for recoverable products. However there are economic and human constants which appear to be universal:

I. Location

In spite of the very best precautions, the activity of ship dismantling remains a dirt-producing, noisy activity, generating nuisances of various kinds (visual, olfactory…). It is scarcely compatible with the closeness of a high density populated area (towns, cities) and even an area of maritime activity (merchant port, fishing port, building site...).

Nonetheless ship dismantling operations require sufficient, long-term sea access for ships to be dismantled, and an outlet for any exports of secondary raw materials. Also numerous companies seem to give priority to economic synergies generated by the proximity of treatment installations (recyclers) or user facilities (steelworks) of land scrap of which there is much larger supply.

II. Infrastructures

The relative shortage of graving docks, competition by nobler activities such as ship building or ship repairs, and the long-term immobilisation costs of these infrastructures have led the dismantling activity to look for solutions to overcome these heavy constraints.

Quayside demolition in successive layers followed by the use of more or less basic slipways on the coast or alongside sea canals amount to industrial models that are gradually gaining ground in the large majority of dismantling sites heedful of man and the environment, irrespective of the “type” process used for demolition.

Before looking into the three main types of dismantling sites, one variant must be cited which can be taken into consideration and applied to each of these types. It consists of initially cutting the ship into vertical sections on a first site, then of transporting these different sections to one or more end dismantling sites using specialised ships or barges for the transport of heavy-lift cargo (cf. Appendix I). This method has been employed on a few rare occasions, warranted essentially by the complexity of the vessel to be dismantled (dismantling of the Tricolor wreck which sank in the North Sea) or by uncertainty as to the buoyancy of the vessel to be dismantled (conventional Russian submarines). This variant of traditional methods has the advantage of quickly releasing overworked infrastructures and of optimising the distribution of work taking into account secondary sites of smaller capacity.

Whether a ship is cut horizontally or vertically, the method used has recourse to a limited number of technologies which are applied separately or in combination in relation to the technical specificities of the ship and the dismantling facility, and in relation to targeted operational costs. These different cutting techniques are given in Appendix II.

Transporting after cutting into sections has the advantage of allowing more complete prior cleaning of the vessel before it is despatched to the ultimate dismantling site. With this method it is also possible to group together small vessels of poor seaworthiness which cannot be been towed over a long distance.

This type of transport will however always remain more costly than mere towing and *a fortiori* more costly than a final voyage under own propelling means.

III. The three types of processes

III.1. The highly mechanised process

Economic model

This type of highly mechanised process is prompted firstly by the search for profitability in an economic setting in which labour is expensive, and in which health, safety and environmental requirements for such labour are values that are given unanimous recognition by all economic players concerned. Nevertheless, it must not be inferred from the above that this type of process is based on high capitalistic leverage. Dismantling does not require either heavy investments (with the exception of acquiring and adapting a site) or highly skilled labour. This labour does however need to hold true specific know-how, acquired through experience on several successive ship dismantling operations. This know-how is a combination of industrial demolition techniques and shipbuilding techniques.

After first preparing the ship for safe dismantling, demolition operations at this type of facility must start by removing the maximum quantity possible of all directly accessible hazardous substances and materials (pressurized tanks, batteries, powder asbestos, neon tubes, batteries, electrical and electronic equipment waste (WEEEs), various effluents…) on the basis of the initial inventory approved by the dismantling facility itself. This first operation must not jeopardize the integrity of the ship or the safety of workers carrying out this initial cleaning, nor must it jeopardize subsequent dismantling.

It is to be noted that at this stage in the process, the economic environment of this type of facility generally makes any dismounting operations, specifically intended for direct reuse of complete equipment, financially and technically marginal.

Details of the industrial process

The actual dismantling operation can then be initiated through the rapid use of mechanical means for horizontal cutting of the ship, which is given priority so that large metal blocks can be removed by crane onto a quayside of the dismantling site. The employment of cutters armed with blowtorches is exclusively reserved for situations that are incompatible with large mechanised means. The last removals of hazardous substances are made as and when they become accessible during the demolition work, the dismantling process being interrupted whenever necessary to take general protective measures.

