DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

A CASE STUDY ISO 14001 AND OHSAS 18001 APPLICATIONS FOR AN INDUSTRIAL PLANT PRODUCED COMPOSITE SAMPLES

by
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September, 2009
İZMİR

A CASE STUDY ISO 14001 AND OHSAS 18001 APPLICATIONS FOR AN INDUSTRIAL PLANT PRODUCED COMPOSITE SAMPLES

A Thesis Submitted to the
Graduate School of Natural and Applied Sciences of Dokuz Eylül University
In Partial Fulfillment of the Requirements for the Degree of Master of Science
in
Environmental Engineering, Environmental Technology Program

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M.Sc THESIS EXAMINATION RESULT FORM

We have read the thesis entitled **"A CASE STUDY ISO 14001 AND OHSAS 18001 APPLICATIONS FOR AN INDUSTRIAL PLANT PRODUCED COMPOSITE SAMPLES"** completed by **NERİMAN TOPBAŞ** under supervision of **PROF. DR. AYŞE FİLİBELİ** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ACKNOWLEDGEMENTS

Special appreciation is given to my supervisor Prof. Dr. Ayşe FİLİBELİ, my Managing Director Alper KALAYCI, Dr. Cenk SEVİM, and my husband and children.

Neriman TOPBAŞ

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ABSTRACT

ISO 14001 and OHSAS 18001 standards are very important for both companies and employees. Both ISO 14001 and OHSAS 18001 are indispensible for organizations and employees as they bring many advantages with them. The companies become more prestigious as they implement these two world wide known standards. On the other hand, employees work in a healthy and safe environment and they are protected against any sudden and unfortunate occupational accident. Details of ISO 14001 and OHSAS 18001 are shown and analyzed. We examined these two important bodies of standards to show the importance of environment, safety and health in companies.

There are many examples from different countries in the thesis. The purpose of this is to provide adequate information about the applicability of ISO 14001 and OHSAS 18001. In these examples, it is clearly seen that every company which implement these standards see the benefits in terms of lowering occupational accidents and occupational illnesses, and increasing company's prestige, etc.

Keywords: ISO 14001, OHSAS 18001, cleaner production, health and safety, management, environment, risk assessment, documentation, materials, methods, manufacturing, waste, measurement.

ISO 14001 VE OHSAS 18001 UYGULAMALARININ KOMPOZİT ÖRNEK ÜRETEN BİR SANAYİ TESİSİNDE UYGULANMASI

ÖZ

ISO 14001 ve OHSAS 18001 standartları hem şirketler hem de çalışanlar için oldukça önemlidir. Hem ISO 14001 hem de OHSAS 18001 beraberinde birçok avantaj getirdiğinden kurumlar ve çalışanlar için vazgeçilmezdir. Şirketler dünyaca ünlü bu iki standardı uyguladığında daha fazla itibar sahibi olurlar. Diğer yandan, çalışanlar sağlıklı ve güvenli iş alanlarında çalışırlar ve herhangi ani ve talihsiz bir iş kazasına karşı korunurlar. Bu çalışmada ISO 14001 ve OHSAS 18001 standartlarının detayları gösterilmiş ve analiz edilmiştir. Şirketlerde çevrenin, güvenliğin ve sağlığın önemini göstermek için bu iki önemli kurallar bütününü inceledik.

Tezde birçok ülkeden örnekler verilmiştir. Bundaki amaç is ISO 14001 ve OHSAS 18001 standartlarının uygulanabilirliği hakkında yeterli bilgiyi vermektir. Bu örneklerden, bu standartları uygulayan şirketlerin mesleki kazaların ve mesleki hastalıkların azalması ve şirket saygınlığının artması vs yönlerinden faydalarını görmekte olduğu apaçık görülmektedir.

Anahtar Kelimeler: ISO 14001, OHSAS 18001, daha temiz üretim, sağlık ve güvenlik, yönetim, çevre, risk değerlendirmesi, dokümantasyon, maddeler, yöntemler, üretim, atık, ölçüm.

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CHAPTER ONE
ABOUT THESIS

1.1 The Aim of the Study

The aim of this thesis is to study on how a workplace can be convenient for both technology and required standards, and on how a workplace can be appropriate to work health and safety rules.

A polymeric composite factory workout is chosen as an application example. The reason for choosing this application example is to show how a good application example can be given by process management and chemical utilization. Under these required standards, infusion method, which is under the vacuum process management title, is the best application example as there is no explicit chemical application. Also, by the usage of resins and hardeners, instead of vinyl polyester, the utilization of chemicals, which has low risk factors, is provided.

By assessment and evaluation studies in OHSAS 18001 and ISO 14001 applications, it is required to make some environmental evaluation and environmental improvement. Thus, the exposure rates of people who work with these applications are decreased under figures which are required by the legislation and the international standards about noise, chemical, hand and arm vibration, and dust.

The aim is to show a good application example by following the environment and work health and safety standards and the corresponding legislation. Although some employers think that this applications increase the costs and decrease the productivity, in long range, in companies where legal procedures, which is composed by some given standards, are followed, there will be no sudden charges or high costs caused by occupational accidents.

In addition, as workers will be in more peaceful and convenient environment, there will be increase in productivity and quality. In this application, it will be

emphasized how to show a good example for raw material variety and method differences in composite production.

As a result, ISO 14001 and OHSAS 18001 standards and procedures which are connected to the corresponding legislation, and rules and adjustments that are needed to be obeyed and the checklists which make it easy to control them should be arranged. Also, it is legally compulsory to revise the assessment and evaluation criteria in certain periods. It is aimed to minimize occupational accidents and occupational illnesses, and to arrange a workplace, which is respectful to both nature and human, by eliminating the environmental risks.

CHAPTER TWO
ISO 14001 AND OHSAS 18001 STANDARDS

2.1 The Perspective

In this part, there will be general outlook and summaries about OHSAS 18001 and ISO 14001. This chapter aims to give information about how the studies started, what benefits it brought to us, why companies prefer it, etc. Leader international institutes like EPA, WHO and ILO support these standards because it enables the action to be performed in order and discipline, and thus the legal requirements and necessary improvements, that these institutes demand, can be accomplished conveniently.

2.1.1 What is OHSAS 18001?

OHSAS 18001 was created via the concerted and combined effort from a number of the world's leading national standards bodies, certification bodies, and specialist consultancy groups.

The Occupational Health and Safety (OHS) management aims to create and maintain a safe working environment, while protecting and maintaining good health of the workers. OHSAS 18001 was first published in 1999 as compatible with ISO 9001 and ISO 14001 management system standards in order to facilitate an integration of the three systems (Zeng et al.,2007)

Although it does not set out specific occupational health and safety performance criteria, nor does it give detailed specifications for the design of a management system, any organization can be OHSAS 18001 compliant by: (1) establishing an occupational health and safety management system (OHSMS) to minimize risks to its employees and other interested parties; (2) implementing, maintaining, and continually improving an OHSMS; (3) assuring itself of its conformance with its stated OHS policy; (4) demonstrating such conformance to others; (5) seeking certification/registration of its

OHSMS by an external organization; (6) making a self-determination and declaration of conformance with the standard's specifications (Tsai et al, 2009).

Although OHSAS 18001 does not set out specific OHS performance criteria, nor does it give detailed specifications for the design of a management system, it is applicable for any organization: (a) to establish an OHS management system to minimize risks to its employees and other interested parties; (b) to implement, maintain, and continually improve an OHS management system; (c) to assure itself of its conformance with its stated OHS policy; (d) to demonstrate such conformance to others; (e) to seek certification/registration of its OHS management system by an external organization; and (f) to make a self-determination and declaration of conformance with the standard's specifications (Zeng et al., 2007).

Essentially, OHSAS helps in a variety of respects; it helps minimize risks to employees, improve an existing OHS management system, demonstrate diligence, gain assurance, etc. The benefits can be substantial.

OHSAS comprises of two parts: OHSAS 18001 is the first. This is an assessment specification for Occupational Health and Safety Management Systems. It was developed to help organizations meet their health and safety obligations in an efficient and effective manner. OHSAS 18002, which is the second, explains the requirements of the specification, and demonstrates how to work towards implementation and registration. Together these comprise emerging standard and methodology to address health and safety within the organization.

Benefits of OHSAS 18001 can be arranged like; reduction in the exposure of employees and other parties to occupational health and safety risks associated with the organizations activities, potential reduction in resultant costs, greater assurance of conformance with occupational health and safety policy, demonstration of conformance to third parties and of due diligence generally, consistent and proven management approach to H&S risks, present and future, deployment of method for continual improvement of the occupational health and safety management system.

Its statutory authority extends to most workplaces where there are employees and staff. State and government workers are excluded from Federal coverage. However, States operating their own workplace safety programs under plans approved by the U.S. Department of Labor cover most private sector workers and are also required to extend their coverage to the public sector.

OSHA regulations also permit states without approved plans to develop plans that cover only public sector workers. In these states, private sector employment remains under Federal OSHA jurisdiction.

Despite early difficulties, over time, manufacturers of industrial equipment have included OSHA-compliant safety features in new machinery, enforcement has become more consistent across jurisdictions, and some of the more unpopular rules have been repealed.

2.1.2 What is ISO 14001?

This International Standard specifies requirements for an environmental management system to enable an organization to develop and implement a policy and objectives which take into account legal requirements and other requirements to which the organization subscribes, and information about significant environmental aspects. It applies to those environmental aspects that the organization identifies as those which it can control and those which it can influence. It does not itself state specific environmental performance criteria.

ISO 14001 is a series of standards and guidelines formulated in 1996 by the ISO with the aim of standardizing the environmental management programs across industries worldwide. The ISO 14000 series are comprised of five aspects: environmental management system (EMS), environmental auditing (EA), environmental labeling (EL), environmental performance evaluation (EPE), and life cycle assessment (LCA). The standards are classified into two types: guidance notes and specifications. All standards except ISO 14001 belong to the former. They are

descriptive documents and not prescriptive requirements. Only ISO 14001-based EMS is a standard. It is the core of the series. Its adoption is voluntary. As a subset of ISO 14000, the EMS takes a systematic approach and provides a tool to enable organizations to control the impact of their activities, products, or services on the natural environment (Zeng et al., 2007).

ISO 14001 consists of general requirements, environmental policy, planning, implementation and operation, checking and corrective action management review. This International Standard is applicable to any organization that wishes to establish, implement, maintain and improve an environmental management system, to assure itself of conformity with its stated environmental policy, to demonstrate conformity with this International Standard by making a self-determination and self-declaration, or any organization which is seeking confirmation of its conformance by parties having an interest in the organization, such as customers, or seeking confirmation of its self-declaration by a party external to the organization, or seeking certification/registration of its environmental management system by an external organization.

All the requirements in this International Standard are intended to be incorporated into any environmental management system. The extent of the application depends on factors such as the environmental policy of the organization, the nature of its activities, products and services and the location where and the conditions in which it functions.

2.1.3 What is life-cycle?

Life-Cycle Assessment purpose is to promote the use of LCA to make more informed decisions through a better understanding of the human health and environmental impacts of products, processes, and activities. The site is divided into four primary areas to help educate people new to the concept of LCA while serving as a focal point for LCA practitioners and decision-makers to stay current with the field of LCA. LCAccess provides information on why one would want to perform an

LCA, an overview of LCA, how to find LCI data sources, and available LCA resources.

LCA is a technique to assess the environmental aspects and potential impacts associated with a product, process, or service, by:

- Compiling an inventory of relevant energy and material inputs and environmental releases,
- Evaluating the potential environmental impacts associated with identified inputs and releases,
- Interpreting the results to help you make a more informed decision.

The following figure is about the products. It shows their life-cycle.

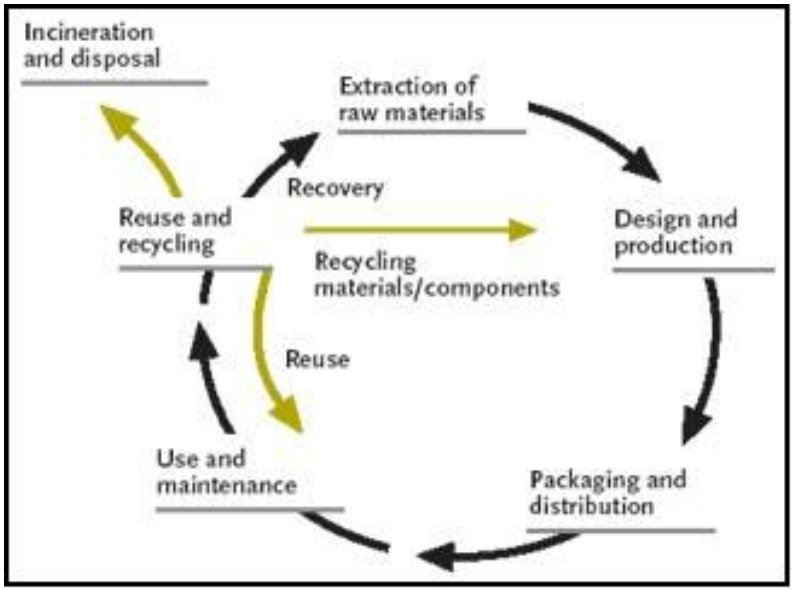

Figure 2.1 This figure shows the life-cycle of the products (Green Procurement Guide).

2.2 Cleaner Production

Cleaner production system helps companies to get better production quality. This section summarizes the definition of the cleaner production, waste definition and classification like infectious waste, medicinal waste, offensive/hygiene waste, and

waste management methods like disposal methods, recycling methods, avoidance and reduction methods.

2.2.1 What is the cleaner production?

Cleaner production promotes pollution prevention, waste minimization, greater efficiency, and energy conservation. As it is summarized in Figure 2.2, Green Procurement Guide defines it as complete studies. The whole system is connected to each other and if one part cannot exist without the other. The dangerous and toxic contaminants should be separated in each step of studies and production.

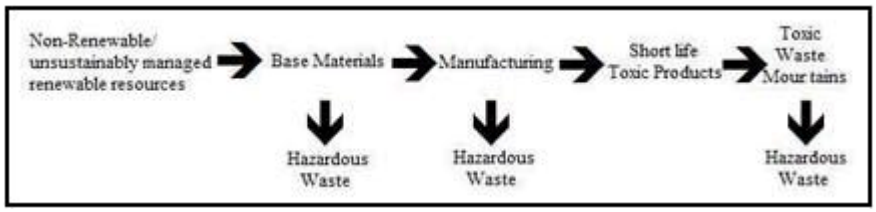

Figure 2.2 This figure summarizes the steps of cleaner production (Green Procurement Guide).

2.2.2 Waste Definition and Classification

Identification of wastes and defining the characteristics are the most important processes in order to decide properly how to dispose.

Waste regulation requires the classification of health care waste, produced as a consequence of health care activities in hospitals and community settings, on the basis of its hazardous characteristics and point of production (Salisbury NHS Foundation Trust [SNHSFT], 2008).

There are two types of healthcare waste; hazardous and non-hazardous wastes.[1]

[1] There are also clinical wastes, which comprise infectious wastes and medicinal wastes, and non-clinical wastes, which comprise offensive/hygiene wastes (Salisbury NHS Foundation Trust, 2008).

Hazardous wastes are listed in the appendix of the corresponding legislation. Hazardous wastes contain chemical materials which are toxic, irritant and corrosive for humans and environment.[2]

2.2.3 Waste Management

Waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is also carried out to recover resources from it. Waste management can involve solid, liquid, gaseous or radioactive substances, with different methods and fields of expertise for each (SNHSFT, 2008).

Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers. Management for non-hazardous residential and institutional waste in metropolitan areas is usually the responsibility of local government authorities, while management for non-hazardous commercial and industrial waste is usually the responsibility of the generator.

2.2.3.1 Disposal Methods

In the disposal of the solid wastes there used a variety of methods. These methods are summarized in this part.

2.2.3.1.1 Landfill. Disposing of waste in a landfill involves burying the waste, and this remains a common practice in most countries. Landfills were often established in abandoned or unused quarries, mining voids or borrow pits. A properly-designed and

[2] All clinical waste needs to be segregated so it can be disposed of appropriately, on the basis of the hazard it poses. The *Safe Management of health care waste* memorandum introduces a new single classification system that enables a unified approach to assessing, at the source of production, whether waste is infectious clinical waste, medicinal waste, or offensive/hygiene waste (SNHSFT, 2008).

well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. Older, poorly-designed or poorly-managed landfills can create a number of adverse environmental impacts such as wind-blown litter, attraction of vermin, and generation of liquid leachate. Another common byproduct of landfills is gas (mostly composed of methane and carbon dioxide), which is produced as organic waste breaks down anaerobically. This gas can create odor problems, kill surface vegetation, and is a greenhouse gas.

Design characteristics of a modern landfill include methods to contain leachate such as clay or plastic lining material. Deposited waste is normally compacted to increase its density and stability, and covered to prevent attracting vermin (such as mice or rats). Many landfills also have landfill gas extraction systems installed to extract the landfill gas. Gas is pumped out of the landfill using perforated pipes and flared off or burnt in a gas engine to generate electricity.

2.2.3.1.2 Incineration. Incineration is a disposal method that involves combustion of waste material. Incineration and other high temperature waste treatment systems are sometimes described as "thermal treatment". Incinerators convert waste materials into heat, gas, steam, and ash.

Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous waste. It is recognized as a practical method of disposing of certain hazardous waste materials (such as biological medical waste). Incineration is a controversial method of waste disposal, due to issues such as emission of gaseous pollutants.

Incineration is common in countries such as Japan where land is scarcer, as these facilities generally do not require as much area as landfills. Waste-to-energy or energy-from-waste are broad terms for facilities that burn waste in a furnace or boiler to generate heat, steam and/or electricity. Combustion in an incinerator is not always perfect and there have been concerns about micro-pollutants in gaseous emissions from incinerator stacks. Particular concern has focused on some very persistent

organics such as dioxins which may be created within the incinerator and which may have serious environmental consequences in the area immediately around the incinerator. On the other hand this method produces heat that can be used as energy.

2.2.3.2 Recycling Methods

PVC, LDPE, PP, and PS are also recyclable, although these are not commonly collected. These items are usually composed of a single type of material, making them relatively easy to recycle into new products. The recycling of complex products (such as computers and electronic equipment) is more difficult, due to the additional dismantling and separation required.

2.2.3.2.1 Biological Reprocessing. Waste materials that are organic in nature, such as plant material, food scraps, and paper products, can be recycled using biological composting and digestion processes to decompose the organic matter. The resulting organic material is then recycled as mulch or compost for agricultural or landscaping purposes. In addition, waste gas from the process (such as methane) can be captured and used for generating electricity. The intention of biological processing in waste management is to control and accelerate the natural process of decomposition of organic matter.

There are large varieties of composting and digestion methods and technologies varying in complexity from simple home compost heaps, to industrial-scale enclosed-vessel digestion of mixed domestic waste. Methods of biological decomposition are differentiated as being aerobic or anaerobic methods, though hybrids of the two methods also exist.

2.2.3.2.2 Energy Recovery. The energy content of waste products can be harnessed directly by using them as a direct combustion fuel, or indirectly by processing them into another type of fuel. Recycling through thermal treatment ranges from using waste as a fuel source for cooking or heating, to fuel for boilers to generate steam and electricity in a turbine. Pyrolysis and gasification are two related

forms of thermal treatment where waste materials are heated to high temperatures with limited oxygen availability. The process typically occurs in a sealed vessel under high pressure. Pyrolysis of solid waste converts the material into solid, liquid and gas products. The liquid and gas can be burnt to produce energy or refined into other products. The solid residue (char) can be further refined into products such as activated carbon. Gasification and advanced Plasma arc gasification are used to convert organic materials directly into a synthetic gas (syngas) composed of carbon monoxide and hydrogen. The gas is then burnt to produce electricity and steam.

2.2.3.3 Avoidance and Reduction Methods

An important method of waste management is the prevention of waste material being created, also known as waste reduction. Methods of avoidance include reuse of second-hand products, repairing broken items instead of buying new, designing products to be refillable or reusable (such as cotton instead of plastic shopping bags), encouraging consumers to avoid using disposable products (such as disposable cutlery), removing any food/liquid remains from cans, packaging, and designing products that use less material to achieve the same purpose.

With the beginning of ISO 14001 studies, wastes are redefined and waste management is composed by providing training to the employees about this subject.

Waste collection points in production departments are illustrated and explained below:

Figure 2.3 This figure is an example for how collection barrels should be ordered in factories.

2.3 OHSAS 18001 Health and Safety Management

The following parts explain the reasons why safety management is important, how the safety was developed and following up the national and local law. In this part, standards about occupational health and safety are generally summarized as what they are, how they are implemented and how they developed.

2.3.1 Why safety management?

A healthy workplace is a place where everyone works together to achieve an agreed vision for the health and well-being of workers and the surrounding community. It provides all members of the workforce with physical, psychological, social and organizational conditions that protect and promote health and safety. It enables managers and workers to increase control over their own health and to improve it, and to become more energetic, positive and contented. In return, the workforce is more stable, committed and productive.

World Health Organization describes the importance of the safety management as follows:[3]

Firstly, a healthy workplace encourages the development of a healthy workforce, which is vital to a nation's economic and social growth. Healthy workers are among the most valuable assets of any nation. A healthy organization supports a healthy workforce, which is fundamental to the socioeconomic well-being of the country. Unhealthy organizations contribute to an unhealthy workforce, resulting in economic losses through absenteeism, injury and disease, direct and indirect health expenditures, and significant social costs to families and communities.

Secondly, a healthy workplace offers the ideal setting for introducing health promotion programmes. Since the majority of the adult population spends approximately one-third of their daily life at work, the workplace offers an excellent environment for promoting health. If neglected, the work environment can have extremely negative consequences for workers' health, causing stress, injury, illness, disability and death.

Thirdly, a healthy workplace acknowledges the non-occupational factors that can influence workers' health, and encourages interaction with families and communities. The health of workers is also affected by non-occupational factors, which, in turn, have an impact on job performance and productivity at work. These factors include poor living conditions, tense family relationships, use of tobacco, alcohol and drugs, unhealthy diet, financial difficulties, and unsafe leisure activities. By improving knowledge and skills on how to better manage their health, both workers and their families should benefit, as does the workplace.

[3] Two concepts are crucial to the achievement of healthy workplaces – *the protection of health* and *the promotion of health*. Fundamental to a healthy workplace is the need to protect individuals, both within and outside the workplace, from harm due to a potentially hazardous, stressful or degraded work environment. Work styles conducive to health and good health practices can be supported through health promotion (WHO, 1999).

Fourthly, a healthy workplace promotes the overall success of the organization. A healthy workplace can result in changes that are beneficial to the long-term survival and success of an organization. Benefits include improved worker health status, increased job satisfaction, enhanced morale and work productivity, cost savings (e.g. reduced absenteeism and employee turnover, lower health care and insurance costs), a positive company image and competitiveness in the marketplace.

Finally, the healthy workplace protects the general environment and supports sustainable development. A healthy workplace reduces and controls environmental pollution and contributes to the development of Healthy Cities and Healthy Islands. Environmental preservation is essential to the health and well-being of future generations, and to sustainable development (WHO, 1999).

2.3.2 How the safety was developed?

Occupational health and safety studies are emphasized with the work plans and implementation steps which are created by WHO. Primary areas and topics are determined in the field of occupational health and safety. Action plans are prepared to direct these studies in fast and accurately. Situation reviews are made by preparing status reports periodically. With the help of these studies, positive progresses are achieved and employers started to give importance to applications.[4]

2.3.3 Follow up National and Local Law

It is an important criterion for OHSAS 18001 and ISO 14001 to be compliant with the corresponding laws. Laws requirements, procedures, instructions and policy have to be checked constantly in the preparation process. Therefore, local and

[4] The steps of the development of safety can be summarized as: ensuring management support, establishing a coordinating body, conducting a needs assessment, prioritizing the needs, developing an action plan, implementing the action plan, evaluating the process and outcomes, and revising and updating the programme (WHO, 1999).

international laws and regulations about environmental and occupational health and safety are monitored consistently.[5]

2.4 ISO 14001 and OHSAS 18001

ISO 14001, as an International Standard, specifies requirements for an environmental management system to enable an organization to develop and implement a policy and objectives which take into account legal requirements and other requirements to which the organization subscribes, and information about significant environmental aspects. It applies to those environmental aspects that the organization identifies as those which it can control and those which it can influence. It does not itself state specific environmental performance criteria.

[5] World Health Organization suggests eleven steps to build a national law. Firstly, a working group must be established to select the lead agency and convene a National Steering Committee; secondly, Major stakeholders and interest groups should be represented on the Committee; thirdly, national baseline data and information must be collected; fourthly, an information seminar on healthy workplaces for members of the working group and the National Steering Committee must be provided; fifthly, a position statement guiding principles and objectives of healthy workplaces must be developed; sixthly, a three- to five-year national strategic plan for healthy workplaces must be developed; seventhly, training for facilitators of healthy workplace programmes must be coordinated; eighthly, the concept of healthy workplaces must be promoted through national conferences and workshops and the media; ninthly, an evaluation and monitoring strategy must be developed to track the progress of the initiative; tenthly, the national position statement, strategic plan and annual action plans based on the review process and feedback from the provinces must be reviewed and revised; and eleventhly, a national policy must be drafted and the regional guidelines for healthy workplaces must be adapted.

