CHAPTER 3

LITERATURE REVIEW

3.1 INTRODUCTION

Publications available in this field have been reviewed and classified into five subject categories viz., Infrastructure for recycling yards & methods of dismantling, Guidelines, codes & regulations regarding ship recycling activities, Environmental & safety aspects of ship recycling, Application of information technology and Demand forecasting. The review and comments are given under various subheadings subsequently.

3.2 SHIP RECYCLING OPERATIONS

Bailey [2005] has elaborately dealt with the prerequisites for recycling of any marine structure by exhibiting a list of provisions in the proposed certificate for dismantling. According to the author this certificate which contains the essential and critical information needed to carry out safe and productive ship dismantling must be made mandatory. A good picture of common occupational hazards and major causes leading to casualties both in terms of loss of life and environmental deterioration has been presented. It has also spoken on an effective legal framework recommended by International Labour Organisation giving duties, responsibilities and rights of various stakeholders involved in the business. Some techniques on assessment of risk during disassembly of heavy parts, while handling poisonous chemicals and during storing of dismantled products have been covered. Various protection, control and welfare measures required for smooth functioning of the process have been touched in the last part of the paper.

Neil [2006] has given account of various disposal options before the recycling business. He has mentioned that once a ship has reached the end of her service life, there are a number of methods of disposal ranging from being laid up, sold on, reefing or converted for recreational purposes. However, with the advent of ever increasing safety and environmental standards associated with the costs of upkeep and upgrades, together with the potential requirement to remove hazardous or restricted materials, there comes a time when the best option is to recycle it. The necessity for a
comprehensive ship recycle plan to identify the costs and manning requirements, and to demonstrate the environmental safety and project risks have been highlighted by him. The methodology also has presented the merits of utilizing Green Passport and an onboard Safety and Environmental Management System (SEMS), both of which will facilitate the smooth handover of the obsolete vessel to the recycling yard. This may be the first citation where recycling of ship at the end of its life time has been termed as a best practice.

An authentic statistics on activities of Alang-Sosiya ship recycling yard located in Gujarat which is the biggest recycling site in the world has been given by Winjgarden [2005]. The data including the dimension of the plots, output of recycled products, turnover, revenues and even death rates are available. On this background the paper has precisely presented the content of the safety manual followed at various operations at Alang yards. It has also spoken about setting up of an oil recovery facility consisting of combination of facilities at sea as well as onshore which will have dual applications like better environmental protection and safer handling operations. The paper has thrown light on formulating integrated Health, Safety and Environment management (HSE) system for better productivity in the dismantling line. A new proposal for early vessel separation, i.e., disassembly of scrap hull while floating has also been discussed.

Stephenson [2005] has discussed dock based dismantling facilities in a UK based recycling yard owned by ABEL group of companies. It has provided deeper technical input in the criteria of selection location of recycling yards and the major requisites leading to access for ships to enter the yard and the access out of the recycling area entering the supply chain. The capacity requirements environmental adaptability and legal attributes such as license, consents and handover in the business have been nicely dealt with in the flow of discussion. The controversial outcomes of recycling such as asbestos, PCB, mercury and radioactive traces also appear in the course of discussion in the paper. Invasive presence and threat from biological microorganisms from ballast have also been projected with due importance. Some valuable tips regarding reuse of components and reuse the same after proper conversion have been also touched very briefly. A detailed account of the contract from MARAD given to ABEL recycling yard has been given towards the end of the paper.
Karpowicz et al. [2006] has described one of the objectives of the EU funded FP6-506606 SHIPMATES project, which has been designed to review the technology of ship repair to identify potential for application in ship recycling. This paper has given the list of all industrial partners of the project, the potential in the foreseeable future, to diversify their product-mix towards ship recycling. This paper has also presented some early results of the project to inform the potential users of it regarding sustainable recycling in Europe. In this paper the author has suggested the idea of the establishing an academic level European Union knowledgebase on ship recycling. At the macro level, key management and organization issues of the future standard ship recycling yard have been discussed. In particular, the fundamental role, significance and tasks of the R&D function within the organizational structure of a competitive ship recycling yard of the future have been investigated and highlighted. The continuously growing importance of the successful performance of the organization function has been strongly emphasized not only from the point of view of the needs of the future ship recycling yard, but for the continuous and systematic improvement of productive and functional performances of the project participants within the frame of their existing product-mix as well.

