A STUDY OF THE METHODOLOGIES USED BY ORGANISATIONS IN DETERMINING THEIR SIGNIFICANT IMPACTS IN THE CONTEXT OF ISO 14001, CLAUSE 4.3.1

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Abstract

This paper examines the methodologies used in the review of environmental aspects and the identification of significant impacts in the context of ISO 14001, Clause 4.3.1. The sources used are both published works and examples from organisations that have implemented ISO 14001.

An outline methodology is proposed with guidance on implementation. The final method of implementation is left to the organisation since each must select a way that meets the demands and complexities of their business. The guidance does cover the essentials that a registrar would need to witness before an organisation is registered to ISO 14001.

The steps advocated are:

1. Data gathering (using checklists and other records)
   a) Scoping
   b) Detailed data collection
2. Analysis (using scoring systems, eFMEA or thresholds)
3. Assignment of 'significance'

The paper recommends that 'significance' be assigned based on three criteria:

1. Legal or regulatory requirement (ISO 14001 Clause 4.3.2)
2. Severity of actual or potential environmental effect
3. Management issues (training, incidents, handling, stakeholder opinions etc.)

An impact that is significant because of its 'legal', 'severity' or 'management' status must have operating procedures associated with the aspect (Clause 4.4.6). All significant impacts should be used as an input to the process of continuous improvement (objectives and targets). The permutation of 'severity' and 'management' criteria may have value in assigning priority to improvement projects

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My particular thanks is extended to the companies who have assisted by providing information to this study. Because of their openness and willingness to help in this study, their contribution, by necessity, must remain anonymous. However, it is acknowledged that the examples cited in this study have been created by dedicated teams and individuals who have worked to understand and apply the requirements of the most challenging of ISO 14001's clauses.

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Introduction / 1

ISO 14001 is an international standard for environmental management systems (EMS) that has arisen from a combination of the success of ISO 9000, Quality Management System standard, and the awakening of the world's business and political communities to the need to demonstrate that action is being taken to limit the unbridled use and abuse of the world's environmental resources. ISO 14001 was introduced in 1996 as an international standard that could be adopted by organisations wishing to demonstrate a commitment to good environmental management and continual improvement.

The creation of an EMS for an organisation is not an easy process even if the organisation's activities are relatively benign; it is a greater challenge for organisations that have complex and extensive interactions with environmental systems. Although many requirements of an ISO 14001 system are similar to ISO 9000 (for example, document control, record keeping, internal audits, corrective action and training), the main workload is in the recognition of legal and regulatory obligations and in identifying the aspects of the organisation's operations which impact on the environment; particularly those which are significant.

Legal and regulatory obligations can be established through a thorough review of environmental, planning and development legislation. Quite often, the impact of legislation is evident through licences, leases and permits which specify levels of environmental performance. Once the relevant legislation has been identified, the level compliance can be established in an objective manner.

ISO 14001's most challenging clause is 4.3.1, Planning, Environmental Aspects and it is particularly important clause because it forms the basis of the whole EMS. Although the 'policy' is the driving force behind the environmental system, the review of the organisation's activities and interactions is the technical centrepiece of the management system

The challenge is to make the review of aspects and impacts as authoritative and complete as possible. The requirement to identify the 'significant' impacts has proved the most elusive of the quests; not because it is impossible, but because there is no defined methodology. The difficulties become most evident when the company decides to have

their ISO 14001 system assessed by the registrar of choice. At an assessment, all the decisions made, the methodology used and the data being examined have to be objectively reviewed to establish whether the organisation's system complies with the intent and requirements of ISO 14001. With so much left undefined in the standard, this area naturally becomes the focus of discussion and potential non-conformance.

This paper reviews published methodologies and requirements and, with the aid of examples of actual systems and the results of registration assessments, attempts to identify approaches which meet the requirements of a satisfactory ISO 14001 EMS in the most effective and practical manner. Whilst it may not be possible to recommend a single process which satisfies all organisations, it is hoped to develop guidance that can be helpful to organisations implementing ISO 14001. Such help should allow organisations to concentrate in the evaluation of their environmental aspects and impacts rather than the probity of their methodology for doing so.

An earlier MSc Thesis (Grimes, C. 1999) made a comprehensive review of methodologies that could be used to analyse and compare environmental aspects and impacts. The author concluded with a survey of Irish companies and their experiences and approaches to ISO 14001 implementation. Although this earlier work did not look at specific examples and techniques in use. it is the starting point for the present study. Some of the approaches discussed in the earlier thesis will be examined and developed further in the context of their practical use in the implementation of ISO 14001 Clause 4.3.1.

Background / 2

2.1 A Brief Historical Context for ISO 14001

The birth of ISO 14001 should be seen against a background of increased global concern for the environment. Although the "Earth Summit" in Rio de Janeiro (United Nations Summit in Rio de Janeiro) attracted a good share of world attention, other events around the same time are indicative of concerns and interests:

1969

- The National Environmental Pollution Act (NEPA): 1969. (USA)

1972

- First United Nations Conference on the Environment

1985

- European Union Directive on Environmental Impact Assessment (85/337/EEC)

1989

- Following the lead of Canada and the United States of America (USA), the Chemical Industry Association's members adopted the policy of Responsible Care©.

1990

- The Business Charter for Sustainable Development (BCSD) was created by an organisation of 50 business leaders with an interest in environment and development issues

International Chamber of Commerce (ICC) Business Charter for Sustainable Development contains 16 principles but, of these, the following are particularly relevant to an EMS:

3. Process Improvement
   To continue to improve policies, programmes and environmental performance, taking into account technical developments, scientific understanding, consumer needs and community expectations, with legal regulations as starting point; and to apply the environmental same criteria internationally.

5. Prior assessment

To assess environmental impacts before starting a new activity or project and before decommissioning a facility or leaving a site.

6. Products or services

To develop and provide products or services that have no undue environmental impact and are safe in their intended use, that are efficient in their consumption of energy and natural resources, and that can be recycled, reused, or disposed of safely.

8. Facilities and operations

To develop, design and operate facilities and conduct activities taking into consideration the efficient use of energy and materials, the sustainable use of renewable resources, the minimisation of adverse environmental impact and waste generation, and the safe and responsible disposal of residual wastes.

10. Precautionary approach

To modify the manufacture, marketing or use of products or services or the conduct of activities, consistent with scientific and technical understanding, to prevent serious or irreversible environmental degradation.

16. Compliance and Reporting

To measure environmental performance; to conduct regular environmental audits and assessments of compliance with company requirements, legal requirements and these principles; and periodically to provide appropriate information to the Board of Directors, shareholders, employees, the authorities and the public.

ISO 14004 – Annex

1991

- General Agreement on Tariff and Trade (GATT) negotiations in Uruguay (The principal aim being to reduce trade barriers).

- ISO set up a strategic group on the Environment (SAGE) to assess the need for an international standard on environmental management

The aim of SAGE was to determine the need for a standard for the environment could:

- Promote a common approach to environmental management similar to that of ISO 9000 and quality management
- Enhance the organizations ability to attain and measure improvements in environmental performance
- Facilitate trade and remove barriers.

(Roberts, H and Robinson, C. 1998)

- Founding of the European Environmental Agency (EEA) in Copenhagen (fully established in October 1993).

The EEA has the objective to provide "objective, reliable, and comparable information enabling them to take the requisite measures to protect the environment, to assess the results of such measures and to ensure that the public is properly informed about the state of the environment"

(Sheerin, J. 1997)

1992

- UN Conference on Environment and Development ("Earth Summit") in Rio de Janeiro (3 to 14 June 1992). The main aim of the "Earth Summit" was to develop global commitment to sustainability and the protection and enhancement of the environment. The product of this summit was the Rio Declaration on Environment and Development that reaffirmed the Declaration of the UN Conference on the Human Environment, adopted at Stockholm on 16 June 1972.

The Earth Summit agreed on "27 Principles" of which the most significant to an EMS are:

Principle 3: The right to development must be fulfilled so as to equitably meet development and environment needs of present and future generations.

Principle 4: In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation to it.

Principle 8: To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies

Principle 15: In order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

ISO 14004: Annex

- The Irish Pharmaceutical and Chemical Manufacturers Federation (IPCMF) was established as part of the European Chemical Industry Council (CEFIC).

The approach of their members can be summed up as follows:

- To recognise and respond to community concerns about chemicals and our operations
- To develop and produce chemicals that can be manufactured, transported, used and disposed of safely.

- To report promptly to officials, employees, customers and the public, information on chemical related health and environmental hazards and to recommend protective measures
- To make health and safety and environmental considerations a priority in our planning for all existing and new products and processes.
- To participate with government and others in creating laws, regulations and standards to safeguard the community, workplace and environment
- To counsel customers on the safe use, transportation and disposal of chemical products
- To operate our plants and facilities in a manner that protects the environment and health and safety of your employees and the public.
- To extend knowledge by conducting or supporting research on health, safety and environmental effects of our products, processes and waste materials
- To work with others to resolve problems created by past handling and disposal of hazardous substance
- To promote the principles and practices of Responsible Care by sharing experiences and offering assistance to those who produce, handle and dispose of chemicals

(Sheerin, J. 1997)

- The publication of the European Union's 5th Environmental Action Plan with its emphasis on sustainable development.

- BS 7750 published in March 1992. This was the first formal systematic environmental standard.

1993

- SAGE recommended that ISO develop what has become known as ISO 14001. SAGE, established as an ad hoc committee, was replaced by ISO Technical Committee (TC) 207 with its secretariat in Canada.

- The European Commission (EC) published its Eco-Management and Audit Regulations (EMAR) and the accompanying EMAS (Eco-Management and Audit Scheme) (1836/93/EEC; July 10th, 1993).

EMAS came into force on April 10, 1995 and initially it only applied to companies in the industry sectors of manufacturing, waste disposal and power. In 1996, it broadened its scope to include transportation companies and municipalities.

Participating organizations are expected to:
- Establish and implement environmental policies, programmes and management systems at individual operating sites
- Systematically and objectively evaluate the performance of established environmental policies, programmes and management systems on a periodic basis

- Provide information about environmental performance to the public.

EMAS II is due to be published in 2000.

Block, M. 1997

The overall aim of EMAS is to meet the EU obligation to develop ' policy and action in relation to the environment and sustainable development' as stipulated in the Treaty of Maastricht in 1992. In conjunction with the preceding council resolutions prescribing the roles and responsibilities of companies both to reinforce the economy and protect the environment, EMAS recognizes that industry has its own responsibility to manage the environmental impact of its activities and therefore should:

- Adopt a proactive approach in this field
- Prevent, reduce and as far as possible eliminate pollution, particularly at the source
- Ensure sound management of resources
- Use clean or cleaner technologies

EMAS introduced the concept that environmental management is not a 'hit or miss' approach to greening your company. Nor is it about replacing all machines, products and processes that have any impact on the environment. It is more akin to the Japanese philosophy of 'Kaizen' which is the relentless pursuit of gradual and unending improvement; only in this case it is a documented and planned process to improve environmental performance. EMAS introduced the PDCA (Plan, Do, Check, Act) improvement philosophy which had been introduced into quality systems by Walter Shewhart, a statistician at Bell Telephone Laboratories in New York.

Hillary, R. 1998

EMAS requires organizations to examine their "environmental effects" at the site and compile a register of those identified as significant. This shall include, where appropriate, consideration of:

- controlled and uncontrolled emissions to atmosphere
- controlled and uncontrolled discharges to water or sewers
- solid or other wastes, particularly hazardous wastes
- contamination of land
- use of land, water, fuels and energy and other natural resources
- discharge of thermal energy, noise, odour, dust, vibration and visual impact
- effects on specific parts of the environment and ecosystems

This includes effects arising, or likely to arise, as consequences of:

- Normal operating conditions
- Abnormal operating conditions
- Incidents, accidents and potential emergency situations

Reliable methods for measuring and reporting environmental performance have to be established as a first priority of the planning process for the environmental

management system. The types, properties and (where possible) quantities of materials released to air, water or land have to be ascertained. Data on fugitive emissions must be estimated by appropriate methods (e.g. by material balances). The procedure needs to take account of and provide guidelines towards monitoring and evaluation of abnormal operation (such as start-up, shut down), spills, accidents, emergencies etc.

EMAS – Annex 1 : 1994

1994

- The Oslo Convention on Sustainable Consumption

1995

- The Dobris Assessment (European Community)

The Dobris Assessment set targets for twelve key environmental areas:

1. Climate Change
   Carbon dioxide gas is the primary consideration. Reductions were set at 8% between 1990 and 2010 (Kyoto. December 1997) but a 'business as usual' scenario is forecast which will show an 8% increase. Only 35% of the total is made up by the output of the energy sector.

2. Depletion of Ozone Layer
   The Montreal Protocol and subsequent extensions has reduced global production of CFCs and emissions by 80-90%. However, the persistence of CFCs in the atmosphere means that the stratospheric ozone layer is expected to take a long time to recover. Now the focus has moved to reducing Methyl Bromide and HCFCs.

3. Acidification
   SO2, NOX and NH3 have fallen by 15% since 1990 but 10% of Europe's land area still has too high a level of acid deposition. NOX emission from the transport sector are too high and legislation has not yet caught up with this growth area. The transport sector is therefore targeted for improvement.

4. Tropospheric ozone and summer smog
   There has been a 14% reduction in ozone precursors from 1990 – 1995. However, smog is still present in some European areas posing a threat to vegetation and human health. Further reductions in Non-Methane Volatile Organic Compounds (NMVOC) and NOX will be required. The 1988 NOX protocol issued under the UNECE Convention on Long-Range Transboundary Air Pollution. (CLRTAP) has the aim of addressing photochemical pollution, acidification and eutrophication. The transport sector is the main contributor except in Central and Eastern Europe (CEE).