By means of precautions taken continuously as the demolition progresses, the keel of the ship gradually collects all the different effluents and liquid wastes that are generated. When this keel has been reduced to a low draught, it is emptied by pumping off all the collected effluents, and it is then hauled onto a slipway from where it is hoisted gradually as it is cut by mechanised means.

The scrap produced by the hydraulic shears is generally reintroduced at this stage into a standard process for recycling land scrap which uses other highly mechanised equipment (large-capacity press shears and/or crusher-sorter) which are little labour-intensive.

Environmental and human aspects

The end non-recyclable wastes are isolated from the recycled metal materials in the same way as land scrap destined for electric furnaces.

The environmental, social and human reliability of this entire process is based on the observance of standardised work methods, employing a reduced number of operators and using equipment which is able to control environmental and human risks:

- Initial removal of the maximum amount of accessible hazardous substances;
- High level work organisation and extensive supervision;
- Introduction of general control and prevention procedures;
- Use of collective and individual protective equipment;
- Reducing naked flame and confined enclosure work to a minimum;
- Reducing concomitant human and mechanised operations;
- Permanent prevention and quick-response fighting of fire and pollutant spillage;
- Limitation of heavy load handling and transfers;
- Collection and treatment of effluent and waste (anti-pollution barriers, drained work surfaces, mechanised sorting…).

III.2. The labour-intensive process:

Economic model

This type of process is found in a social and economic environment offering abundant, cheap labour and within a civil society that is little sensitive to the social and environmental aspects of this activity and of other industrial activities in general. In addition, the low level of development of surrounding populations firstly encourages the direct resale of some of the substances and equipment contained onboard the ship, and secondly promotes the creation of strong human activity for the repair and commercial re-distribution of another part of the ship's equipment.

On the other hand, the lack of any shipbuilding or ship repair activity within a close geographical area does not allow this dismantling activity to benefit from infrastructures which have been economically amortised. The low level of economic development does not allow the acquisition and maintaining of costly, energy-consuming mechanised means. For the same reasons, the lack of these initial means hinders the building of new infrastructures (slipways, graving docks, waste collection and treatment networks, transport links) and gives priority to rapid reuse of the recovered substances and materials within a close regional area (forging, drawing and re-rolling raw scrap).

This functioning on a just-in-time basis, to supply workshops and warehouses on the shore and to clear the ship grounding area to leave way for the dismantling of another ship, has prompted site owners to reduce initial cleaning to a minimum which would otherwise delay the actual dismantling work. Under these conditions, either the hazardous substances are abandoned on the beach and left to the biotope in the hope that the tide will take them in charge, or the inhabitants of the coastline and the workers of the entire recycling chain are exposed to these hazardous substances which gradually disperse into the natural environment.

The ships are progressively cut into vertical sections using blowtorches, starting with the front parts and the ship sections are then gradually hoisted onto the shore away from tide waters. These sections are subsequently cut into strips of metal which can each be carried by a team of twenty or so workers having no handling equipment, these strips being sized mostly to meet the requirements of the re-rolling workshops located in direct, close vicinity of the dismantling site.

The process therefore mobilises a maximum amount of labour for a minimum amount of mechanised equipment and infrastructures, while guaranteeing a return on investment (ship purchase price and salaries) that is extremely short-term and efficient. In this economic model, the capitalistic and financial leverages are practically zero, and the model's resistance to any positive or negative variation in work load is only based on the elasticity of labour resources and the very strong appetite of the local market for crude metal products of low quality (concrete reinforcement rods and cages, re-rolled plate). Without being infinite, the resources of non-trained labour are particularly high and can easily be mobilised within the area concerned (Indian subcontinent), which largely contributes to the sustainability of this type of dismantling process in spite of market fluctuations. The lack of any geographical infrastructure or equipment further reinforces this technical and economic flexibility of the process in the face of any variations in work load.