Shahid [2005] has given, detailed account of ship breaking activities in Pakistan, one of the major ship recycling centers of Asia. The paper has clearly depicted a comprehensive domain of ship breaking processes followed in a site near Karachi, with the help of neat layout of the yard and its organizational structure. Various associated manufacturing activities, handling operations and storing procedures have been discussed in a basic level. The author has explicitly pointed out the important roles and responsibilities of some of the participating agencies, such as governmental bodies, ship-breakers associations, and local bodies, in the day-to-day running of the business. Predictions, based on simple logic, ship breaking scenario in Pakistan and available data, have been provided for the coming years with respect to number of ship ready for recycling and the employment and skill requirements. The role of classification societies as a leading force in setting the course of ship recycling towards environmentally sound and risk free industrial business has also been addressed. The simple and scientific forecasting methods have been used in the ship breaking activities by the author and this may be given a pioneer status in this regard.
Various options regarding recycling of different types FRP in the ship industry have been discussed by Kostopoulos et al [2006]. The paper has also thrown enough light on the potential reuse of recycled FRP products. The last action before landfill, according to waste hierarchy, is energy recovery. According to the findings recorded by the author the efforts made by the maritime community and other interested groups towards a sustainable global ship recycling would not be effective if adequate attention is given for recycling of fibre reinforced composite materials that are increasingly used in the ship building industry the last decades. Some of the viable concepts for the recycling which are essential for the FRP industry over the coming years, as per the European Waste Directives, have also been included in the discussion.

Chaturvedi et al [2006] has critically evaluated the water budget for a typical ship breaking yard and characteristics of waste water from a ship breaking yard in Alang, India. This paper has explained the details regarding the requirement of fresh water and disposal of waste water. The paper has described two important methods employed in waste water treatment. In this research, it has been highlighted that natural waste treatment systems have now been emerging as alternate and appropriate and the application of the same has been suggested as the best practice in waste water treatment for ship recycling yards in India. The authors have put forward various arguments on sustainable wastewater management strategy which includes water recycle and reuse opportunities in premises of the ship dismantling yard.

Mahindrakar et al [2006] presents the major environmental problems faced by Indian ship recycling industries with regard to disposal of anti-corrosive and anti-fouling paints in recycling yards and in steel rolling mills. The major threats to the environment from heavy metals and resins have been discussed by analyzing a ship of average size. More serious effect of handling of sand blast paint mixture has been presented separately. It has also proposed new methods to study the leaching characteristics of various hazardous coatings used in ships. Comparison with provision of Environmental Protection Agency [EPA], USA standard in this field has also been highlighted. Need for strict measure to stop the contaminations from marine paints has been listed as the concluding remark.

Asolekar [2006] has overviewed the present ship dismantling methodologies adopted
in India along with environmental, health, and safety related issues. It has also included a very comprehensive list of all solid waste items produced in the recycling process and has classified the same into hazardous and nonhazardous category. An integrated approach dealing with the potential threat from pollution, health hazards and accidents has been given in this paper. The human resources development part has separately been dealt in the background of these three major issues present in Indian ship recycling locations. The content of this paper can be considered as a major input to the knowledgebase on land filling and solid waste production management.

Kinigalakis et al [2006] in their paper have dealt with the necessity of designing risk analysis methods useful for various ship recycling processes. The emphasis has been given for individual ship recycling process conducted in a specific location. The paper has given an analysis of the influence of technical trade skills of the personnel, complexity of ship structures, dismantling procedures and other technical factors on the safety of dismantling operations. A review of established risk analysis methods has been provided within the frame of the ship dismantling project, aiming to develop a modified method suitable for application for ship recycling.