5. Chemicals
   A vast number of chemicals are in use and there is a lack of knowledge about both the way they move through the environment and accumulate and their

human and ecological impacts. There have been voluntary reduction programmes and toxic release and emission registers.

6. Waste

   The generation of waste has increased by 10% between 1990 and 1995 with the dominant disposal method being landfill. Programmes of waste minimisation and prevention have been adopted and recycling is strongest in countries (mostly Western Europe) which have a strong waste management structure. The aim is to establish better waste separation and landfill management in the CEE and Newly Independent States (NIS)

7. Biodiversity

   Main enemies of biodiversity are agriculture, forestry, urbanisation and infrastructure development. Increasingly, biodiversity has been affected by the large scale management of agriculture and forestry, the fragmentation of the landscape, the loading by chemicals, water extraction, disturbance and the influx of alien species. There has been slow implementation of laws and the CEE and NIS are under great pressure though increased development.

8. Inland Waters

   There are water shortages round urban areas in the CEE and there are general concerns about inefficient water use and pipe leakages. Groundwater quality is affected by nitrates (from agriculture) and pesticides. Waters are also being polluted by of heavy metals, hydrocarbons and chlorinated hydrocarbons. Groundwater pollution will take much time to improve. Since 1990, there has been no overall improvement in river quality in Europe although there has been a reduction in phosphate use (40-60%) through phosphate free detergent.

9. Marine and coastal waters

   Many areas are affected by salination and erosion.

10. Soil degradation.

    There have been 300,000 contaminated sites identified in Europe. Military areas in CEE and NIS are a cause for concern.

11. Urban environment

    The urban environmental is under stress through poor air quality, excessive noise, traffic congestion, loss of green areas and degradation of monuments and buildings. Over 290 cities have subscribed to Agenda 21 by 1998.

12. Technological and natural hazards

    This includes floods and soil sealing under urban areas

European Environment Agency. 1998

1996

- ISO 14001 published by the International Organisation for Standardisation (ISO).

2.2 An Introduction to the Requirements of ISO 14001

ISO 14001 was published in 1996 and was closely modelled on the British Standard, BS 7750, which was published in 1992. The EMAS model, which had been the basis for Irish Standard I.S. 310, was not adopted because it requires public reporting on environmental performance; although this is not the only difference between ISO 7750 / ISO 14001 and EMAS / I.S. 310, in the climate of concern about placing too much information in the public forum (and the associated uncertainly about legal action and interpretation), it was the principal issue.

ISO 14001 comes as part of a set of standards that are intended to be a complete framework for environmental action.

The family of ISO Environmental Standards are:

Environmental Management Systems

- ISO 14001: Environmental Management Systems – Specification with guidance for use. (1996)
- ISO 14004: Environmental Management Systems – General guidance on principles, systems and supporting techniques. (1996)

Environmental Auditing

- ISO 14010: Guidelines for environmental auditing – General principles (1996).
- ISO 14011: Guidelines for environmental auditing – Audit procedures – Auditing of environmental management systems (1996)
- ISO 14012: Guidelines for environmental auditing – Auditor qualification criteria (1996)
- ISO 14015 Environmental Management – Environmental assessment of sites and organisations. (ISO/CD 14015.1 / ISO/TC 207/SC 2/WG 4. Dated 20 December 1998).

Environmental Performance Evaluation

- ISO 14031: Environmental Management – Environmental Performance Evaluation – Guidelines (1999)

Environmental Aspects in Product Standards

- ISO 14060: Environmental Aspects in Product Standards – Guide for Environmental aspects in Product Standards.

Life Cycle Analysis

- ISO 14040: Life Cycle Analysis - Principles and Framework
- ISO 14041: Life Cycle Analysis – Goal and Scope Definitions and Inventory Analysis
- ISO 14042: Life Cycle Analysis - Impact Assessment
- ISO 14043: Life Cycle Analysis – Interpretations

Eco-Labelling

- ISO 14020: Eco Labelling / Product Labelling - Principles of All Environmental Labelling
- ISO 14021: Eco Labelling / Product Labelling - Self Declaration of Environmental Claims – Terms and Definitions
- ISO 14022: Eco Labelling / Product - Labelling Symbols
- ISO 14023: Eco Labelling / Product Labelling - Testing and Verification
- ISO 14024: Eco Labelling / Product Labelling - Practitioner Programmes: Guiding Principles and Procedures for Multi-Criteria (Type 1)

Vocabulary

- ISO 14050: Environmental Management – Vocabulary (1998)

This study only concerns Environmental Management Systems and, in particular, ISO 14001 which is the "specification" (or auditable standard – sometimes also referred to as the "contractual" standard). However, ISO 14001 and ISO 14004 should be seen as a harmonised pair of standards that are intended to support each other.

In ISO 14004, Overview, there is an introduction to why an organisation might be interested in introducing an EMS. "As concern grows for maintaining and improving the quality of the environment and protecting human health, organisations of all sizes are increasingly turning their attention to the potential environmental impacts of their activities, products and services. (…) Achieving sound environmental performance requires organisational commitment to a systematic approach and to continual improvement of the environmental management system (EMS)."

It is intended that the standard should be applicable to all sizes of organisations (SMEs (Small to Medium Sized Enterprises) are specifically mentioned as are diverse cultural, social and organizational frameworks).

The benefits of introducing an EMS are given, in ISO 14004, as providing confidence to its interested parties that:

- A management commitment exists to meet the provisions of its policy, objectives and targets
- Emphasis is placed on prevention rather than corrective action
- Evidence of reasonable care and regulatory compliance can be provided and
- The systems design incorporates the process of continual improvement.

Potential benefits include:

- Assuring customers of commitment to demonstrable environmental management
- Maintaining good public/community relations
- Obtaining insurance at reasonable cost
- Enhancing image and market share
- Meeting vendor certification criteria
- Improving cost control
- Reducing incidents that can result in liability
- Demonstrating reasonable care
- Conserving input of materials and energy
- Facilitating the attainment of permits and authorizations
- Fostering development and sharing environmental solutions
- Improving industry-government relations

In order to achieve an understanding of how any organisation interacts with the environment, it is necessary to review the activities of the organisation: this is called the "Initial Environmental Review". ISO 14001 does not require companies who have already done this exercise in another context to repeat the process for ISO 14001 but, in practice, most organisations commence the implementation of ISO 14001 with an initial environmental review. Figure 2.01 shows a diagram representing the Continuous Improvement Cycle upon which the standard is based; this study is concerned with Environmental Aspects, Clause 4.3.1, is part of the planning activity.

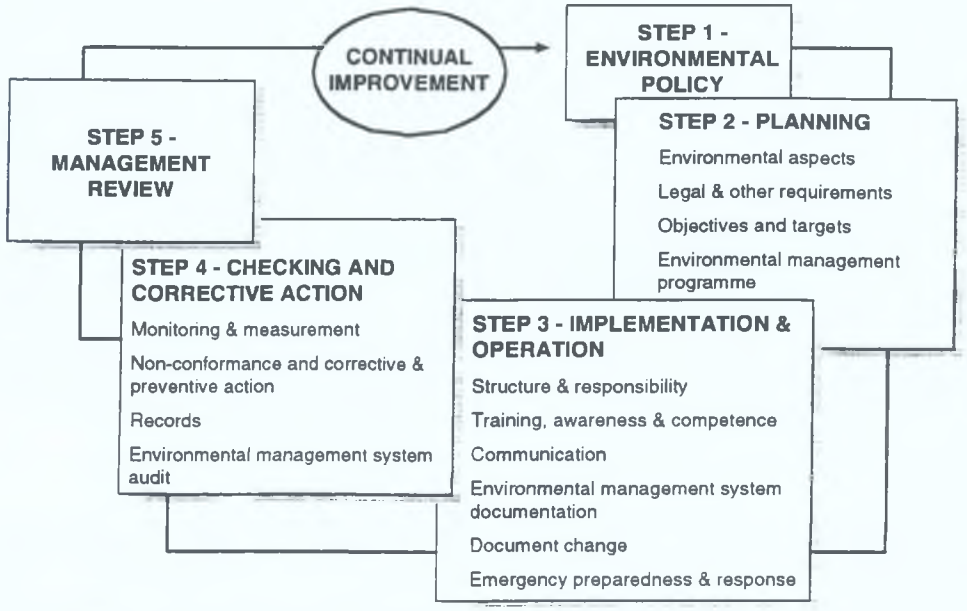

Figure 2.1: Continuous Improvement Cycle in ISO 14001 *(Starkey, 1998)*

ISO 14004 advises that the initial review can cover the following:

- Identification of legislative and regulatory requirements
- Identification of environmental aspects of its activities, products or services so as to determine those that have or can have significant environmental impacts and liabilities.
- Evaluation of performance compared with relevant internal criteria, external standards, regulations, codes of practice and sets of principles and guidelines.
- Existing environmental management practices and procedures
- Identification of the existing policies and procedures dealing with procurement and contracting activities
- Feedback from the investigation of previous incidents of non-compliance
- Opportunities for competitive advantage
- The views of interested parties
- Functions or activities of other organisational systems that can enable or impede environmental performance.

In this context, it would be normal to use one or more of the following common techniques:

- Questionnaires
- Interviews
- Checklists
- Direct inspection and measurement
- Record review
- Benchmarking

The clause in ISO 14001 that covers this initial environmental review is 4.3.1. This states:

> **4.3.1 Environmental aspects**
>
> The organisation shall establish and maintain (a) procedure(s) to identify the environmental aspects of its activities, products or services that it can control and over which it can be expected to have an influence, in order to determine those which have or can have significant impacts on the environment. The organisation shall ensure that all aspects related to these significant impacts are considered in setting its environmental objectives.
>
> The organisation shall keep this information up-to-date.
>
> *ISO 14001: 1996*

This embodies the principle, in the introduction to ISO 14001, that "to be effective, they (reviews) need to be conducted within a structured management system and integrated with overall management activity". Another important issue which is covered in the introduction is that, when conducting the review, "this International Standard does not establish absolute requirements for environmental performance beyond commitment, in the policy, to compliance with applicable legislation and regulations and to continual improvement. Thus two organisations carrying out similar activities but having different environmental performance may both comply with its requirements". The review is therefore an internal process for the company which, if there are no applicable regulatory or legislative requirements specifying thresholds / limit values, can be conducted relative to the organisation's own policies, capabilities and requirements. Although the policy must contain a commitment to continuous improvement and the prevention of pollution (Clause 4.2 (b)), the manner in which this is actually implemented is left to the organisation to determine and demonstrate.

In the initial environmental review, the company should consider the following:

- Environmental aspects arising from the organisation's past, existing or planned activities, products or services (ISO 14001 – Annex A1)

and from ISO 14001 – Annex A3:

- Legislative and regulatory requirements
- An identification of significant environmental aspects
- An examination of all existing environmental management practices and procedures
- An evaluation of feedback from the investigation of previous incidents

and ISO 14004 advises that the following questions should be considered:

- What are the aspects?
- Are there any that are significantly adverse?
- Is there a procedure for evaluating impact of new projects?
- Is there any special concern such as sensitive environmental areas?
- How will any proposed changes impact on the environment?
- How significant would the effects of process failure be?
- How frequently does the situation arise?

- What are the significant environmental aspects considered impacts, likelihood, severity and frequency?
- Are the impacts local, regional or global in scope?

The first difficulty which organisations face is the terminology and this can be a barrier to the exercise. ISO 14001/14050 gives the following definitions (see also Table 2.01)

Environmental Aspects: Element of an organisation's activities, products or services that can interact with the environment.

Environmental Impacts: Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.

Activity, product or service	Aspect	Impact
Activity – Handling of hazardous materials	Potential for accidental spillage	Contamination of soil or water
Product – Product refinement	Reformulation of the product to reduce its volume	Conservation of natural resources
Service – vehicle maintenance	Exhaust emissions	Reduction of air emissions

TABLE 2.01: Example of Impacts and aspects (ISO 14001: 1996)

This process can obviously take a great deal of time, particularly in a large or complex organisation. ISO 14001 – Annex A.3, advises that an organisation should consider:

Operating Conditions

- normal operations
- abnormal operations (e.g. start-up and shut down)
- potential or foreseeable emergency situations

Aspects

- Emissions to air
- Releases to water
- Waste management
- Contamination of land
- Use of raw materials and natural resources
- Other local environment and community issues

ISO 14004 advises that the analysis can be facilitated by considering the following:

Environmental concerns:

- The scale of impact
- The severity of impact
- Probability of occurrence
- Duration of impact

Business concerns

- Potential regulatory and legal exposure
- Difficulty of changing the impact
- Cost of changing the impact
- Effect of change on other activities and processes
- Concerns of interested parties
- Effect on the public image of the organisation

However, although the preface to ISO 14001 advertises that it "provides practical advice on implementing or enhancing such a system" it does not give any guidelines on exactly how to conduct an analysis of aspects and impacts (methodology) or, having made an analysis, how to determine "significance". This is a major element in the implementation of the standard and yet there is scant practical advice on methodology.

2.3 Significance

The aim of this study is to look at the methodologies for determining significance, both in theory and practice, and to discover whether any additional guidance can be provided. Guidance is needed by organisations to reduce the time it takes to develop a suitable process and to ensure that the process is sufficiently robust to pass the scrutiny of a registrar (an organisation accredited to award certificates of conformance to ISO 14001) and of customers and stakeholders.