On the other hand, there are nine suggestions to build a local law. Firstly, provincial or local Steering Committees must be established to coordinate activities; secondly, a position statement on healthy workplaces and a three- to five-year strategic plan must be developed; thirdly, potential facilitators and implementers of healthy workplace programmes must be identified; fourthly, a list of governmental and nongovernmental agencies that can provide support to workplaces in the development of their programmes must be identified and prepared; fifthly, training courses for facilitators who will be responsible for the design and implementation of healthy workplace programmes must be provided; sixthly, healthy workplace programmes in selected trial sites must be implemented; seventhly, a follow-up training workshop for facilitators must be provided to refresh and reinforce knowledge and skills; eighthly, success stories must be collected and publicized; and ninthly, the strategic plan and annual action plan must be revised and their implementation must be coordinated (WHO, 1999).

Additionally, OHSAS 18001 was created via the concerted and combined effort from a number of the world's leading national standards bodies, certification bodies, and specialist consultancy groups. It was developed to help organizations meet their health and safety obligations in an efficient and effective manner. It helps in a variety of respects; it helps minimize risks to employees, improve an existing OHS management system, demonstrate diligence, gain assurance, etc. The benefits can be substantial.

2.4.1 Environmental Policy

The environmental policy is the driver for implementing and improving an organization's environmental management system so that it can maintain and potentially improve its environmental performance. This policy should therefore reflect the commitment of top management to comply with applicable legal requirements and other requirements, to prevent pollution and to continually improve. The environmental policy form the basis upon which the organization sets its objectives and targets. The environmental policy should be sufficiently clear to be able to be understood by internal and external interested parties, and should be periodically reviewed and revised to reflect changing conditions and information.

The environmental policy should be communicated to all persons who work for, or on behalf of, the organization, including contractors working at an organization's facility.[6] Communication to contractors can be in alternative forms to the policy statement itself, such as rules, directives and procedures, and may therefore only include pertinent sections of the policy. The organization's environmental policy should be defined and documented by its top management within the context of the environmental policy of any broader corporate body of which it is a part, and with the endorsement of that body. It is important that top management usually consists of

[6] Many organizations have recognized the need for a comprehensive workplace health policy as a way to show their commitment to the health of their workers. Unlike more specific policies that address single issues such as smoking, a comprehensive health policy addresses the whole range of factors that influence workers' health (WHO, 1999).

a person or group of people who direct and control an organization at the highest level.

2.4.2 Environmental Planning

In the preparation of environment planning, the issues to be considered are to create a system which responds to working environment to be open to improvements, which is corresponding with local and international environment policy and legislation, and which fulfils the demands of the workers and customers.

A global perspective should be taken into consideration by keeping in mind the domino effect in environment planning. For example, the effects of the possible explosion in nearby factories should be taken into consideration. Likewise, the environmental effects of a possible accident in the working environment should be anticipated and the necessary action plans should be prepared.[7]

2.4.3 Health and Safety Policy[8]

Law compliance, occupational health and safety objectives and working with companies involved with the commitments will be taken under this policy and

[7] World Health Organization explains the necessities of a healthy environment and they offer five suggestions. Firstly, they suggest that an organization should provide a safe and healthy environment for its staff. In designing buildings, pathways, plant, equipment and ventilation systems, the organization should regard health and safety as a major consideration. Secondly, the organization should eliminate or minimize the exposure to work-related hazards, such as emission of dust, fumes, radiation, excess heat or cold, noise, vibration and contact with dangerous substances or materials. Thirdly, the organization should clearly define the procedures for the safe handling of materials including the use of personal protective clothing and equipment. Fourthly, the organization should ensure that the direct line manager is held clearly accountable for the health and safety of the workforce within his or her jurisdiction. And fifthly, the organization should ensure basic hygiene and sanitary workplace conditions (WHO, 1999).

[8] According to World Health Organization, basic health and safety policies should be like this: there should be programmes to promote healthy lifestyles and personal health skills; there should be healthy lifestyle programmes that include tobacco use, alcohol and other drug use, physical activity, mental health, reproductive and sexual health; and families and communities should be connected to the organization (WHO, 1999).

declared. Main topics and issues related to the preparation of the targets must be clearly stated. They should be adopted by the employees and this policy should be explained to them, too.

2.4.4 Health and Safety Planning[9]

The organization should provide a safe and healthy environment for staff. In designing buildings, pathways, plant, equipment and ventilation systems, the organization regards health and safety as a major consideration. Work stations are well-spaced to ensure adequate light, ventilation and noise control. Rest areas and designated eating places are provided. The organization undertakes periodic health and safety audits of all buildings, plant and equipment to ensure that they are safe and in good working condition. Walking and working surfaces are kept clean, clear and free from hazards. Switches and controls are properly designed and within easy reach of workers. Proper guards are attached to protect employees from dangerous moving parts of machines and power transmission equipment. The organization has a fire prevention plan and well-maintained fire extinguishers. Employees are periodically instructed in their role in fire protective procedures. Fire exits are appropriately designated. All electrical equipment is in compliance with applicable codes. All powered equipment is locked out before servicing or maintenance. Guidelines for the use of plant and equipment are developed in the form of health and safety manuals and checklists. Training programmes are conducted for all staff with continuous upgrading. A strategic plan with a clear timeframe and allocation of resources is developed for the upgrading of buildings, plant, and equipment.

[9] World Health Organization suggests the following three suggestions for healthier and safer working environments: firstly, the organization must develop an environmental management strategy to prevent negative impacts on the external environment from the plant and work processes; secondly, the organization must promote worker access to adequate and safe transport to and from work; and thirdly, the organization must play a positive role in local community life (WHO, 1999).

2.5 Documentation

The OH&S management system documentation shall include: the OH&S policy and objectives; description of the scope of the OH&S management system; description of the main elements of the OH&S management system and their interaction, and reference to related documents; documents, including records, required by this OHSAS Standard; and documents, including records, determined by the organization to be necessary to ensure the effective planning, operation and control of processes that relate to the management of its OH&S risks. It is important that documentation is proportional to the level of complexity, hazards and risks concerned and is kept to the minimum required for effectiveness and efficiency.

2.5.1 Risk Assessments

Risk analysis studies are made to determine the danger and danger levels in the working environment. Determination of danger and the extent of the danger are very important in terms of which practice should be made initially. This allows the anticipation and correction of risks in both environmental and occupational health and safety before they occur. There are a variety of risk analysis methods. The main goal of the risk priority is to determine whether the risk is immediate and requires to be eliminated before it reaches unpreventable size.

Occupational risk refers to the likelihood and the severity of an injury or an illness occurring as a result of exposure to a hazard. The main aim of occupational risk assessment is to protect workers' health and safety. Risk assessment helps to minimize the possibility of the workers or the environment being harmed due to work-related activities. It also helps to keep your business competitive and effective. Under health and safety laws, all employers must carry out regular risk assessment (European Agency for Safety Health at Work [EASHW], 2009).

You can assess risk arising from a hazard in two ways:

Firstly, for each identified hazard, decide if risk is small, medium, or high taking into account the probability and severity of harm which can be caused by a hazard. Use the table below to make the decision (EASHW, 2009).

Table 2.1 This table indicates the severity of consequences (Risk Assessment Tool).

	Severity of consequences		
Probability	Moderate harm	Medium harm	Extreme harm
Highly improbable	Small (1)	Small (1)	Medium (2)
Probable	Small (1)	Medium (2)	High (3)
Highly probable	Medium (2)	High (3)	High (3)

Highly improbable should not materialize during the entire occupational career of an employee. Probable may materialize only a few times during the occupational career of an employee. Highly probable may materialize repeatedly during the occupational career of an employee. Moderately harmful accidents and illnesses not causing prolonged distress (such as small nicks, eye irritations, headaches, etc.). Medium harmful accidents and illnesses causing moderate, but prolonged or periodically recurring distress (such as wounds, simple fractures, second-degree burns on a limited body surface, dermal allergy, etc.). Extremely harmful accidents and illnesses causing grave and permanent distress and/or death (e. g., amputations, complex fractures leading to disability, cancer, second- or third-degree burns on a large body surface, etc.) (EASHW, 2009).

The management of occupational injury is of strategic importance in a refinery from the organizational, engineering and economic point of view. The determination of an algorithm, that allows a methodical and as far as possible automatic approach to management of injury data, can lead to substantial improvements in the organization of work and in the decision-making processes (Bevilacqua et al, 2008).

The main aim is to determine and troubleshoot the primary risks and to prevent the risk before it gets too dangerous.

To see risk evaluation, danger/determination and risk evaluation table, and general risk evaluation sample form, please look at appendixes 2, 4, and 5.

2.5.2 Document Control

The organization shall establish and maintain procedures for controlling all documents and data required by this OHSAS specification to ensure that: (a) they can be located; (b) they are periodically reviewed, revised as necessary and approved for adequacy by authorized personnel; (c) current versions of relevant documents and data are available at all locations where operations essential to the effective functioning of the OH&S system are performed; (d) obsolete documents and data are promptly removed from all points of issue and points of use or otherwise assured against unintended use; and (e) archival documents and data retained for legal or knowledge preservation purposes or both are suitably identified.

You can document risk assessment for each workplace using the “risk assessment sheet” above. You should record basic information: company name and address, name of the workplace for which assessment has been conducted, name(s) of person(s) working at the workplace, date of the assessment and the name(s) of person(s) conducting the assessment. You should also record identified hazards (for which you have ticked “YES” in the GENERAL CHECKLIST) in column 2 of the “risk assessment sheet”. For each identified hazard: you should record preventive/protective measures used to limit risk arising from a hazard in column 3; record the results of risk assessment (e. g., high/unacceptable) in column 4; record actions planned to reduce risk in column 5 (EASHW, 2009).

2.5.3 Operational Control

The organization shall identify those operations and activities that are associated with identified risks where control measures need to be applied. The organization shall plan these activities, including maintenance, in order to ensure that they are carried out under specified conditions by:

a) Establishing and maintaining documented procedures to cover situations where their absence could lead to deviations from the OH&S policy and the objectives;

b) Stipulating operating criteria in the procedures;

c) Establishing and maintaining procedures related to identified OH&S risks of goods, equipment and services purchased and/or used by the organization and communicating relevant procedures and requirements to suppliers and contractors;

d) Establishing and maintaining procedures for the design of workplace, process, installations, machinery, operating procedures and work organization, including their adaptation to human capabilities, in order to eliminate or reduce OH&S risks at their source.

If risk is high and assessed as unacceptable, actions to reduce it need to be taken at once. If risk is medium and assessed as acceptable, it is recommended to plan actions to reduce its level. If risk is small and assessed as acceptable, it is necessary to ensure that it will remain at the same level. Preventive and protective measures should be implemented in the following order of priority: eliminate hazard/risk, minimize hazard/risk, through organizational measures, minimize hazard/risk, through collective protective measures, and reduce risk through appropriate personal protective equipment (EASHW, 2009).

As this part of the environmental management system provides direction on how to take the system requirements into day-to-day operations, requires the use of documented procedures to control situations where the absence of documented procedures could lead to deviations from the environmental policy and the objectives and targets.

2.5.4 Emergency Preparedness and Response

The organization shall establish and maintain plans and procedures to identify the potential for, and responses to, incidents and emergency situations, and for preventing and mitigating the likely illness and injury that may be associated with them. The organization shall review its emergency preparedness and response plans and procedures, in particular after the occurrence of incidents or emergency situations. The organization shall also periodically test such procedures where practicable.

The procedures should take into account potential consequences of abnormal operation conditions, potential emergency situations and potential accidents. It is the responsibility of each organization to establish emergency preparedness and response procedure that suits its own particular needs. In establishing its procedure, the organization should include consideration of;

a) The nature of on-site hazards (e.g. flammable liquid, storage tanks, compressed gases and measures to be taken in the event of spillages or accidental releases),

b) The most likely type and scale of an emergency situation or accident,

c) The potential for an emergency situation or accident at a nearby facility (e.g. plant, road, railway line),

d) the most appropriate method for responding to an accident or emergency situation,

e) The actions required to minimize environmental damage,

f) Training of emergency response personnel,

g) Emergency organization and responsibilities,

h) Evacuation routes and assembly points,

i) A list of key personnel and aid agencies, including contact details (e. g. fire department, spillage clean-up services),

j) The possibility of mutual assistance from neighboring organizations,

k) Internal and external communication plans,

l) Mitigation and response action to be taken for different types of accident or emergency situation,

m) Need for process for a post-accident evaluation to establish and implement corrective and preventive actions,

n) Periodic testing of emergency response,

o) Information on hazardous materials, including each material's potential impact on the environment, and measures to be taken in the event of accidental release,

p) Training plans and testing for effectiveness, and

q) Process for post-accident evaluation to define corrective and preventive actions

Safe place strategies are underpinned by the risk assessment process and the application of the hierarchy of controls up to the point where alterations are made to the existing physical environment. Safe place strategies also include arrangements for abnormal emergency situations, as well as monitoring and evaluation to assess the efficacy of solutions applied and peer review of modifications. These techniques are most effective when the hazards are predictable and there is an abundance of information available about the potential problems. The flexibility and adaptability of this approach represent some of its greatest merits; however it is not without its limitations (Makin et al, 2008).

As a result, preparing emergency situation plan properly and declaring this emergency situation plan to the employees allow fast and effective intervene in a possible hard situation. This is the main aim of the study. In this way, with a successful emergency situation plan, a possible emergency situation can be overcome with the minimum injury.

2.6 Checking and Corrective Action

For an environmental management system to be effective on an ongoing basis, an organization should have a systematic method for identifying actual and potential nonconformity (-ies), making corrections and taking corrective and preventive action, preferably preventing problems before they occur. Nonconformity is non-

fulfillment of a requirement. A requirement may be stated in relation to the management system or in terms of environmental performance. Situations may occur where part of the system may not function as intended or environmental performance requirements are not met.

Examples of such situations can include

a) System performance:

1) Failure to establish environmental objectives and targets;

2) Failure to define responsibilities required by an environmental management system, such as responsibilities for achieving objectives and targets or for emergency preparedness and response; and

3) Failure to periodically evaluate compliance with legal requirements.

b) Environmental performance:

1) Energy reduction targets are not achieved;

2) Maintenance requirements are not performed as scheduled; and

3) Operating criteria (e.g. permitted limits) are not met.

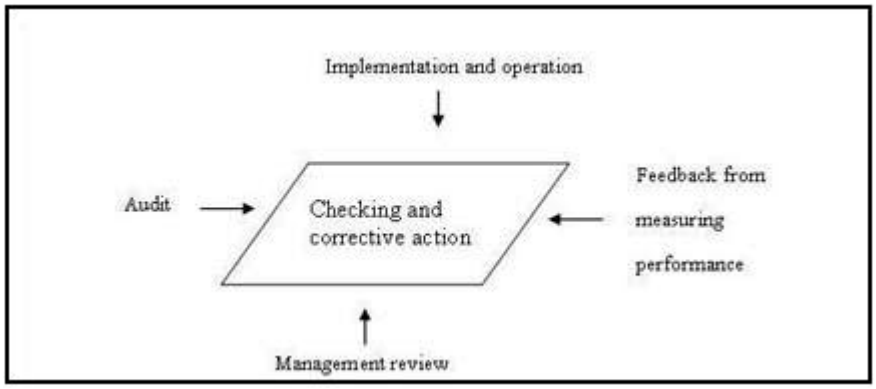

Figure 2.4 This figure shows the factors that are involved in checking and corrective action (OHSAS 18001:1999).

2.6.1 Environmental Management

The organization shall establish, implement and maintain a procedure for dealing with actual and potential nonconformity and for taking corrective action and preventive action. The procedure shall define requirements for: (a) identifying and

correcting nonconformity(ies) and taking action(s) to mitigate their environmental impacts; (b) investigating nonconformity(ies), determining their causes and taking actions in order to avoid their recurrence; (c) evaluating the need for action to prevent nonconformity and implementing appropriate actions designed to avoid their occurrence; (d) recording the results of corrective action(s) and preventive action(s) taken; and (e) reviewing the effectiveness of corrective action and preventive action taken.

Action taken shall ensure be appropriate to magnitude of the problem and the environmental impacts encountered. The organization shall ensure that any necessary changes are made to environmental management system documentation.

2.6.2 Measurement of Safety and Health

Safety attitudes were assessed with 65 items tapping attitudes toward safety at the organizational/management, group, and individual level. Safety attitudes and perceptions have been measured using a variety of instruments, with few replications using the same measures. In an attempt to capture as many relevant aspects of safety attitudes as possible, we administered items based on a combination of several previously developed safety attitude and climate measures (Bergman, Henning, Keren, Mannan, Payne & Stufft, 2008).

Given our focus on safety attitudes as opposed to safety perceptions, items needed to assess attitudes and beliefs individuals may hold concerning workplace safety regardless of experience. Thus, items assessing perceptions of safety in the workplace (e.g., ‘‘Safety has a high priority”) were revised to reflect attitudes toward safety (e.g., ‘‘Safety should have a high priority”). Further, items referring to specific organizational contexts (e.g., ‘‘Depot Safety Committee is effective”) were revised to be more general (e.g., ‘‘Safety committees are effective”). Items that could not easily be revised in such a manner were not included in the study. Because of these revisions and the administration of several scales, an exploratory factor analysis using principal components extraction was conducted. Based on these results, six

safety attitude scales were constructed: (1) general attitudes: beliefs regarding whether organizations should give safety a high priority; (2) what workers should do: how individual workers should behave in regards to safety; (3) what management should do: beliefs about how managers should behave in regards to safety and when given information from subordinates regarding safety issues; (4) safety as an expense and interference with productivity: beliefs regarding monetary and production costs associated with safety; (5) compromising safety in favor of production: beliefs regarding taking risks and shortcuts in Exchange for productivity; and (6) safety discipline: beliefs regarding whether those who depart from safety procedures should be disciplined (Bergman et al., 2008).

2.7 Management Review

The management review should cover the scope of the environmental management system, although not all elements of the environmental management system need to be reviewed at once and the review process may take place over a period of time.

The organization's top management shall, at intervals that it determines, review the OH&S management system, to ensure its continuing suitability, adequacy and effectiveness. The management review process shall ensure that the necessary information is collected to allow management to carry out this evaluation. This review shall be documented.

The management review shall address the possible need for changes to policy, objectives and other elements of the OH&S management system, in the light of OH&S management system audit results, changing circumstances and the commitment to continual improvement.

Input to management reviews shall include: (a) results of internal audits and evaluations of compliance with applicable legal requirements and with other requirements to which the organization subscribes; (b) the results of participation and

consultation; (c) relevant communication(s) from external interested parties, including complaints; (d) the OH&S performance of the organization; (e) the extent to which objectives have been met; have been met; (f) status of incident investigations, corrective actions and preventive actions; (g) follow – up actions from previous management reviews; (h) changing circumstances, including developments in legal and other requirements related to OH&S; and (i) recommendations for improvement.

The outputs from management reviews shall be consistent with the organization's commitment to continual improvement and shall include any decisions and actions related to possible changes to: (a) OH&S performance; (b) OH&S policy and objectives; (c) resources; and (d) other elements of the OH&S management review shall be made available for communication and consultation.

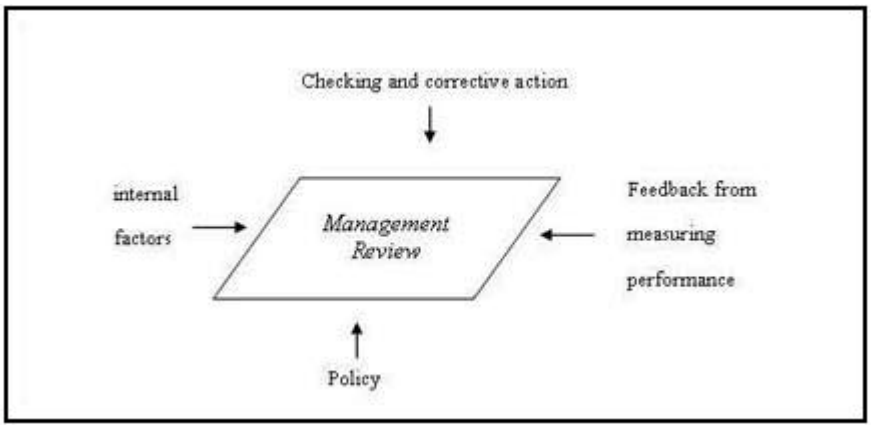

Figure 2.5 This figure shows the factors that are involved in management review (OHSAS 18001:1999).

CHAPTER THREE
MANUFACTURING PROCESSES

3.1 Materials and Methods

This chapter includes materials and methods, manufacturing plan, and the objectives of OHSAS 18001 and ISO 14001. Under these headlines; raw materials and auxiliary material that are used in manufacturing, manufacturing processes like spray lay-up process, wet lay-up/hand lay-up process, vacuum bagging process, filament winding process, pultrusion process, resin transfer moulding process, distribution of roles are summarized.

3.1.1 Raw Materials and Auxiliary Materials Used in Manufacturing

In its most basic form a composite material is one which is composed of at least two elements working together to produce material properties that are different to the properties of those elements on their own. In practice, most composites consist of a bulk material (the ‘matrix’), and a reinforcement of some kind, added primarily to increase the strength and stiffness of the matrix. This reinforcement is usually in fibre form. Today, the most common man-made composites can be divided into three main groups:

Polymer Matrix Composites (PMC’s) are the most common and will be discussed here. Also known as FRP - Fibre Reinforced Polymers (or Plastics) – these materials use a polymer-based resin as the matrix, and a variety of fibres such as glass, carbon and aramid as the reinforcement.

Metal Matrix Composites (MMC’s) are increasingly found in the automotive industry; these materials use a metal such as aluminum as the matrix, and reinforce it with fibres such as silicon carbide.

Ceramic Matrix Composites (CMC's) Used in very high temperature environments, these materials use a ceramic as the matrix and reinforce it with short fibres, or whiskers such as those made from silicon carbide and boron nitride.

Resin systems such as epoxies and polyesters have limited use for the manufacture of structures on their own, since their mechanical properties are not very high when compared to, for example, most metals. However, they have desirable properties, most notably their ability to be easily formed into complex shapes.

Materials such as glass, aramid and boron have extremely high tensile and compressive strength but in 'solid form' these properties are not readily apparent. This is due to the fact that when stressed, random surface flaws will cause each material to crack and fail well below its theoretical 'breaking point'. To overcome this problem, the material is produced in fibre form, so that, although the same number of random flaws will occur, they will be restricted to a small number of fibres with the remainder exhibiting the material's theoretical strength. Therefore a bundle of fibres will reflect more accurately the optimum performance of the material. However, fibres alone can only exhibittensile properties along the fibre's length, in the same way as fibres in a rope.

It is when the resin systems are combined with reinforcing fibres such as glass, carbon and aramid, that exceptional properties can be obtained. The resin matrix spreads the load applied to the composite between each of the individual fibres and also protects the fibres from damage caused by abrasion and impact. High strengths and stiffnesses, ease of moulding complex shapes, high environmental resistance all coupled with low densities, make the resultant composite superior to metals for many applications.

Since PMC's combine a resin system and reinforcing fibres, the properties of the resulting composite material will combine something of the properties of the resin on its own with that of the fibres on their own.

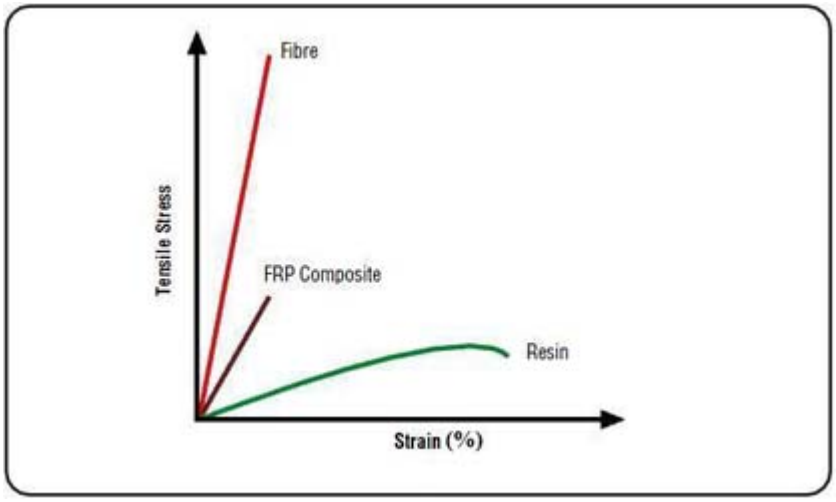

Figure 3.1 Polymer Matrix Composites (Guide to Composites, 2005).

The above figure shows the ingredients of polymer matrix composites. Overall, the properties of the composite are determined by: (a) the properties of the fibre, (b) the properties of the resin, (c) the ratio of fibre to resin in the composite (Fibre Volume Fraction), (d) the geometry and orientation of the fibres in the composite.[1]

It is also important to note that with metals the properties of the materials are largely determined by the material supplier, and the person who fabricates the materials into a finished structure can do almost nothing to change those 'in-built' properties. However, a composite material is formed at the same time as the structure is itself being fabricated. This means that the person who is making the structure is creating the properties of the resultant composite material, and so the manufacturing processes they use have an unusually critical part to play in determining the performance of the resultant structure.