Also, the multiple channels available for marketing all the items resulting from dismantling (direct sale of ship equipment for reuse, sale of scrap to steelworks, re-rolling) substantially reduces the sensitivity of this process to variations in the economic environment (price of raw materials, the country's inflation rate).

Details of the industrial process

This industrial process starts by grounding the ship on the shoreline, if possible benefiting from an exceptionally high tide so as to place the working area away from the effects of rising and ebbing tides. Simultaneously with the disembarking of all equipment and materials which are easy to handle, the front of the ship is cut with a blowtorch on the beach itself by a strong labour force. The dismantling of the ship then progresses in vertical sections towards the stern of the ship. The sections that have been cut are brought higher up onto the beach so that cutting can be completed into smaller parts. Unlike the cold mechanical method used on European sites, here all cutting operations are hot cutting operations (blowtorches) which can cause fires or explosions if previous de-gassing of the hull has not been properly carried out, and can also cause highly harmful atmospheric pollution caused by burning the coatings of the cut metal.

The lack of any infrastructure (slipway, quayside …) is overcome by choosing a natural inter-tidal inclined plane with extensive tidal range. The removal of pollutants and effluent is ensured either by the tide or manually.

The lack of mechanised equipment (cutting, handling, sorting equipment…) is offset by the presence of an abundant labour force equipped with individual cutting means which reduces the ship to manageable parts that can be directly recycled (metal sheet 4m x 1.5m) by forging or re-rolling workshops located in the immediate vicinity of the beach.

Environmental and human aspects

The work in these metal workshops is conducted under high temperature conditions, but the temperatures are nonetheless too low to expect any destruction of pollutants which still remain on the scrap metal. The conditions are similar to forge working conditions however, with no collective or individual protection means for the workers.

For their part, the electric steelworks which treat this non-recycled scrap locally are not all equipped with fume separation or filtering installations capable of trapping these pollutants. This scrap is treated in the same way as common land scrap.

As a result, this entire non-mechanised process generates high environmental and social costs which are neglected by the economic players concerned since they do not directly have to take these in charge:

- Social costs of the harsh, poor living conditions of workers who have often emigrated from distant, poor agricultural provinces;

- Social and economic cost of occupational injuries and diseases due to working conditions and the hazardous substances handled, and due to the lack of any training for operators and lack of individual and collective protections;
- Social and economic cost of diseases due to air and water pollution, and polluted food resources affecting surrounding populations;
- Environmental costs of pollutants dispersed in the marine environment;
- Environmental costs of pollutants (scrap recycling and reuse of obsolete equipment) dispersed immediately or over the longer term in the land environment (air, soil and water).

III.3. <u>The intermediate process</u>:

This type of process, which employs abundant relatively cheap labour, also uses mechanised equipment. This model is based on the existence of low-cost national or immigrant labour.

The dismantling methods remain essentially manual, but the partial use of equipment such as cranes overcomes the need for heavy handling work and extensive manual cutting of the ship, thereby reducing risks and the harshness of work conditions.

Additionally, the existence of specifically built slipways or wet berths allows the use of standardised, stable methods allowing better heed of worker safety and the environment.

This economic model remains viable in a social environment whose standards of worker protection and environmental protection are close to European standards (Turkey, USA).

In this type of dismantling process, the general invariants related to location and infrastructure appear to weigh almost as heavily as in highly mechanised Western dismantling sites. This type of process appears to be characteristic in its real desire to treat pollutants and hazardous substances in order to reduce the impact of the dismantling site on the environment and on workers' safety. The fact that practically no direct conversion facilities exist for recovered metals reduces the pressure on dismantling times and allows recourse to an initial cleaning phase.

The steps of this intermediate process, as in the highly mechanised process, therefore start with an inventory phase to list the hazardous substances on board. The ship is then taken to an industrial site having the necessary infrastructures (quayside, slipway, wet berth). The accessible hazardous substances are then disembarked before the dismantling phase properly-so-called is commenced.