Significance is crucial for the implementation of ISO 14001 because, having identified the "Significant Impacts" it follows that there are "Significant Aspects" and "Significant Activities" associated. It is a requirement to:

- Set objectives and targets with respect to these *significant impacts* (Clause 4.3.3)
- Maintain programmes to achieve the targets set (Clause 4.3.4)

- Train and educate personnel whose work may create a *significant impact* on the environment (Clause 4.4.2)
- Consider external communication on *significant impacts*. (Clause 4.4.3)
- Establishing and maintaining documented procedures relating to operations and activities which are associated with identified *significant aspects* (Clause 4.4.6)
- Establishing and maintaining procedures for emergency preparedness (e.g. those situations which could have a *significant environmental impact* (Clause 4.4.7)
- Monitor and measure key characteristics of operations which have a *significant impact* (Clause 4.5.1)

It can be appreciated, therefore, that failure to adequately identify all significant impact can seriously reduce the effectiveness of the system and will therefore prejudice the company's ability to achieve or maintain ISO 14001 certification.

The term "significance" first came to prominence in an environmental context in the USA's National Environmental Protection Act, 1969 (NEPA). NEPA requires significance to be determined with consideration of both context and criteria (Canter 1996) and "significance" is critical to a verdict of FONSI (Finding Of No Significant Impact) when an Environmental Impact Statement is not required.

Marriott (1985) states that, in the context of NEPA, "use of the word *significant* has become somewhat controversial; some agencies now refuse to include it in environmental documents because it assumes a judgement and other agencies insist that every possible impact be tagged *significant* or *nonsignificant*. The identification of significant impacts often becomes critical to an agency's commitment to provide mitigation for an expected impact".

Singleton, Castle and Short (1999) note that, in the context of the Environmental Impact Assessment Directive (85/337/EEC), "in 1991, belatedly, but in accordance with a requirement in the Directive itself (Article 11(3)) the European Commission carried out a comprehensive review across all member states of the application and effectiveness of the EA Directive (the "Review") for the six year period from July 1985 to July 1991. One of the main points noted in the Review was (…)difficulties with interpretation and meaning

of words and terms used in the EA Directive (for example, "Significance of the environmental effect")"

In the context of Environmental Impact Assessment, Gilpin (1995) quotes the Regulations of the Council on Environmental Quality (CEQ) who refer to "actions significantly affecting the quality of the human environment" and the European Commission EIA Directive 1985 and the UN ECE Convention of EIA in Transboundary Context which both use the term significant and notes that at no time is the word significant determined. He concludes that, although social scientists may define significant as a variation of greater than 5% outside the acceptable limits, "significance, in the end, is a collective judgement of officers, elected persons and the public"

Michael O'Sullivan (University College Cork's Resource and Environmental Management Unit's publication of conference papers, 1990) states that "definitions of the term 'significance' are various and often controversial. Mostly, they are the function of the perception of certain groups in society who possess certain pre-determined values against which the significance of certain activities is judged. The determination of significant issues is similarly, therefore, a phrase which is open to misunderstanding and for this reason is often substituted by the term 'key issues'"

Sheerin (1997), in the context of EMS, quotes Mr. Barry Carey of EG + G Sealol as stating "the most difficult aspect of developing any environmental management system is the identification and classification of environmental effects. Once this is achieved, procedures can be put into place to address these issues." and Mr. Des O'Keefe and Mr. Tom Murphy of Printech as stating that one of the negative aspects was that "no definitive acceptance criteria were available to help verify the interpretation of the specification"

Woodside, Aurrichio and Yturri (1998) state that "The planning process begins with the identification of environmental aspects and, subsequently, significant environmental aspects. This concept of identifying environmental aspects is unique to the ISO 14001 standard and, although many organizations may have considered environmental outcomes when setting priorities, few likely have developed procedures for a formalised process. As required by the standard (...) it is not uncommon for this element to cause a substantial amount of "churn" when the organisation begins implementing ISO 14001. The "churn" consists of lengthy discussions about the definition of an aspect, the definition of

significant versus non-significant aspects and impacts, the need for a rating system, the number of people to include in the process and other topics of conversation that encourage dissent, confusion and chaos."

In an article in Quality Digest (USA) (June 1997. Hale and Hemingway), the authors state that "The key to a successful registration is to figure out which impacts are significant and deserve the most attention"

Hillary, R (1998) in reviewing the feedback on the subject of the initial environmental review from companies involved in the BS 7750 pilot study remarks that they "did not want a standard format for the register [of environmental aspects / impacts] but did identify that more guidance was required to establish what were significant effects for a sector (...) implementing organizations were comfortable with the time period (past, present and future) of the register but used a variety of approaches to establish environmental effects and significance"

Margetson (1998) quotes Roger Brockway, a member of the Original Technical Committee (ES/1) and currently a senior civil servant within the British Standards Institute (BSI), as commenting that the lack of guidance on how to assess significance " was the topic of many meetings during the development phases of the standard (...) the view of the committee was that if a suggested method or guidelines were supplied, then the whole process of implementing the EMS would have been reduced to a "box-ticking" exercise. It was felt [by the committee] that if this happened then companies would use the ISO 14001 logo as an easy 'badge' to collect, without having any real commitment to a more environmentally sustainable business operation. By forcing the company to develop their own evaluation methods, the standard would ensure that its purpose would be taken seriously, leading the company down a road towards continuous environmental improvement." Each organisation was therefore left to their own devices.

The committee drafting ISO 14001 seems to have made a deliberate decision to exclude any specific guidance on methodology in the ISO 14001 and 14004 standards. In deciding not to give guidance, the technical committee followed the precedent of earlier writers of environmental regulations.

2.4 Previous Sligo IT Thesis (Grimes, C. 1999)

In a previous thesis entitled "Aspects Identification and Impacts Evaluation in Environmental Management Systems – An appraisal of available methodologies and current practices", the author concluded that aspect and impact identification was one of the most critical and often most difficult requirements of an EMS implementation.

A survey of Irish companies was conducted with the aim of ascertaining whether the initial environmental review was perceived as a problem area, establishing the degree of difficulty and determining if companies required external assistance. The survey also examined whether those aspects which were found to be significant were those with regulatory control.

The author's survey covered 52 companies with 73% response (38). The "level of difficulty" is reported in Table 2.02 (5 being the highest level of difficulty).

Area	Total response	Response of 4 or 5		
		Rating 4	Rating 5	Rating 4 + 5
Other Area	4	1	0	1
Environmental Policy	84	5	1	6
Measuring Environmental Performance	96	6	2	8
Environmental Training of Personnel	100	8	3	11
Other Documentation	102	6	2	8
Environmental Auditing	105	7	1	8
Setting Targets and Objectives	107	8	3	11
Correcting Non-conformances	108	7	4	11
Register of legislation	116	12	3	15
Identification of Legal Requirements	119	10	5	15
Register of Aspects	132	11	9	20
Identification of Aspects / Impacts	139	9	13	22
Identification of Significant Impacts	141	8	14	22

TABLE 2.02: Survey of Irish Companies and Level of Difficulty in Implementing ISO 14001 *(Grimes, 1999)*

From the results, it was concluded that the top three areas of difficulty all concerned ISO 14001, Clause 4.3.1. The author did not examine the strengths and weaknesses of actual examples nor the particular reasons for difficulty.

The author's survey did establish the frequency of use of the methodologies identified (refer to Tables 2.03 and 2.04).

%	**Methodology**
86.1	Ranking Techniques
74.1	Risk Assessment
70.4	Input / Output Analysis
52.8	Checklists
48.1	Environmental Impact Analysis
33.3	Life Cycle Analysis

TABLE 2.03: Ranking of Types of Methodology Used by Irish Companies *(Grimes, 1999)*

Method Type	Number of Companies	% of Companies using the method
Simple ranking / scoring system	31	86.1
Interviews with relevant personnel	24	66.7
Checklists	19	52.8
Input-Output Analysis	15	41.7
Questionnaire	12	33.3
Simple Matrices	10	27.8
Energy Diagrams	9	25.0
FMEA	6	16.7
HAZOP / HAZAN	5	13.9
Weighted Matrices	4	11.1
Cause and Effect Diagrams	4	11.1
CBA	4	11.1
Environmental Evaluation System	4	11.1
Decision Analysis	4	11.1
Goals Achievement Matrix	2	5.6
Computer Simulation Models	1	2.8
Overlay Maps	1	2.8
FTA / ETA	1	2.8
Leopold Matrix	0	0
Networks	0	0

TABLE 2.04: Methodologies used by Irish Companies ranked by Frequency of Use *(Grimes, 1999)*

The author acknowledges that the interpretation of the methodologies might not be straight-forward because of differences in terminologies understood by the respondents. Most companies used more than one methodology as illustrated in Table 2.04. Interestingly, the significant aspect with the highest frequency was not legislation or regulation driven but of concern from a business / financial perspective (see Table 2.05)

Over 70% of companies in the survey needed help in Identification of Significant Aspects/ impacts and Legislation and half of them reported that the registrar, during the assessment, required changes to the methodology. One of the conclusions was that additional information was needed on methodologies and how to apply them.

The survey also identified that odour and noise were the main reasons for complaint from third parties but that this was rated, generally, as not significant by the organisations which participated (see Table 2.05)

Significance Aspect	Number of Companies	% of Companies
Energy Conservation	34	89.5
Liquid Discharges	28	73.7
Air Emissions	19	50
Water Consumption	18	47.5
Disposal of non-hazardous Waste	18	47.5
Use/ Disposal of Hazardous Materials	17	44.7
Consumption of Other Raw Materials	14	36.8
Storage of Hazardous Materials	10	26.3
Noise / Vibration	6	15.8
Dust / Particulates	5	13.2
Indirect Aspects	4	10.5
Traffic / Transportation	4	10.5
Visual Impacts	3	7.9
Storage of Non-hazardous Waste	3	7.9
Odour	1	2.6
Occupational Exposure	1	2.6

TABLE 2.05: Frequency at which Irish Companies designated an aspect as "significant". *(Grimes, 1999).*

3.1 Aims of Risk Assessment

The aim of any risk assessment is to evaluate the relevant issues arising from a certain situation either existing or proposed; this is normally by looking at the issue under three headings:

- Hazard
- Pathway
- Target Sensitivity

'Hazard' is defined as the capability to cause harm.

'Risk', although used in everyday language to mean "chance of disaster", when used in the process of risk assessment it has specific definitions and is defined by the Royal Society as being:

> "The combination of the probability, or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence" (Fairman, Mead, and Williams. 1998).

The reasons for carrying out such a risk assessment are various but, in all cases, a certain set of circumstances will be analysed to understand better the nature of the hazard, the methods of control (the pathway) and the affect on the target(s). Often such assessments are used as comparisons between options (such as in a road building problem) but can be used as a management tool to assess weaknesses to help prioritise action or test designs (such an example would be HAZOP).

Unless the scope of the risk assessment is very limited, all methodologies are a mixture of subjective and objective inputs. In specific circumstances, risks are defined by law (such as in the Seveso Directive which defines quantities of reactive chemicals are which, when stored in excess of a given quantity, constitute a risk that requires certain precautions and advance planning). In other cases, the law refers only to when a risk assessment needs to be carried out (as in the Environmental Impact Assessment Directive or Environmental

Protection Agency (Licensing) Act (1994) where certain types and sizes of activities are defined).

Risk Assessment is always going to be, at best, a good approximation: no system gives a fully objective view. Some of the factors that influence the results:

- the completeness and accuracy of data
- the state of scientific knowledge
  - knowledge about the hazard
  - understanding of the physical routes from hazard to subject
  - knowledge about the affects on the subject (acute / chronic)
- the technique used

In carrying out a risk assessment, a balance has to be maintained between the time and effort put into the risk assessment and the quality of results. At a certain point, the law of diminishing returns applies. A scoping review is recommended before a detailed review since this can identify the issues that are likely to be most important and where the focus of the study is required.

In order to understand the origins of some of the methodologies used in the implementation of ISO 14001, it is useful to gain an overview of the range of methodologies with which organisations will be familiar.

3.2 Safety Risk Assessment

Some organisations have been using risk assessments in the context of Health and Safety at Work studies.

LIKELIHOOD OF EVENT		SEVERITY OF RESULT	
Almost Certain	9	Death	9
Very Likely	8	Total incapacity	8
Probable	7	Severe incapacity	7
More then evens	6	Slight incapacity	6
Even chance	5	Absent 3 weeks plus recovery	5
Less than evens	4	Absent 3 days plus recovery	4
Improbable	3	Absent less than 1 day	3
Highly Improbable	2	Minor injury	2
Almost impossible	1	Insignificant injury	1

TABLE 3.01: Safety Risk Assessment Scoring *(Quest. 1995)*

These studies are focussed on one target (the human being) and this results in techniques which are often less complex. As an example of this kind of technique (Quest, 1995), Table 3.01 shows the permutation of Likelihood and Severity for each particular work situation. The actions to be considered are divided into several categories depending on the permutation of the likelihood and the severity (see Table 3.02)

BAND	SCORE	ACTION
A	over 40	Extensive, foolproof precautions with considerable expenditure of money, intensive training and stringent rules with severe penalties for infringement.
B	20 to 40	Preventative measures and policies vigorously maintained
C	less than 20	Some risk acceptable. Training at regular intervals and high standard of supervision.

TABLE 3.02: Safety Risk Assessment Outcome *(Quest, 1995)*

The system used by the UK Health and Safety Executive is a modified version that simplifies the scoring system but uses the same principle (see Table 3.03)

EFFECT OF OCCURENCE		LIKELIHOOD OF OCCURRENCE	
Major	3	High	3
Serious	2	Medium	2
Slight	1	Slight	1

TABLE 3.03: UK Health and Safety Executive Risk Scoring *(Quest, 1995)*

The merits of using a simple ranking system (scoring only three options) over a more complex system (scoring ten options) are debated by the author. However, the number of options in such a scoring system must be chosen relative to what is being scored. The definition of a satisfactory scoring system is one where there are sufficient options to rank distinct effects but not too many to provoke unproductive argument through overlapping perceptions.