[1] The geometry of the fibres in a composite is also important since fibres have their highest mechanical properties along their lengths, rather than across their widths. This leads to the highly anisotropic properties of composites, where, unlike metals, the mechanical properties of the composite are likely to be very different when tested in different directions. This means that it is very important when considering the use of composites to understand at the design stage, both the magnitude and the direction of the applied loads. When correctly accounted for, these anisotropic properties can be very advantageous since it is only necessary to put material where loads will be applied, and thus redundant material is avoided (Guide to Composites, 2005).

3.1.2 Properties of the Resin System

Any resin system for use in a composite material will require the following properties: (a) good mechanical properties, (b) good adhesive properties, (c) good toughness properties, and (d) good resistance to environmental degradation.

3.1.2.1 Mechanical Properties of the Resin System

The figure below shows the stress / strain curve for an 'ideal' resin system. The curve for this resin shows high ultimate strength, high stiffness (indicated by the initial gradient) and a high strain to failure. This means that the resin is initially stiff but at the same time will not suffer from brittle failure.

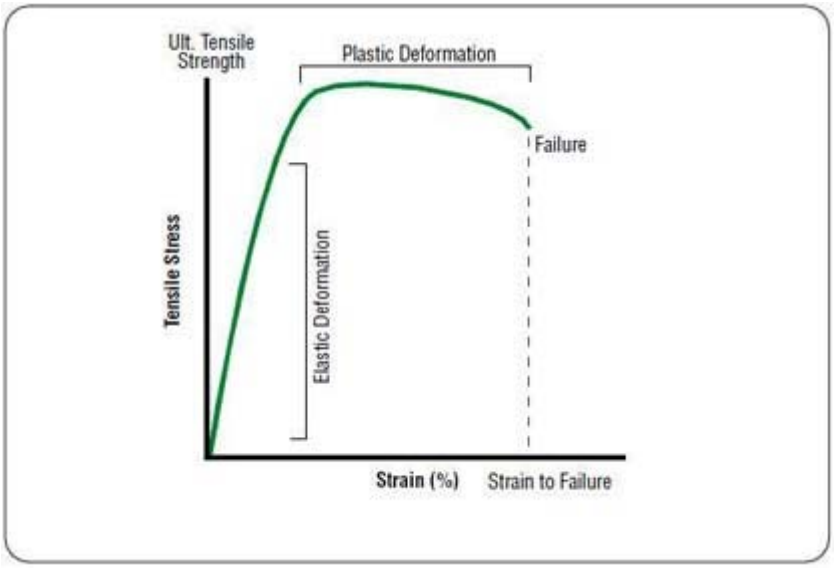

Figure 3.2 Mechanical Properties of the Resin System (Guide to Composites, 2005).

The above figure shows the mechanical properties of the resin system. It should be noted that when a composite is loaded in tension, for the full mechanical properties of the fibre component to be achieved, the resin must be able to deform to at least the same extent as the fibre. The following figure gives the strain to failure for E-glass, S-glass, aramid and high-strength grade carbon fibres on their own (i.e. not in a composite form). Here it can be seen that, for example, the S-glass fibre,

with an elongation to break of 5.3%, will require a resin with an elongation to break of at least this value to achieve maximum tensile properties.

The following figure shows other mechanical properties of the resin system.

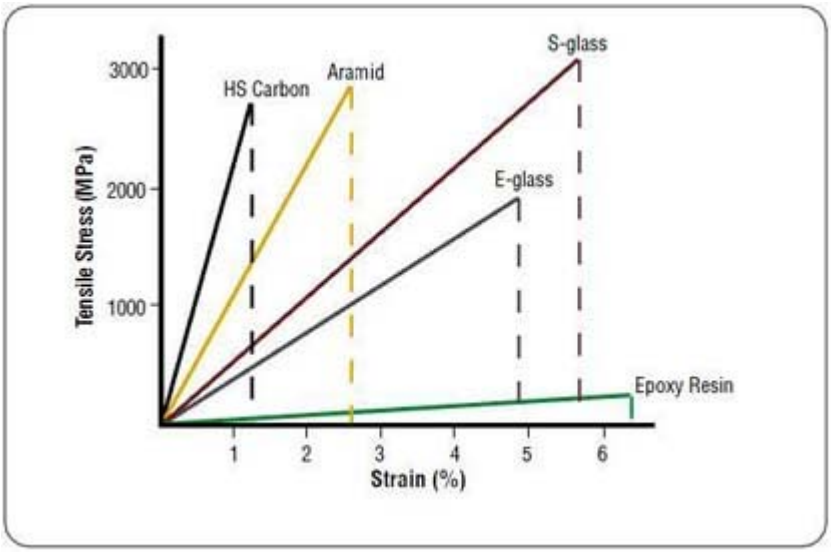

Figure 3.3 Mechanical Properties of the Resin System (Guide to Composites, 2005).

3.1.2.2 Adhesive Properties of the Resin System

High adhesion between resin and reinforcement fibres is necessary for any resin system. This will ensure that the loads are transferred efficiently and will prevent cracking or fibre / resin debonding when stressed.

3.1.2.3 Toughness Properties of the Resin System

Toughness is a measure of a material's resistance to crack propagation, but in a composite this can be hard to measure accurately. However, the stress / strain curve of the resin system on its own provides some indication of the material's toughness. Generally the more deformation the resin will accept before failure the tougher and more crack-resistant the material will be. Conversely, a resin system with a low strain to failure will tend to create a brittle composite, which cracks easily. It is important to match this property to the elongation of the fibre reinforcement.

3.1.2.4 Environmental Properties of the Resin System

Good resistance to the environment, water and other aggressive substances, together with an ability to withstand constant stress cycling, are properties essential to any resin system. These properties are particularly important for use in a marine environment.

3.1.3 Resin Types

There are many types of resins. The resins that are used in fibre reinforced composites are sometimes referred to as ‘polymers’. All polymers exhibit an important common property in that they are composed of long chain-like molecules consisting of many simple repeating units. Manmade polymers are generally called ‘synthetic resins’ or simply ‘resins’. Polymers can be classified under two types, ‘thermoplastic’ and ‘thermosetting’, according to the effect of heat on their properties.

Thermoplastics, like metals, soften with heating and eventually melt, hardening again with cooling. This process of crossing the softening or melting point on the temperature scale can be repeated as often as desired without any appreciable effect on the material properties in either state. Typical thermoplastics include nylon, polypropylene and ABS, and these can be reinforced, although usually only with short, chopped fibres such as glass.

Thermosetting materials, or ‘thermosets’, are formed from a chemical reaction in situ, where the resin and hardener or resin and catalyst are mixed and then undergo a nonreversible chemical reaction to form a hard, infusible product.

Although there are many different types of resin in use in the composite industry, the majority of structural parts are made with three main types, namely polyester, vinylester and epoxy.

3.1.3.1 Polyester Resins

They are the most widely used resin systems, particularly in the marine industry. By far the majority of dinghies, yachts and work-boats built in composites make use of this resin system.

Polyester resins such as these are of the 'unsaturated' type. Unsaturated polyester resin is a thermoset, capable of being cured from a liquid or solid state when subject to the right conditions. It is usual, however, to refer to unsaturated polyester resins as 'polyester resins', or simply as 'polyesters'.[2]

The following figure shows the idealized chemical structure of typical polyester. Note the positions of the ester groups (CO - O - C) and the reactive sites (C* = C*) within the molecular chain.

The following figure shows the idealized chemical structure of typical isophthalic polyester.

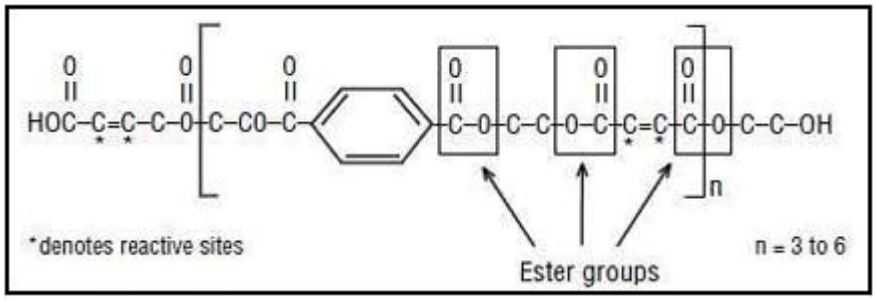

Figure 3.4 Idealised Chemical Structure of a Typical Isophthalic Polyester (Guide to Composites, 2005).

[2] There are two principle types of polyester resin used as standard laminating systems in the composites industry. Orthophthalic polyester resin is the standard economic resin used by many people. Isophthalic polyester resin is now becoming the preferred material in industries such as marine where its superior water resistance is desirable (Guide to Composites, 2005).

3.1.3.2 Vinylester Resins

They are similar in their molecular structure to polyesters, but differ primarily in the location of their reactive sites, these being positioned only at the ends of the molecular chains. As the whole length of the molecular chain is available to absorb shock loadings this makes vinylester resins tougher and more resilient than polyesters. The vinylester molecule also features fewer ester groups.

The figure below shows the idealized chemical structure of a typical vinylester. Note the positions of the ester groups and the reactive sites (C* = C*) within the molecular chain.

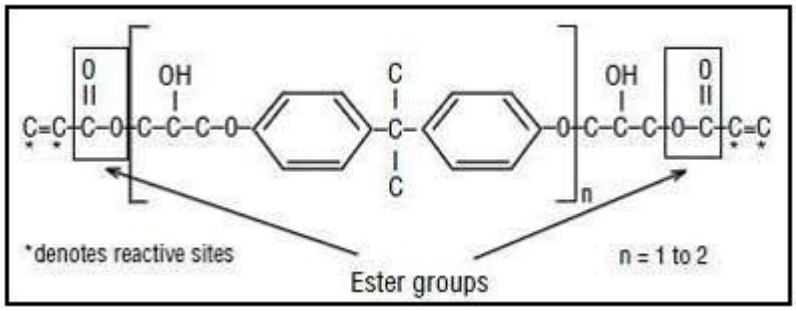

Figure 3.5 Idealised Chemical Structure of a Tupical Epoxy Based Vinylester (Guide to Composites, 2005).

The molecular chains of vinylester, represented below, can be compared to the schematic representation of polyester shown previously where the difference in the location of the reactive sites can be clearly seen:

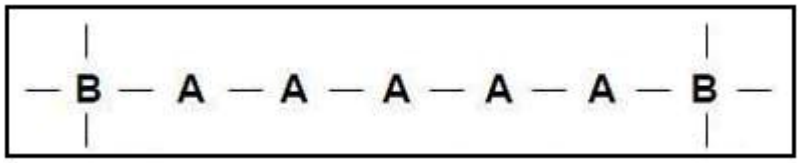

Figure 3.6 Schematic Representation of Vinylester Resin (Uncured) (Guide to Composites, 2005).

With the reduced number of ester groups in a vinylester when compared to polyester, the resin is less prone to damage by hydrolysis. The cured molecular

structure of the vinylester also means that it tends to be tougher than polyester, although to really achieve these properties the resin usually needs to have an elevated temperature post-cure.

The figure below shows the schematic representation of vinylester.

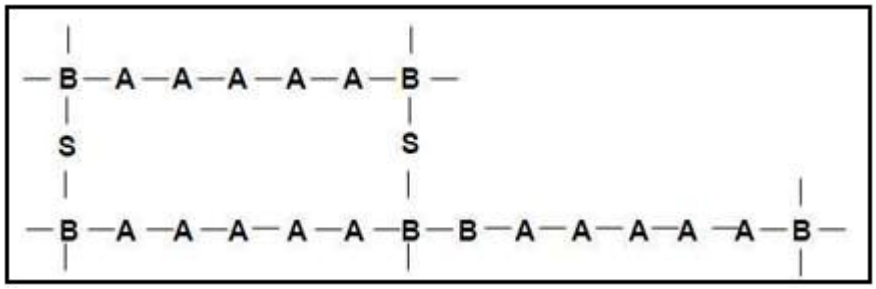

Figure 3.7 Schematic Representation of Vinylester (Cured) (Guide to Composites, 2005).

3.1.3.3 Epoxy Resins

The large family of epoxy resins represents some of the highest performance resins of those available at this time. Epoxies generally out-perform most other resin types in terms of mechanical properties and resistance to environmental degradation, which leads to their almost exclusive use in aircraft components.

The term ‘epoxy’ refers to a chemical group consisting of an oxygen atom bonded to two carbon atoms that are already bonded in some way. The simplest epoxy is a three-member ring structure known by the term ‘alpha-epoxy’ or ‘1,2-epoxy’. The idealized chemical structure is shown in the figure below and is the most easily identified characteristic of any more complex epoxy molecule.

The figure below shows the idealized chemical structure of a simple epoxy (ethylene oxide).

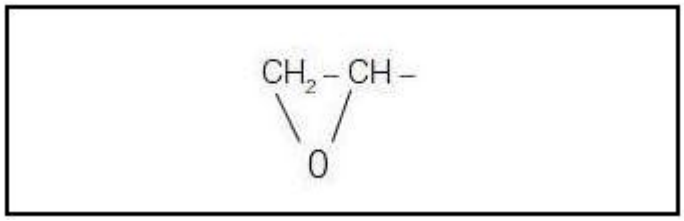

Figure 3.8 Idealised Chemical Structure of a Simple Epoxy (Ethylene Oxide) (Guide to Composites, 2005).

Usually identifiable by their characteristic amber or brown coloring, epoxy resins have a number of useful properties. Both the liquid resin and the curing agents form low viscosity easily processed systems. Epoxy resins are easily and quickly cured at any temperature from 5°C to 150°C, depending on the choice of curing agent. One of the most advantageous properties of epoxies is their low shrinkage during cure which minimizes fabric 'print-through' and internal stresses. Epoxies find uses as adhesives, caulking compounds, casting compounds, sealants, varnishes and paints, as well as laminating resins for a variety of industrial applications.

In the epoxy resin, however, these reactive sites are formed by epoxy groups instead of ester groups. The epoxy molecule also contains two ring groups at its centre which are able to absorb both mechanical and thermal stresses better than linear groups and therefore give the epoxy resin very good stiffness, toughness and heat resistant properties.

The figure below shows the idealized chemical structure of a typical epoxy. Note the absence of the ester groups within the molecular chain.

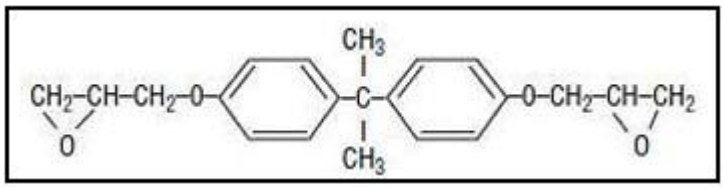

Figure 3.9 Idealised Chemical Structure of a Typical Epoxy (Diglycidyl Ether of Bisphenol-A) (Guide to Composites, 2005).

Besides polyesters, vinylesters and epoxies there are a number of other specialized resin systems that are used where their unique properties are required.

3.1.3.4 Phenolics

Primarily used where high fire-resistance is required, phenolics also retain their properties well at elevated temperatures. For room-temperature curing materials, corrosive acids are used which leads to unpleasant handling.

3.1.3.5 Cyanate Esters

Primarily used in the aerospace industry. The material's excellent dielectric properties make it very suitable for use with low dielectric fibres such as quartz for the manufacture of radomes.

3.1.3.6 Silicones

Synthetic resin using silicon as the backbone rather than the carbon of organic polymers. Good fire-resistant properties, and able to withstand elevated temperatures.

3.1.3.7 Polyurethanes

High toughness materials, sometimes hybridized with other resins, due to relatively low laminate mechanical properties in compression.

3.1.3.8 Bismaleimides

Primarily used in aircraft composites where operation at higher temperatures (230°C wet/250°C dry) is required. e.g. engine inlets, high speed aircraft flight surfaces.

3.1.3.9 Polyimides

Used where operation at higher temperatures than bismaleimides can stand is required (use up to 250°C wet/300°C dry). Typical applications include missile and aero-engine components. Which uses toxic raw materials in its manufacture. Polyimides also tend to be hard to process due to their condensation reaction emitting water during cure, and are relatively brittle when cured. PMR15 and LaRC160 are two of the most commonly used polyimides for composites.

3.1.4 Manufacturing Processes

Taking composite materials as a whole, there are many different material options to choose from in the areas of resins, fibres and cores, all with their own unique set of properties such as strength, stiffness, toughness, heat resistance, cost, production rate etc. However, the end properties of a composite part produced from these different materials is not only a function of the individual properties of the resin matrix and fibre (and in sandwich structures, the core as well), but is also a function of the way in which the materials themselves are designed into the part and also the way in which they are processed. This section compares a few of the commonly used composite production methods and presents some of the factors to be borne in mind with each different process, including the influence of each process on materials selection.

3.1.4.1 Spray Lay-Up Production Method

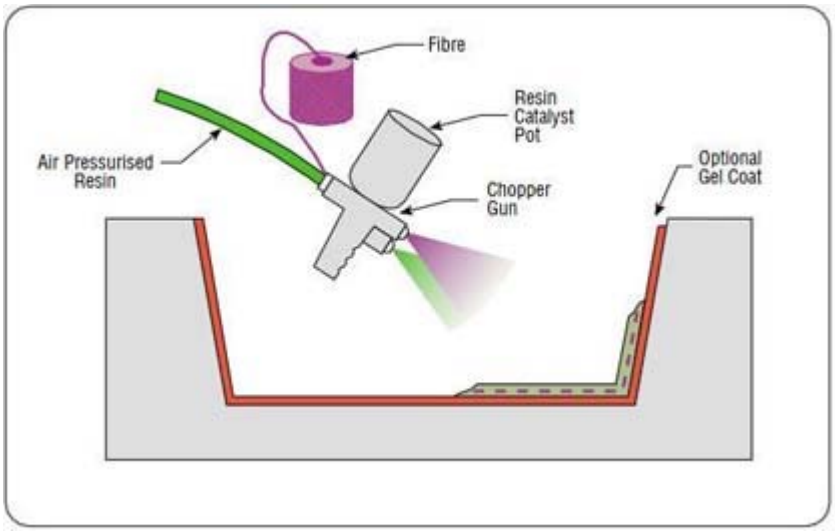

Figure 3.10 This figure is an example for Spray Lay-up Production Method (Guide to Composites, 2005).

The above figure shows the spray lay-up production method. Fibre is chopped in a hand-held gun and fed into a spray of catalyzed resin directed at the mould. The deposited materials are left to cure under Standard atmospheric conditions. Resins will be primarily polyester; fibres will be glass roving only; and there will be no cores. These materials have to be incorporated separately.

Main advantages of spray lay-up are that they are widely used for many years; they are low cost way of quickly depositing fibre and resin; and they have low cost tooling.

On the other hand, main disadvantages of spray lay-up can be lined up as these:

(a) Laminates tend to be very resin-rich and therefore excessively heavy. (b) Only short fibres are incorporated which severely limits the mechanical properties of the laminate. (c) Resins need to be low in viscosity to be sprayable. This generally compromises their mechanical/thermal properties. (d) The high styrene contents of spray lay-up resins generally means that they have the potential to be more harmful and their lower viscosity means that they have an increased tendency to penetrate

clothing etc. (e) Limiting airborne styrene concentrations to legislated levels is becoming increasingly difficult.

Typical applications are simple enclosures, lightly loaded structural panels, e.g. caravan bodies, truck fairings, bathtubs, shower trays, some small dinghies.

3.1.4.2 Wet Lay-Up/Hand Lay-Up Production Method

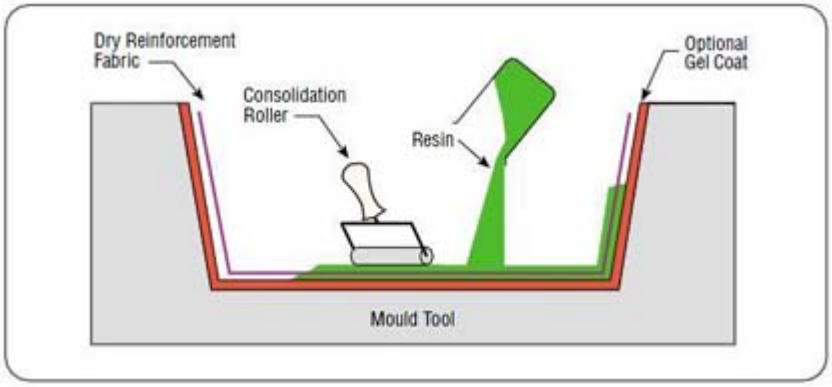

Figure 3.11 This figure is an example for Wet Lay-up/Hand Lay-up Production Method (Guide to Composites, 2005).

The above figure shows the wet lay-up/hand lay-up production method. Resins are impregnated by hand into fibres which are in the form of woven, knitted, stitched or bonded fabrics. This is usually accomplished by rollers or brushes, with an increasing use of nip-roller type impregnators for forcing resin into the fabrics by means of rotating rollers and a bath of resin. Laminates are left to cure under standard atmospheric conditions.

Main advantages of Wet Lay-up/Hand Lay-up are as follows: (a) widely used for many years; (b) Simple principles to teach; (c) Low cost tooling, if room-temperature cure resins are used; (d) Wide choice of suppliers and material types; and (e) Higher fibre contents, and longer fibres than with spray lay-up.

Main disadvantages of this manufacturing process can be arranged as follows: (a) resin mixing, laminate resin contents, and laminate quality are very dependent on the skills of laminators. (b) Health and safety considerations of resins. The lower

molecular weights of hand lay-up resins generally mean that they have the potential to be more harmful than higher molecular weight products. (c) Limiting airborne styrene concentrations to legislated levels from polyesters and vinylesters is becoming increasingly hard without expensive extraction systems.

3.1.4.3 Filament Winding Production Method

Typical applications are standard wind-turbine blades, production boats, and architectural mouldings.

The below figure 3.12 shows the filament winding production process. This process is primarily used for hollow, generally circular or oval sectioned components, such as pipes and tanks. Fibre tows are passed through a resin bath before being wound onto a mandrel in a variety of orientations, controlled by the Fibre feeding mechanism, and rate of rotation of the mandrel.

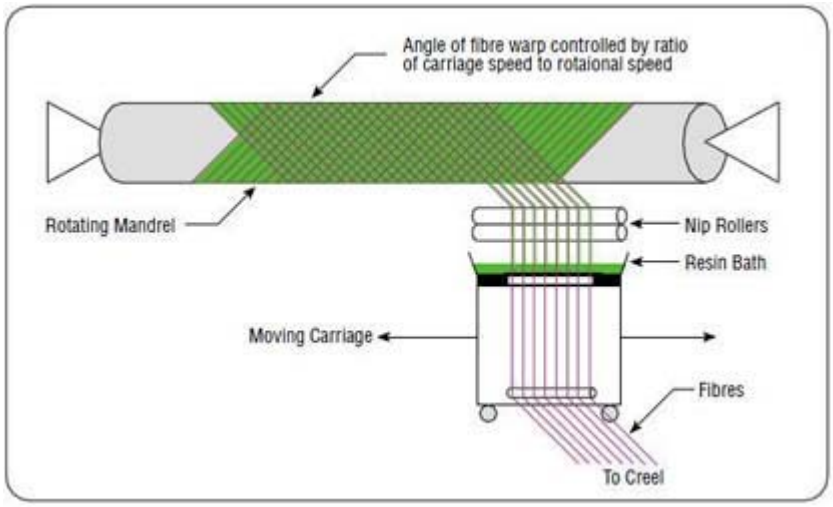

Figure 3.12 This figure is an example for Filament Winding Production Method (Guide to Composites, 2005).

Main advantages of filament winding are as these: (a) this can be a very fast and therefore economic method of laying material down; (b) resin content can be controlled by metering the resin onto each fibre tow through nips or dies; (c) fibre cost is minimized since there is no secondary process to convert fibre into fabric

prior to use; and (d) structural properties of laminates can be very good since straight fibres can be laid in a complex pattern to match the applied loads.

Main disadvantages of this manufacturing process are that (a) the process is limited to convex shaped components; (b) fibre cannot easily be laid exactly along the length of a component; (c) mandrel costs for large components can be high; (d) the external surface of the component is unmoulded, and therefore cosmetically unattractive; and (e) low viscosity resins usually need to be used with their attendant lower mechanical and health and safety properties.

3.1.4.4 Pultrusion Production Method

Typical applications are chemical storage tanks and pipelines, gas cylinders, fire-fighters breathing tanks.

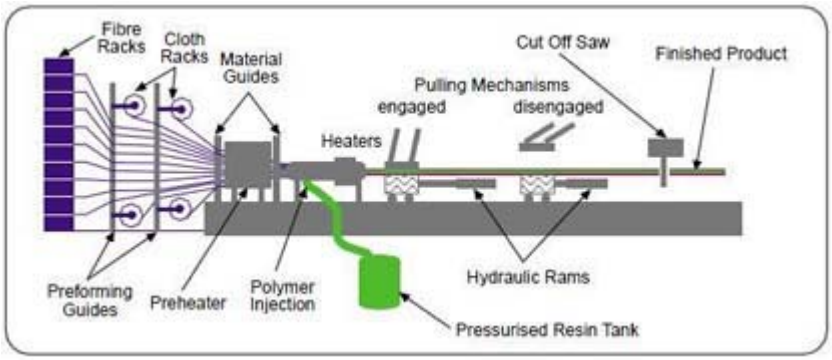

Figure 3.13 This figure is an example for Pultrusion Production Method (Guide to Composites, 2005).