Dismantling is essentially manual (using blowtorches), proceeding in horizontal layers similar to the method used in the highly mechanised process. Non-accessible hazardous materials which could not be removed during the initial phase are removed as and when demolition progresses. The remaining bottom shell of the ship is cut manually in vertical sections, either in an insulated wet berth or on a slipway after pumping off effluent.

The scrap that is generated is cut on drained platforms before being stored, awaiting dispatch to steelworks for recovery.

It is to be noted that this intermediate process involves the direct reuse of some equipment recovered on board, but in a manner that is much less systematic than in the Indian subcontinent. On the other hand, practically no direct reuse is made of secondary raw materials, which means that all the scrap is directed towards large electric steelworks to undergo a complete cycle which provides a better guarantee for the removal of waste still remaining on this scrap.

Appendix I

The sea transport of heavy-lift cargo

Individual unit, non-standardized cargos, commonly called heavy-lift cargos, used to be transported on barges towed by one or more tugs.

The constraints of this method, in particular the slowness of convoys, have led to other solutions being considered for the transport of heavy-lift cargos.

Henceforth this type of transport is mostly ensured by dedicated ships called “heavy-lift cargo vessels”.

By examining the different methods used and their performance levels, it is sought to determine whether the vessels and the barges under consideration in this respect are able to transport a heavy tonnage time-expired ship, whether partly cut or not, towards a destined demolition site.

I. Notion of heavy-lift cargo

The notion of a heavy-lift cargo is difficult to define:

- firstly, it varies in relation to the type of vessel being considered: for a conventional liner a cargo would be considered heavy on and after 15 tonnes;
- secondly, a cargo may be considered heavy-lift on account of its size or the specific apparatus required for its handling.

Therefore, the American defence department and the NATO consider an individual unit of cargo weighing 100 tonnes as heavy-lift, while some shipping companies and classification societies increase this threshold to 200 tonnes.

Those cargos which conventionally fall under this general definition include industrial equipment (wind turbines, cranes, electricity transformers, etc…) oil platforms, other ships (units unable to be towed, yachts transported over long distances), locomotives, pressurized tanks, drilling equipment, etc.

II. Heavy-lift cargo vessels

There is no definition or official name in French regulations for a heavy-lift cargo vessel. Alongside this expression terms are frequently encountered such as “*bâtiment transporteur de charges lourdes*”, “*navire de transport gros porteur*”.

These vessels are divided into five main categories:

II.1. Lo-Lo vessels (load on – load off):

These are vessels equipped with vertical handling means such as derricks or cranes.

They most often comprise a single hold of parallelepiped shape which can be sub-divided by partitions and removable intermediate decks. This hold is closed by panels able to withstand a load in the order of 3.5 t/m^2. The deck surface forms one interrupted stretch of surface once the panels have been closed.

The superstructure lies at the front of the ship or may be positioned on the sides with the cranes. This allows for easier loading and enables longer cargos to extend over the bow and stern.

The load capacity ranges from 2000 to 15 000 t depending on the type of vessel.

The capacity of the cranes varies between 200 tonnes and 800 tonnes. These cranes are often used concomitantly for the vertical loading or unloading of the heaviest loads.

II.2. Ro-Ro vessels (roll on-roll off):

These ships are designed for horizontal loading and unloading, for the transport of wheeled cargo.

The working load limit (WLL) of their ramps is as high as 5000 tonnes for Ro-Ro vessels specially dedicated to the transport of heavy-lift cargo.

II.3. Open deck vessels:

This type of ship is not widely used. Most of these units were built in the 80s and a large proportion thereof have been converted since that date.

Externally they are similar to semi-submersible ships which are discussed below: a wide, unencumbered deck, with a superstructure at the front end. On the other hand, unlike semi-submersibles, they cannot be submerged to take on loads by floating. Except for a very few exceptions they are not equipped with cranes.

Loading is therefore accomplished by rolling or sliding over a rear ramp whose width extends over the entire breadth of the vessel.

The deck and ramp can be equipped with rails and are reinforced to withstand local forces exerted by the wheels of convoys.