Hedlund et al [2006] have stressed the need and importance of comprehensive information about the constituents of polymer materials found in ships. The author has developed and included a model for assessing various waste disposal techniques especially for polymer composite materials. In this model nine influencing internal factors have been identified. These are closely associated to the generated wastes and the processing of them. Necessity of developing an integrated information handling system for productive ship recycling has been put forward by the author

3.3 GUIDELINES, CODES AND REGULATIONS IN SHIP RECYCLING

Throughout the life cycle stages, ships are subjected to application of various guidelines, codes and regulations. Most of the important guidelines are formulated by expert committee working groups of International Maritime Organization which is the maritime agency working directly under the United Nations. Only exception to this is ship recycling, where till recently no concrete rules and regulations have been implemented. The Marine Environment Protection Agency (MEPC) meeting, MEPC 59, 2009 has made significant progress in developing draft guidelines for safe and
environmentally sound ship recycling intended to assist with the voluntary implementation of all important IMO, Hong Kong Convention, 2009. Outcome of this convention is considered as the pioneering guidelines for formulation of rules in ship recycling field. Some of the ongoing and past attempts in this area have been explained in the subsequent subheadings.

3.3.1 General

Dimakopoulouse [2005] has referred to the major contributions of International Maritime Organisation in formulating a frame work of rules for ship recycling industry. This paper has projected the essence of the efforts carried out in ship recycling industry by considering recycling as one of critical stages in the life cycle of ships. The issue of Green Passport as a tool to develop an efficient reporting system for ships destined for recycling has been elaborated. It has also tried to lay-down a concrete, fool proof and standard approach of reporting the developments in ship recycling.

Parkinson [2005] in his paper has recommended a code of practice to be developed in order to improve the quality standard of ship recycling. The paper has stressed on elevation of existing ship recycling activities mainly scattered over South East Asia to an international level engineering industry. The author has emphasized the need of developing and implementing rules and regulations in ship recycling industry as in international shipbuilding. He has also pointed out some of the basic issues leading to the definition of a ship as scrap or ready for recycling by pointing out the differences in approach of agencies such IMO, MARPOL on one side and declarations approved in basic charter of agreements like Basel Convention on the other side.

Anderson [2005] has critically analysed the concept of Green Passport and its essentiality in the ship-breaking scenario. The paper has been critical on non-conformity of rules framed by various UN bodies such as IMO, ILO and UNEP (Basel Convention), but very firm on the stand adopted by Dets Norske Veritas in implementation ship inventory Dossier Environment and subsequent issue of Green Passport clearance. According to the author, ships are queuing up before DNV to acquire the Green Passport as this certificate has been foreseen as a must in the business in the years to come. Detailed methodology adopted by DNV teams on systematic surveys to arrive at the hazardous content in a ship has been categorically
listed in the second half of the paper. The preparations and procedures of awarding Green Passport have been nicely narrated.

Watkinson [2006] has thrown light on new developments in the issue of management of marine environment, initiated by IMO, in order to standardize the ship recycling operations in various countries. The paper has done a detailed debate on the role of Environmentally Sound Management (ESM) put forward by IMO. Key requirements for the sustainable development of ship recycling facilities, conforming to the principles and practice of recycling have been taken up for analysis. The paper has also described the relevance of guidelines prepared by three UN bodies, the IMO, the Basel Convention and the ILO which are to be followed very strictly by the recycling industry worldwide.

Ahluwalia [2006] in his paper, has listed the guidelines developed by Basel Action Network (BAN) and ILO for safe dismantling and disposal of obsolete vessels. The paper has envisaged effective implementation of the guidelines to identify hazards present on board ships, to help control environmental pollution, to control workers’ exposure to hazardous substances, to build a healthy work environment, and most of all to comply with international standards. It has also dealt with the benefits for the business community due to implementation of these guidelines.