The above figure shows the pultrusion production method. Fibres are pulled from a creel through a resin bath and then on through a heated die The process pulls the materials through the die for impregnation, and then clamps them in a mould for curing. This makes the process non-continuous, but accommodating of small changes in cross-section.

Main advantages of Pultrusion can be enumerated as this: (a) this can be a very fast, and therefore economic, way of impregnating and curing materials; (b) resin

content can be accurately controlled; (c) fibre cost is minimized since the majority is taken from a creel; (d) structural properties of laminates can be very good since the profiles have very straight fibres and high fibre volume fractions can be obtained; and (e) resin impregnation area can be enclosed thus limiting volatile emissions.

Main disadvantages of this process are that (a) limited to constant or near constant cross-section components; and (b) heated die costs can be high.

3.1.4.5 Resin Transfer Moulding Production Method

Typical applications are beams and girders used in roof structures, bridges, ladders, frameworks.

The below figure 3.14 shows the resin transfer moulding process. Fabrics are laid up as a dry stack of materials.

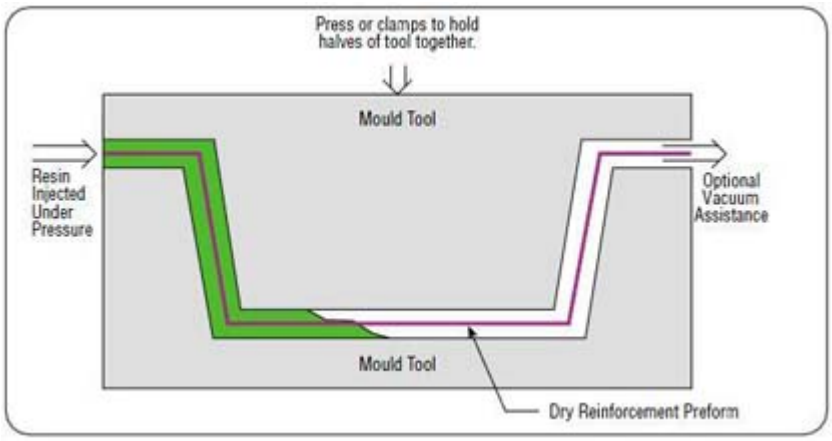

Figure 3.14 This figure is an example for Resin Transfer Moulding (RTM) Production Method (Guide to Composites, 2005).

These fabrics are sometimes pre-pressed to the mould shape, and held together by a binder. These ‘preforms’ are then more easily laid into the mould tool. A second mould tool is then clamped over the first, and resin is injected into the cavity. Vacuum can also be applied to the mould cavity to assist resin in being drawn into the fabrics. This is known as Vacuum Assisted Resin Injection (VARI). Once all the fabric is wet out, the resin inlets are closed, and the laminate is allowed to cure.

Main advantages of this process are that (a) high fibre volume laminates can be obtained with very low void contents; (b) good health and safety, and environmental control due to enclosure of resin;(c) possible labour reductions and (d) both sides of the component have a moulded surface.

Main disadvantages of this process are as follows: (a) matched tooling is expensive and heavy in order to withstand pressures; (b) generally limited to smaller components; and (c) unimpregnated areas can occur resulting in very expensive scrap parts.

3.1.4.6 Other Infusion Processes

Typical applications are small complex aircraft and automotive components, train seats.

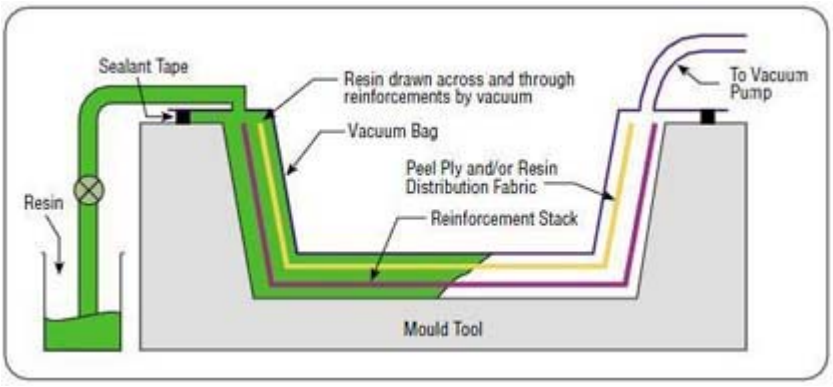

Figure 3.15 This figure is an example for Other Infusion Processes – SCRIMP, RIFT, VARTM, etc. (Guide to Composites, 2005).

The above figure shows the other infusion processes. Fabrics are laid up as a dry stack of materials as in RTM. The fibre stack is then covered with peel ply and a knitted type of non-structural fabric. The whole dry stack is then vacuum bagged, and once bag leaks have been eliminated, resin is allowed to flow into the laminate. The resin distribution over the whole laminate is aided by resin flowing easily through the non-structural fabric, and wetting the fabric out from above. Resins are generally epoxy, polyester and vinylester. Any conventional fabrics are appropriate

for fibres. Stitched materials work well in this process since the gaps allow rapid resin transport. Any cores, except honeycombs, are appropriate.

Main advantages of this process can be arranged as this: (a) as RTM above, except only one side of the component has a moulded finish; (b) much lower tooling cost due to one half of the tool being a vacuum bag, and less strength being required in the main tool; (c) large components can be fabricated; (d) standard wet lay-up tools may be able to be modified for this process; and (e) cored structures can be produced in one operation.

Main disadvantages of this process are that: (a) relatively complex process to perform well; (b) resins must be very low in viscosity, thus comprising mechanical properties; (c) unimpregnated areas can occur resulting in very expensive scrap parts; and (d) some elements of this process are covered by patents (SCRIMP).

3.1.4.6.1 Prepregs. Typical applications are semi-production small yachts, train and truck body panels.

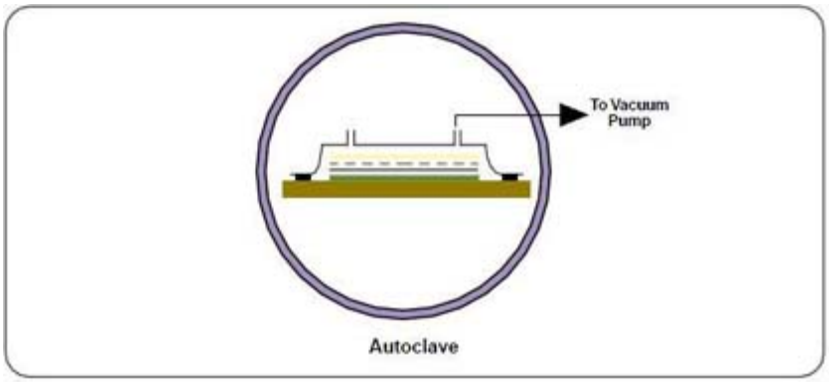

Figure 3.16 This figure is an example for Prepregs (Guide to Composites, 2005).

The above figure shows the prepregs. Fabrics and fibres are pre-impregnated by the materials manufacturer, under heat and pressure or with solvent, with a pre-catalyzed resin. The resin is usually a near-solid at ambient temperatures, and so the pre-impregnated materials (prepregs) have a light sticky feel to them, such as that of adhesive tape. Unidirectional materials take fibre direct from a creel, and are held

together by the resin alone. The prepregs are laid up by hand or machine onto a mould surface, vacuum bagged and then heated to typically 120-180°C. This allows the resin to initially reflow and eventually to cure. Additional pressure for the moulding is usually provided by an autoclave (effectively a pressurized oven) which can apply up to 5 atmospheres to the laminate. Resins are generally epoxy, polyester, phenolic and high temperature resins such as polyimides, cyanate esters and bismaleimides. Any fibres are appropriate. They are used either direct from a creel or as any type of fabric. Any core is appropriate although special types of foam need to be used due to the elevated temperatures involved in the process.

Main advantages of this type can be enumerated as this: (a) resin/catalyst levels and the resin content in the fibre are accurately set by the materials manufacturer. High fibre contents can be safely achieved; (b) the materials have excellent health and safety characteristics and are clean to work with. (c) fibre cost is minimized in unidirectional tapes since there is no secondary process to convert fibre into fabric prior to use; (d) resin chemistry can be optimized for mechanical and thermal performance, with the high viscosity resins being impregnable due to the manufacturing process; (e) the extended working times (of up to several months at room temperatures) means that structurally optimized, complex lay-ups can be readily achieved; and (f) potential for automation and labour saving.

Main disadvantages of this type are that: (a) materials cost is higher for pre-impregnated fabrics; (b) autoclaves are usually required to cure the component. These are expensive, slow to operate and limited in size; (c) tooling needs to be able to withstand the process temperatures involved; and (d) core materials need to be able to withstand the process temperatures and pressures.

Typical applications are aircraft structural components (e.g. wings and tail sections), F1 racing cars, sporting goods such as tennis racquets and skis.

3.1.4.6.2 Low Temperature Curing Prepregs.

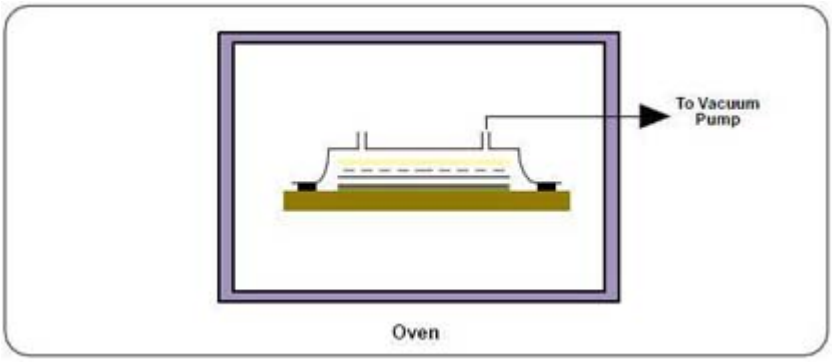

Figure 3.17 This figure is an example for Low Temperature Curing Prepregs (Guide to Composites, 2005).

The figure above shows the low temperature curing prepregs. These prepregs are made exactly as conventional prepregs but have resin chemistries that allow cure to be achieved at temperatures from 60-100°C. At 60°C, the working life of the material may be limited to as little as a week, but above these working times can be as long as several months. The flow profiles of the resin systems allow for the use of vacuum bag pressures alone, avoiding the need for autoclaves. Resins are generally only epoxy. Any fibres are appropriate as for conventional prepregs. Any cores are appropriate although standard PVC foam needs special care.

Main advantages are as follows: (a) all of the advantages ((i)-(vi)) associated with the use of conventional prepregs are incorporated in low-temperature curing prepregs; (b) cheaper tooling materials, such as wood, can be used due to the lower cure temperatures involved; (c) large structures can be readily made since only vacuum bag pressure is required, and heating to these lower temperatures can be achieved with simple hot-air circulated ovens, often built in-situ over the component; (d) conventional PVC foam core materials can be used, providing certain procedures are followed; and (e) lower energy cost.

Main disadvantages can be enumerated as: (a) materials cost is still higher than for non-pre-impregnated fabrics; (b) an oven and vacuum bagging system is required to cure the component; (c) tooling needs to be able to withstand above-ambient

temperatures involved (typically 60-100°C); and (d) still an energy cost associated with above-ambient cure temperature.

3.1.4.7 Resin Film Infusion Production Method

Typical applications are high-performance wind-turbine blades, large racing and cruising yachts, rescue craft, train components.

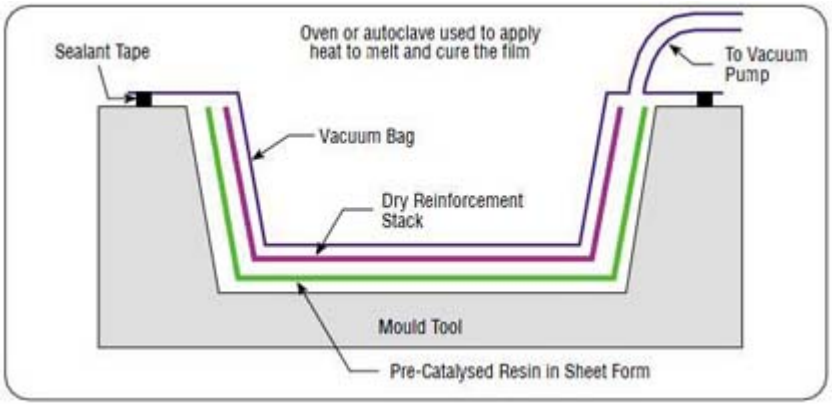

Figure 3.18 This figure is an example for Resin Film Infusion (RFI) Production Method (Guide to Composites, 2005).

The above figure shows the resin film infusion (RFI) process. Dry fabrics are laid up interleaved with layers of semi-solid resin film supplied on a release paper. The lay-up is vacuum bagged to remove air through the dry fabrics, and then heated to allow the resin to first melt and flow into the air-free fabrics, and then after a certain time, to cure. Resins are generally epoxy only. Any fibres are appropriate. Most cores are appropriate although PVC foam needs special procedures due to the elevated temperatures involved in the process.

Main advantages of this process are that: (a) high fibre volumes can be accurately achieved with low void contents; (b) good health and safety and a clean lay-up, like prepreg; (c) high resin mechanical properties due to solid state of initial polymer material and elevated temperature cure; (d) potentially lower cost than prepreg, with most of the advantages; and (e) less likelihood of dry areas than SCRIMP process due to resin travelling through fabric thickness only.

Main disadvantages are that: (a) not widely proven outside the aerospace industry; (b) an oven and vacuum bagging system is required to cure the component as for prepreg, although the autoclave systems used by the aerospace industry are not always required; (c) tooling needs to be able to withstand the process temperatures of the resin film (which if using similar resin to those in low-temperature curing prepregs, is typically 60-100°C); and (d) core materials need to be able to withstand the process temperatures and pressures. Typical applications are aircraft radomes and submarine sonar domes.

3.1.3 Distribution of Roles

It is important for companies to arrange the organization structure to make the work flow uninterrupted and continuous. When arranging the distribution of roles, the following titles should be taken into consideration.

1) Analyzing what kind of skills that the job requires
2) Exploring if there is any specific topics that requires specialization
3) Defining the level of required education
4) Analyzing if the physical and cultural characteristics are effective or not for the job.

If there is a need for a specific certificate or diploma, it is important to define this and appoint the worker in the employment process. For example, while employing a person as a Work Safety Expert, it should be examined if this person has gone through the certification process and has worked in a similar position.

The required education level is determined according to the job. People who have got chemistry education work in a factory where there are many chemical processes whereas mechanics work in a factory where there are many mechanical processes (like machine, material, etc.). In addition, in some cases signature authorization is given to some given occupation groups. It is compulsory for such jobs to hire only the workers who have diploma on that occupation. For example, a company doctor has to be graduated from medical school.

Even if physical and cultural characteristics seem like secondary factor in occupations, in fact, they are the most important ones among the main topics. For women, working in heavy and dangerous works and in buildings under construction is very hard except for some particular cases. And in some works, you may have to employ people who have specific physical characteristics. For example, minion workers are needed to be employed in small areas as they more easily access such areas.

These criteria are used in the study which is given as an example.

a) The quality manager representative has doctorate title and has completed the processes of quality management systems education.
b) Work safety expert has an environment diploma and B group work safety expert diplomas and has the authority to teach.
c) People who are responsible for maintenance and facility consist of electrical engineers and mechanical engineers.
d) People who are responsible for production: they are engineers from different disciplines and are chosen after they completed their special training which is provided by the company.
e) Managers are graduated from school of economics or have corresponding certificates.

3.2 Manufacturing Plan

In this part, how distribution of roles and qualifications of employees should be, how training plan should be prepared and presented, and what are the advantages of ISO 14001 and OHSAS 18001 are summarized under their own headlines.

3.2.1 Distribution of Roles and Qualifications of Employees

The roles, responsibilities and authorities of personnel who manage, perform and verify activities having an effect on the risks of the organization’s activities, facilities

and processes, shall be defined, documented and communicated in order to facilitate OH&S management.

Ultimate responsibility for occupational health and safety rests with top management. The organization shall appoint a member of top management (e.g. in a large organization, a Board or executive committee member) with particular responsibility for ensuring that the OH&S management system is properly implemented and performing to requirements in all locations and spheres of operation within the organization.

Management shall provide resources essential to the implementation, control and improvement of the OH&S management system. It is important that resources include human resources and specialized skills, technology and financial resources.

The organization's management appointee shall have a defined role, responsibility and authority for:

a) Ensuring that OH&S management system requirements are established, implemented and maintained in accordance with this OHSAS specification;

b) Ensuring that reports on the performance of the OH&S management system are presented to top management for review and as a basis for improvement of the OH&S management system. All those with management responsibility shall demonstrate their commitment to the continual improvement of OH&S performance.

The following examples illustrate environmental responsibilities:

The responsibility of president, chief executive officer (CEO), or board of director is to establish overall direction. Relevant managers' responsibility is to develop environmental objectives, targets and programmes. Chief environmental manager's responsibility is to monitor overall environmental management system performance. All managers' responsibility is to assure compliance with applicable legal requirements and other requirements to which the organization subscribes. All managers' another responsibility is to promote continual improvement. Sales and

marketing staff's responsibility is to identify customer's expectations. Purchasers', or buyers', responsibility is to identify requirements for suppliers. Finance/accounting managers' responsibility is to develop and maintain accounting procedures. All persons', who are working for or on behalf of the organization, responsibility is to conform to environmental management system requirements. Top management's responsibility is to review the operation of the environmental management system.

It should be remembered that companies and institutions have different organizational structures and need to define environmental management responsibilities based on their own work processes. In the case of an SME, for example, the owner can be the person responsible for all of these activities.

3.2.2 Training Plan

The organization shall ensure that any person(s) performing tasks for it or on its behalf that have the potential to cause a significant environmental impact(s) identified by the organization is (are) competent on the basic of appropriate education, training or experience and shall retain associated records.

The organization shall identify training needs associated with its environmental aspects and its environmental management system. It shall provide training or take other action to meet these needs, and shall retain associated records.

The organization shall establish, implement and maintain procedures to make persons working for it or on its behalf aware of: (a) the importance of conformity with the environmental policy and procedures and with the requirements of the environmental management system; (b) the significant environmental aspects and related actual or potential impacts associated with their work, and the environmental benefits of improved personal performance; (c) their roles and responsibilities in achieving conformity with the requirements of the environmental management system; and (d) the potential consequences of departure from specified procedures.

Personal shall be competent to perform tasks that may impact on OH&S in the workplace. Competence shall be defined in terms of appropriate education, training and/or experience. The organization shall establish and maintain procedures to ensure that its employees working at each relevant function and level are aware of: the importance of conformance to the OH&S policy and procedures, and to the requirements of the OH&S management system; the OH&S consequences, actual or potential, of their work activities and the OH&S benefits of improved personal performance; their roles and responsibilities in achieving conformance to the OH&S policy and procedures and to the requirements of the OH&S management system, including emergency preparedness and response requirements; the potential consequences of departure from specified operating procedures Training procedures shall take into account differing levels of; responsibility, ability and literacy; and risk.

It is necessary to make some preliminary study in order to determine the need for education before the creation of the education plan. Generally workers' certificates and educations, that they had before they start their jobs in this company, are investigated. And then the compulsory education by the law should be determined and it should be decided if there is any need for specific education that the working environment pins down. For example, the training of the person who makes the first aid: It is compulsory by the law that 10% of workers who work in heavy and dangerous occupations have to get the first aid training.

The personnel who are going to work in boiling room should get the corresponding education and if the company uses natural gas, it is legal obligation for him or her to complete natural gas management course and to pass the exam.

The outline of this education is given in detail in the working law code 4857. (Method and Principle of Workers' Work Health and Safety Education.)

Official Gazette Date/No: 07.04.2004/25426

Clause 11 – The education for the workers is chosen among the following and similar topics according to the field of activity;

a) General work health and safety rules,

b) The reasons for occupational accidents and occupational illnesses and the risks in the company,

c) The application of the preventive techniques against accident, injury and illness,

d) Safe utilization of the work equipments,

e) Legal rights and responsibilities of the workers,

f) Information about legal legislation,

g) Establishment of safe environment and systems in workplaces,

h) Utilization of the personal preventive equipment,

i) Using screened equipments,

j) Warning signs,

k) Risks that come out with chemical, physical and biological materials,

l) Hygiene and order,

m) Fire and protection against fire,

n) Thermal comfort conditions,

o) Ergonomics,

p) Electric dangers, risks and precautions,

r) First aid, rescue.

The people who can teach are determined in this legislation. Work safety experts who have trainer certificate, company doctors in given fields, etc.

3.2.2.1 Training Types

1) On-the-job training
2) Certification training
3) Routine work safety trainings
4) Briefing training about changes in workflow and in new layout creation
5) Corresponding trainings when new machine or equipment is purchased.

In addition to this, it is legal obligation that the worker has to be given the education in order to learn the risks and dangers around the working environment and to learn how to protect himself or herself. Also, it is obligatory for the human resources department to give briefing education to let the workers learn their legal rights and know their working environment.

Besides, it is necessary to make assessment and evaluation in certain periods to determine the necessities while giving education. After assessment and evaluation it is planned to provide education to workers who need education. Making the assessment and evaluation in parallel to the objective and realistic education enables us to evaluate the effectiveness of the given education.

3.2.3 Advantages of ISO 14001 and OHSAS 18001

In this section, the benefits of these standards to firms summarized.

3.2.3.1 Advantages of ISO 14001

Environment management system is known as ISO 14001 in all over the world and is very fast known and practiced in international operations after ISO 9000 quality management system.

Aim of developing of ISO 14001 environment management system in operations; (a) increasing of adaptation of national and /or international regulations; (b) increasing of environment performance; (c) market strategies; (d) providing of advantages in international competition; (e) increasing of image and market of operation; (f) expenses are decreased and productivity is increased by developing of financing control; (g) getting ready against unacceptable situations (earthquake, fire, flood etc) and accidents and these accidents are decreased; (h) controlling and decreasing of pollution starting from resources; (i) providing of savings of raw material and energy; (j) easy taking of permission and power certificates; (k) ISO 14001 is known by all world and uses common language for global market and is

acceptable; (l) determining of effect of company actions to environment and environment risks and decreasing of bad effecting thing to environment;
(m) adapting to related environment regulations and rules; (n) removing or decreasing of yielding of environment effects in emergency situations; (o) against formal establishment, legal and regulations were adjusted that can be showed by ISO 14001 and quality management system; (p) getting of image to organization to recognize in national and international; (r) increasing of environment consequences of company personnel by training; (s) working of company which does not give harm to environment, not effecting bad to motivation of employees; (t) answering of expectation of consumers about environment, reaching to consumers which have consequences and increasing chance to get them; (u) using of resources efficiency (providing of saving of energy, water, etc.); and (w) decreasing of left wastes to environment (Karapetrovic et al, 2008).

3.2.3.2 Advantages of OHSAS 18001

Benefits of occupational health and safety management system are these: (a) Protecting employers from bad effects and accident of workplace, providing of comfortable and safety work environment; (b) increasing of employee motivation and attending of employee; (c) decreasing of work and work power losing because of work accident and occupational diseases, increasing of work productivity and expenses are decreased; (d) taking with preventions in work environment, providing of operation safety with removing of fire, explosion, out of machines, etc. which can give dangers for company; (e) adjusting of national and international regulations and standards; (f) increasing of work performance; (g) giving sensitive , a responsibility image against other companies and customers; (h) providing of advantages against rivals; and (i) determining of sensitive about organization occupational safety, in front of formal places (Karapetrovic et al, 2008).

3.3 Objectives

The organization shall establish and maintain documented occupational health and safety objectives, at each relevant function and level within the organization.

Objectives should be quantified wherever practicable. When establishing and reviewing its objectives, an organization shall consider its financial, operational and business requirements, and the views of interested parties. The objectives shall be consistent with the OH&S policy, including the commitment to continual improvement.

CHAPTER FOUR
CASE STUDY

Case Study: ISO 14001 and OHSAS 18001 Applications for an Industrial Plant Produced Composite Samples

4.1 OHSAS 18001 and ISO 14001 Management Systems

It is wished that there will be composed an ISO 14001 and OHSAS 18001 management system in XYZ company. Even if it is evaluated separately that these two management systems are thought simultaneously, these subjects are elaborate with each other. As a result, some companies set up Total Quality Management System instead of separate quality management systems. In addition, in new trend, social responsibility (SA 8000) system is also included to the quality management systems.

The XYZ Company, which is given as an example in the thesis, sets up ISO 14001 and OHSAS 18001 management systems in order to emphasize the importance of the environment and human beings. Our company, which is respectable to nature and which ensures respecting laws and orders, aim to include all the employees to this system. One of the main aims of our company is the constant improvement of environmental management system in order to achieve developments, in consistent with environmental policy, in general environmental operations. The outline of our company's environmental policy is to explain our aims and principles about general environmental operations and it is prepared to constitute a framework with activities and environment aims and goals.

In our XYZ Company, it is provided as a base to re-connect in order to avoid, minimize or control the pollution, to subject it to another process, to make some changes in the process, to apply to every process and application which includes controlling the mechanisms, utilization of the sources and material replacement, and to the utilization of the products.

OHSAS 18001 in our XYZ Company, whether you are in production or in service sector, it is compulsory for you by the laws to render the workplace safer for the employees. OHSAS 18001 is an international standard which helps us accomplish this obligation.