3.3 Seveso Directive

(Seveso II Directive 96/82/EEC (revokes Seveso Directive 82/501/EEC)

This directive is aimed at better risk management, better land use planning and better acknowledgement of transboundary aspects. It amends the earlier directive that excluded certain industries even though they have similar hazards to those industries included. This

directive still excludes landfills, military establishments, exploration for minerals and handling at docks and in pipelines.

Annex I gives, by chemical and category, the amounts which if met or exceeded cause a need for either:

a. (Article 6 and 7) The establishment to register with the authorities and to draw-up and implement a 'major-accident prevention policy' and the provision for allowing inspections by a competent authority or

b. (Article 9) The production of a safety report covering policy, safety management, measures to limit occurrence and consequences, suitable design, construction and maintenance, emergency planning and information to the authorities (one inspection every twelve months by a competent authority)

For example:

Petroleum Spirits	≥ 5000 Tonnes	Article 6 and 7 applies
	≥ 50000 Tonnes	Article 9 applies

The remaining annexes give:

- Annex II: the format for information in a Safety Report (see Article 9)
- Annex III: the principles for a satisfactory management plan
- Annex IV: the data to be included in emergency plans
- Annex V: the information to be communicated in the event of a major accident.
- Annex VI: the criteria for notification being:5% or more of a qualifying substance (see Annex I) involved in a spill, accident or explosion or consequences detailed which include death, evacuation of neighbours, distribution of services, damage to an aquifer or freshwater or terrestrial habitats, damage to property or transboundary damage.

The Directive is important because it introduces clear definitions for flammability etc. and rules for adding the effects of similar substances. It also gives good guidelines on what is to be considered when evaluating the potential or actual impact of any substance at a facility (Annex II):

e.g. historical uses / activities
geology / hydrology
operating methods

The effect of Annex II and III is to require a company to introduce a system that is similar to ISO 14001 and to prepare a 'safety report' which is very similar to a register of significant aspects / impacts.

3.4 Subjective Ranking Systems

In the above example, words such as 'Almost certain', 'Very likely', 'Probable', Almost Impossible' etc are used. These words are subjective and while any individual may believe they know what any word means to them, there is an inevitable spread in the perception of a wider population.

This issue has been explored by Peter Moore (1983) who asked a group of 250 of his students at the London Business School to rank the following words on a scale of 1 to 10 ('1' being the highest certainty, '10' being the lowest certainty).

Quite Certain	Expected	Likely
Probable	Not unreasonable that	Not Certain
Hoped	Possible	Doubtful
	Unlikely	

The questions was phrased in the context of consumer durables and, whilst this is not directly relevant to the environment, it illustrates the subjectivity of a rating system based on such words.

The author recorded the scores for each work for each of the 250 students. The table below shows the range of the values for each word and is ordered by the mean value for each word. (see Table 3.04)

KEY WORD	MEAN	LOWEST – HIGHEST	RANGE
Quite Certain	1.10	1 - 3	3
Expected	2.95	1 - 6	6
Likely	3.85	2 - 7	6
Probable	4.25	2 - 9	8
Not Unreasonable that	4.65	3 - 7	5
Possible	6.10	3 - 9	7
Hoped	7.15	3 - 10	8
Not certain	7.80	3 - 10	8
Doubtful	8.60	7 - 10	4
Unlikely	8.75	3 - 10	8

TABLE 3.04: Response to Key Words: Perception of Meaning *(Moore, 1983)*

The table illustrates that there is no predictable response to any of the words although there is a trend of understanding. Although there is no data presented to give the standard deviation in the responses, it can be seen that some words (such as 'Hoped' and 'Not Certain') exhibited a wide range of response.

The survey was conducted three months later and, although on a different number of the students, it showed that there was no repeatability in the results and that the same subject would answer differently on different occasions.

3.5 Product/Manufacturing Risk Assessment

One of the areas where risk assessment and management is commonly used is in product design and manufacture. For every plane or car that is designed and manufactured, a complex programme of evaluation is carried out by the designers and the manufacturers. This programme is aimed at trying to predict every 'failure mode' in every component and assembly. The approach is very strictly controlled and is known as Failure Mode and Effect Analysis (FMEA).

Each failure mode is analysed for its Severity (effect on the user, customer or downstream processes), for its Occurrence (how stable is the process relevant to the failure mode) and for its Detection (how well can this failure be detected before it reaches that user, customer or downstream process). The analysis awards a score of between 1 and 10 (10 being most severe, highest occurrence, worst detection) to each of the parameters and then multiplied to get a Risk Priority Number (RPN).

Essentially the three modes of 'hazard', 'pathway' and 'target' have been transferred into 'occurrence', 'detection' and 'severity' respectively. The target in risk analysis is the downstream system – in FMEA this is severity (the affect on the next process, the customer or the end user (sometimes all three)). The pathway is the route to the target – in the FMEA this is detection (the opportunity to intercept a failure before it reaches the target / severity). The hazard is the nature of the risk – in FMEA, occurrence (the amount of control over the process or the inherent misbehaviour of the operation). Often the FMEA's occurrence is linked to preventive or proactive action whereas detection is linked to corrective or reactive action. As the potential or actual weaknesses in the design or manufacturing process result in failure modes, it is appropriate that that FMEA seeks to

address these weaknesses at source rather than in increasing the effectiveness of the detection of the failure mode / corrective action to compensate.

Action is taken to reduce the RPN with focus on the highest severity ratings. The chart (simplified) is shown in Table 3.05.

Element	Failure Mode	Failure Mechanism	SEVERITY		OCCURENCE		DETECTION		RPN
			Description	#	Description	#	Description	#	
Door	Rust	Poor Surface Preparation	Reduces life of element and poor visual performance	6	Wrong grade raw material	2	C of C	1	12
					Cleaning bath at wrong temperature	4	Temp check every hour	3	72
					Cleaning bath chemicals too dilute	4	Analysis once per shift	3	72
					Part misses cleaning bath	1	Kanban flow. Bar coding	1	6
					Primer wrong thickness	5	DFT sampling. SPC chart.	4	120
					Irregular spray pattern of primer	3	Robot spray pattern validated each shift	4	72
					Nozzle block on paint spray	5	Clean every 100 parts	2	60

TABLE 3.05: FMEA Example *(After information from QS 9000: FMEA Manual)*

This methodology is a very powerful tool if it is maintained as a live document. As a live document, it has to be continually reviewed and revalidated using data from the processes and inspection feedback. This can be in the form of customer complaints, inspection records, machine logs, scrap figures, machine capability studies, maintenance reports etc. The live feedback then allows RPNs to be adjusted to reflect actual data and new failure modes, when discovered, to be added to the analysis.

One of the strengths of the QS 9000 FMEA system is that the award of scores for Severity, Occurrence and Detection are defined.

The definitions (Table 3.06, abbreviated for simplicity) for severity, occurrence and detection are very well explained. Although they could have been left as 'high', 'low' and 'remote', a better concurrence with respect to interpretation has been gained by explaining what each means in each category. A score of '3', for example, is applied for 'minor' and

'low' in Severity and Occurrence; this avoids some of the subjectivity that can make such scoring systems difficult to apply uniformly.

SEVERITY		OCCURRENCE			DETECTION	
HAZARDOUS WITHOUT WARNING. Affecting safe vehicle operation and/or compliance with government regulation. Failure will occur without warning.	10	VERY HIGH. Failure almost inevitable.	PPM 500. 000	10	ALMOST IMPOSSIBLE. No known control(s) available to detect failure mode.	10
HAZARDOUS WITH WARNING. Affecting safe vehicle operation and/or compliance with government regulation. Failure will occur with warning.	9		PPM 330, 000	9	VERY REMOTE. Very remote likelihood current control(s) will detect failure mode.	9
VERY HIGH. Vehicle inoperable, loss of primary function. Customer very dissatisfied.	8	HIGH. Generally associated with processes similar to the previous processes that have often failed.	PPM 125, 000	8	REMOTE. Remote likelihood current control(s) will detect failure mode.	8
HIGH. Vehicle operable but with reduced level of performance. Customer dissatisfied	7		PPM 50, 000	7	VERY LOW. Very low likelihood current control(s) will detect failure mode.	7
MODERATE. Vehicle operable but with some level of reduced performance. Customer experiences discomfort.	6	MODERATE: Generally associated with processes similar to previous processes which have experienced occasional failures but not in major proportions.	PPM 12. 500	6	LOW. Low likelihood current control(s) will detect failure mode.	6
LOW. Vehicle operable but with some level of reduced performance. Customer experiences some dissatisfaction.	5		PPM 2500	5	MODERATE. Moderate likelihood current control(s) will detect failure mode.	5
VERY LOW. Fit and finish / squeak and rattle item does not conform. Defect noticed by most customers.	4		PPM 500	4	MODERATELY HIGH. Moderately high likelihood current control(s) will detect failure mode.	4
MINOR. Fit and finish / Squeak and rattle item does not conform. Defect noticed by most customers.	3	LOW. Isolated failures associated with similar processes.	PPM 67	3	HIGH. High likelihood current control(s) will detect failure mode.	3
VERY MINOR. Fit and finish / Squeak and rattle item does not conform. Defect noticed by discriminating customers.	2	VERY LOW. Only isolated failures associated with almost identical processes.	PPM 6	2	VERY HIGH. Very high likelihood current control(s) will detect failure mode.	2
NONE. No effect	1	REMOTE: Failure is unlikely. No failures ever associated with almost identical processes.	PPM < 0.67	1	ALMOST CERTAIN. Current controls are almost certain to detect the failure mode. Reliable detection controls are known with similar processes.	1

TABLE 3.06: QS9000 Scoring System *(After QS 9000: FMEA Manual)*

One difficulty is that the 'Occurrence' can only be applied with accuracy once sufficient data is gathered. if 10,000 parts have been made with one type of failure mode detected, the precautionary principle would suggest a PPM of at least 100 but a statistician could argue that the lack of data gives a high uncertainty (a PPM of 1 does not mean that the failure will be detected on the 1,000,000th part, it could have been that the 1st part that failed and the next 999,999 showed no failure)

The short-comings of this process is that it takes dedication and effort to create an FMEA model and that it only looks at failure. If one is producing something like a car, the liability in the case of failure will be sufficient to warrant funding a comprehensive FMEA programme. It will be necessary to ensure that any potential failure is evaluated and that the appropriate action is taken. However, the FMEA process, of itself, will not cover the use of resources (such as the use of paint in the above example) and, although the manufacturer will no doubt be conscious of the use of resources, the methods used to ensure that excesses do not occur will be through yield studies rather than through the FMEA.

It is important to note that the QS 9000 FMEA manual states (underlined) "In general practice, regardless of the resultant RPN, special attention should be given when severity is high ". This implies that the inherent 'severity' of the failure to the customer, end user or next process is a priority even though the RPN score may have been reduced by improving the reliability of processes and detection of the failure. In QS 9000 this is regarded as an important aspect of the FMEA process.

3.6 Environmental Risk Assessment

Environmental risk assessment has been used for a while but has been particularly relevant since the (USA) National Environmental Protection Act of 1969. The basic principles for all environmental risk analyses are to assess the context and the intensity or magnitude. (Wood, C. 1995).

CONTEXT: The significance relative to society as a whole (human / national), the affected region, the affected interests, the locality and the duration of the effects.

INTENSITY: The severity of the impact.

These two criteria can be developed into more specific categories (HMSO 1995 with overlay information from Wood, C. 1995 and US Forest Service "Threshold of Concern"):

- **Extent and Magnitude (A)**
  - Beneficial or adverse
  - Direct or indirect
  - Geographical area affected
  - Amount of pollutant / media
- **Short term, medium term or long term – time related (B)**
  - Chronic or Acute
  - How quickly is impact realised
  - Bio-accumulating
- **Probability (C)**
  - How likely is the event
- **Reversible or Irreversible (D)**
  - Renewable or non-renewable resources
  - Sustainable development
- **Performance v. Standards - Scientific Understanding (E)**
  - The degree to which the effects are highly uncertain or involve unique or unknown risks
- **Sensitivity of receptor (F)**
  - The degree to which the proposed action affects public health and safety
  - Unique characteristics of the geographic area
  - The degree to which the effects on the quality of human environment are likely to be controversial
  - Whether the action is related to any other action which is individually insignificant but is a cumulatively significant impact
  - The degree which action may adversely affect designated sites, highways, structures etc
  - The degree which action may endanger or threaten species
- **Compliance with policies (G)**
  - The degree to which the action may establish a precedent
  - Whether the action risks violating national, state or local laws.

These above factors compare with the criteria used by the USA Federal Environmental Review Office given in Table 3.07.

Aspect	Not Significant	Significant
Nature / Form (A)	Low Priority	High Priority
Aggregation (A)	Not considerable / Discrete	Considerable / Compounded / Cross impacts
Direction (A) / (B)	Stable / Steady	Improving / Worsening
Magnitude (A)	Small	Big
Priority (C)	Low	High
Rate (B)	Slow	Fast
Timing / Duration (B)	Short / Infrequent	Long / Continuous / Frequent
Area / Geographic Limits (A)	Small / Contained	Large / Uncontained
Reversibility (C)	Reversible	Irreversible
Scope for amelioration (F)	Easy / Inexpensive / Certain	Difficult / Expensive / Uncertain
Compliance with Legislation (G)	Compliant	Non-compliant
Unknown factors (E)	All key factors known / Predictable	Key factors unknown / Unpredictable

TABLE 3.07: Criteria from the Federal Environmental Assessment Review Office 1994 *(Wood, 1995)*

An environmental impact analysis is more complex since it has to address multiple targets, various degrees of uncertainty, long durations of effect, interrelationships of effects, conservation of resources, and the realisation that a full understanding of the systems involved will take an infinite number of resources.