3.3.2 Marine Environment Protection Committee and IMO Resolutions

IMO Resolution A962 (23) IMO guidelines on Ship Recycling., adopted on 5 December 2003 (Agenda item 19) is the most significant document prepared by IMO regarding ship recycling. Resolution A.981(24), 2005 is another resolution adopted by IMO regarding legally binding regulations to be implemented in various life cycle stages of the ships, ship recycling yards and enforcement of ship recycling reporting and certification. These resolutions are outcome of deliberations made during the meetings of Marine Environment Protection Committee, working group of IMO on global environmental issues. MEPC 42, 1998 to MEPC 61, 2010 has discussed the ship recycling issue with proper importance and seriousness.

IMO Resolution A962 (23) has envisaged the process of recycling in general, as one of the basic principles of sustainable development. The document has mentioned that for the disposal of all ‘time-expired’ ships there are few alternatives to recycling. This
can be considered as a well focused extension of the proposals put forward by the London convention 1972 (Dumping of waste and marine pollution) regarding recycling of steel by converting into other utility structures. The resolution has categorically stated that recycling is the best option for all time-expired tonnage and firmly assert that in the process of recycling ships, virtually nothing goes as waste. The resolution has identified ship recycling as green industry if the guidelines are followed in its true spirit. However, the guidelines have recognized that, although the principle of ship recycling may be sound, the working practices and environmental standards in the yards often leave much to be desired. The resolutions have affirmed that the ultimate responsibility for conditions in the yards has to lie with the country in which these are situated and other active stake holders.

IMO [2009] has pointed out the need for preparing ship recycling plan by the concerned ship recycler performing the assigned operations and the basic issue of Green Passport extended over the life cycle stages by the ship owners. IMO has mentioned the importance of implementing best practices for ship recycling process for the first time in this convention. Also the active collaborative efforts by the relevant United Nations agencies and conventions dealing with ship recycling have been reasserted in the convention report.

3.3.3 UNEP – Basel Convention Guidelines

Basel [2005] has dealt with identification of potential hazardous material onboard and method to prevent the haphazard handling of these materials. The Basel convention [2005] recommendation stresses the need of best practices to be followed in ship recycling process. The recommendations have focused more on environmental control procedures at ship dismantling yards by picking each and every potentially hazardous material present onboard.

3.3.4 Environmental Protection Agency (USA) Recommendations

US EPA [2000] has prepared a very comprehensive document regarding regulatory measures to be implemented in the United States ship dismantling yards. This document is the most extensive document dealing ship recycling issues related to pollution and hazards. The content of guidelines has dealt mainly with handling of hazardous materials onboard. Identification, handling and management of main
hazardous wastes such as asbestos, PCB paint bilge and ballast water, waste water and oil and fuel have been described in a very detailed manner. This document has also thrown light on practices involved in metal cutting, managing scrap and removal and disposal of ships machinery.

3.3.5 International Labour Organisation (ILO) Guidelines

[ILO 2004] has provided guidelines on ship recycling which has focused mainly on worker safety and health during ship dismantling. The ILO documents on ship recycling mainly have dealt with the health and safety of the labour work force employed in ship recycling yards. The guidelines have covered general safe ship breaking operations, involving manual labour, safety requirements for tools, machines and equipment.

3.3.6 Regional Rules and Regulations

3.3.6.1 Gujrath Maritime Board

Gujarat Maritime Board (GMB) is the governing body of world’s largest ship recycling destination. GMB has its own rules which can be considered as local rules. GMB has formulated certain rules regarding handling and disposal of asbestos and waste oil. The transportation and disposal of solid waste also has been brought under the preview of these rules.

3.3.6.2 Supreme Court of India

Supreme Court of India has given historic ruling in connection with denial or permission for infamous French Aircraft Carrier, Clemenssau, to Alang Ship Recycling Yard. The Supreme Court of India has given some strict guidelines regarding ship recycling activities in India. These guidelines are very general in nature and more specific rules have to be formulated for actual implementation at the recycling yards.