The aim of OHSAS 18001 is to manage a healthy workplace with a safe working by removing or minimizing the aforesaid risks in the light of the law, legislation, principles and regulations about workplace health and safety. OHSAS 18001, with an approach similar to ISO 9001 and ISO 14001, brings constant and proactive solutions.

As a result, it is one of our company's goals that these standards and procedures are prepared, the application is adopted by all the employees of the company, and these are controlled in every stage of the process.

4.1.1 Integration of Management Systems

Management system integration is very important for the companies to get long-term efficiencies. Ken Whitelaw explains this process in his book *ISO 14001 Environmental Systems Handbook* as follows:

Small- to medium-sized enterprise may hesitate to integrate their management systems. They may have stretched their resources to implement and achieve separate management systems in the past and may not now have the resources to 'knit' two or three management systems together. An increase of management time input in the short term could be difficult, even though there is no dispute over the longer-term efficiencies. So, integration may well be low on the list of their business priorities (Whitelaw, 2004).

Organizations without any management systems may spend some time debating whether to implement systems separately or to take a bold step and seek initial integrated certification. Both routes have their advantages and disadvantages, and

seeking advice on the best route may give conflicting opinions and delay any implementation decisions. Such organizations ask certification bodies questions about the integration process. Such questions can be categorized into the following set:

- Does having ISO 9001 certification assist in the process of implementation of ISO 14001?
- Is it just as easy to internally audit two systems as one?
- Are costs reduced because elements of the separate systems overlap?
- Will a non-conformance in one management system have a negative impact on the others?
- How well will the new system (ISO 14001 and/or OHSAS 18001) fit into, or combine with existing management systems - such as quality assurance, data protection and so forth?
- Will a whole new set of manuals and procedures be required, i.e. doubling or trebling the existing QMS system for example?

Different ways of managing this integration are discussed and several 'models' put forward. None of these models are right or wrong. The extent, depth and breadth of integration are decided by each individual organization (Whitelaw, 2004).

Note that an integrated management system does not take the place of, or compete with a Total Quality Management (TQM) system. TQM seeks changes in the culture of the organization and fundamental reappraisal of business practices and can be quite revolutionary in its outcome. Integration is still concerned with elements of 'compliance to procedures' and is somewhat less revolutionary in philosophy, as it considers a narrower set of criteria of running a business such as:

- Management responsibilities and accountabilities
- Business processes
- Deployment of resources, skills, knowledge and technology.

These aspects are integrated to ensure that the business delivers its objectives. The objectives of the business include elements of quality, the environment and occupational health and safety (Whitelaw, 2004).

Organizations implementing integration respond with two predominant answers when asked about their reasons for seeking an integrated management system:

4.1.1.1 Reducing Costs to the Business and Adding Value to Processes

When quality standards and procedures are implemented consistently, the costs decrease and expenditures drop off. Additional incomes are obtained with the increasing number of customers and prestige. Additionally, because work is done in consistent with laws and legislations, there will be no fines and compensation payments due to nonconformities.

'Adding value' was a reason also given, and a definition can be to ensure that the activities and processes of operating a management system, have a positive and measurable impact upon the profit and loss accounts of a business. Note that:

- 'Added value' within management systems has a history. As ISO 9000:1994 matured, concerns were raised world-wide that this quality standard should be the driver for improvements to products and services, rather than just a control tool.

- Certification bodies were questioned by industry and commerce as to their ability to add value to ongoing audits. This added value meaning passing on positive ideas for improvement rather than just auditing for compliance to the Standard and documented procedures, leaving negative comments behind in the form of corrective action requests.

- Certification body auditors were certainly well placed to offer such ideas for improvement, as throughout their auditing careers they had been in a unique

and privileged position of having access to a wide variety of organizations, cultures, processes and business sectors reviewing both inadequate practices, but more significantly having exposure to 'best practices'.

- It was generally felt that if clients of certification bodies were not making more profits or becoming more secure commercially, than they would be without certification, then no value was being added. Added value was often seen as getting closer to understanding what a company's key business issues were. Since those days of course, ISO 9001:2000 demands an approach of continuous improvement with setting of quality objectives and/or business objectives, and although certification bodies will still offer opportunities for improvement based on best practices, in a sense this original definition and debate of added value has become redundant. The concept and understanding of added value has undergone many changes, and in the context of this chapter refers to the value obtained by integrating two or three management systems, i.e. the synergy obtained by the resultant integrated management system (Whitelaw, 2004).

4.1.1.2 Reducing Risks to the Viability of the Business

There are many risks in working conditions that can cause serious accidents. Below figures show the possible risk examples and danger signs.

Figure 4.1 This figure shows the possible traffic accident caused by close driving.

Figure 4.2 This figure shows the possible accident caused by improper placement of materials.

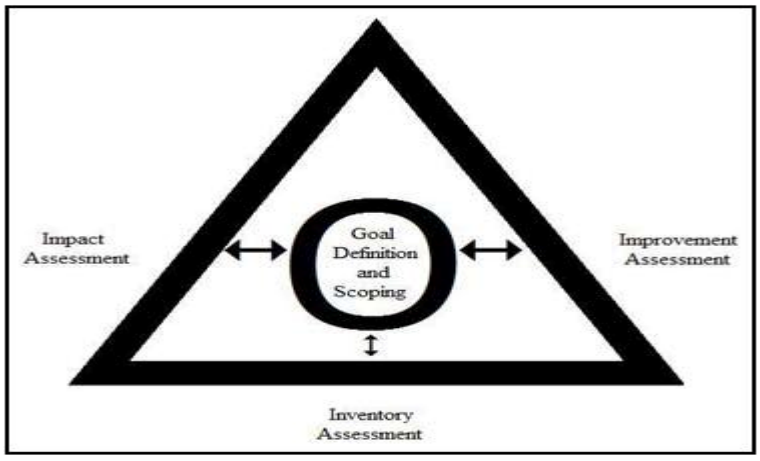

Figure 4.3 This figure shows the danger symbols and signs that are used in labeling dangerous materials and factory-made chemicals according to the legislation about the classification, packaging and labeling of dangerous materials and factory-made chemicals (Green Procurement Guide, 2009).

Corrective and preventive actions are started according to the results of internal auditing of risk analyses and therefore continuity of improvement and minimization of occupational accidents are achieved.

Risk analysis of the factory and environmental risk analysis have been made. With the environmental risk analysis, necessary precautions have been taken keeping in mind the possible hazards from nearby factories, flood, fire, explosion, etc. Nearby factories which have the potential risks have been warned and made to take the necessary precautions.

Below is an example table from factory risk analysis.

Table 4.1 This table indicates the severeness of the risks in some given situations.

Department Name:	General

Risk Analyse Form

No	Machine/ Process	Determined Improperty	Probable Risk and Damage	A	c%	B	d%	R	Corrective-Preventive Corresponding Action	Risk Group	Deadline/ Explanations
1	Noise	Inefficient Usage of Ear Protectors	Irreversible hearing loss may emerge when exposed to noise louder than 85 bD for a long time.	3	100	5	80	12	Workers should become used to wear ear protectors regularyly.	Medium Risk	Workers who have ear problems should be followed.
2	Emergency Escape Ways	Putting materials on Emergency Exit ways	It can be hard to access emergency exit doors in any emergency situation.	5	100	2	90	9	Working conditions may be improved by revising the edges of the moulds.	Medium Risk	30.04.2009
3	Fire Extinguishers	Putting dry chemical dust tyoe extinguishers directly on the concrete	Dry chemical dust type fire extinguishers may not work when they are directly put on the concrete floor.	5	100	3	80	12	Mistakes of the employees may be prevented by controlling also the fire system in field controls and giving training to the employees about the topics.	Medium Risk	Necessary control tables should be created.
4	Manual Handling	Uncontrolled carrying and lifting actions	Waist muscle system may be damaged or health problems like herniated disk may emerge.	4	100	4	80	12,8	Employees should not always perform manual handling and they should be trained about accurate handling techniques. They should handle with the necessary subsidiary equipments.	Medium Risk	Trainings about those topics should be repeated in defined periods.
5	Retaining Wall	Retaining wall deficiency of the nearby factory	It poses the risk of landslide or flood risks in a possible heavy rainfall or earthquake.	4	100	3	100	12	The problem should be explained to the related nearby factory and they should be made to build the retaining wall urgently.	Medium Risk	The issue should be followed by the management.

A: Severeness of the Danger
c%: Number of Employees who are affected by the Danger
B: Probability of the Emergence of the Danger
d%: Work Safety Control Frequence
R: Risk

RISK EVALUATION SCALE
0-8 Low Risk Level
8-15 Medium Risk Level
15-20 High Risk Level
20-25 Production Stoppage Requirement

Organization Doctor	Date:	Signature:	Work Safety Expert	Date:	Signature:

The management of an organization may well perform an analysis of the risks to the business. Many forward thinking organizations look at three components and question:

4.1.1.2.1 Quality. What are the risks of supplying a product or service that does not meet customers' requirements and more to the point does not keep up to date with these changing and more demanding requirements (the concept of continuous improvement). ISO 9001 is the tool for reducing this risk.

4.1.1.2.2 Environment. What are the risks of not complying with legislation? If the organization does not keep up to date with best practices of environmental management? What risks are being taken in terms of adverse publicity towards 'household names' etc. if the organization is perceived to be of poor environmental probity?

ISO 14001 is the tool for the reduction of these risks (Whitelaw, 2004).

4.1.1.2.3 Occupational Health and Safety. What are the risks of causing injury to the workforce through the use of out of date or negligent practices? These risks include at the least lost time at work- therefore productivity suffers- to civil or criminal proceedings from injured personnel, costing time and financial penalties as well as adverse publicity.

OHSAS 18001 is the tool for managing these risks (Whitelaw, 2004).

Such organizations know that there are always new challenges and demands to be met when managing any business, especially when viewed against:

- Significant competition
- High customer and community expectation
- Returns on capital employed
- Regulatory compliance

- Executive liability risk

If an organization is to meet the challenges above successfully, then it needs to call on all its management resources - especially when fulfilling the requirements of Quality, Health and Safety and Environmental Standards. Integration of these management standards would allow common areas of the standards to be managed, thereby making more effective use of management time and addressing the above challenges. Looking at the implications and consequences of a separate systems approach:

- Actions and decisions are made in isolation and are therefore not optimal.
- Employees are presented with a proliferation of information and even conflicting instructions which may put the company at risk.
- Bureaucracy can flourish - how many systems can the organization cope with?
- Lack of ownership.
- Wrong and costly decisions are made due to non-optimization of resources (Whitelaw, 2004).

These consequences can be addressed by developing an integrated approach to quality, health and safety, and environmental management in particular as these three standards cover a high proportion of the scope of any business. Integration will expose areas of waste and no-value-added activity, and provide opportunity for rationalization of:

- Documentation
- Auditing and review processes
- Barriers across departments and functions (by their removal) (Whitelaw, 2004).

ISO 9001:2000 and OHSAS 18001 Standards are the most likely 'candidates' to be integrated with ISO 14001.

ISO 9001:2000 is the Standard for the management of quality. The majority of organizations implementing ISO 14001, or who have gained certification, generally have been operating a quality management system for some years. Due to its long history of development, which is some 30 years or so, there are many excellent books available covering all aspects of quality assurance. However, some description would be useful at this point for comparison purposes with ISO 14001:

Briefly, in order to be successful an organization must offer products or services that:

- Meet a well-defined need, use or purpose
- Satisfy customer expectations
- Comply with applicable standards and specifications
- Are made available at competitive prices
- Are provided at a cost which will yield a profit

ISO 9001 acts as a model for an organization to follow in order to meet these requirements (Whitelaw, 2004).

OHSAS 18001:1999 is the Standard for the management of occupational health and safety. It is based upon hazard identification and risk assessment, i.e. the management of risk, which sets it apart from previous national and international safety standards.

In recent years organizations of all types have been actively addressing the question of health and safety in the workplace, partly in response to legal requirements but also in response to the fear of litigation and the pressures of increasing insurance premiums.

Adverse publicity associated with unsafe practices, realization that accidents have negative cost implications for organizations' money through stoppages, investigations, loss of productivity are all drivers for better safety controls.

True assurance on safety can only be achieved in the context of a structured management system, which strives to manage safety in an active way rather than simply to react to events.

As yet, it is not a true 'ISO' Standard, but has gained international acceptance very quickly.

On the other hand, according to Karapetrovic and Casadesús, the objectives and methodology of a company should be like this:

4.1.1.2.4 The Scope of Standardization. MSSs today cover a broad spectrum of areas within an organization, and are aimed at providing confidence to different internal and external stakeholders. Therefore, organizations looking to address a particular organizational function or satisfy a specific group of stakeholders by way of a MSS have a good choice that is only going to widen in the future. For example, ISO has recently announced the initiation of the development of MSSs for road safety and energy MSs. Karapetrovic and Willborn address a number of factors that influence decisions on the implementation of specific MSSs, ranging from the availability of internationally-accepted MSSs to stakeholder pressures. For example, while an energy company may not need ISO 9001 registration due to the general lack of pressures to standardize a QMS, it may require a formalized ISO 14001 EMS. On the other hand, a company in the automotive sector is likely to have both a standardized QMS and a standardized EMS, together with an ISO/TS 16949 extension for quality management. Overall, the three most popular standardized functions and the respective MSSs are quality with ISO 9001: 2000, environment with ISO 14001: 2004 and safety with OHSAS 18001: 2008, although it may be expected that newly published or planned standards regarding information technology (e.g., ISO 20000: 2005 for services and ISO 27001: 2005 for security), corporate social responsibility (the upcoming ISO 26000) and other areas will not lag too far behind.

As a result, every standard has been created on specific topics in course of time according to the needs. On the other hand, occupational health and safety and environmental management system standards are general standards and they can be implemented in all the fields (Karapetrovic et al, 2008).

4.1.1.2.5 The Sequence of Implementation. Applications start according to voluntary base and according to the needs of institutions. Due to the differing needs of organizations in terms of the scope of application, as well as the sequential development of MSSs themselves, it can be expected that the order in which standardized MS are implemented also varies among industry sectors and individual organizations themselves.

In most cases, the sequence of implementation will trail the publication of standards, namely ISO 9001-based QMS would be introduced first, followed by an ISO 14001-compliant EMS. Subsequently, other functions would be standardized, for instance HSMS in accordance with OHSAS 18001. Other organizations, albeit in a minority would use ISO 14001 before ISO 9001. In addition, the diversity of available MSSs makes it possible to simultaneously apply several standards covering different organizational functions or stakeholders, for example ISO 14001 and OHSAS 18001. This manner of implementation, especially if supported by good integration models and methodologies, could be used often in the future (Karapetrovic et al, 2008).

4.1.1.2.6 The Time Required for Implementation. The question of how much time organizations require to implement multiple MSSs across functions is particularly interesting as it relates to both the efficiency in the use of resources and the effectiveness of the application of standards. Since MSSs contain a number of common characteristics, in addition to their identical nature and sharing of the underlying concepts, a company with one standardized MS in place would already follow most, if not all, of the fundamental principles, models and requirements of any new standard it is implementing. Therefore, additional standards should take less time to implement compared to their predecessors. Furthermore, due to synergy

effects, if a company is applying two or more MSSs at the same time, the lead time for such an implementation should be shorter than the sum of the times required for the sequential implementation.

It is an important criterion for the application to start in the period when the companies are ready in order to increase the success rate. It is important in terms of timing to make the essential background preparations before the start of these practices (Karapetrovic et al, 2008).

4.1.1.2.7 The Scope of Integration. Today's target trend is to set up the integrated management systems in the companies. Integrated systems are more successful and more compatible as their results cover all the fields.

One of the most interesting questions in the field of IMSs based on standards is how pervasive the actual integration is among the organizations that have implemented multiple MSs. Since integration makes much more sense than disintegration, in other words leaving the internal standardized management systems as separate; it can be hypothesized that a larger portion of organizations would choose integration over separation. What is also important to note is that integration in this sense refers to the amalgamation of MSs that cover different functions or stakeholders, rather than the systems that were designed to meet different standards in the same organizational area. For example, cross-functional integration would imply the melding of environmental and quality MSs, but not the integration of an EMS to meet both the requirements of ISO 14001 and the Eco-Management and Audit Scheme (EMAS), or a QMS for ISO 9001, ISO/TS 16949 and additional such standards.

To tackle these four questions, an empirical study had been designed that, by means of a mail survey, revealed a wide range of options that organizations came up with to address each question. Based on the results obtained and presented in the next section, four organizations were then selected to carry out in-depth case studies. By doing so, we are trying to explain why organizations of similar characteristics opted

for one option or another, for example, implement ISO 9001 or ISO 14001 first, and integrate their MSs or not. Thus, through both the survey and the analyzed cases, we are hoping to give as comprehensive an answer as possible to these different questions.

Karapetrovic and Casadesús give an example organization and continue describing and exemplifying the terms scope, sequence, time and integration as follows:

Founded in 1968, Roberlo, S.A. has specialized for more than 30 years in the manufacture and development of chemical products for automobile repairs, such as abrasives, aerosols and paints, as well as for gluing and maintenance in construction, for example anti-slip products and putties. The company's facilities, located in the province of Girona (Spain), contain advanced manufacturing systems, totally automated warehouses, Research and Development laboratories and a training centre. With the integrated logistics system, Roberlo is currently capable of distributing its products to more than 70 countries through a network of distributors and companies of its group.

Until the 1990s, Roberlo, S.A. was a family-run business. Managed by the founder and his son, it employed 22 persons and there were no clearly defined work functions or procedures. In 1993, the incorporation of young managers into the company structure compelled it to open up to new markets and to commit itself to exporting. Within a few years, the company had close to 100 employees, and there was a serious need for appropriate restructuring. With that aim, the company management was convinced of the need to promote the implementation of a QMS based on ISO 9001: 1994. To do that, advisors were contracted to provide the company with working procedures in accordance with the standard, even though, according to the organization, the procedures were not overly practical at first. After a two-year process of intense work, during which an important simplification of the system documentation was completed, in 1997 Roberlo obtained the ISO 9001: 1994 certificate.

In 2001, the company completed the transition to the more recent version of the standard, namely ISO 9001: 2000, which subsequently led to the certification of their EMS to ISO 14001: 1996 in 2002. During the early months of 2006, the company's registrar performed the most recent review process and the certificates were renewed until 2009.

According to the company management, the implementation of those MSs together with the development of a large sales department have been two of the fundamental pillars of Roberlo's growth in recent years. The company has a very positive view of the incorporation of management indicators used in decision making, for example, the inventory turnover rate into the most recent version of their QMS. Specifically, every three months, the Quality Committee meets to analyze the indicators and any other inputs resulting from audits or customer complaints. Those indicators have not yet been incorporated into the EMS because the data, such as the total consumption of water, are not easily obtained, but it is expected that they will be incorporated gradually.

From early on, the implementation of the second MS, namely the EMS, was integrated with the first (QMS). As a result, the company has always worked with a single management manual, currently 35 pages long, although it ''develops'' in different ways depending on the requirements to be fulfilled. There is, for example, one process to evaluate suppliers and another one for sub-contractors, since the requirements to be met are different. On the other hand, there is only one ''system review'' procedure. In any case, the requirements related to each procedure are included in the manual according to the requirements of both standards.

Although the IMS was initially supported by some common office computer tools, since April 2006 the company has been using a specialized software package for standardized MSs to manage the IMS. According to the company, this software, which is not integrated with the enterprise resource planning, is outstanding for its system management possibilities (such as the management of corrective and

preventive actions and complaints) rather than for its capacity to store information (for example, work procedures and manuals).

Roberlo believes that integrating MSs is necessary because it simplifies them, avoids duplications of efforts and at the same time facilitates communication between the workers and the departments of the company. In addition, there is great synergy between the two MSs. In this sense, for example, analyzing the cost of each complaint (quality cost) together with the cost of dealing with the solid waste produced (environmental cost) converts the entire system into an authentic and very efficient management tool, which does much more than simply satisfy independent requirements. According to the company itself, if the systems had not been integrated, their efficient use would have been more difficult, although it might have been easier to familiarize people with them and carry out the training activities for employees. Finally, the HSMS is only partially integrated with the existing IMS, but the remaining integration is being carried out gradually (Karapetrovic et al, 2008).

Roberta Salomone explains integrated management systems by giving her study as an example and continues like this:

The analysis of the common aspects in terms of motivations and obstacles that companies meet when implementing each of the management systems analyzed allow to explore internal and external pressures and restraining forces; this put in evidence that driving forces to Integrated Management System are markets (customers, image, competitiveness), human resources (to reduce lack of knowhow and management difficulties) and the continual improvement based on Deming cycle (Salomone, 2008).

The integration of management systems was also analyzed in detail, asking companies how they implemented their integration strategies (Salomone, 2008).

First of all, in our sample, 73% of the companies declared they had totally integrated various aspects of QMS, EMS and OHSMS and 26% said they had

achieved partial integration. Only one firm, a medium sized company in the chemical sector located in north-eastern Italy, reported it had not undertaken any type of integration because it was waiting for a guideline on IMS to come out.

Integration (total/partial) related to all three standards for 87% of firms, for 12% only ISO 14001 and OHSAS 18001 while for 1% only ISO 9001 and OHSAS 18001. Almost all firms indicated the ease of integrating ISO 14001 and OHSAS 18001, while it proved more difficult to integrate these two with ISO 9001. Indeed, two of the firms that said they had integrated the management systems also specified they had done so by first integrating, ISO 9001 with ISO 14001 and then ISO 14001 with OHSAS 18001.

The integration of management systems for the overwhelming majority of companies (90%) was a choice made by management for internal convenience; deriving firstly from the affinity of the standards and secondly, for some firms, from the fact that the same staff work on the different systems therefore integration evolved spontaneously, while in other firms in which there were different teams for the management systems it was necessary to organize meetings and assign duties and responsibilities to specific members of staff. For 13% integration was a consequence of pressure from certifying bodies. A very few cited pressure from customers or suppliers (both 2%).

Firms identified numerous benefits arising from integration of systems, while the obstacles seem to be fewer.

The most outstanding benefits were the optimization/unification of audit, both internal (78%), and external (65%), reduction in the bulk of documentation (69%), and, in general, all areas in which synergies between the three systems could be exploited, thereby saving time, money and labour.

The biggest obstacles indicated by firms were the risk of not attributing the right level of importance to each variable quality, environment, safety (48%) and the difficulty in organizing an Integrated Management System (46%).

An interesting finding was that 10% of the companies that declared having integrated their management system also stated they had not faced any obstacle to integration. These companies operate for the most part in northern Italy (90%), 80% are in the manufacturing sector and 80% are small or medium size firms (Salomone, 2008).

Additionally, Stanislav Karapetrovic and Jan Jonker explain the importance and utilization of methodology as follows:

One of the questions posed earlier in the paper related to the availability of 'one best' methodology for integrating management systems. Just like we cannot create the best IMS model, it is not possible to develop a methodology that will work in all cases. This is partly because both the objectives (ending points) and initial conditions (starting points) on the path to an IMS are different for different companies. For example, some organizations may not require a fully integrated system, while the goal for others may be exactly that. On the other hand, certain companies may already start their integration efforts with partially amalgamated systems (e.g. for environment and safety), while others may start from scratch (i.e. completely independent systems). Therefore, the actual paths to an IMS will be different, even though the roadmap, represented by the methodology, may be the same (Jonker & Karapetrovic, 2002a). In fact, the methodology itself will not contain an illustration of what must be done in each individual case to reach an IMS, but rather it will contain the principles and techniques that can be generally applied to implement an IMS (Jonker & Karapetrovic, 2002b). Thus, the systems approach depicted above contains a set of ingredients necessary for the effort to succeed, as well as some principles (related to how, in general, those ingredients should be put together) for a successful integration. The recipes, which use the systems approach as a 'cookbook', will depend on each individual organization (the 'cook') (Karapetrovic et al, 2003).

Ahmet Murat Türk, on the other hand, gives a Turkish study case as an example for OHSAS 18001 and ISO 14001 Standards. He explains his studies as follows:

4.1.1.2.8 Survey Sample and Analysis Method. The survey was conducted in July 2004 with 138 construction firms. The sample frame includes non-certified and certified firms which were selected as samples because they were registered in the Turkish Contractors Association which represents the top category of firms operating in both national and international markets. After the preparation of questionnaire, a pilot survey was carried out with 12 construction firms. According to the results of this survey, some questions were revised.

As of August 2004, 42 out of 138 construction firms had returned the questionnaires. At the end of September, a total of 68 forms had been returned after making one-on-one telephone calls to the non-responding ones. The rate of return was 49%. The 68 completed questionnaires included 28 from certified firms with ISO 14001 and 40 from non-certified firms. After completion of the questionnaire survey, the data obtained from the results of such questionnaire survey were processed in SPSS 9.5 software. In the analysis of the data, descriptive analysis, one sample t-test, and an independent sample t-test analyses were utilized (Türk, 2009).

4.1.1.2.9 Profile of Firms in Survey. In the survey, 67.6% (46) were answered by the quality department managers, 10.3% (7) by the general manager, 5.9% (4) by the administrative manager, 5.9% (4) by the engineering department manager and 10.3% (7) by other personnel. In other words all were professionals who replied to the questionnaire.

The total number of employees working in 53% (35) of those surveyed firms is above 200, between 100 and 200 employees in 16.7% (11) of the firms, between 50 and 100 employees in 12.1% (8) of the firms, between 20 and 50 employees in 15.2% (10) of the firms, between 10 and 20 employees in 1.5% (1) of the firms, and between 1 and 10 employees in 1.5% (1) of the firms. The total number of employees

is quite high as they represent the top category operating in both national and international markets.