Their deadweight tonnage ranges from 8000 to 18 000 t. In length they vary from 120 to 150 metres and in breadth from 27 to 38 metres. Their draught rarely exceeds 5 metres, enabling them to access most ports and work sites.

II.4. Flo-Flo vessels (float on-float off):

These ships, also called “well deck ships” or “dock ships”, were designed in the 70s on the basis of a tank landing ship design. They are characterized by their high sides extending over the entire length of the ship.

Cargos can be loaded by cranes or via a ramp at the stern. Their specificity however consists of their capability to lower themselves below the surface of the water by filling their ballast tanks until the well deck is flooded. They are then able to take on board other ships and floating cargos.

The deadweight tonnage of the largest units can reach 60 000 tonnes. Their length ranges from 90 to 215 m.

II.5. Semi-submersible vessels:

These ships, having no handling means or holds, are provided with an expansive apron extending over a large part of the length and breadth of the ship.

Large ballasts are positioned in the hull, allowing the ship to be lowered until there is a sufficient quantity of water over the deck, typically around ten metres, to permit the embarking of heavy cargos by floating them aboard. The presence of buoyancy reserves at the stern end makes it possible to maintain the trim of the ship when it is submerged and to ensure uniform contact between the deck and the cargo when the ship resurfaces.

Heavy cargos can also be loaded by rolling on board.

There are two main categories of submersible ships:

- open deck ships in which the superstructure is positioned at the bow and the cargo at the stern,
- “tanker-shaped ships” in which, the design is reversed with the cargo at the bow and the superstructure at the stern.

Most semi-submersibles belong to the first category.

Their deadweight ranges from 14 000 to 76 000 t. A new ship with a deadweight of 83 000 tonnes is at the planning stage but its economic viability has not been proven.

In length they vary from 130 m to 214 m, and in breadth from 32 m to 63 m, with a draught of 6.3 m to 10.8 m when navigating, and 14.5 to 29.3 m when in submersion.

It is worth mentioning the studies currently being carried out by the US Navy to use two semi-submersible ships in tandem.

III. Barges.

A barge can generally be defined as a seagoing vessel having no self-propelling means used for hauling goods in holds, in tanks or on deck.

It is towed, and at times pushed when navigating in inner waters. Some barges may have a propelling system enabling them to carry out some limited manœuvres, their main method of propulsion however remaining the propulsion supplied by another unit such as a tug or pusher.

Since a barge has no motorization, it has an unobstructed loading deck.

The length of the barges under consideration here is generally in the region of 100 metres, with a breadth/length ratio of 1/3.

They can be equipped with handling equipment and powerful ballast systems.

The various categories of barges destined for the transport of heavy-lift cargo have *mutatis mutandis* correspondence with self-propelled ships dedicated to the same use. However two types of barge that are mainly adapted for this type of activity are the following:

- “deck barges” or “flat top barges” with open deck;

- semi-submersible barges for flo-flo loading.

The largest barges (140 m in length) have a deadweight tonnage of 24 000 t.

IV. Stowing and securing

Improper stowing and securing of cargos have led to numerous accidents at sea during handling operations.

As a result the IMO has drawn up a “Code of Safe Practice for Cargo Stowage and Securing” (CSS) of which some annexes deal with heavy-lift cargo.

To limit risks, the position of the centre of gravity of the heavy cargo must be calculated with the greatest accuracy so that the cargo can be properly positioned on board the ship or barge. The use of a load calculating instrument for this purpose is essential.

Securing is ensured by means of steel cables, chains or even weld points to secure the heavy cargo to the ship or barge. Frequently a custom cradle is made to ensure proper seating of the heavy cargo.

During the transport voyage, weather routing is at times necessary and suitable itineraries followed so as to limit as much as possible all risks of any sliding or tipping of the heavy cargo due to weather and ocean forces.

V. Examples of heavy-lift cargo transport

The different examples of heavy-lift cargo transport detailed below were chosen on account of their close similarity to the operations to which ship dismantling can give rise, whether for the transport of a whole ship or solely of a ship in sections.