In an attempt to simplify these concerns, they can be grouped as shown in Table 3.08.

Hazard	Magnitude, duration, nature / form, adverse / beneficial, scientific knowledge, unknown factors.	Occurrence
Pathway	Rate, direction, likelihood, geographical area	Detection
Target	Reversibility, scope for amelioration, sensitivity, direct / indirect effects	Severity
Others	Legislation.	

TABLE 3.08: Simplified Matrix of Concerns

Quantification helps analysis but not all environmental effects can be quantified in a neat and defensible way. For example, 'magnitude' may be easy to measure and evaluate but that the 'sensitivity of receptor' is a more difficult category to fully quantify – how sensitive is a plant or eco-system is to a certain pollutant? The precautionary principle becomes a important when data may be incomplete or missing: it is necessary to err on the

side of caution. Another issue is the comparison between different environmental aspects. How can one compare, say, the impacts of the consumption of fossil fuels with the release of SO_2?

A number of techniques have been developed to try to establish the relative importance of environmental effects. One example of a methodology is the weighted matrix (Table 3.09):

	Relative Importance	Severity Score (out of 10)	Weighted Score
Water Quality	42	3	126
Air Quality	21	7	147
Waste Management	37	2	74
	100%		347

TABLE 3.09: Weighted Matrix *(Glasson and Therivel, 1994)*

This technique awards a relative importance to each aspect. The severity score is then multiplied by the relative importance weighting to obtain a weighted score. This method was designed to be used in comparative assessments and has a value in any assessment where the relative importance of the aspects has been established (such as inter-plant assessments in the same industry sector). This technique owes its origins to the work of the Battelle Columbus Laboratories (Munn 1975) where various attributes were given relative weightings such as:

Air Quality (after Battelle Columbus Laboratories)

Pollutant	**Weighting**	**Pollutant**	**Weighting**
CO	5	Photochemical Oxidants	5
Hydrocarbons	5	SOx	10
NOx	10	Other	5
PM10	12		

Alternatively, thresholds can be set for certain aspects / impacts and schemes can be assessed against these thresholds. This technique is known as the Sassaman checklist (Table 3.10). Like all checklists. the Sassaman checklist depends on completeness. Assuming all impacts have been identified, the quantities have to be measured accurately under defined conditions. The challenge of this technique is completeness (i.e. can one be sure that Barn Owls (as in the example) are representative of the rare species) and data quality (i.e. can one measure the threshold adequately – in the above example, how can one be sure that 'Alternative X' will result in 18 pairs and not 22?). This technique is closely

related to ISO 14031 – the standard that encourages the use of environmental performance indicators.

Component/Aspect	Criterion	Threshold of Concern (TOC)	Alternative X	Greater than TOC? Yes / No
Air Quality	Smoke	PM10> 2 mg/l	1.6 (A)	No
Water Quality	BOD	BOD > 20 mg/l	35 (A)	Yes
	S/S	S/S > 30 mg/l	60 (A)	Yes
Rare Species	Barn Owl (pairs)	20 pairs	18 (C)	Yes

Where (A) = short duration affect (< 1 year)
(B) = medium duration affect (1 to 10 years)
(C) = long term duration (10+ years)

TABLE 3.10: Sassaman Checklist *(Glasson and Therivel, 1994)*

In an alternative methodology, the Rapid Impact Assessment Matrix (RIAM) (Pastakia and Jenson. 1998 from Grimes, C. 1999)) aims to be more transparent, quick and easy. A checklist (see Table 3.11) is used to score each aspect. As the name of the technique suggests, the aim is to achieve a rapid assessment of the relative weightings of various impacts. In order to obtain a fast result, the technique is open to the criticism that it is subjective and superficial.

To use RAIM, the different aspects are divided into four groups:

- Physical and Chemical (PC)
- Biological and Ecological (BE)
- Sociological and Cultural (SC)
- Economic and Operational (EO)

Then each is rated in the following manner with the Environmental Score being:

Environmental Score = A1 x A2 x (B1 + B2 +B3)

The RAIM system has the advantage that it recognises positive impacts (whereas many of the systems used are entirely negative in their scoring). The A1 category may need to be tailored to suit the aspect being addressed because, in the above example, the scoring of

local issues lower than global issues will not suit all situations (for example, if pre-cursors of tropospheric ozone were being considered, local issues might score higher than global).

Criteria	Scale	Description
A1: Importance of condition	4	Important to national / international interests
	3	Important to regional / national interests
	2	Important to areas immediately outside the locality
	1	Important only to the locality
	0	No importance
A2: Magnitude of change / effect	+3	Major positive benefit
	+2	Significant improvement in status quo
	+1	Improvement in status quo
	0	No change / status quo
	-1	Negative change to status quo
	-2	Significant negative change
	-3	Major negative change
B1: Permanence	1	No change
	2	Temporary
	3	Permanent
B2: Reversibility	1	No change
	2	Reversible
	3	Irreversible
B3: Cumulative	1	No change
	2	Non-cumulative / single
	3	Cumulative / synergistic

TABLE 3.11: RAIM Scoring System *(Grimes, 1999)*

Environmental Score	Range Bands	Description of Range Bands
+72 to +108	+E	Major positive change / impacts.
+36 to +71	+D	Significant positive changes / impacts
+19 to +35	+C	Moderately positive change / impacts
+10 to +18	+B	Positive change / impacts
+1 to +9	+A	Slightly positive change / impacts
0	N	No change / status quo / not applicable
-1 to –9	-A	Slight negative change / impacts
-10 to –18	-B	Negative change / impacts
-19 to –35	-C	Moderately negative change / impacts
-36 to –71	-D	Significant negative change / impacts
-72 to –108	-E	Major negative change / impacts

TABLE 3.12: RAIM Analysis *(Grimes, 1999)*

It is also difficult to justify the mathematics. Why should the Environmental Score = A1 x A2 x (B1 + B2 +B3) Why not A1 x A2 x B1 X B2 x B3? Why not (A1 + A2) x (B1 + B2 + B3)? This illustrates a common criticism with scoring systems. The mathematics

has an influence on the outcome and care should be taken to ensure that no particular factor is allowed to dominate the outcome unless this has been knowingly determined.

The above examples show some of the difficulties:

- completeness of the data
- subjectivity
- quantification
- understanding of the issues
- mathematics

The 'good points' and 'bad points' of a successful analysis are seen by the EEA (Fairman, Mead and Williams 1998) as:

Good points

- A technique which can weigh-up information that is basically in different "languages"
- A mechanism to aid decision making
- A basis for effective communication
- A method for highlighting and prioritising (research) needs

Pitfalls

- Possible over-reliance and over confidence in results
- Narrow focus on parts of the problem rather than the whole
- Awkward relationship between risk assessment and the precautionary principle
- The philosophical basis for carrying out such assessments in the first place.

The benefits of carrying out such assessments should be seen against the 'do nothing' alternative and "the main advantages of risk assessment are the encouragement to use scientific data and competence as a basis for decision making and, in that process, discrimination between scientific facts (as far as possible) and values." (Fairman, Mead and Williams. 1998)

3.7 Specific Ratings Systems

A number of industries have attempted to define their own concerns more exactly. For instance, Fairman, Mead and Williams (1998) quote the example of chemical safety where the International Programme on Chemical Safety (IPCS) is leading a project that aims to

develop an understanding of the methods and principles used by countries and organisations (with the aim of harmonisation within the EU).

Difficulties of using many environmental management tools include the availability and treatment of the basic scientific data on toxicity, ecotoxicity, fate and transport models. The challenge is to keep a satisfactory balance between the safe approach (assuming that everything is harmful until proven otherwise) and the alternative (assuming that everything is harmless until proven by science to be harmful).

The precautionary principle is fundamental in the EU's approach to environmental issues. At the Bergen conference in 1990, ministers declared that "Environmental measures must anticipate, prevent and attack the cause of environmental degradation. Where there are threats of serious damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation" (O'Riordan and Cameron, 1994).

One common term used in defining a level of risk that is 'acceptable' and to assist in choosing between risk reduction options is the concept of ALARP (as low as is reasonably practicable). ALARP compares the costs of 'doing nothing' (the risk existing) with the costs incurred in trying to reduce the risk - similar to BATNEEC. ALARP is somewhere between (a) the maximum acceptable level of risk that should not be exceeded irrespective of the economic or social benefit that would result and (b) a negligible risk level at which it is not sensible to try to reduce the risk any further (EEA – Envirowindows 2000). ALARP, as BATNEEC, depends on the sector being evaluated. In an environmental context, there are now plans, within the EU, to establish benchmarking performance indicators through the CEIDOCT (Comparable Environmental Impact Data on Cleaner Technologies) initiative. The aim of CEIDOCT is to bring together the separate industry approaches and provide a minimum dataset to be used by all industries. This dataset would be supplemented by the relevant industry to acknowledge prevailing local conditions and specific industry concerns.

3.8 Toxic Chemicals – A specific example.

In the rating of environmental risk, specific classifications should be used where possible. Examples of this may be found in MSDS (Materials Safety and Data Sheets) or in specific chemical hazard identification systems.

In the USA, the CPL classification looks, in particular, at the nature of a chemical and the harm it can do as well as the physical state of the chemical. (Table 3.13).

Low	**TYPE OF HARM**		High
IRRITANT	HARMFUL CORROSIVE	TOXIC	CARCINOGEN

Low – easier to control	**PHYSICAL STATE**			High – difficult to control
Solid	Liquid	Dust	Vapour	Gas

TABLE 3.13: CPL classification of chemical nature. *(Harte, 1998)*

The USA EPA define Acute Toxicity as LD50 (Harte 1998) and have the following classification regarding the Toxicity Category (Tables 3.14) and carcinogens (Table 3.15)

Rating by Dose					
	Toxicity Category	**Oral LD50 (mg/kg)**	**Dermal LD50 (mg/kg)**	**Inhalation LC50**	
				(mg/L dust)	**(PPM vapour/gas)**
I	DANGER POISON	≤50	≤50	≤2	≤200
II	WARNING	50 – 500	200 – 2000	2 – 20	200 – 2000
III	CAUTION	500 – 5000	2000 – 20000	20 – 200	2000 – 20000
IV	caution	> 5000	>20000	> 200	>20000

Rating by Effect		
	Eye Effect	**Skin Irritation**
I	Irreversible corneal opacity at 7 days	Severe irritation or damage at 72 hours
II	Corneal opacity reversible within 7 days or irritation lasting 7 days	Moderate irritation at 72 hours
III	No corneal opacity, irritation reversible within 7 days	Mild or slight irritation at 72 hours
IV	No irritation	No irritation at 72 hours

TABLE 3.14: EPA (USA) Guidelines *(Harte, 1998)*

Group	Name	Description
A	Human Carcinogen	This classification indicates that there is sufficient evidence from epidemiological studies to support cause-effect relationship between the substance and cancer
B	Possible Human Carcinogen	B1: Substances are classified as B1 carcinogens on the basis of sufficient evidence from animal studies and limited evidence from epidemiological studies. B2: Substances are classified as B2 carcinogens on the basis of sufficient evidence from animal studies but the epidemiological data are inadequate or non-existent
C	Possible Human Carcinogen	For this classification, there is limited evidence of carcinogenicity from animal studies and no epidemiological data.
D	Not Classifiable as to Human Carcinogenicity	The data from human epidemiological and animal studies are inadequate or completely lacking, so no assessment as to the substances cancer causing hazard is possible.
E	Evidence of Non-carcinogenicity for Humans	Substances in this category have tested negative in at least two adequate (as defined by the EPA) animal cancer tests in different species and in adequate epidemiological and animal studies. Classification in group E is based on available evidence; substances may prove to be carcinogenic under certain conditions.

TABLE 3.15: EPA Classification of Carcinogens *(US Interagency Staff Group on carcinogens. 1986. Chemical Carcinogens: A Review of the Science and its Associated Principles. Environmental Health perspectives 67:210-282. quoted in Harte, 1998)*

3.9 Conclusions

The route from risk management to environmental risk management offers much distraction. A large number of methods have been proposed from the simple to the complex. The more complex methods would appear to be 'better' since they tend to give more definition and the results are quantified suitable for comparison. The risk is that methods developed for a particular circumstance or industry may not be directly suitable foe use in another situation. This is one of the reasons why the ISO Technical Committee probably shied away from prescribing a method in ISO 14001. There is also a risk that numerical analysis may suggest precision which can not necessarily be supported.

The method used should not lose touch with the principles of risk assessment: hazard, pathway and target. This is seen clearly in the standard approach to vibration / noise attenuation:

1) Eliminate the creation of vibration / noise
2) If this can not be done, stop the vibration / noise being transmitted to the target
3) If neither of the above can be done, protect the target directly

In environmental risk assessment, it is necessary to consider:

1) HAZARD / SOURCE: What are the direct / indirect environmental aspects of the activity?
   a) inputs, outputs, type, magnitude, frequency, persistence etc.
   b) technology guidelines
2) PATHWAY: What can be / is being done to reduce the impact on the target / media affected?
   a) monitoring, attenuation, containment, training etc.
   b) emission limit values
3) TARGET / MEDIA AFFECTED: What is the actual or potential nature (direct and indirect) of the impact(s) on the environment or eco-system.
   a) ozone depletion, global warming, species affected, land use, visual nuisance, acid rain etc. (see Appendix D)
   b) particular concerns regarding thresholds, local issues etc.
   c) ambient pollution data / ground level concentrations

4.1 ISO 14001 Context

The ISO 14001 standard, clause 4.3.1 requires:

> **Environmental aspects**
>
> The organisation shall establish and maintain (a) procedure(s) to identify the environmental aspects of its activities, products or services that it can control and over which it can be expected to have an influence, in order to determine those which have or can have significant impacts on the environment. The organisation shall ensure that all aspects related to these significant impacts are considered in setting its environmental objectives.
>
> The organisation shall keep this information up-to-date.