91.2% (62) of these firms hold ISO 9001 certificates, and 8.8% (6) of the firms do not possess ISO 9001 certification. Among all responding firms, 71.8% (28) of non-certified firms are considering obtaining ISO 14001 certification in the near future. Among the firms having ISO 14001 surveyed, 42.9% (12), 50% (14) and 7.1% (2) of them have applied ISO 14001 certificates for between 0 and 1 year, 1 and 3 years and 3 and 5 years, respectively. As can be seen from the results survey, the use of the ISO 14001 by construction firms in Turkey is rather new (Türk, 2009).

4.1.1.3 Relation between Firm Characteristics and Having ISO 14001 Certification

It could be beneficial whether relationship between construction firms characteristics and having ISO 14001 certification. In order to perform this assessment, certain hypotheses are set up.

There is no difference related to perception of ISO 14001 certification depending on firm characteristics, and their positive opinion about ISO 14001 certification, there is a relation between firms characteristics and having ISO 14001 certification. Having ISO 14001 certification is dependent on the size of the firm or whether the firm has been awarded contracts in the international market. When the size of construction firms (taking into consideration business volume and the average number of personnel employed in the surveyed firm) and business volume of construction firms from international markets increase, having ISO 14001 certification increases. The construction firms whose size is small and that do not undertake the business from international markets despite their positive opinion, do not have ISO 14001 certification. The situation can explain the costs related to ISO 14001 certification (Türk, 2009).

4.1.1.3.1 Reasons for Seeking ISO 14001 Certification for Certified Construction Firms. Reasons for obtaining ISO 14001 of certified firms have been analyzed using t statistical testing. According to the results, the most significant reason for the firms to obtain ISO 14001 certification is its easy access opportunity into the international market. In particular, the adaptation process to access the European Union and the extensive use of ISO 9000 QMS and ISO 14001 EMS and standardization within construction sectors of member countries of the European Union have accelerated the urgency to seek ISO 14001 certification in the construction sector in Turkey. Other significant reasons are the desire of the firm to develop its EMS and the desire of the firm to change. One of the reasons for the certified firms to obtain certificates is the requirement of tender specifications to have the certificate. As can be understood from the results of the analysis, there is a similarity between the reasons for obtaining ISO 9001 certificates and the reasons for obtaining ISO 14001 certificates. According to the study of Turk, the reasons for Turkish construction firms to obtain ISO 9000 certificates were determined to be: access to the international market, its obligation in tender specifications, general consideration of its being mandatory in the near future and the development of a quality system. There is a similarity between the reasons for obtaining ISO 9001 certificates and the reasons for obtaining ISO 14001 certificates in Turkey except for the area of client request. Contrary to ISO 9001 certification, client request is not an effective reason for obtaining ISO 14001 certification. This indicates that ISO 9000 was customer-driven; however, ISO 14000 is more driven by stakeholders, the community or regulators. A similar tendency was found in the other studies (Türk, 2009).

4.1.1.3.2 Benefits Gained from Having ISO 14001 for Certified Construction Firms. The survey studies four aspects of the benefits of certification, including improvement in ‘‘environmental benefits and internal operations’’, ‘‘corporate managements’’, ’’marketing effects’’ and ‘‘subcontractor relations’’. The questions related to benefits gained from ISO 14001 registration are on a four-scale tier (varying from totally agree, to agree, to disagree, and to totally disagree). The results of the questions are assessed according to the scales (Türk, 2009).

4.1.1.3.3 Environmental Benefits and Internal Operations. All responding firms gave high positive scores for the variables under environmental benefits and internal operations variables. 96.4% of the respondents were very aware that having ISO 14001 certification provided improvement of environmental awareness for their company. In implementing ISO 14001, construction firms are required to provide training to employees to increase environmental awareness. This is valid for Turkish construction firms. Also, of the respondents, 96.4% agreed strongly that they had benefited from improving standardization in environmental management. This is related closely to ISO 14001 in which the standardization of EMS procedures is maintained through five stages: (1) environmental policies; (2) planning; (3) implementation and operation; (4) checking and corrective action; and (5) management review. 92.8% of the respondents also agreed that after ISO 14001 certification they had benefited from decreasing negative impacts on the environment. This is consistent with the main aim of ISO 14001 registration. 6.4% of the respondents declared that ISO 14001 had benefits of sustainable development in the environment. Also, 89.2% of the respondents indicated that complaints against the company about environmental problems decreased with ISO 14001 (Türk, 2009).

4.1.1.3.4 Corporate Management. 78% of the respondents established that the social recognition of their company has increased. Success in internal operations such as ‘‘decreasing negative impacts on environment’’, ‘‘decreasing of complaints against the company’’ can stimulate the social recognition of these firms. The different types of pollution, such as land deterioration, resource depletion, waste generation, air pollution, noise pollution and water pollution due to construction activities can be reduced via ISO 14001 and the firm can be recognized in the sector. All of these efforts will also increase the awareness of the company. Likewise, 89.2% of the respondents accepted that the self-confidence in their company had increased. Almost all respondents (96.4%) strongly agreed that their company’s image had improved after ISO 14001 certification. All of the certified firms were proud of successful registration. They believed that their customers and stakeholders would have more confidence in the management and in the way the company was managed (Türk, 2009).

4.1.1.3.5 Marketing Effects. The aim of the foundation of the companies is to make a profit. The shortest way to increase the profits is to increase the market demand and decrease the costs. The numeric values of these can be seen in the scientific articles, too.

78.5% of the respondents found that having ISO 14001 certification provided marketing advantages such as an increased market share. Also, 89.2% of respondents accepted that ISO 14001 registrations provided improvement of client satisfaction (Türk, 2009).

4.1.1.3.6 Subcontractors' Relations. These practices are made controllably by making the sub-companies to obey the standards. The company is introduced to sub-companies and the possible risks are described. Necessary trainings are given and the possible dangers that they may cause are eliminated in advanced. Sub-company working procedures are created in this way.

4.1.1.3.7 Benefits Gained from ISO 14001 Certification: An environmental policy, which is sustainable through this certification, is created. The company gains prestige and reputation. A very convenient workplace is created in this way for both the employees and the management.

According to analysis results, there are differences in the perceptions of environmental impact of construction, and behavior toward environmental management among ISO 14001 certified firms and non-certified firms. That is, firms having ISO 14001 are determined to be more careful about environmental effects of construction and behavior toward environmental management. Both ISO 14001 certified and non-certified firms find the ISO 14001 suitable for construction firms and consider that it has a positive effect on the Turkish construction sector. In other words, the construction firms in the sector have a positive approach to the EMS.

All these results show that ISO 14001 certification puts in to construction firms not only in term of environmental benefits but also corporate management and

marketing effects. This also verifies that the ISO 14001 has a positive impact on the Turkish construction sector.

The difficulties encountered as cited by the certified firms in obtaining ISO 14001 are determined as ‘‘company management is not open to research and criticisms’’, ‘‘registration process is too lengthy’’, ‘‘volume of documentation and paperwork has been increasing’’ and ‘‘ISO 14001 has increased expenses’’. Increasing expenses and the increase in documentation and paperwork are also determined as the main difficulties encountered in the study by Zeng et al (Türk, 2009).

As a last case study, we can show S. X. Zeng, Vivian W. Y. Tam and C. M. Tam’s case study about the construction industry of China. They narrate their study as follows:

4.1.1.3.8 Survey. To investigate the existing status in implementing the OHSAS 18001 safety management system in the Chinese construction industry, a questionnaire survey is conducted. The contents of the questionnaire focus on:

- evaluation of the OHS status in the construction industry;
- exploration of behavior and OHS management measures of construction firms;
- evaluation of OHS legal support in construction;
- exploration of attitude towards the OHSAS 18001 implementation;
- demand for the OHSAS 18001; and
- evaluation of benefits and difficulties in integrating the OHSAS 18001 and ISO 9001 management systems (Zeng, Tam & Tam, 2008).

Before designing the questionnaire, 12 senior managers charged with safety management responsibility were interviewed. Then the structured questionnaires were sent to senior management representatives of about 200 ISO 9001 certified construction firms in China and those listed in the Dictionary of Certified Enterprises

of China National Accreditation Board for Certifiers. About 76 completed questionnaires were received with the response rate of about 38%.

The reason for sending the questionnaire to ISO 9001 certified companies to investigate the implementation status of OHSAS 18001 is that it is very uncommon for construction firms to seek certification of OHSAS 18001 in China as revealed from the discussions with the senior managers.

After receiving the questionnaires, individual structured interviews were arranged with eight respondents. The interviews were intended to further gather comments, and elaborate and interpret the questionnaire results to compensate for the limitation of the low response rate (Zeng et al., 2008).

4.1.1.4 Results and Analysis

4.1.1.4.1 OHS Status in the Composite Industry. From the interview, one of the interviewees explained that four main types of pollution (i.e. air, noise, solid waste and hazardous waste) generated on construction sites had seriously affected labors' health. Another interviewee noted that health hazards affecting construction equipment operators include: vibration to body and hand, chemical expore dust, noise, temperature extremes, and shift work and night work. Construction sector, such as the prevalence of mortal accident is low. However, personal protection and proper manufacturing techniques are not used properly in the long term does not apply occupational diseases may occur.

4.1.1.4.2 Behavior on Occupational Health and Safety Management. When the employee health and safety system is created, the general behavior of the companies would be supervising and protecting the employees.

Surveys show that, with respect to OHS accidents, about 58% of the respondents declare that they have recorded occasional accidents in the past three years. Although about 42% of the respondents claim that they hitherto have no OHS accidents

recorded, in fact, it does not mean that there are no accidents but might be due to the fact that some firms would rather compensate the victims than reporting the accidents, especially for minor accidents. From the interview, the interviewees noted that there were a large number of peasant-workers in the Chinese construction industry, who had received limited education and were unskilled, untrained, and inexperienced. If they were injured, they would not have effective channels to protect their right (Zeng et al., 2008).

4.1.1.4.3 Measures for OHS Management. The companies create a work plan towards OHS policy. In the work plans there created a plan for the improvements and trainings towards the risk analysis. Some people from the management unit are appointed for this field. Representatives among employees are selected through election. An OHS committee is created. Explaining the risks and the ways they can protect themselves to the employees is an important factor for occupational health and safety. The importance that the managers give to the training and support of the employees gives clue about the approach of the management to the OHS studies.

The effectiveness of training to improve construction safety has been advocated. From the interview, the interviewees highlighted that training programs could help firms in effectively carrying out various activities, establishing a positive safety attitude, and integrating safety with the construction and quality goals. In fact, the level of education and training for labors is a very important factor during the OHS implementation process. One of the interviewees claimed that some accidents such as ‘‘falling from height” and ‘‘hit by falling materials” in construction could easily be prevented from implementing training programs to their employees.

About 88% of the respondents indicate that their firms have full time staff in charge of the OHS management, and about 12% have part time staff. From the interview, the interviewee highlighted that protection of labor from OHS diseases and accidents was defined by law in the China; i.e. construction sites having about 50 employees or more, main contractors have to nominate a full time safety inspector on site; for sites exceeding 10,000 m2 there must be at least 2 safety inspectors on site;

wherever the sites exceed 50,000 m2, the main contractor has to establish a safety management team (Zeng et al., 2008).

4.1.1.4.4 OHS Legal Support. Legal grounds are always in the foreground in OHS and environmental management policy. Legal necessities have to be performed. In occupational health and safety, legal bases guide us by showing us the road maps. It helps us to form a boundary for the responsibilities of the employer and define them.

In general, strict legal enforcement is effective in changing people's mindsets. If the government enforces safety management for all projects, all contractors will take extra attention in the implementation of safety systems. One of the interviewees argued that the government should initiate proactively the spread of knowledge and advocate the importance of safety work place (Zeng et al., 2008).

4.1.1.4.5 Attitude towards OHSAS 18001 Implementation. OHSAS 18001 helps to start the application samples in a proper way. International institutions which concern about business life and local ministries which concern about the topic encourage these studies and they encourage the good samples of applications. Sometimes encouragements about this topic are obtained through good application project studies. All the quality management systems aim to bring sustainable order to the business life.

From the 65 non-OHSAS 18001-certified firms, about 38 firms (58%) suggest that they would not seek certification of the OHSAS 18001 in the near future. Although the other 27 firms (42%) feel that they have intension to adopt the standard, they would rather adopt a wait-and-seek attitude. From the interview, the interviewees highlighted that ISO 9001 implementation is the most attractive international standard for construction firms. Another interviewee explained that ISO 9001-certification could enable them to bid for tenders as the ISO 9001 is becoming a mandatory requirement for bidding public projects in the Asian construction markets. Therefore, with the initiation from top management, most organizations put extra attention and resources to obtain certification of ISO 9001 quality management system. Most organizations are also aware of the importance of the OHSAS 18001.

One of the interviewees noted that one of their senior project managers foresaw the future potential mandatory requirement of OHSAS 18001 certification for tendering. This organization has employed five employees to develop a safety management department to control and to improve on-site safety performance. The interviewees also claimed that construction firms must complete projects in scope, on schedule, and on budget. If clients only routinely focus on safety records of construction firms at the ‘‘pre-qualification” or ‘‘request for proposal” stages on a procurement process, construction firms with a successful safety program and a good safety performance can enjoy sustainable competitive advantages. Under this circumstance, this can encourage construction firms to implement the OHSAS 18001.

Improvements in occupational health and safety results in the development of working life and offers the workers more peaceful workplaces. Workers’ happiness leads them to support these studies. This increases the good applications and therefore it affects the success gained.

OHSAS 18001 studies are coherent with ISO 9001 studies. The creation of workers’ health and safety systems are the results of the responsibilities brought by ISO 9001 standards. These systems are also example for necessary studies. These systems brought the view that if the general view can provide quality standards in production, then why the same quality cannot be obtained in occupational health, too. Good application samples helped the development of these studies (Zeng et al., 2008).

4.1.1.4.6 Benefits in Implementing an Integrated Management System (IMS). The results show that about 47% of the respondents consider that an integrated management system can avoid duplication of procedures; about 35% think that an integrated system can reduce requirements for resources; and about 11% believe that the IMS can reduce conflict of procedures. Benefits of the IMS have also been reported in other literature.

Possible risks have been eliminated through the improvements and foresights which these studies have brought. This is the main reason why these systems are applied as an integrated part (Zeng et al., 2008).

4.1.1.4.7 Difficulties in Implementing the IMS. Difficulties in implementing the IMS can be grouped under internal and external barriers. Internal barriers are obstacles arisen within the firms which prevent or impede IMS implementation or its adoption. The internal barriers are classified into five main categories: (i) human resources; (ii) understanding and perception; (iii) organizational structure; (iv) company culture; and (v) others. External barriers are obstacles arisen outside the firms which prevent or impede IMS implementation from its adoption. The external barriers are classified into five main categories: (i) certifying bodies; (ii) stakeholder and customers; (iii) institutional environment; (iv) technical guidance; and (v) others.

Traditionally, organizations have separate and competing staff groups to handle different management systems, which easily results in organizational conflicts. In addition, coordination from top leaders to employees is very important in implementing the management systems. The leaders must personally be involved in communicating the company's goals and plans and in motivating and rewarding employees. Top management must be seen by the rest of the employees to be totally committed and involved. Its support and commitment are thus essential for the integration process to be initiated, completed and subsequently maintained within organizations. The managers consequently need to recognize that for the integrated system to be implemented and maintained, they must continuously push it forward. Negative corporate attitude towards the IMS and any unfavorable company culture, often cited in organizations, conspire to deprive the IMS implementation process. When quality and OHS management systems exist as two parallel systems, the quality and OHS management systems are focused respectively, which results in cultural incompatibility in organizations.

Although the scopes of quality and safety system audits are different, the procedure is almost identical. After identifying the auditing objectives, roles and

responsibilities of all parties involved, the audit is initiated, the scope is defined, and an audit plan is prepared. Subsequently, audit, reports and records executed by auditors or audit teams are submitted to clients, and appropriate follow-up actions are taken. Not to integrate them will certainly cause unnecessary waste of resources. Apart from the focus on the overall system improvement, joint audit systems will bring cost savings, better allocation and deployment of human, material and information resources, as well as a unified problem solving approach that will increase efficiency and effectiveness of other interlinked systems (Zeng et al., 2008).

4.1.1.4.8 Supports Needed for Implementing the IMS. The necessary supports for the creation of all the studies can be separated into two as technical and human resources. Financial aid for the technical resources is provided by the top management. Also, educated personnel are appointed to the trainings and therefore studies and procedures are followed properly and in due time. The education of the authority personnel and assistant personnel is very important. Human resource should be thought as a raw material and the importance should be given to their training. Thus the management should create a noticeable budget.

About 27% of the respondents expect support from the certifying bodies, which had to face the demand to conduct joint certifications. About 16% of the respondents feel that it is important to obtain support from customers. Moreover, about 9% of the respondents expect support from their employees. The ISO 9001 and the OHSAS 18001 standards require all working procedures to be traceable and auditable. An interviewee who had implemented the integration suggested that if a firm planned to implement the IMS, it was indispensable for the employees to be trained with a good understanding of the new system.

In practice, it is not easy for construction firms to implement the IMS. Some researchers developed different approaches for the integration. For example, Wilkinson and Dale's developed 'total quality model'. Rahimi suggested integrating the strategic planning (long-term) of safety inside total quality management. A conceptual frame is developed to include concepts of strategic safety management

and self managed teams. One of the characteristics of Rahimi's model is the integration of safety and quality management teams. The idea includes integrating teams with workers from several levels: (a) people with enough experience to design and to supervise physical components of the working environment (for example machines, teams and facilities, and buildings) and (b) people able to plan, to organize, to direct, and to control actions that need to be carried out. These working teams do not eliminate authorities from top management but they provide additional tools for continuous improvement. These working teams have to begin integrating, so that top management and workers have enough time to adapt to the new rules. An interviewee suggested that the working teams should begin by working on small pilot projects and then move forward to adopt new organizational structures.

Karapetrovic and Jonker analyzed a 'system model' for the integration. They indicated that using a system approach could lead towards the formulation of a set of 'ingredients' necessary for the establishment of the IMS in an organization. These ingredients are the common elements of function-specific management system standards that are harmonized under generic IMS framework. The system model for IMS contains five ingredients: (i) determination of goals; (ii) system planning and designing; (iii) acquisition and deployment of resources; (iv) system implementation; and (v) system evaluation and improvement.

Pun and Hui proposed a process model of safety-focused quality management (SQM) based primarily on the total quality management philosophy and compliance requirements of the ISO 9001 and the OHSAS 18001:1999 standards. The model has three processing stages: planning, integration and installation.

In the planning stage, corporate vision and mission of an organization need to be established. The vision indicates where the organization wants to go and the mission shows why a function is important to the organization. Safety/quality goals and objectives need to be clearly set, so that everyone is aware of the desired results.

In the integration stage, the organization needs to document policies and procedures in combining quality and safety management into a single system.

In the installation stage, top management commitment, training and education, documentation control and audit govern the adoption of the system.

Generally, in order for OHSAS 18001 and other standards to work properly, resources and workforce should be chosen correctly, and planning should be done correctly. It should be statistically manifested that the aimed goals are accomplished (Zeng et al., 2008).

4.1.2 Vacuum Bagging Production Method

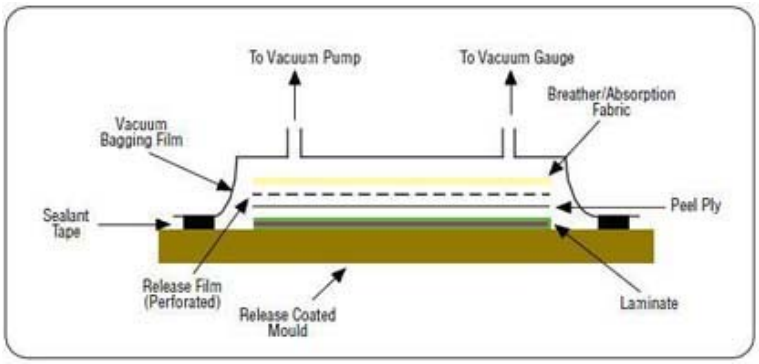

Figure 4.4 This figure is an example for Vacuum Bagging Production Method (Guide to Composites, 2005).

The figure above shows the vacuum bagging production method. This is basically an extension of the wet lay-up process described above where pressure is applied to the laminate once laid-up in order to improve its consolidation. This is achieved by sealing a plastic film over the wet laid-up laminate and onto the tool. The air under the bag is extracted by a vacuum pump and thus up to one atmosphere of pressure can be applied to the laminate to consolidate it. Resins will be primarily epoxy and phenolic. Polyesters and vinylesters may have problems due to excessive extraction of styrene from the resin by the vacuum pump; in fibres, the consolidation pressures mean that a variety of heavy fabrics can be wet-out; and any core is appropriate.

Main advantages of vacuum bagging are that (a) higher fibre content laminates can usually be achieved than with standard wet lay-up techniques; (b) lower void contents are achieved than with wet lay-up; (c) better fibre wet-out due to pressure and resin flow throughout structural fibres, with excess into bagging materials; (d) Health and safety: The vacuum bag reduces the amount of volatiles emitted during cure.

Main disadvantages are as follows: (a) The extra process adds cost both in labour and in disposable bagging materials; (b) a higher level of skill is required by the operators; and (c) mixing and control of resin content still largely determined by operator skill.

Typical applications are large, one-off cruising boats, racecar components, and core-bonding in production boats (Guide to Composites, 2005).

4.2 Commitment and Policy

Under this headline, ISO 14001 stages in XYZ Company, XYZ Company safety management according to OHSAS 18001 work health and work safety management system application stages are going to be summarized, each under its own headline.

4.2.1 ISO 14001 Application Stages in XYZ Company

4.2.1.1 Preparations for the Start of the Project

Project management group is constituted, appropriate workplace and conditions are defined, required standards and sources are provided and the constitution of the working plan is provided.

4.2.1.2 Analyzing the Current Situation

The current situation of the company is analyzed in accordance with ISO 14001 Environmental Management System and reported to the management.

4.2.1.3 Providing the Necessary Training

In the basis of these studies, there is the training of the workers and the specialized personnel. The effectiveness of training given to the workers can be measured with development of proper behavior in the personnel who have been trained.

Corresponding counselor company provided the necessary training with the aim of introducing Environmental Management System and project stages. The training, which is given in this extent, is explained below.

- ISO 14001 Environmental Management System Training
- Defining the environmental dimensions and risk analysis
- Environmental System Documentation Training
- Inner Study Training

4.2.1.4 Creating the System Documentation

Required documentation (Environment Handbook, Organization Handbook, Procedures, Instructions, Forms, etc.) are prepared under the guidance and supervision of counselor company.

4.2.1.5 Application of the System

Applications are carried out according to the document which is approved to be appropriate to the ISO 14001 standard requirements. The counselor company has revised the applications; defects are determined and required correction suggestions are presented to our XYZ Company.

4.2.1.6 The Process of Inner Studies under the Supervision of the Counselor Company

Following the establishment of the system, surveys are made by the inner study group constituted by the counselor company and the results are reported to the top management.

4.2.1.7 Application for Certification

After completing all the preparations, our company applied for certification to the corresponding certification institution.

4.2.1.8 Management of Organizational Change

Analyzing the ISO 14001 implementation strategies at the company studied, it is possible to highlight the following best practices in relation to the management of organizational change:

- Commitment from top management through investment, interaction, accessibility, and support of decisions made by the environmental management committee;
- Formation of a multidisciplinary and integrated committee for environmental management, where information on the environmental management system is exchanged daily;
- Evaluation of the company's vision, mission, values, and policies before and during the ISO 14001 implementation process, striving to maintain focus and reinforce environmental management strategies;
- Investment in technical environmental training and human development of employees, including equal schooling, thus improving an understanding of ISO 14001. Training sessions must include themes such as ethics, communication, and working in groups;

- Creation of a partnership with Human Resources to better identify training needs, employee sensibility, recruitment and selection, development of leaders, and a policy of functions and wages linked to management by competencies and always focusing on environmental matters;
- Contracting of an external consulting company based on experience with environmental management systems, qualified, team composition and time dedicated to the project, and cost benefits;
- Intensive investment in internal communication, according to the most appropriate media for each organization (bulletin boards, information bulletins, quarterly journal, and annual magazine); and
- Development of a mechanism for the management of environmental knowledge throughout the company through constant updating, integration, and availability of key information (De Oliveira & Pinheiro, 2009).

4.2.2 XYZ Company Safety Management: OHSAS 18001 Work Health and Work Safety Management System Application Stages in XYZ Company

First of all, it is important to give the production plan of the XYZ Company and then other stages in XYZ Company can be analyzed more efficiently. Below is the scheme that shows the production stages in XYZ Company.