3.3.6.3 Departments of Trade & Industry and Environment, Food and Rural Affairs, U.K

Rules and regulations related to decommissioning of offshore installations, ships and pipelines in the United Kingdom have been started by the end of last millennium.[UK 1998] Two different government departments have prepared separate guidelines
regarding ship recycling in UK. These documents prepared by the Department of Trade and Industries, United Kingdom and though these guidelines prepared are for dealing with offshore structures, the same can be very useful in ship recycling context also. Separate guidelines have been provided for heavy and light structures. Notes have been provided for concrete structures used in offshore installations considering special characteristics associated with it. Another UK government body, Department of Environment, Food and Rural Affairs has prepared a similar ship recycling document [UK 2007]. This has spoken about the UK ship recycling strategy in detail.

3.3.6.4 MARISEC, London

Industry Code of Practice on Ship Recycling [MARISEC 2001] is general purpose ship recycling guidelines. These guidelines have been prepared by the Industry Working Party on Ship Recycling working under Marisec which is a consortium of number of international maritime agencies, operating from London. The working group on ship recycling is under the coordination of International Chamber of Shipping (ICS). The ship recycling in codes are given in the book titled “Industry Code of Practice on Ship recycling”. European Union council regulations No.259/93 has been referred in this as the supporting document. Content of this code is of promotional nature and the code calls for voluntary kind of participation by the ship recycling and other interested maritime industries in clean and safe recycling activities in recycling destinations of the world. It is the only document which strongly speaks about necessity for an efficient and concrete ‘Industry Policy on Ship Recycling’.

3.4 APPLICATIONS OF INFORMATION TECHNOLOGY

Karpowicz et al [2005] have elaborated the need for a proper and efficient Knowledge Base support for healthier ship recycling activities all over the world. The paper has drawn the attention of various engineering professionals and practicing managers, technocrats and other interested groups in the process of initiating a common information platform by which the prospects of the recycling industries can be made brighter. It has presented an interesting matrix depicting very clear roles and responsibilities of various participating elements in the recycling engineering system. The paper has categorically suggested that if any recycling industry has to survive,
especially that from the EU nations, they will have to turn toward implementation of an effective knowledge base support mechanism in the day to day activities.

Sibal.P, [2001] in her project work, has described the process of development of a software tool and associated databases to show various information available such as, ship name, type, year built, ship status, light ship displacement, length, beam, changes made, dead weight, number of propellers, propulsion type, dismantling site of ship(s). This work has dealt in detail the development of a Database for Dismantling of Obsolete Vessels (DOVE) by providing total towing cost for a selected ship based on the total tow distance, the light ship displacement of the ship, the unit tow cost/mile-ton and the tow preparation cost. A cutting technology database is discussed which was developed and populated to provide information about the various cutting technologies, decontamination technologies and waste processing methodologies. It has included yet another database system in the work which gives the account of recycled metals and alloys is successfully integrated to the DOVE system. Information links to all the regulations by the OSHA and the EPA regarding the hazardous chemicals have also been listed in thesis.

Gramann, [2006] has provided an overview on the background of data management and development of an appropriate tool incorporating the needs and requirements related to the new legally binding instrument on ship recycling, which is currently under development at IMO. The paper has nicely projected the need of a high computing database system allowing different approaches by creation of technical and logical data relations.

Koumanakos et al [2006] have considered various factors involved in ship recycling, and propose an information support framework that supports decision making for the dismantling of obsolete vessels. The proposed framework has integrated a dynamic simulation tool with decision support features and functionalities to address the individual needs of the different stakeholders involved. Framework presented in this paper highlights points such as support decision making concerning the design and execution of the dismantling process of a vessel, the suitability of a dismantling yard for a specific vessel, the recycling of the vessel’s materials, the economic feasibility of a dismantling yard to undertake a dismantling process. In addition, the proposed framework integrates a set of well-structured databases that maintain data concerning
vessels, dismantling yards and processes, associated technologies and equipment, customers, as well as directives and regulations concerning occupational health and environmental sustainability.