V.1. Transport of naval vessels:

- *Heavy-lift cargo*: the destroyer HMS Southampton
  - *Characteristics*:
    - weight: 3 500 t
    - length: 120 m
    - beam: 14.3 m
  - *Sea route*: from Dubai to Southampton (GB)-November 1988
  - *Carrier*: semi-submersible ship: Mighty Servant 1
  - *Type of on-/off-loading*: flo-flo

- *Heavy-lift cargo:* the frigate USS Samuel B.Roberts
  - *Characteristics*:
    - weight: 4 000 t
    - length: 125 m
    - beam: 14.3 m
  - *Sea route*: from Abu Dhabi to Newport (USA)-July 1988
  - *Carrier*: semi-submersible ship: Mighty Servant 2
  - *Type of on-/off-loading*: flo-flo

- *Heavy-lift cargo*: HMS Nottingham
  - *Characteristics*:
    - weight: 4 516 t

    - length: 125 m
    - beam: 12 m
    - height: 34 m
  - *Sea route*: from Tasmania to England – 12,279 NM from 28 October to 13 December 2002
  - *Carrier*: semi-submersible ship: Swan
  - *On-/off-loading*: flo-flo

- *Heavy-lift cargo*: 3 ex-Soviet nuclear submarines, Victor-I class (hulls NPS 602 and NPS 606) and SSN November (hull NPS 291)
  - *Sea route*: from Murmansk to Severodvinsk – 430 NM, August and September 2006
  - *Carrier*: semi-submersible ship Transshelf (length: 137 m, beam: 40 m) belonging to the Dutch shipping company Dockwise
  - *On-/off-loading*: flo-flo

V.2. Transport of offshore rigs:

- *Heavy-lift cargo*: semi-submersible platform, Thunder Horse (BP)
  - *Characteristics*:
    - weight: 59 500 t
    - length: 155 m
    - width: 114 m
    - height: 132 m
  - *Sea route*: from Okpo (South Korea) to Corpus Christi (USA) via the Cape of Good Hope – 15,813 NM from 23 July to 23 September 2004
  - *Carrier*: semi-submersible ship, Blue Marlin
  - *On-/off-loading*: flo-flo

- *Heavy-lift cargo*: spar, Holstein (BP)
  - *Characteristics*:
    - weight: 59 500 t
    - length: 155 m
    - width: 114 m
    - height: 132 m
  - *Sea route*: from Pori (Finland) to Ingleside (USA)– 6 500 NM from 26 September to 21 October 2003
  - *Carrier*: semi-submersible ship, Black Marlin
  - *On-/off-loading*: sideways skid-on loading, off-loading by float-off.

- *Heavy-lift cargo*: module for the Conoco Heidrun platform, loaded on the barge Giant 3
  - *Characteristics*:
    - weight: 8 602 t (Conoco Heidrun) + 9,694 t (Giant 3)
    - length: 80 m and 140 m
    - width: 27 m and 36 m
    - height: 20 m + 8 m
  - *Sea route*: from Verdal to Stavanger (Norway) – March 1994 (1-day transit)
  - *Carrier*: semi-submersible ship, Mighty Servant 3
  - *On-/off-loading*: flo-flo

- *Heavy-lift cargo*: module for the Norsk Hydro Troll platform
  - *Weight*: 9 000 t
  - *Sea route*: England to the North Sea
  - *Carrier*: semi-submersible barge AMT Trader

- *Heavy-lift cargo*: module for the jack-up platform Marinia
  - *Weight*: 6 000 t
  - *Sea route*: Persian Gulf
  - *Carrier*: barge, AMT Transporter

- *Heavy-lift cargo*: module for the Njord platform
  - *Weight*: 15 000 t
  - *Sea route*: Norway – North Sea
  - *Carrier*: barge, AMT Transporter

V.3. Maritime industry:

- *Heavy-lift cargo*: 24 barges, 3 pontoons, 1 pusher
  - *Characteristics*:
    - weight: 7 800 t
    - length: 66 m
  - *Sea route*: from New Orleans (Venezuela) to Buenos Aires (Argentina) – from April to May 1997
  - *Carrier*: semi-submersible ship Teal
  - *On-/off-loading*: flo-flo

- *Heavy-lift cargo*: 6 barges
  - *Characteristics*:
    - weight: 15 900 t
    - length: 850m max.
    - width: 27 m max.
    - height: 5 m max.
  - *Sea route*: from Batangas (Philippines) to Salvador (Brazil) via the Cape of Good Hope – 30 days between March and April 2002
  - *Carrier*: semi-submersible ship, Blue Marlin
  - *On-/off-loading*: flo-flo

- *Heavy-lift cargo*: 2 container gantries
  - *Characteristics*:
    - weight: 2x650 t
    - width: 96 m
    - height: 59 m
  - *Sea route*: from Hamburg to Lanzarote (Canaries) – May 2006
  - *Carrier*: Fairpartner
  - *On-/off-loading*: skid-on/crane hoisting

Appendix II

Ship cutting methods

I. Slicing using a cutting wire.

This method has been used in dismantling operations for wrecked ships, such as for the Russian submarine Kursk and for the Tricolor, a Norwegian Ro-ro vessel. The principle is to slice the wreck into several sections using a giant, diamond encrusted cutting wire actuated by robots. The sections are then brought to the surface and taken to a cutting yard.

II. Oxy-acetylene cutting (C_2H_2).

A flame of acetylene and oxygen heats the metal to its melt point, which is approximately 1230°C for ship steel. The steel is then burnt by additional oxygen injected into the flame. This technology is chiefly used for basic steel or low-alloy steel and for metal sheet having a thickness ranging from 3 to 300 mm. It is currently the simplest technology used for the cutting of large-thickness steel.

The various types of equipment used for oxy-acetylene cutting at shipyards range from simple manual cutters to highly mechanised machines consisting of cranes, robots and gantries. Manual cutting is chiefly used for ship repairs or for cutting into small pieces.

III. Plasma cutting

Plasma technology provides for very rapid cutting that is also very precise. Its drawback however is that it is a very noisy method, creating large quantities of dust since the molten material is expelled at very high speed. Also the electric arc positioned in the gas plasma releases ultraviolet radiation (UV).

These harmful effects can be inhibited by cutting under a liquid film making the process more complex and making it less adaptable to every situation. The noise level can thereby reduced to below 75dB, and dust and UV radiation are absorbed. Plasma cutting machines are now commonly used in all modern shipyards. They are mostly used for cutting the metal of plating and structural parts. Their use for dismantling operations is rare.

IV. Laser cutting

Laser cutting is little used in ship building, partly owing to the progress achieved with plasma cutting equipment. Investment costs are high for laser cutting, and cutting speeds are relatively low for the steels using in ship building.

On the other hand, CO_2 laser technology is successfully used in shipyards for all types of materials (steel, aluminium, composite, wood, etc…), as is the case at the Blohm and Voss yards in Hamburg.

Laser cutting has rarely been used for dismantling ships except for a few spot experiments. Its safety restrictions are high.

V. ARC-AIR method

The ARC-AIR method uses an electric arc to raise the temperature locally of a metal part which is to be cut, bringing the temperature to its melt point; when this melt point is reached a hollow electrode injects a stream of air or gas into the metal to expel the molten metal and gradually cut the metal part. This method is somewhat similar to cutting with an oxy-acetylene torch but requires a strong electrical power source. However, it has a faster cutting speed than oxy-acetylene torches.

VI. Water jet cutting

This method uses a very fine water jet that is highly pressurized (2000 bars), and requires the piercing of a start hole for the cutting of very thick metal sheet. Water jet cutting can be used to cut assemblies of heterogeneous materials (metal and non-metal). It is used in Russia for some phases of the dismantling operations of nuclear submarines (simultaneous cutting of the thick metal hull and applied anechoic coatings).