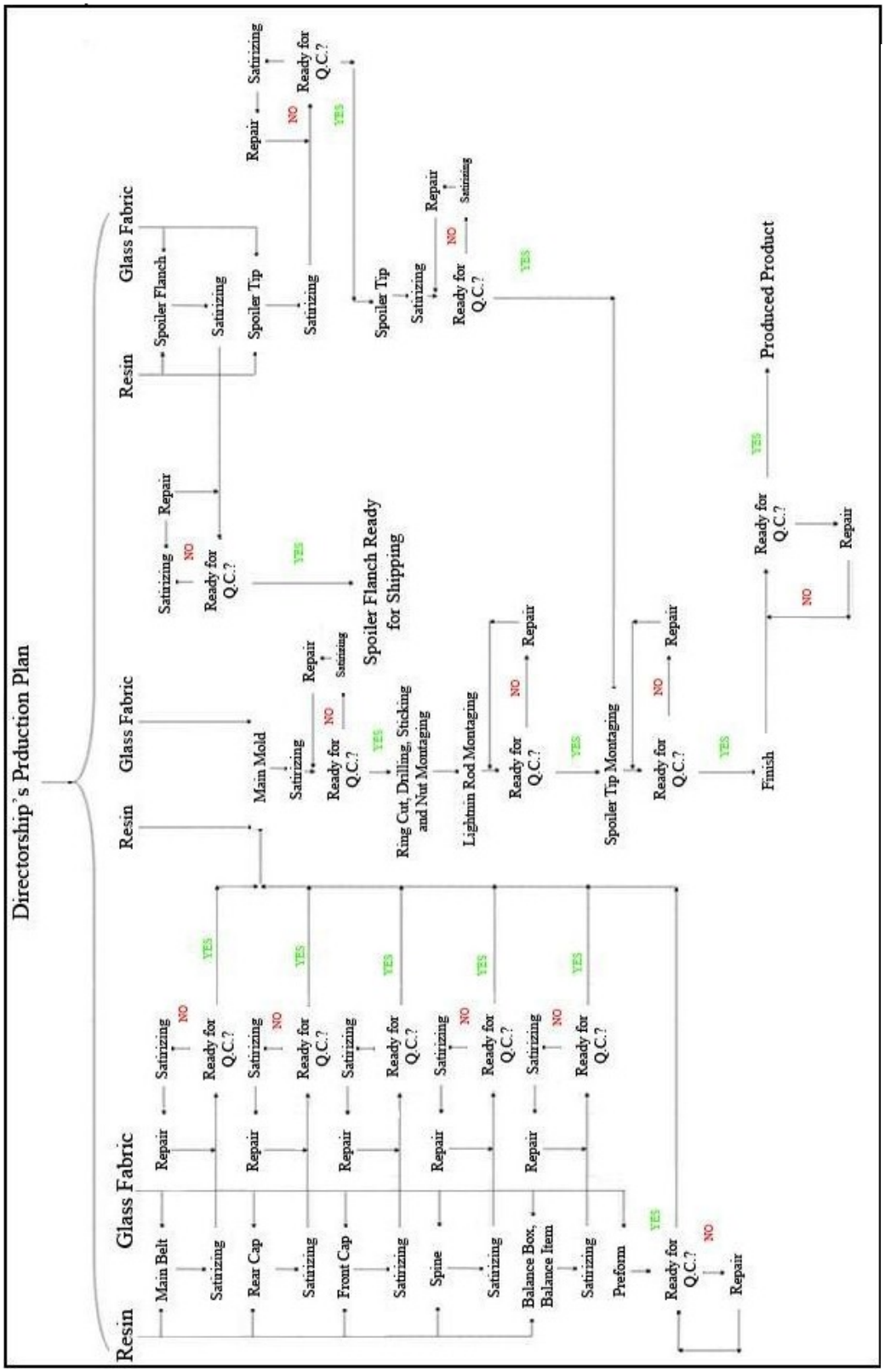

Figure 4.5 This figure shows the production plan of XYZ Company which is provided by the company's directorship.

4.2.2.1 Evaluation of the Current Situation

In the first stage, dangers of current works, evaluation of the situation according to laws and other requirements, current work health and safety controls/applications and past occupational accidents and occupational illnesses are determined in our company.

4.2.2.2 Work Health and Work Safety Management System Development Plan

Parties and assistant units are formed to organize work health and work safety management system service. Timetables are prepared to use the time efficiently and to determine the responsibilities and topics. This plan has been revised and updated, if necessary.

4.2.2.3 Training

Danger symbols are explained to workers in trainings. With the help of information in the MSDS, topics like storage and storage conditions of chemicals, personal protectors that applicators use, and preparedness for emergency action are explained to all the workers. Trainings about specific chemicals are especially explained to applicators and their supervisors. To see symbols and their meanings, danger symbols and signs, and material safety data sheet, please look at appendix 1, appendix 3, and appendix 6.

The effectiveness of trainings is evaluated with assessment and evaluation exams and the missing information are given through additional trainings. Work health and work safety management system is introduced to key workers in the suitable positions. Instead of giving all the details to all the workers, responsibilities and authorizations, suitable detail and content are introduced. Only in this way our current sources (trainers, trainees and corresponding cost) are used efficiently and no one is drowned in the unnecessary details.

4.2.2.4 Building Work Health and Work Safety Management System

Practical applications about this topic are generally make us to form work groups according to the wealth of the company. With the leadership of these groups, risk evaluation method and dangers that cannot be tolerated in some cases are determined. Politics that address the company's risk about work health and work safety is created by the top management. A work health and safety management programme is prepared for the risks that are in unacceptable level. Working methods to control these dangers are determined. Possible emergency situations, precautions and the things that will be done in such cases are determined. Emergency situation procedures and plans are prepared. Work health and work safety performance parameters are determined.

4.2.2.5 Implementation of Inner Surveys

After the decision is given about the completion of work health and work safety management system creation, inner surveys are made in order to test if subsystems are working correctly, to test their harmony, and to control their effectiveness. Nonconformities/The things which are open to improvement are re-handled and re-evaluated within a plan.

4.2.2.6 Revision

Top management have revised inner surveys, goals, corrective/preventive actions, processes and their performance, customer complaints and their satisfaction, and source necessities. They also provided the effectiveness and consistency of the system.

4.2.2.7 Application for Certification

Application for certification is made to the corresponding institute by our company when these performances are thought to be completed.

4.2.3 Annual Work Safety Report: Period of 01 January 2008 – 31 December 2008

4.2.3.1 Occupational Accident According to Injury Types in Our Company

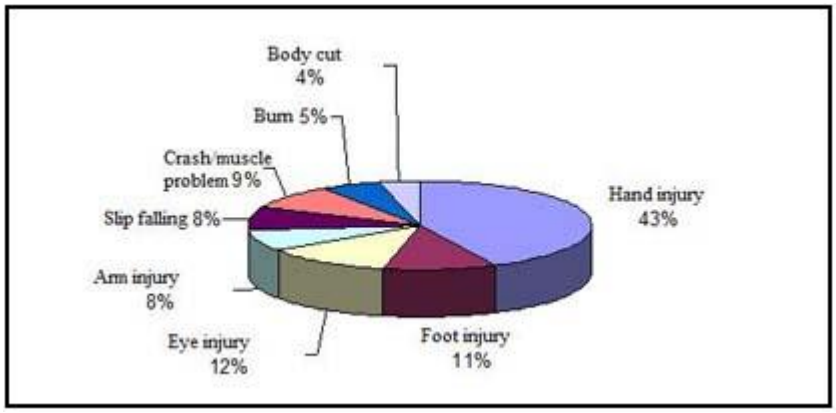

Figure 4.6 Occupational Accident According to Injury Types in Our Company.

Most accidents are hand injuries, eye injuries and foot injuries. Special scissors are purchased to cut resin hoses in order to reduce the hand injuries. Nevertheless, our employees sometimes forget using scissors and cut with curved knife and therefore cause some accidents. Also, some injuries happened as a result of crash and friction because of not using gloves in different hand works.

Eye injuries are caused by not wearing goggles or not properly wearing goggles. In work health and safety training, workers are given necessary training about wearing personal goggles accurately and necessary warnings are made in factory controls.

Foot injuries and slide downs are caused by stressful working and workplace disorganization. In order to minimize this, “5 S + Safety” trainings started and our goal in is to implement this in the year 2009.

4.2.3.2 Occupational Accident According to Months in Our Company

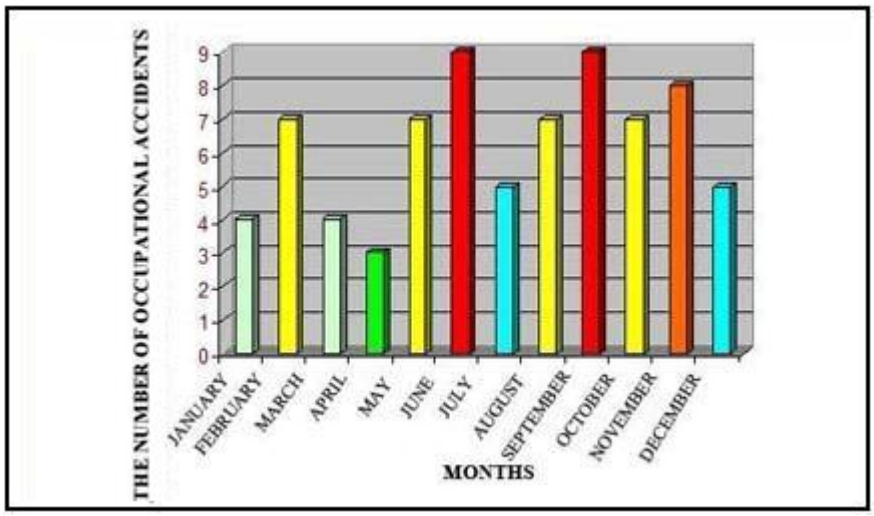

Figure 4.7 Occupational Accident According to Months in Our Company.

Unfortunately, in the major part of the year, the number of occupational accidents is high. There is a decrease in April. With the warming weather, there have been nine occupational accidents in our company because of distractibility.

Also, in September, concentration has been given to the new model wing production and as a result there have been occupational accidents in the adaption period. After the new moulds arrived, employees in this department are provided with the necessary training.

Table 4.1 The following table shows the number of occupational incidents according to the months.

Months	The Number of Occupational Accidents
January	4
February	**7**
March	4
April	3
May	7
June	9
July	5
August	7
September	9
October	7
November	8
December	5

4.2.3.3 Occupational Accident Incidences

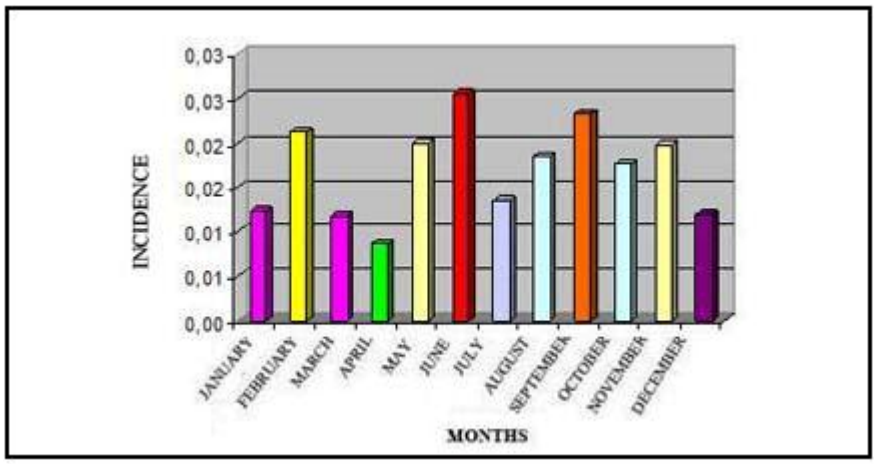

Figure 4.8 Occupational Accident Incidences in Our Company.

As the number of occupational accidents is high in June and September, accordingly the number of our incidents is high, too.

Incidence Calculation: The Number of Occupational Accidents / (The Number of Personals).

4.2.3.4 Occupational Accident According to Departments in Our Company

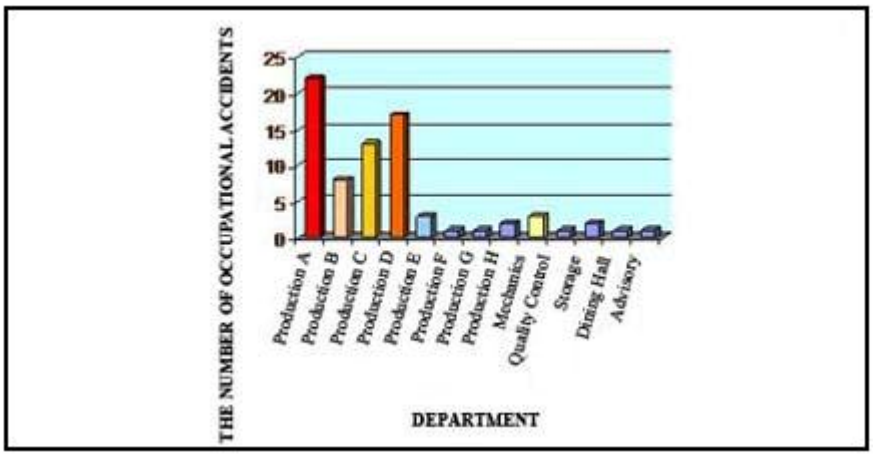

Figure 4.9 Production A department has the most accidents. Responsible people of this department should concentrate on this and make the necessary studies.

Table 4.2 The following table shows the number of occupational accidents according to the departments.

Departments	**The Number of Occupational Accidents**
Department A	22
Department D	17
Department C	13
Department B	8
Department E	3
Mechanics	3
Storage-Logistics	2
Department F	2
Others	1

4.2.3.5 Occupational Accident Range of Department A

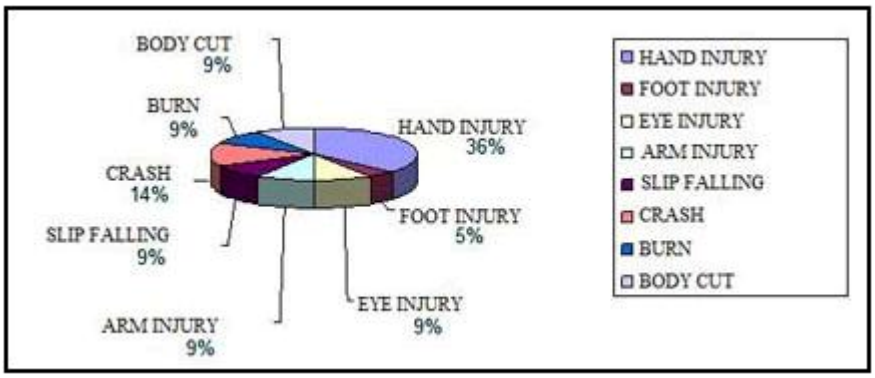

Figure 4.10 Major part of occupational accidents in this department took place in accordance with traumas caused by hand injury and crash or slip downs. With the arrival of new moulds, any probability of accident, during the process of plugging in and out of the hot water hoses, has been eliminated.

Production A needs a serious recovery process. All the corrections must be completed by collaborating with the responsible engineer.

Table 4.3 The following table shows the number of occupational accidents in Department A according to the injury type.

Hand injury	**8**
Slipping down and crash	**2+3=5**
Arm and foot injury	**2+1=3**
Burning	**2**
Eye injury	**2**
Body cut	**2**

4.2.3.6 Occupational Accident Range of Department D

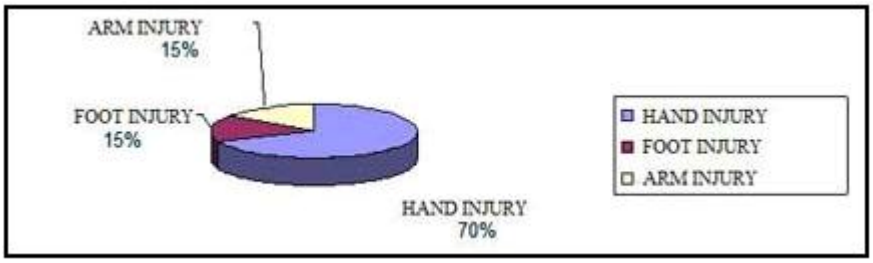

Figure 4.11 Hand injuries and foot injuries caused by slip downs constitute the major part of occupational accidents in Department D.

In order to minimize the hand injuries, working without gloves in dado cut process is prohibited and post processors are warned about the dangers.

Table 4.4 The following table shows the number of occupational accidents in Department D according to the injury type.

Hand injury	**9**
Foot injury	**2**
Arm injury	**2**

4.2.3.7 Occupational Accident Range of Department C

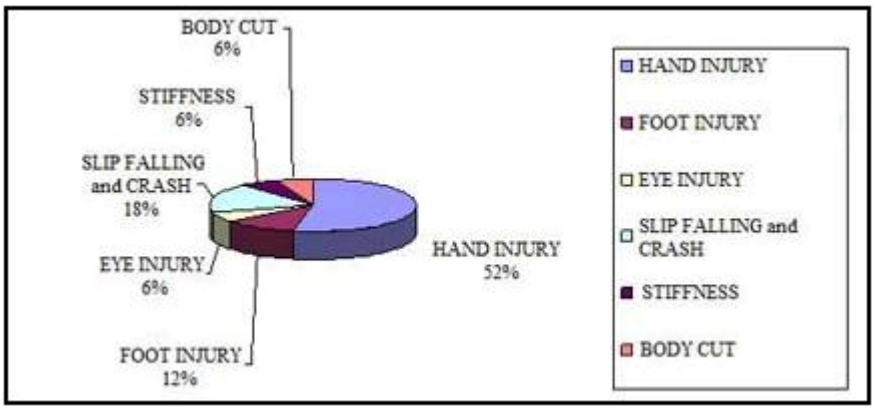

Figure 4.12 Department C is one of the most dangerous departments as it includes repair, montage of hand lamination, backplate and aluminum. Hand cuts are very probable during the montage of particles. Therefore, wearing protective gloves against hand and finger cuts are extremely important. Responsible people should always be warned about this danger.

Table 4.5 The following table shows the number of occupational accidents in Department C according to the injury type.

Hand injury	**9**
Slip downs and crash	**3**
Foot injury	**2**
Eye injury	**1**
Stiffness	**1**
Body cut	**1**

4.2.3.8 Occupational Accident Range of Department B

Figure 4.13 Resin hoses are cut by scissors instead of curved knives in order to prevent hand injury. Also, check valves are bound to hot water hoses in order to prevent the recurrence of burns caused by hot water.

Table 4.6 The following table shows the number of occupational accidents in Department B according to the injury type.

Hand injury	**3**
Eye injury	**2**
Foot injury	**1**
Crash	**1**
Burn	**1**

4.2.3.9 Analyzing the Results

Table 4.7 The following table shows the number of occupational accidents and wasted days according to year 2007 and 2008.

Year 2007		**Year 2008**	
The Number of Occupational Accidents	Wasted Days	The Number of Occupational Accidents	Wasted Days
79	502	75	472

There is a 5.1 % fall in occupational accidents and a 5.9 % fall in the wasted days. After we started OHSAS 18001 studies, we see that we achieved the aimed 5 % decrease with 2008 annual reports.

These studies both bring prestige to the organizations and enable us to see the improvements mathematically. In addition, workers' motivation increases and accordingly work efficiency and quality increase. Workplaces become more peaceful and efficient, and working hours are used more efficiently.

As a result, in order to prevent occupational accidents, improve mechanical and technological conditions, and eliminate any serious accident factors, we meet on the basis of departments, make situation assessment, and perform the necessary improvements.

4.3 Planning

In this part, evaluation of compliance and legal and other requirements are going to be discussed and summarized under their own headlines. There are going to be brief information about each topic.

4.3.1 Evaluation of Compliance

Consistent with its commitment to compliance, the organization shall establish, implement and maintain a procedure(s) for periodically evaluating compliance with applicable legal requirements. The organization shall keep records of the results of the periodic evaluations. It is important that the frequency of periodic evaluation may vary for differing legal requirements. The organization shall evaluate compliance with other requirements to which it subscribes. It should be remembered that the frequency of periodic evaluation may vary for differing other requirements to which the organization subscribes.

4.3.2 Legal and Other Requirements

The organization shall establish and maintain a procedure for identifying and accessing the legal and other OH&S requirements that are applicable to it. The organization shall keep this information up-to-date. It shall communicate relevant information on legal and other requirements to its employees and other relevant interested parties.

The organization needs to identify the legal requirements that are applicable to its environmental aspects. These may include: national and international legal requirements; state/provincial/departmental legal requirements; local governmental legal requirements.

Examples of other requirements to which the organization may subscribe include, if applicable: agreements with public authorities; agreements with customers; non-regulatory guidelines; voluntary principles codes of practice; voluntary environmental labeling or product stewardship commitments; requirements of trade associations; agreements with community groups or non-governmental organizations; public commitments of the organization or its parent organization; and corporate/company requirements.

The determination of how legal and other requirements apply to an organization's environmental aspects is usually accomplished in the process of identifying these requirements. It may not be necessary, therefore, to have a separate or additional procedure in order to make this determination.

4.4 Waste Control

Under this headline, there are going to be summaries of solid waste control and hazardous waste control types. Each topic is going to be discussed briefly.

4.4.1 Solid Waste Control

Package wastes are separated into two categories. Hazardous wastes which are contaminated with hazardous contaminants are sent to recycling firms that have the license for taking wastes which are contaminated with hazardous contaminants, and also clean package wastes which are not contaminated are sent to licensed recycling firms.

Solid wastes can be separated into three categories. First category is resins and this category generally includes epoxies, polyesters, vinylesters, phenolics, polyimides, cyanate, esters, and bismaleimides. The second category is fibers and any conventional fabrics can be included in this category. The third category is cores which includes any solid materials. Other solid wastes can be enumerated like metal scraps, plastics, papers, glasses, lamps that contain mercury vapor, sodium and fluorescent, plastic containers, etc.

Below figures can be good illustrations of solid wastes.

Figure 4.14 Waste hose not contaminated by resin.

Figure 4.15 Folio not contaminated by resin or dye.

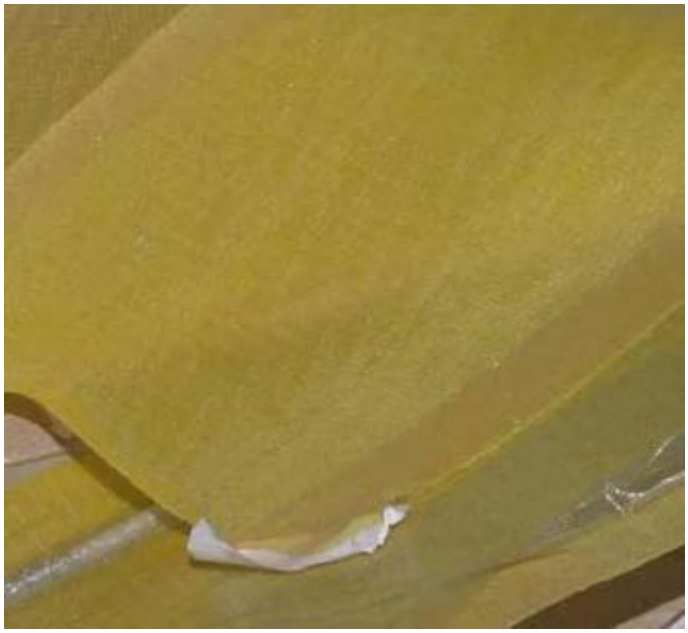

Figure 4.16 Dry waste – Catalyzer.

Figure 4.17 Nonhazardous dry waste.

Figure 4.18 Paper package waste. This should be collected separately and added to other wastes.

Figure 4.19 Nonhazardous package waste. They should be collected separately because they are hard to compress as they are hard and in cylinder shape.

4.4.2 Hazardous Waste Control

Many substances that are used regularly at work will contain chemicals, which if not handled correctly can cause harm. These substances can be solids or liquids and include paints, varnishes, glues, printing inks, cleaning fluids, fuels, fertilizers, feed additives and pesticides as well as the substances that are used in the more established chemical factories. This part gives advice on how these chemicals can be safely handled providing the material supplied has been classified and has the classification on the product label or safety data sheet. The procedures in this part does not generally apply to process generated dusts and fumes as these are not classified, although many of the solutions described in the toolkit can be successfully be used to control these problems.

Within any population there will be susceptible groups of individuals such as children or pregnant women who may require additional protection when exposed to specific hazardous materials. For these susceptible groups a more precautionary approach may be prudent and contact with hazardous substance of concern should either be avoided or a greater degree of control provided.

There are five stages have to be followed. (a) Find the hazard classification and match it to a hazard group using the table supplied. (b) Find out how much of the substance you are going to use. (c) Find out how much of the substance is going to get into the air. (d) Find the control approach. (e) Find the task-specific control guidance sheet(s).

Different substances can harm you in different ways, and some are more poisonous or can cause more harm than others. For example, some substances will only cause minor irritation to your eyes or throat, whilst other substances can make it more difficult to breathe or can kill you. Some effects will be obvious straight away, whilst other effects will take many years to appear. It is important that all these effects are controlled, but substances which can cause more serious effects will need a greater degree of control than less harmful substances.

Substances are placed into six different groups. Five groups, from group A to group E tell you how dangerous it is to breathe the substance in. Group A is the safest and group E the most dangerous. The sixth group, group S tells you if it is dangerous to get the substance on the skin or in your eyes.

Below figures can be good illustrations of hazardous wastes.

Figure 4.20 Big bags for dust cleaning. The personnel who use this kind of cleaning bag should wear tyvek workwear, dust mask, and gloves.

Figure 4.21 Fabrics contaminated by waste dust. Theses cannot be disposed with wastes that are contaminated by dye and gelcoat.