The organisation is required to develop a procedure which can consistently identify its environmental aspects. As part of the procedure, a plan needs to be made for keeping the information up-to-date (frequency and methodology). There is an immediate requirement that the aspects associated with the significant impacts are considered when setting environmental objectives and targets (Clause 4.3.3 requires the setting of Objectives and Targets consistent with the organisation's environmental policy). Organisations experience little difficulty in addressing these management issues.

The area of difficulty is in interpreting the meaning of "its activities, products or services that it can control and over which it can be expected to have an influence, in order to determine those which have or can have significant impacts on the environment." The difficulties are in the following areas:

- **Thoroughness:** embracing all aspects of "activities, products and services" which it can be expected to have either direct or indirect influence over.
- **Scope:** considering all aspects which "can or can have" significant impacts and those aspects over which it has control or expected to have influence.
- **Significance:** developing a methodology which works (i.e. can be used by other qualified persons with repeatable results).

The first places of reference must be the ISO 14001 which contains guidance in the introduction and annexes and ISO 14004.

It is important to realise that there are no "absolute requirements for environmental performance beyond commitment, in the policy, to compliance with applicable legislation and regulations and to continual improvement. Thus two organisations carrying out similar activities but having different environmental performance may both comply with its requirements" (ISO 14001, 1996). Neither is there an implication that environmental measures must be taken regardless of other business priorities since "This process (aspects identification) should take into account the cost and time of undertaking the analysis and the availability of reliable data. (...) Organisations may also take into account the degree of practical control they have over the environmental aspects being considered." (ISO 14001, 1996: Annex A.3). In essence, the standard suggests that organisations use a balanced approach and acknowledge any limitations (such as reliability of data, time and cost) rather than to go for a comprehensive in depth examination.

McCallum and Fredericks (1996) believe that at least three types of information are required to enable risk managers to address environmental risks:

1. Data regarding the organisation's environmental performance and relevant environmental issues
2. Criteria upon which to base environmental decisions
3. A framework in which to make risk-based decisions

The authors recommend that "a balance of frequency and consequence is used to assess significance and care should be exercised to resist the temptation to select a certain measurable item because it is measurable and seems on the surface to relate somehow to the issue. (...) One difficulty in the interaction between organisation and ISO registrar is the absence of a common approach that the registrars can adhere to as there are no related ISO standards on either risk management or environmental assessment". As already discussed, frequency and consequence are only two of the issues which might be considered; there is an argument to suggest that other issues should be considered as well.

A review of the current position of the organisation with regard to the environment is required unless the organisation has an existing system. Information already developed for regulatory or other purposes may be used in this process. (ISO 14001 1996). In practice,

most organisations will have not undertaken a thorough review as previous licensing may have been 'single media'; even with an integrated pollution control license (IPC) there are areas which are not covered (environmental aspects of services and products, for example). For a new system, Sheldon and Yoxon (1999) advise that 40% of an organisation's time (when implementing an ISO 14001 system) should be spent on the identification of aspects and impacts.

4.2 Thoroughness and Scope

The standard explains that the scope must include "the inputs and outputs associated with their current and relevant past activities, products and/or services" (ISO 14001. 1996)

To aid the organisation, ISO 14001 advises that, apart from legislation, the areas which are most important:

- An examination of all existing environmental management practices and procedures
- An evaluation of feedback from the investigation of previous incidents.

Any situation being examined should be considered:

- under normal operation
- at start-up and shut-down
- abnormal operation
- reasonably foreseeable or emergency situations.

The main concerns identified by ISO 14001 are:

- Emissions to air
- Releases to water
- Waste management
- Contamination of land
- Use of raw materials and natural resources
- Other local environment and community issues

The approach advocated by ISO 14004 suggests the use of "checklists, interviews, direct inspection and measurement, results of previous audits or other reviews depending on the nature of the activities". In the thesis by C. Grimes (1999), the author identified the techniques used by the 38 respondents in her survey (see Table 4.01). By looking at the

total response, the total number of all methodologies is 158 that suggests that an average of about 4 techniques were used by each of all the respondents. This shows that no one methodology is regarded as sufficient. The methodologies can be broken down into those used for information gathering (I = checklists, interviews, observation etc.) and those used for analysis and understanding (A = networks, matrices, quantitative methods etc.).

No. Used	Method Category	Examples
31	Ranking (A)	
24	Ad-hoc Methods (I)	Interviews,
31	Checklists (I)	Simple, descriptive, questionnaire and threshold of concern
14	Matrices (I/A)	Simple, magnitude, Leopold, weighted, Saratoga, component interaction matrix, three-dimensional matrices, stepped matrices and rapid impact assessment matrix, cause and effect diagrams.
33	Network Methodologies (A)	Sorenson, IMPACT, coherence, systems diagrams and environmental impact identification systems, input/output, life cycle analysis, HAZOP.
1	Overlay Methods (A)	
6	Quantitative Methods (A)	Environmental evaluation system, water resources assessment method, Sondheim method, sphere quantified matrix, fuzzy mathematics, FMEA
	Geographical Information Systems (A)	
	Monetary Evaluation Techniques (A)	Cost benefit analysis
15	Multi-Criteria / Attribute Methods (A)	CBA, environmental evaluation systems, decision analysis, goal and achievement matrix and FTA/ETA. multi-criteria analysis, decision analysis, goal achievement matrix, multi-attribute utility theory, delphi-method, judgement analysis.
1	Expert Systems (A)	Computer systems

TABLE 4.01: Assessment Methodologies *(Grimes, 1999)*

Block (1997) recommends the examination of individual processes "because every process is bounded by the discrete parameters of inputs (such as materials and energy), a value added transformation, and outputs (such as finished product, reusable materials, wastes)". This concurs with the recommendations in ISO 14004 which outlines a four-step approach and advocates selecting an activity, product or service and looking at its aspects and impacts (Tables 2.01 and 4.02 define the terms Aspect and Impact).

	Process	Product	Service
Example	Manufacture of acrylonitrile monomer	Styrofoam cup	Lawn maintenance
Aspect	Ammonium sulphate	Non-degradable or recyclable	Application of herbicides and pesticides
Impact	Injection of a ammonium sulphate into deep wells	Landfill	Non-point pollution

TABLE 4.02: Aspect and Impact for Activity, Product or Service *(Block, 1997)*

In a practical example, the storage of a chemical in a tank would involve consideration of the following:

Normal (no special event)

- nature of material in the tank
- use of the material in the tank
- venting / fugitive losses
- historical (losses to soil / groundwater)
- rainwater disposal from bund / tanker loading bay
- odours ?
- visual impact

Start-up / Shut-down / Abnormal

- the filling of the tank
- the cleaning of the tank
- the painting of the tank
- disposal of tank residues
- taking samples for laboratory analysis

Potential Emergency

- integrity of pipelines to/from tank
- integrity and size of bund wall
- use of naked flame by tank
- rupture of tank
- overfilling of tank
- grounding of tank / lightning protection
- mixing contents of tank
- valving and controls failure
- accidental damage caused by tanker used to fill tank
- minor spillages
- vandalism / security issues

Indirect Impacts

- selection of chemical supplier / transport company
- selection of contractors used for painting and maintenence

A similar process is then carried out for each activity. The danger of an activity based approach is that some aspects will be missed because:

- the activities are discrete (e.g. abstraction of water from aquifer via well-head) or
- the activities are inherent at the site (e.g. asbestos in the building or insulation fabric or PCBs in transformers) or
- the activities are not current (e.g. occasional use of water for cooling in summer, area of ground that was used for burning of rubbish, the old oil tank area before the switch to natural gas etc.)

The last point is covered by Block (1997) who, in addition, mentions "construction, changes in operations and clean-up projects". Changes in operations need to be considered and there is a specific requirement under clause 4.3.4 'Environmental Management Programmes' – "If a project relates to new developments and new or modified activities, products or services, programme(s) shall be amended where relevant to ensure that environmental management applies to such projects".

Sheerin (1997) quotes Mr. James Greaney of Symantec Ltd. as saying that a difficult issue was deciding whether something was normal or abnormal

- Is a decaying load of food on a truck stuck in a port a normal or abnormal situation?
- If a factory located in a residential area, is running a three shift system for a short period a normal or abnormal situation?
- If odours are sensed near a factory only during hot weather, is this a normal or abnormal situation?
- If security lighting is installed around a building and it impinges on the public roadway, is this a normal or abnormal situation?

In practice, the distinction between abnormal and normal activities may be difficult to establish objectively but, in the analysis, it should not affect the designation of significance and, provided an aspect is considered, the precise normal/abnormal definition is academic.

ISO14004 (1996) specifically states that "organisations do not have to evaluate each product, component or raw material input. They may select categories of activities, products or services to identify those activities, products or services to identify those aspects most likely to have significant impact." However, most organisations start by carrying out an inventory of their inputs (raw materials and energy) and outputs (wastes

and products) and, although not a requirement, will have a look at mass balance and life cycles to aid their understanding.

Internal	External
Activities	**Activities**
• waste handling and disposal • materials and product handling • process operations • maintenance	• wastewater management • property use • waste disposal
Physical conditions	**Physical conditions**
• heating and cooling systems • piping and venting • containment, drains and sumps • storage containers / tanks • utilities supply • stains • noise, light, vibration and heat • air emissions • landfills	• site surroundings and adjacent properties • soil and groundwater conditions • stained surfaces and stressed vegetation • waste handling and disposal • fill materials • on-site disposal tanks • fuel and other storage tanks • hazardous materials, products and substances • containment • air emissions • discharges to water

TABLE 4.03: Areas which should be reviewed in as assessment *(ISO 14015)*

ISO 14001 advises that one need only look at aspects "over which the organisation can control or can be expected to have an influence". Block (1997) notes that "a contractor or supplier to the organisation may have comparatively little control, while the organisation responsible for product design can alter the aspects significantly by changing, for example, a single input material. Whilst recognising that organisations may have limited control over the use and disposal of their products, they should consider, where practical, proper handling and disposal mechanisms. The provision is not intended to change or increase an organisation's legal obligations."

ISO 14015 (in committee draft stage) is a standard for environmental assessment of sites and organisations. Like ISO 14031, the scope states that it is not specifically intended for use with ISO 14001. However, it provides general guidance on the scope of assessment as well as suggesting documents and records that should be collected and reviewed in order to obtain a comprehensive understanding of the site or organisation. It also includes a schedule of areas that might be covered in the review (see Table 4.03)

4.3 Checklists

A normal way of considering all the above advice and distilling it into a form that can be reviewed is to prepare checklists. Grimes (1999) identified this method as one of the most commonly used. Appendix C gives examples of published checklists.

It should be noted that no two checklists are identical and all have their merits in certain circumstances. One example tags aspects and associated impacts; this helps achieve a method of cross-referencing with objectives which can be similarly indexed so that, for example, objective WU (Water Use) can be clearly related to associated impacts and aspects.

4.4 Life Cycle Assessments

Although not regarded as a necessary methodology, life cycle assessments often help organisations examine the aspects and impacts associated with the use of their products. This is particularly relevant where the organisation has control over the design of the product, its packaging or servicing. An example is given in Table 4.04.

ACTIVITY	ENVIRONMENTAL ASPECT	ENVIRONMENTAL IMPACT
Obtaining the raw materials	Extraction of oil	Natural resource depletion. Potential water contamination. Ecological habitat damage.
Obtaining raw materials	Extraction of metals	Natural resources depletion. Potential water contamination. Ecological habitat damage. Visual impact.
Manufacturing the plastic feedstock	Energy consumption	Greenhouse effect. Local air quality. Noise.
Manufacturing the plastic feedstock.	Use of chemicals, solvents etc.	Potential air and water contamination Local air quality.
Manufacturing the pen	Energy consumption	Greenhouse effect. Local air quality. Noise.
Packaging the pen(s)	Energy Consumption Paper and card	Greenhouse effect Local air quality Ecological habitat damage
Transporting the pens	Energy consumption	Greenhouse effect. Local air quality. Noise.
Disposal of the pens	Landfill	Ecological habitat damage Visual intrusion Waste burden

TABLE 4.04: Life Cycle Analysis "Manufacture of a Pen" *(Sheldon and Yoxon, 1999)*

Hunt and Johnson (1995) suggest that a checklist could be used based on a life cycle model (Table 4.05).

	Stage of life cycle				
Effects	**Raw Material**	**Production**	**Distribution**	**Use**	**Disposal / recycling**
On Air					
On Water					
On Land					
Resources					
Nuisances					

TABLE 4.05: Life Cycle Checklist *(Hunt and Johnson, 1995)*

4.5 Significance

The European Environmental Agency has published a table (EEA, 1998 quoted in Sheering, 1997 and others) which defines generic organisation types and the issues that are likely to be significant (see Table 4.06).

This is a top level mapping of significance but the organisation will have to examine its own particular concerns and make its own determination as to what aspect and impacts are significant.