### 3.5 ROLE OF NAVAL ARCHITECTS AND CLASSIFICATION SOCIETIES

Alkaner et al. \[2006\] have referred to the point of development of industrial facilities as a process which involves extensive interaction among numerous layout design parameters. This paper has also stressed the need of re-engineering the current processes and facilities to suit environmentally friendly solutions for the “product’s funeral”. In this paper, a systematic approach to the facility development problem for a generic ship dismantling yard has been presented. A comparison is made between the current layout and facility types used in ship dismantling and shipbuilding, emphasising the similarities between both industries. Current ship dismantling practices and facility formations from the main ship dismantling countries have been critically evaluated and presented. Departing from abstract and broadly defined facility components, this study has focused on selected stages of the processes and has introduced a detailed and streamlined modeling approach for critical facility components. A series of layout alternatives is systematically generated at the concept development stage, based on the variants of the primary and secondary phase dismantling processes. A set of performance criteria for ship dismantling facility layouts has been developed in order to compare and evaluate the performance of each layout alternative. Performance indices have also been used to determine the input data and systems modeling needs of the study. A simulation model for each layout variant is developed to evaluate the performance of each alternative under various operating and environmental conditions. The stochasticity of real-life cases has been introduced into the model to analyze the dynamic nature of ship dismantling processes and systems. Integrated fuzzy multiple-criteria multiple attribute decision support systems for facility design evaluation for ship dismantling has also been presented for selecting the best alternative.

Alkaner et al. \[2006\] have done a comparative analysis of ship dismantling with ship production. Moreover, ship dismantling has occasionally been referred to as “reverse” shipbuilding. The paper has investigated both activities from the point of view of process characteristics and key performance indicators for both processes are listed. It has highlighted the Health and Safety rules and regulations in both processes and later
has brought out comparison of facilities management in ship production and ship dismantling. Another area touched by the authors is the environmental impact of yard operations, i.e.; emissions and handling of hazardous materials. In this paper, “design for disassembly (DfD)” concepts have also been discussed in the ship lifecycle performance improvement context. DfD activities consider the end of life stage of the product as early as possible during the initial stages of design and construction. Among the subjects discussed under that section are design aspects, material inventories and reusability issues.

3.6 SHIP RECYCLING DEMAND FORECASTING

Bruce et al [2005] have presented a model for assessment of future market for ship dismantling. The authors have been successful in arriving at a reasonable prediction using time series over a ten year period. The method used in the prediction is a Free-Forward Neural Network which has been trained for logic of interaction between the identified parameters affecting ship recycling demand. The authors have expressed doubts over the prediction accuracy of their model in the event of sudden and unexpected developments in the international shipbuilding sector. This is one of the very few technical papers available in ship recycling dealing with demand forecasting of ship recycling.

3.7 INFERENCES

It has been observed that most of the works are of promotional nature and reflect concerns regarding issues related to Safety, Environment and Pollution. The reported works by Winjgarden [2006], Stephenson [2005], Shahid [2005], Asolekar et al [2006] and the like in ship recycling field deal with only peripheral issues with shades of regional aspects. The active role of IMO in the ship recycling industry has been elucidated in IMO [2003]. There are more guidelines than the actual recycling activities and these guidelines still remain as recommendations. The ship recycling nations have not yet made it mandatory, though there are some concrete move in this direction initiated by IMO and some member states. ‘Rules’ remain as a Black Box yet to be decoded by the industry for implementing them in a real situation. The efforts undertaken by the ship classification society, Det Norske Veritas [DNV, 2000] are reflected at many places in the literature. The Green Passport issue put forward by the DNV has got a good coverage and IMO is referring to this in its reports.
Though ship recycling has been accepted as one of the main life-time-activities of ships, the presence of naval architects is felt seldom. The literature presented in this report has only one technical deliberation in a field which connects naval architecture and ship recycling viz, Das et al [2006]. Experts representing mechanical, chemical, safety and environmental engineering are more active in this filed now. The reported studies in ship recycling are more in terms of industrial projects than academic research. Database creation for obsolete vessels has been dealt by Sibal [2001]. The necessity of developing knowledgebase has been proposed by Karpowicz et al [2005]. Database creation of rules and regulations in ship recycling has been emphasized by Gramann [2006] and creation of dynamic decision support tool for planning operations in ship recycling has been proposed by Koumanakos et al [2006]. Bruce et al [2005] have touched a small part of vast area of demand forecasting in ship recycling.