Figure 4.22 Waste organic dissolvent, hazardous waste. They cannot be drained into sewer or rain drainage system. After being dumped into the described barrels, waste organic dissolvent barrels should be removed to the place where dye barrels are disposed. After being distilled with the distilling machine, which is purchased in waste minimization plan, waste organic dissolvent can be used in cleaning especially in maintenance department.

Figure 4.23 Waste glass fabric. It should be collected separately and must not be mixed with other wastes.

4.5 Checking and Corrective Action

Monitoring and measurement, control of records, and auditing topics are going to be summarized and discussed briefly through this part. Each headline is going to be handled separately. Practices of preventive and corrective actions are shown in the appendix 7

4.5.1 Monitoring and Measurement

The operations of an organization can have a variety of characteristics. For example, characteristics related to monitoring and measurement of wastewater discharge may include biological and chemical oxygen demand, temperature and acidity.

Data collected from monitoring and measurement can be analyzed to identify patters and obtain information. Knowledge gained from this information can be used to implement corrective and preventive action.

Key characteristics are those that the organization needs to consider to determine how it is managing its significant environmental aspects, achieving objectives and improving environmental performance.

When necessary to ensure valid results, measuring equipment should be calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards. If no such standards exist, the basic used for calibration should be recorded.

4.5.2 Control of Records

The organization shall establish and maintain records as necessary to demonstrate conformity to the requirements of its environmental management system and of this Internal Standard, and the results achieved. The organization shall establish, implement and maintain a procedure for the identification, storage, protection, retrieval, retention and disposal of records. Records shall be and remain legible, identifiable and traceable.

4.5.3 Auditing

The organization shall establish and maintain an audit programme and procedures for periodic OH&S management system audits to be carried out, in order to:

a) Determine whether or not the OH&S management system

- Conforms to planned arrangements for OH&S management including the requirements of this OHSAS specification;
- Has been properly implemented and maintained; and
- Is effective in meeting organization’s policy and objectives;

b) Review the results of previous audits;

c) Provide information on the results of audit to management.

The audit programme, including any schedule, shall be based on the results of risk assessments of the organization's activities, and the results of previous audits. The audit procedures shall cover the scope, frequency, methodologies and competencies, as well as the responsibilities and requirements for conducting audits and reporting results. Wherever possible, audits shall be conducted by personnel independent of those having direct responsibility for the activity being examined. Selection of auditors and conduct of audits shall sure objectivity and the impartiality of the audit process.

4.6 Confined Space Management Plan

Before work is undertaken, potential hazards associated with all confined spaces located on UQ properties should be identified by a risk assessment. The results should be recorded and form the basis of the confined spaces register for future reference. The assessment should look at the following areas: (a) hazards within the space e.g. contaminants, heat, electrical, radiation, sparks; (b) work required to be done within the space, including whether it is necessary to enter; (c) the range of methods by which the work can be done; (e) equipment required and the hazards associated with these e.g. welding in a flammable atmosphere can be hazardous; (f) emergency and rescue procedures; (g) number of persons required to enter space, and number required outside space to maintain equipment essential for work in the confined space and communicate with those inside; (h) the identity and nature of the substances last contained in the confined space; (i) the atmospheric testing to be undertaken and the parameters to be tested before entry permit is issued; (j) the availability and adequacy of personal protective equipment; (k) whether cleaning of the confined space is necessary; (l) whether hot work is to be conducted within the space; (m) whether certain activities, equipment or substances should be prohibited from the area e.g. naked flames, combustion sources; and (n) class of confined space.

Risk assessments should be kept for up to five years in accordance with statutory requirements.

For such confined spaces, a single hazard identification and risk assessment can be carried on a single or representative sample of the similar confined spaces. These generic risk assessments save time and avoid unnecessary duplication of the identification and risk assessment process. Where there are any differences in the circumstances, such as the environment of the confined space or the work performed in it, which could result in a different risk this generic procedure may not be appropriate.

CHAPTER FIVE
CONCLUSION

5.1 Conclusion

The thesis gives information about how an organization can provide healthy and safe workplaces for its employees. In the case study chapter of this thesis, examples from different countries are given to show how ISO 14001 and OHSAS 18001 standards are implemented in different countries across the globe.

Under the title of vacuum process management, we gave detailed information about infusion method to show process management and chemical utilization. Because there is no obvious chemical application, we preferred to explain this method of process management. In addition, instead of vinyl polyester, we preferred to exemplify resins and hardeners in order to provide the utilization of chemical that has lower risk factors.

In order for the managements to support these studies and provide financial aid, both customer's demands and the employer's income should be increased numerically. The more good samples of application increase, the more gladness of workers increase, too, and as the loss of workforce will decrease the employers will support these studies and provide the necessary sources.

We tried to show good examples of applications which are corresponding with work health and safety standards, i.e. ISO 14001 and OHSAS 18001. When applied, these standards are likely to lower the costs that are caused by occupational accidents and occupational illnesses. This means that both employees and employers are going to benefit from these standards. Also, the productivity and quality of the workers are going to be in higher rate because they are going to work in peaceful and safe working places.

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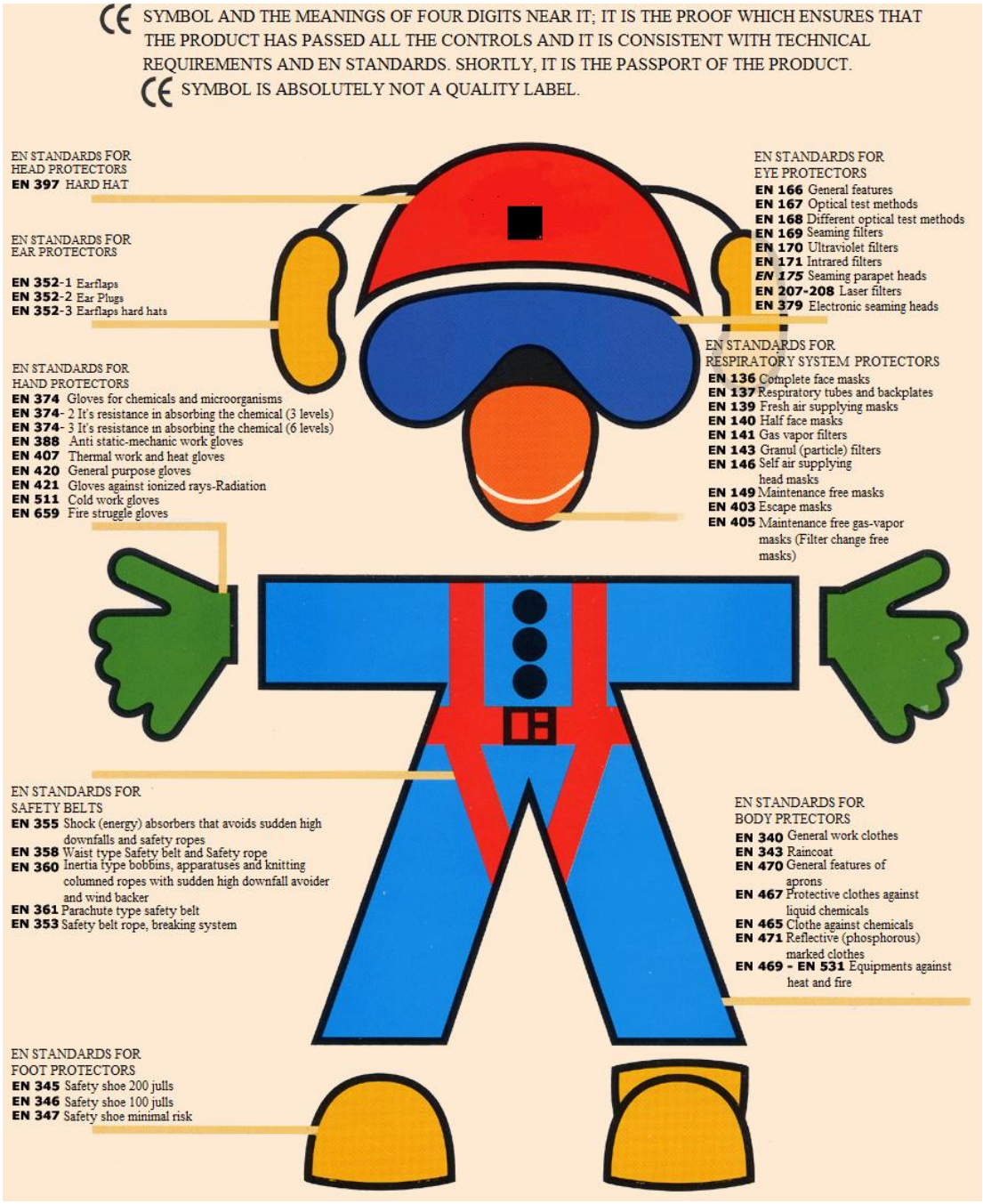
APPENDIXES

Appendix 1. Symbols and their meanings.



Appendix 2. The risk assessment sheet.

Risk Assessment Sheet

Date:_____ Card No.: _____

Company name and address

Risk assessment undertaken by:

Workplace:

Name of employee:

No.	Hazard	Preventive/Protective Measures Used	Risk Estimation / Evaluation	Actions Planned to Reduce Risk
1	2	3	4	5

Signature[s] of people carrying out risk assessment

Signature[s] of people working at the workplace

Appendix 3. Danger symbols and signs.

DANGER CHARACTERISTIC	SIGN	SYMBOL (Black pres over orange ground)
EXPLOSIVE	E	
OXIDIZING	O	
FLAMMABLE	F	
HIGHLY FLAMMABLE	F+	
TOXIC	T	
HIGHLY TOXIC	T+	

CORROSICVE	C	
HARMFUL	Xn	
IRRITANT	Xi	
SENSITIZING Sensitizing through aspiration	Xn	
SENSITIZING Sensitizing through skin contact	Xi	
CARCINOGENIC Category 1 and 2	T	
CARCINOGENIC Category 3	Xn	

MUTAGEN Category 1 and 2	T	
MUTAGEN Category 3	Xn	
TOXIC FOR REPRODUCTİVE SYSTEM Category 1 and 2	T	
TOXIC FOR REPRODUCTİVE SYSTEM Category 3	Xn	
DANGEROUS FOR ENVIRONMENT	N	

Appendix 4. Danger / determination and risk evaluation table.

LOGO					DANGER / DETERMINATION and RISK EVALUATION TABLE								
MAIN PROCESS					PERSON IN CHARGE OF OPERATION						DATE		
SUBPROCESS											REVISION		
	DETERINATION OF DANGERS					**RISK EVALUATION**							
LINE NO	**PROCESS STEP**	**DANGER**	**DANGER SOURCE**	**EFFECT**	**AFFECTED PEOPLE**	**NUMBER OF AFFECTED (People)**	**POSSIBLE REASON**	**STRENGTH OF THE HARM**	**RİSK SCORE**	**RESULT**	**CURRENT PROTECTIVE PRECAUTIONS**	**ADDITIONAL PROTECTIVE PRECAUTIONS NEEDED**	**LEGAL RESPONSIBILITIES**

Appendix 5. General risk evaluation sample form.

GENERAL RISK EVALUTION SAMPLE FORM

Risk Evaluation No:					
Date:					
Employer:					
Work Address:					
What is the work? (Explain briefly.)					
Number of Employees:	Male	Female	Child	Apprentice	Student

What is the aim of risk evaluation?		
1.	There have never been a risk evaluation before	
2.	A new machine or equipment is purchased	
3.	Changes made in work organization and work flow	
4.	Entering the process of producing new raw materials and semi-finished materials	
5.	A new legislation goes in effect or change is made in the existing legislation	
6.	Development of new techniques	
7.	Occurrence of occupational accident or occupational illness	
8.	Occurrence of event like fire, flaming and explosion which affect the work place health and safety even if it does not end in occupational accident or occupational illness	
9.	Others (Explain.)	

INFORMATION AND DATA COLLECTION	
Works done and the duration and frequency of these works	
Received Education (like ISO 9000, 14000, 18000, 17025 and 45000 series)	
Which prior authorizations are necessary for the performance of the work?	1- 2- 3- 4-
Machine and equipment used during the procession of the work	1- 2- 3- 4-
Instruction manual of these machine and equipments	1- 2- 3-
Materials to be removed or moved	1- 2- 3-
Chemicals which are used	1- 2- 3-
Others (Explain.)	

Occupational accidents and occupational illnesses which occurred in the last 5 years

Occupational Accidents			Occupational Illnesses		
Date	Death	Injury	Date	Death	Injury

EVALUATION OF THE FOLLOWING TABLES ARE NOT COMPULSORY, IT IS UNDER THE INITIATIVE OF THE EMPLOYER

ADDITIONAL TABLE I
(POSSIBILITY OF THE OCCURANCE OF A KNOWN DANGEROUS EVENT)

Nearly certain (It is expected strongly in many situations)	
Probably (It will possibly occur in many situations)	
Possible (It is sometimes expected to occur)	
Improbable (It is minimal chance to occur)	
Scarcely (It occurs only in exceptional circumstances)	

ADDITIONAL TABLE II
(THE STRENGTH OF DAMAGE, HARM AND INJURY WHICH ARE CAUSED BY THE RESULTS OF THE DANGEROUS INCIDENT)

Unimportant (No injury, low financial loss)	
Low (It requires first aid treatment and quick removal from the place of incident, medium financial loss)	
Medium (It requires medical treatment and removal from the place of incident with external help, high financial loss)	
High (Heavy injury, loss of production skills and it requires to be removed from the place of incident)	
Very high (Death, it requires to be removed from the place of incident, very high financial loss)	

ADDITIONAL TABLE III
(SIGNIFICANCE RATIO OF THE RISKS)

Probability	Strength of Damage				
	Unimportant	**Low**	**Medium**	**High**	**Very high**
Nearly certain	Y	Y	A	A	A
Probable	O	Y	Y	A	A
Possible	D	O	Y	A	A
Improbable	D	D	O	Y	A
Scarcely	D	D	O	Y	Y

Significance Ratio of the Risks (Conclusion) :

A: Very High Risk; It requires immediate response

Y: High Risk; Attention of the top management is compulsory

O: Medium Risk; Responsibility of the management should be clearly assigned

D: Low Risk; It should be managed by the routine procedures

Attention: The work should not be resumed if the risk strength ratio is still high or very high as a result of the precautions.

WHAT ARE THE CURRENT DANGERS?

1.	Falling because of slipping, trip, etc.		16.	Illumination	
2.	Falling off		17.	Working with screened equipments	
3.	Falling of the objects		18.	Main comfort circumstances (Heat, moisture and air-conditioning)	
4.	Loud noise and vibration		19.	Chemical factors (Toxic gas and vapors, organic solvents and dusts)	
5.	Inappropriate posture and working styles		20.	Biological agents (Microorganisms, bacteria, virus)	
6.	Radiation and ultraviolet rays		21.	Routine working	
7.	Utilization of the mobile hand equipments		22.	Workplace settlement plan	
8.	Utilization of static machines and stalls		23.	Work stress	
9.	Mobile reaching equipments (ladders, platforms)		24.	Working indoors	
10.	Mechanic lifting equipments		25.	Working alone	
11.	Products, emissions and wastes		26.	Utilization of motored equipments, logistics and roads	
12.	Fire, flame and explosion		27.	Working on or near the water	
13.	Hand carrying works		28.	Exposure to violence or abuse	
14.	Electric equipments		29.	Unwanted human behaviors (carelessness, tiredness, indifference, acatalepsy, anger, fight)	
15.	Compressive pots		30.	Other danger sources according to workplace circumstances	

Danger No.	Current Dangers	Current Control Precautions	Risk Evaluation Result			Additional Precautions to be Taken
			Strength Damage, Harm or Injury	Possibility of the occurrence of the dangerous incident	Importance of the Risk (R=ŞxO)	

People's or person's, who make the evalution,					
Name Surname		Occupation	Title	Signature	Date
1.					
2.					
3.					

People' or person's, who audits,					
Name Surname		Occupation	Title	Signature	Date
1.					

Who are the ones that are exposed to danger?	
1. Academic personel	
2. Maintenance personel	
3. Contractors (Vendors)	
4. Technical personel	
5. Bureau personel	
6. Auditing personel	
7. Visitors	
8. Cleaning personel	
9. Emergency situation personel	
10. Others (People who have special medical disturbances, disabled people, people who have recently begun working, children, apprentices, etc.)	

What are the current control precautions? **(The list of all the present and undertaken control precautions)**	
1. Local airconditioning	
2. Machine protectors	
3. Utilization of the personel protectors	
4. Protectors against fire	
5. Current emergency situation processions	
6. Others (Explain.)	

What are the required additional precautions to minimize the risks?	
1. Trying to eradicate the risks in their sources	
2. Changing the dangerous with the less dangerous one	
3. Preferring collective protection precautions to the personal protection precautions	
4. Taking engineering precautions	
5. Utilizing the ergonomic approaches	
6. Others (Explain.)	

Appendix 6. Material safety data sheet.

MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

PRODUCT NAME:
OTHER NAMES:
USE:
SUPPLIER NAME:
ADDRESS:
TELEPHONE: GENERAL ENQUIRIES:
CUSTOMER SERVICE:
FAX: GENERAL ENQUIRIES:
CUSTOMER SERVICE:
EMERGENCY TELEPHONE NUMBER:
COUNTRY: …… (ALL HOURS)
INTERNATIONAL: …… (ALL HOURS)

2. HAZARDS IDENTIFICATION

HAZARD CLASSIFICATION:
HAZARD CATEGORY:
RISK PHRASES:

SAFETY PHRASES:

The information contained in this MSDS is specific to the product when handled and used neat. This product when diluted may not require the same control measures as the neat product. Check with your technical representative if in doubt.

3. COMPOSITION / INFORMATION ON INGREDIENTS

INGREDIENT CAS No.
PROPORTION (% w/w)

*The ingredients below are considered either **hazardous, dangerous goods or poison scheduled** according to the criteria of NOHSC, ADG Code and SUSDP (respectively) at the levels used in the product.*

MATERIAL SAFETY DATA SHEET

4. FIRST AID MEASURES

INGESTION:

EYE CONTACT:

SKIN CONTACT:

INHALATION:

FIRST AID FACILITIES:
NOTES TO PHYSICIAN:

5. FIRE FIGHTING METHODS

SUITABLE EXTINGUISHING MEDIA:
HAZARDS FROM COMBUSTION:

PRECAUTIONS FOR FIRE FIGHTERS AND
SPECIAL PROTECTIVE EQUIPMENT:

HAZCHEM CODE:

6. ACCIDENTAL RELEASE MEASURES

EMERGENCY PROCEDURES:

METHODS AND MATERIALS
FOR CONTAINMENT AND
CLEAN UP:

7. HANDLING AND STORAGE

PRECAUTIONS FOR SAFE HANDLING:

CONDITIONS FOR SAFE STORAGE:

MATERIAL SAFETY DATA SHEET

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

NATIONAL EXPOSURE STANDARDS:

BIOLOGICAL LIMIT VALUES:
ENGINEERING CONTROLS:

PERSONAL PROTECTIVE EQUIPMENT:

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE:
ODOUR:
PH (NEAT):
SPECIFIC GRAVITY OR DENSITY:
VAPOUR PRESSURE:
PERCENT VOLATILES:
BOILING POINT / RANGE:
FREEZING / MELTING POINT:
SOLUBILITY:
FLASH POINT:
FLAMMABILITY LIMITS:
IGNITION TEMPERATURE:
SHELF LIFE:
OTHER:

10. STABILITY AND REACTIVITY

CHEMICAL STABILITY:
CONDITIONS TO AVOID:

INCOMPATIBLE MATERIALS:
HAZARDOUS DECOMPOSITION PRODUCTS:
HAZARDOUS REACTIONS:

11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

ACUTE EFFECTS INGESTION:
EYE CONTACT:
SKIN CONTACT:
INHALATION:
LONG TERM EFFECTS:
ACUTE TOXICITY / CHRONIC TOXICITY:

MATERIAL SAFETY DATA SHEET

12. ECOLOGICAL INFORMATION

ECOTOXICITY:

PERSISTENCE AND DEGRADABILITY:
MOBILITY:
OTHER:

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHODS:

SPECIAL PRECAUTIONS FOR LANDFILL OR INCINERATION:

14. TRANSPORT INFORMATION

ROAD AND RAIL TRANSPORT:

UN NUMBER:
UN PROPER SHIPPING NAME:
CLASS AND SUBSIDIARY RISK(S):
PACKAGING GROUP:
HAZCHEM CODE:
INITIAL EMERGENCY RESPONSE GUIDE:
SEGREGATION DANGEROUS GOODS:

MARINE TRANSPORT:

UN NUMBER:
UN PROPER SHIPPING NAME:
CLASS AND SUBSIDIARY RISK(S):
PACKAGING GROUP:
STOWAGE AND SEGREGATION:

AIR TRANSPORT:

UN NUMBER:
UN PROPER SHIPPING NAME:
CLASS AND SUBSIDIARY RISK(S):
PACKAGING GROUP:
ERG CODE:

15. REGULATORY INFORMATION

POISONS SCHEDULE (AUST.):
APVMA STATUS:
TGA STATUS:
AICS STATUS:
AQIS STATUS:
OTHER:

MATERIAL SAFETY DATA SHEET

16. OTHER INFORMATION

GENERAL INFORMATION:
MSDS ISSUE NUMBER:
MSDS ISSUE DATE:
In any event, the review and, if necessary, the re-issue of a MSDS shall be no longer than 5 years after the last date of issue.
REASON(S) FOR ISSUE: Update to conform to requirements of NOHSC:2011(2003); 16-header format.

THIS ISSUE NUMBER REPLACES ALL PREVIOUS ISSUES.

LITERARY REFERENCE:
SOURCES FOR DATA:

LEGEND:

AICS	Australian Inventory of Chemical Substances
APVMA	Australian Pesticides and Veterinary Medicines Authority
AQIS	Australian Quarantine and Inspection Service
AS	Australian Standard (as issued by Standards Australia)
ERP Code	Emergency Response Drill Code as found in the ICAO (International Civil Aviation Organisation) Doc 9481
MSDS	Material Safety Data Sheet
NOHSC	National Occupational Health and Safety Commission
STEL	Short Term Exposure Limit - A 15 minute TWA exposure which should not be exceeded at any time during a working day even if the eight-hour TWA average is within the TWA exposure standard. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than four times per day. There should be at least 60 minutes between successive exposures at the STEL.
TGA	Therapeutic Goods Administration
TLV	Threshold Limit Value - TLV is a proprietary name registered by the American Conference of Governmental Industrial Hygienists (ACGIH) and refers to airborne concentrations of substances or levels of physical agents to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect.
TWA	Time Weighted Average - The average airborne concentration of a particular substance when calculated over a normal eight-hour working day, for a five-day working week.

This MSDS has been prepared from current technical data and summarizes at the date of issue our best knowledge of the health and safety information of the product, and in particular how to safely handle and use the product in the workplace.
If clarification or further information is needed to ensure that an appropriate assessment can be made, the user should contact this company. Our responsibility for products sold is subject to our standard terms and conditions, a copy of which is sent to our customers and is also available upon request.
This MSDS may only be reproduced in full. Summaries or excerpts from this MSDS may not contain all the relevant information and thus are not permitted.

End of MSDS

Appendix 7. Topics and results. Continual improvement studies are made and corresponding checking and corrective action forms are created.

No	Topic	Start Date	Result	Due Date
1	Creating the system that prevents breda door from opening when using the emergency exit doors over the breda doors.	19.11.2008	Photo cell sensors have been assembled to both breda doors.	26.11.2008
2	Preparing proper cabinet for the grinding process during assessment.	06.10.2008	In order to prevent dust, mobile cabinet has been prepared.	14.10.2008
3	Placing the electrical cables of the fabric cutting department into the rail system.	13.10.2008	Rail system is created and cables are removed from the floor.	27.10.2008
4	Air conditioning the new preform area by using the current system.	26.08.2008	Basin of the corresponding line has been completed.	05.11.2008
5	Building preservation in order to prevent the materials from falling onto the steel shelves of the store which sidecast to the preform department.	21.07.2008	Necessary steel protection barriers have been assembled.	18.08.2008
6	Repairing the broken emergency exit doors.	21.07.2008	Repairing is completed.	30.08.2008
7	Repairing the break system of the ladders and tables which are on the production section.	09.06.2008	Rollers of the corresponding ladders and tables have been replaced.	28.07.2008
8	Covering the place which sidecast to the storage section of the entresol in order to prevent materials from falling.	05.05.2008	That section of the entresol which sidecasts to the storage has been covered with plyboard.	12.05.2008
9	Repairing the break systems of the ladders and tables which are in the production section.	06.05.2008	Rollers of the corresponding ladders and tables have been replaced.	09.05.2008
10	Redrawing the emergency exit ways in the factory according to the new order.	24.03.2008	Emergency exit ways have been redrawn according to the new order.	29.03.2008
11	Preparing suitable waste dumping mechanism near the sandblasting machine in order to collect the waste dust of the sandblasting machine.	28.03.2008	A suitable carriage has been prepared for the big bags and placed near the sandblasting machine.	18.04.2008
12	Renewing the emergency exit ways according to the new settlement.	16.02.2008	Emergency exit ways are updated and painted. Old road lines have been erased.	06.03.2009
13	There is a need for expanding the waste area.	09.01.2008	It is provided to expand the waste area by classification and wastes can now be separated conveniently.	02.03.2009

Necessary improvements have been completed with the checking and corrective actions.