ISO 14031, Environmental Management - Environmental Performance Evaluation – Guidelines (1999) states in the introduction that it "Can assist in identifying its environmental aspects determining which it will treat as significant" although , having given the impression that it can be used as additional guidance for ISO 14001 implementation, it explicitly excludes that relationship. However, it does describe the Plan, Do, Check, Act cycle (Shewhart Cycle) and advises in clause 3.2.1, that "To determine significant environmental aspects such an organisation should consider:

- the scale and nature of material and energy usage
- emissions
- risks
- the condition of the environment
- the possibility of incidents
- legal, regulatory and other requirements to which the organisation subscribes"

Moderately significant Highly significant

Industry Type	S	E	T	U	V	P	R	W	A	N
Agriculture, forestry and fishing										
Energy and water supply										
Minerals, metals, chemicals and plastics										
Metal goods, engineering and vehicles										
Food, drink and tobacco										
Pulp, paper and other manufacturing										
Distribution and Transport										
Communications, printing and publishing										
Banking, finance and insurance										
Retailing										
Marketing and advertising										
Construction										

S = Solid Waste
E = Energy
T= Transport
W= Water Pollution
V= Visual Impact / Wildlife
P = Purchasing
R = Resources
N = Noise Pollution
A = Air Pollution
U = Use of water

TABLE 4.06: Environmental Aspects by Industry Sector *(EEA, 1998)*

ISO 14031 adds specific mention of 'energy use' and the 'condition of the environment' which are not mentioned in ISO 14001 or ISO 14004. This brings into question the compatibility of the various ISO Environmental Standards which are the outcome of separate technical committees as there appears no reason for ISO 14031 to give a different list of what makes an aspect significant (even though it says it excludes ISO 14001). (Refer to Section 2.2 for details of the guidance on assessing significance from ISO 14001 and 14004).

Hunt and Johnson (1995) believe that more guidance "is simply not practicable in a generic standard which can only advise that subjective judgements will be necessary and that the evaluation system should be self-consistent. (...) Fundamental issues which need to be taken into account include:

- The breadth of the evaluation which mean that a structured approach is required
- The fact that all activities have effects so that a continuous process of effect identification and evaluation is necessary. In other words, one cannot simply list all effects and then evaluate their significance; some degree of evaluation is necessary in the initial identification step.

- The identification and evaluation process involves a fundamental conflict between on one hand ensuring that important effects are not overlooked, and on the other hand, that most attention is paid to potentially significant effects."

However, from the advisory notes, it is evident that the following factors should be considered (Table 4.07).

KEY WORDS	OTHER MEANINGS
Scale	Magnitude
Severity	Magnitude, Local, Regional, Global, Scientific data
Duration	Reversibility, Acute/Chronic,
Probability	Likelihood, Frequency
Legal	Licences, prosecution, liability
Possibility for Change	Technology
Cost of Amelioration	
Interested Parties	
Public Image	
Local Concerns	Sensitive location, Existing issues

TABLE 4.07: Environmental Factors *(Derived from Hunt and Johnson, 1995 and ISO 14004:1996)*

The advisory book for UK local government (HMSO 1993) suggests that 'significance' can be determined by looking at:

- The magnitude of the effect in relation to the issues concerned
- The magnitude of the effect in relationship to the other effects of the operational unit in question
- The environmental issue concerned.

However, no specific guidance is given on how this can be practically achieved besides suggesting that this take place in three stages:

- Scoping Review: identifying which are the significant effects of the operational unit.
- Detailed Review: identifying exactly how much and what kind of effects are being caused in these ways.
- Review Report: drawing a general pattern and conclusion from the detailed work done.

Quantity alone will not be sufficient to judge significance since, as Sheerin (1997) notes, it only took 1 litre of benzene to contaminate over 100 million litres of drinking water at Perrier, France.

Hunt and Johnson (1995) note the difficulty in evaluating effects which are not regulated, but which appear to be potentially significant. This is because there is no universal metrics for comparing widely differing effects (for example, comparing the discharge of a hazardous substance to a watercourse with an increased energy use or with a loss of habitat). To avoid wasting time, it is suggested that quantification should only be used where:

- A preliminary review has established that the impact is likely to be judged significant
- It is needed to reach a judgement
- It will be required for setting objectives
- Performance improvements deem that better metrics are required to drive further improvement

In a review of the process (Quality Digest, June 1997), C. Foster Knight is quoted as dividing impacts into two classes, the regulated and the non-regulated. This implication being that regulated impacts are normally regarded as 'significant' and an identification of these impacts will allow the time to be spent on determination of the non-regulated impacts.

Roberts and Robinson (1998) suggest that the significance test should be based on the following questions:

1. Is the identified aspect or impact associated with any legislation, regulation, authorisations or industry codes of practice by which your site or company is bound?
2. Is the identified aspect or impact the source of complaints from your employees, neighbours, stakeholders or the community in which you operate?
3. Is the identified aspect or impact of concern to your employees, shareholders, bankers, customers, clients, insurers or lawyers.
4. Is the identified aspect or impact clearly associated with any of the more serious global environmental issues such as:
    - Global warming and the Greenhouse Effect
    - Ozone depletion
    - Acid Rain and acidification
    - Eutrophication
    - Deforestation
    - Loss of Biodiversity
    - Non-renewable resource use

5. Is the identified aspect or impact associated with the use of substances that are known, or suspected to be, toxic to plant, animal or human life on the planet.

To this is added :

6. Is the aspect identified quantifiable, is the amount of use significant
7. Is the aspect quantifiable, is the amount or frequency of use significant

But the above contributions do not define 'significant' but illustrate some of the concerns that need to be addressed by an organisation determining the significance of their impacts. There threshold when an impact becomes significant must be left to the organisation to determine depending on the aspect and the relative severity of the impacts on the environment: this is normally accomplished through a scoring system.

4.6 Scoring Systems

There are very few systems in use or reference books that do not introduce scoring systems. However, Roberts and Robinson (1998) are quick to note that prioritisation is not a requirement of the ISO 14001 standard (although it is required in EMAS). Many would argue that, without prioritisation, it is more difficult to set objectives and targets but it is important to establish that prioritisation is optional even though the process has its merits if driven by accurate data and sound evaluation.

As an example of a very simple approach, Sheerin (1997) quotes Mr. Barry Carey of EG+G Sealol as looking at

- The degree of hazard of the aspect being considered
- The potential impact involved.

and then categorising the environmental effects as either:

- Class A: - Major Environmental Effect
- Class B – Intermediate Environmental effect
- Class C: - Minor Environmental Effect

Although this is not an uncommon method, it requires good backup (checklists, working evaluations etc.) to be effective and, moreover, it only works in comparatively simple situations.

Although discussing EMAS, Hillary (1998) notes the important issue "is that the methodology they use is logical and defendable as it is likely that the accredited environmental verifier will examine the system in place used to determine 'significance' rather than the significance *per se*" Hillary sees significance as:

Significance = legislation + standards + stakeholder views + scientific evidence + regulator's demands + public attitudes"

Hillary introduces the idea of either using a simple approach as shown in Table 4.08 where an impact is either 'negligible', 'minor', 'significant' or 'major'. This approach, if adapted to suit a organisation's actual circumstances, would be adequate. However, the danger is that it could lead to a complacency when all impacts are, eventually, scored as insignificant because abnormal conditions (as distinct from emergencies and incidents) can be prevented from causing a breach in statutory regulations. This would hinder the process of continuous improvement that is required by the standard.

Scale	Key word	Description
1	Negligible	Very small effect Low probability of occurrence
2	Minor	Abnormal conditions would cause a breach of statutory regulations. Effect and probability of occurrence are both small
3	Significant	The activity has an effect under normal operating conditions and results in a breach of statutory regulations under abnormal conditions. Effect and probability of occurrence are moderate.
4	Major	The activity under abnormal conditions is a major breach of statutory regulations. Effect, as result of quantity and type of material, is extensive.

TABLE 4.08: Scoring system for Environmental Impacts *(Hillary, 1997).*

An alternative approach is suggested by the same author where Occurrence (O) and Detection (D) are added and graphed against Severity (S) (Table 4.9). It is intended that a zone be established on the graph and designated as 'significant. Instead of graphing, it can be expressed as (O+D)*S= 'significance' with an arbitrary value given for when an impact becomes significant. The advantage of a scoring system is that it does facilitate continuous improvement with the higher scoring impacts attracting the greater focus. The difficulty is that the descriptions are highly subjective and it is unclear where some of the issues mentioned in ISO 14004 are covered (in particular, legal requirements).

Likelihood of Occurrence		Likelihood of Detection		Severity of Consequences	
Very High	5	Certain	0	None	0
High	4	Very High	1	Minor	2
Moderate	3	High	2	Low	4
Low	2	Moderate	3	Moderate	6
Very Low	1	Low	4	High	8
None	0	Very Low	5	Very High	10

TABLE 4.09: Scoring System: *(Hillary, 1997)*

In an attempt to widen the scoring system to include more elements (see ISO 14004), Roberts and Robinson (1998) have proposed a scheme which is part checklist and part subjective scoring – essentially it is Severity x Impact = Significance. The method requires a subjective judgement on the severity (a score of 1 to 5) (Tables 4.10 and 4.11) coupled with a score which is devised from answering a set of questions about the impact (one point for each 'yes' answer). This method expands on that proposed by Hillary in allowing the consideration of more issues but it is still weak in its reliance on subjectivity. Given that it is normal for organisations to consider any legal requirement as significant, legislation would not appear to be weighted sufficiently as an 'impact'. For example, an organisation with a requirement to keep sulphates in water discharges to below 800 mg/l might rate this as a 'slight environmental effect' and only give one impact point for legal requirement (even that might be given begrudgingly since legal is in the same question as hazardous which might suggest that a legal requirement on a non-hazardous substance should get ½ point). The result is unlikely to score higher than '2' which would be insignificant.

Severity Factor

1	No or minor environmental effect
2	Slight environmental effect
3	Moderate environmental effect
4	Serious environmental effect
5	Disastrous environmental effect

TABLE 4.10: Severity Factor *(Roberts and Robinson, 1998)*

Impact Factor (one point for each answer 'yes')

	Legislation or code? Hazardous or restricted substances?
	Stakeholder concern?
	Global environmental effect?
	Amount significant?
	Frequency/amount of use significant?

TABLE 4.11: Impact Factor *(Roberts and Robinson, 1998)*

Considering that legal compliance is at the forefront of an adequate environmental system, a system that does not address this adequately is unsatisfactory (although, in this case, the methodology is interesting and worthy of adaptation).

FREQUENCY OF EVENT	1	very rare (e.g. infrequent production campaign)
	5	continuous (e.g. treated effluent discharge)
LIKELIHOOD OF LOSS OF CONTROL	1	extremely unlikely (e.g. complete failure of a robust process control element)
	5	= highly likely (e.g. the spillage of a widely used solvent)
SEVERITY OF CONSEQUENCES	1	very limited, localised impact (e.g. local dust problem)
	5	extensive and severe damage (e.g. toxic spills to a large watercourse)

TABLE 4.12: Scoring System *(Hunt and Johnson, 1995)*

Hunt and Johnson (1995) use a formula for significance that is:

Significance =Frequency x Likelihood of Loss of Control x Severity of Consequences

Table 4.12 gives the basis of the scoring system. Thus, under air emissions, the need to manually transfer a solvent which is normally piped might score as '1' (frequency = a rare event), '4' (likelihood of loss of control = a problematic operation with a good chance of spillage) and '1' (severity = a very local problem as the high BP solvent is not flammable and can easily be cleaned-up) giving a total of '4'. The system is subjective and does not consider legal requirements but the criteria selected concur with other authors and with many systems used in practice.

Another interesting technique suggested by Hunt and Johnson suggests that significance could be related to a national context; for example, the use of electricity. A company with a turn-over of £43m and an annual use of 310 GWh of electricity is in a country that has a GDP of £543,000m and a generation capacity of 273,000 GWh. The significance is calculated on whether the organisation uses 'more than its fair share' when comparing the ratios of turnover/GDP and power use. This is an interesting technique but, if carried to its logical conclusion, it would suggest that almost everything that the developed world does is significant in a world context (i.e. 20% of world population using 80% of world resources). Even though this is, in some eyes, a correct conclusion, it is a little too far from the grasp of the average organisation and a more 'domestic' approach to significance is more beneficial.

Sheldon and Yoxon (1999) (Table 4.13) advise that a scoring system should be based on:

- SIZE of potential problem?
- LIKELIHOOD of the problem occurring?
- HAZARD: how hazardous is the potential impact?

Using a scoring for each of 1, 2 or 3 and the multiplying to get a figure (max. 27)

This is then entered in a table and each significance score is the adjusted by adding score (again 1, 2 or 3) which reflect:

- ENVIRONMENT: knowledge, receiving environment, contribution, what is likely to happen.
- INTERNAL BUSINESS: regulatory, health and safety, cost of production, best practice, personnel.
- EXTERNAL BUSINESS: bank, insurers, public, customers

SIGNIFICANCE (circle score and multiply in each category)				**SCORE**
Size	1	2	3	Max. 27
Likelihood	1	2	3	
Hazard	1	2	3	
Environment	1	2	3	Max. 27
Internal Business	1	2	3	
External business	1	2	3	
Description of impact				**Statement**
Must Do: these actions could be legal requirements, cost saving necessities or customer demands.				
Will do: these actions could be short term investment which would bring immediate cost savings				
Could Do: these actions could be longer term management programmes which have been identified as effective investments and will bring measurable benefits				
Aspect: what is the business activity that is the cause of these impacts.				
Options: what management options already exist or could exist.				

TABLE 4.13: Scoring System *(Sheldon and Yoxon, 1999)*

Although this system is subjective, it is simple and could be improved by developing guidance on how to score more objectively. The legal requirements are covered in the 'must do' section; this acknowledges that there may be lower impact items which may become significant through the existence of legislation. The 'must do' is the highest significance with 'will do' referring to significant impacts of a lower priority. 'Could do' is the category where continuous improvement is identified but where programmes are not

at present in place. 'Could do' items would be reviewed annually and might become 'Will Do' items if management consider the time is right to implement the improvement.

A very specific system is offered by The Environmental Advice Centre, UK (BTCV 1997). After discussing the merits and difficulties of an ad hoc system which it concludes to be "quite heavily (reliant) on human judgement thus giving a highly subjective result." The authors note that "the major problems with this method are that judgements can be clouded by human irrationality and fears, financial implication and a lack of consistency from one assessment to the next. The latter aspect could be due to new awareness of environmental issues or changes in team members. Human fears and financial implications are still important, however, but generally play a part in a subsequent function or prioritising action. For instance, certain actions may need to be taken due to a concern or fear amongst neighbouring communities"

The system offered is based on a series of charts that are each completed and scored. Each table has five criteria and five scoring bands depending on the aspect being considered. An additional weighting is obtained from tables that give five bands relative to quantity. The total score for each aspect can be from 1 to 125. Each aspect is entered on the appropriate table and scored (see Table 4.14 and Appendix C).

#	**Aspect Evaluated**	**Five Criteria Considered**
1	Pollution	Range, Toxicity, Interaction, Control, Permanence
2	Resource	Implications, Scarcity, End point, Up-stream, Down-stream
3	Nuisance	Category, Range, Receiving area, Control, Occurrence
4	Incident	Range, Hazard type, Dose-response, Remedial action, Control
5	Contractor	Energy use, Env. risk, Main resources, Nuisances, Waste production
6	Waste	Hazard nature, Recyclability, End point, Disposal effects, Control
7	Packaging	Up-stream risk, Recyclability, Marking, % Recycled, Down-stream

TABLE 4.14: Aspects evaluated and criteria considered *(BTCV 1997)*

Any score more than 25 is significant with a category of 'very significant' for any score over 91.

A	Very significant	=	91 – 125
B.	Significant	=	26 – 90
C.	Low significance	=	5 – 25

This method is very well defined with each of the work sheets specific to the media being considered and is a good example of a thorough methodology. The criteria are well defined. It appears complex but the data on which the tables are based is only an example. Any organisation using this method would need to adapt the data to their own requirements and need not include more categories than are relevant.

4.7 Expert Systems

Through an internet search, an expert system by Entropy International (www.entropy-international.com) has been downloaded and assessed. The system uses a 'Significance Wizard' which initially constructs a flow chart of the business processes to which aspects are attached as appropriate. The aspects are attached to the process flow chart by a drag-and-drop process and the menu is extensive (see Appendix C)

#	Question	Answer / Score	
1	Is the aspect associated with any legislation, regulations, authorisations or industry codes of practice? OR Does the identified aspect involve the use of any hazardous, restricted or special substances? *List of all CAS numbers available on drop down menu*	Yes No	1 0
2	Is the aspect of concern to stakeholders i.e. employees, clients, customers, neighbours, shareholders, lawyers, bankers, insurers or the local community	Yes No Possibly	1 0 0.5
3	Is the identified aspect or impact clearly associated with any of the more serious global environmental issues e.g. global warming and greenhouse effect, ozone depletion, acid rain and acidification, eutrophication, deforestation, loss of biodiversity or non-renewable resource use.	Yes No Possibly	1 0 0.5
4	Is the aspect quantifiable, is the amount significant?	Yes No Possibly	1 0 0.5
5	If the aspect identified is quantifiable, is the frequency of use significant	Yes No Slightly	1 0 0.5

TABLE 4.15: Aspects Drop Down Menu from Significance Wizard *(Entropy International, 2000)*

Having attached the appropriate aspects to the activities on the network, each aspect has to be assessed for significance. This is done by using a menu driven system that is called-up

for each aspect. The significance is assigned by selecting options under 'impact' and 'severity'. Each has a maximum score of 5 points and the result is multiplied. Results of 12 and over are 'significant' and those of 7 and over 'notable' (see Tables 4.15 and 4.16).

Severity Option	Score
No or minor environmental effect?	1
Slight environmental effect?	2
Moderate environmental effect?	3
Serious environmental effect?	4
Disastrous environmental effect?	5

TABLE 4.16: Impacts Drop Down Menu from Significance Wizard *(Entropy International, 2000)*

The expert system allows the user to get straight down to the task of inventorying the aspects and impacts and it also has excellent reporting and other modules which work with the basic "significance wizard". The programme produces useful graphs and reports that would help the environmental manager and save a great deal of time in 're-inventing the wheel'. Obviously, by using an expert system, much of the methodology is defined in the programme and may not be able to be customised. However, it would appear possible to alter the significance thresholds, for example, if there are few scores over 7. Positive impacts would be scored as negative impacts (the options on severity can be seen in a positive context if needed). Indirect and direct impacts are selected by a switch and the programme automatically prompts with the impact of any of the aspects selected. The user can add to the script and/or add notes against any aspect. The programme does not appear to take into account cumulative effects. Small amounts of the same environmental impact in different locations might each be reported as insignificant but, when seen together, become a significant impact for the site as a whole.

The programme comes with a useful tutorial and checklists that can be used to gather information before constructing the significance network. An example of the type of questionnaire can be found in Appendix C.

4.8 FMEA (Failure Mode and Effect Analysis) Approach

The FMEA approach is very attractive to systems managers. It is commonly used in industries that need to reduce or eliminate risk; for example, aerospace or automotive. It is a well documented approach in quality management with strict guidelines on use and interpretation but its application to environmental systems is not well established even if it

is commonly used. In an article in Quality Digest 11/98, Vandenbrande advocates the use of the FMEA approach.

The key to the use of an FMEA is the 'milking stool' concept – finding three variables which have an important influence on the downstream risk and quantifying each to reach a determinant for the total risk. The method is described in Section 3.5 These values are transferred to the environmental arena by defining them as (i) how 'severe' the impact is to the environment, (ii) how effectively the impact can be 'detected' before it reaches the environment and (iii) the likelihood of 'occurrence' of the impact. Vandenbrande approaches the three criteria in the following manner (see Tables 4.17, 4.18 and 4.19)

The process is one of teamwork and it is important that all functions are involved. The result is a chart (which the author calls a PNEIA – Potential Negative Environmental Impact Analysis) describing each impact is analysed (see Table 4.20)

Severity of Impact	**Ranking**
Will hardly be noticeable. Very low to negligible impact on the environment	1 – 2
Non-compliance with company policy. Low to very low impact on the environment	3 – 4
Non-compliance with legal and regulatory requirements and possible damage to the reputation of the company. Moderate damage to the environment.	5 – 6
The health of the people living in the surrounding area could be threatened. Serious damage to the reputation of the company. Serious damage to the environment.	7 – 8
Endangers the lives of people living in the surrounding area. The further existence of the company is threatened. Very serious damage to the environment	9 – 10

TABLES 4.17: Severity PNEIA definitions. *(Vandenbrande, 1998)*

Occurrence		**Ranking**
Remote. Highly unlikely condition will ever occur	< 1 in 1000000	1 – 2
Low. The condition occurs in isolated cases but the chances are low.	1 in 20000 to 1 in 2000	3 – 4
Moderate. The condition has a reasonable chance to occur (could be at start-up or shut-down)	1 in 80 to 1 in 2000	5 – 6
High. The condition occurs very regularly and/or during a reasonable amount of time	1 in 8 to 1 in 80	7 – 8
Very High. The condition will inevitably occur during long periods (typical for normal operation)	About 1 in 2	9 – 10

TABLES 4.18: Occurrence PNEIA definitions. *(Vandenbrande, 1998)*

Detection	Ranking
The current controls will almost certainly immediately detect the aspect and reaction can be instantaneous.	1 – 2
Chances are high that the aspect will be detected shortly after occurrence and a quick reaction is possible	3 – 4
There is a moderate chance that this aspect will be detected in a reasonable time frame and/or it will take some time to react.	5 – 6
It is unlikely that this aspect will be detected or it will take a fairly long time before action can be taken and results seen.	7 – 8
The aspect will not be detected in a reasonable time frame or there is no reaction possible during normal operating conditions	9 – 10

TABLES 4.19: Detection PNEIA definitions. *(Vandenbrande, 1998)*

In the advocated methodology, all the environmental aspects and associated impacts of the plant are established and are then examined for each process or function. This ensures that no aspect is overlooked (assuming that all aspects have been identified initially). The author believes that the problem with the FMEA is that, with just severity, occurrence and detection, very small contributors to an overall aspect can score the same as very large contributors (for example, in the author's example of the hammer mill, the smell produced by the SO2 would score 300 for regular operation and 168 for abnormal (elevated temperature) operation simply because the elevated temperatures occur less frequently and there are detection devices to alarm for elevated temperature (normal operation scores 10 for detection because normal operation is 'optimum' and no reaction within the existing operating system is possible). An additional factor, contribution (see Table 4.21), is added to reflect the perception of the problem which is that, during normal operation, there is very little smell and it is that during elevated temperatures that the smell is most noticeable. It is a factor to establish the quantity relative to the overall quantity from the plant as a whole. It does not appear that the author intends that, when looked at by aspect, that all the contributions add up to unity or 100%; it is just intended as a relative factor to reflect that some of the aspects from a function/process do not warrant the full RPN rating attracted just by looking at severity, occurrence and detection.

In the PNEIA example, the normal operation of the hammer mill, when it produces molybdenum dust carries a severity of 6 (because of non-compliance with legal and regulatory requirements, possible damage to the reputation of the company and moderate damage to the environment), an occurrence of 10 (as it is a very high - a condition which will inevitably occur during normal operation), a contribution of 0.5 (as it is moderate, overall and the element has a 'reasonable' contribution to the total impact) and a detection

of 10 (because it is a normal operating condition and no reaction is possible (besides stopping the process)

Process/activity/product: Roasting												PNEIA No. 1 Page 1 of 1				
Team: Sadaci												Prepared by: WV				
Responsible: WV												FMEA date 10/13/97 (rev. 1)				
												Results				
Sub-process/ function	Environmental aspect	Environmental impact	Severity	Condition / situation	Contribution	Occurrence	Present detection / intervention systems	Detection	EPN	Recomm-ended action(s)	Respons-ibility and due dates	Action(s) taken	Severity	Occurrence	Detection	EPN
Hammer Mill	Generation of molybdenum oxide dust	Soil contami nation	6	Normal operation	0.5	10		10	300							
				Abnormal: Elevated temp.	1	8	Regular furnace temp. by the operators	7	336							
	Generation of sulphur dioxide gas	Bad smell	3	Normal operation	0.1	10		10	30							
				Abnormal: Elevated temp.	1	8	Regular furnace temp. check by the operators	7	168							

TABLE 4.20: PNEIA Example. *(Vandenbrande, 1998)*

The author has modified the QS 9000 FMEA in order to capture the relative contributions of the aspects being considered. The approach of introducing 'contribution' is an alternative to quantifying the relative amount under 'severity'. This may have the advantage of apparent simplicity, but, when examining 'severity', it is necessary to consider the quantity so that the potential impact on the environment can be assessed (e.g. "will hardly be noticeable" already considers quantity). The need to give an additional score for 'contribution is questionable.

Contribution to the impact	**Score**
Remote. The contribution of the impact is hardly noticeable	0.1 – 0.2
Low. There is a slight contribution to the overall impact.	0.3 – 0.4
Moderate. The element has a reasonable contribution to the total impact.	0.5 – 0.6
High. The impact of the element on the environment is almost as high as the total impact on the plant	0.7 – 0.8
Very high. The impact of the element is as high as that of the plant.	0.9 – 1.0

TABLE 4.21: "Contribution" definitions. *(Vandenbrande, 1998)*

'Occurrence' is concerned with the likelihood or frequency of the effect. This is similar to QS 9000 except that in an environmental FMEA many environmental effects may be features of normal operations whereas, in QS 9000, it assumes normal operation and is concerned with frequency of failure occurrence. Except for abnormal conditions and incidents, it will be likely that most of the impacts will be scored at a maximum of 10. In QS 9000, data will normally be available in the form of PPM or CPk but in environmental FMEAs, the data may be more difficult to quantify.

'Detection' is normally reflected in QS9000 by the effectiveness of QC methodologies. Good detection would be seen very effective detection ('mistake proofing') and no customer complaints concerning the failure mode. The author has included both detection and the effectiveness of the reaction (when detected, how good is mitigation) and also scores the 'normal operating conditions' as maximum. Normal operations have already been scored high under occurrence and it is possible that scoring normal operations high because there is no possible reaction, covers similar ground. Normal operations would seem to be unfairly penalised because, although important, the 'occurrence' score should already take into account that there is no reaction (otherwise, the severity or that occurrence should be amended by mitigation: "do not do it so often or if you have to do it often, make the effects less severe". With this is mind, it might work better if 'detection' scoring be modified as follows (Table 4.22).

Detection and intervention systems	**Ranking**
There is continuous monitoring. Controls will immediately detect the aspect and reaction can be instantaneous. Any intervention system fitted has demonstrated capability to deal with all plant conditions.	1 – 2
Chances are that the aspect will be detected within a day of occurrence and a quick reaction is possible or that reaction time will be up to one day. Intervention systems have the capability to meet 99% of potential situations.	3 – 4
Chances are that this aspect will be detected within a week of occurrence and that reaction will be immediate or that detection will occur earlier but that reaction will take place within a week of occurrence. Intervention systems have a capability to meet 98% of potential situations.	5 – 6
Chances are that this aspect will be detected within a month of occurrence or that detection will occur earlier but that reaction will take up to a month. Intervention systems have a capability to meet 95% of potential situations.	7 – 8
This aspect will be detected more than a month of occurrence or that reaction will take more than a month Intervention systems have unknown capability or less than 90%.	9 – 10

TABLE 4.22: Alternative Approach to Detection

In conclusion, the author has suggested an approach which demonstrates that the FMEA can be used in environmental analysis (where 'failure' must also address the use of raw

materials and energy). The need to quantify the contribution of various processes has been noted. The only draw-back would appear to be the author's proposed 'detection' scores which would penalise normal operations excessively

4.9 Single Industry Systems

Systems which are developed for single industries can be more helpful for the organisation needing guidance. As examples of this approach, GG43 in the UK Environmental Technology Best Practice Programme and ISO 14061 have been considered.

4.9.1 GG43 Guide: Environmental Management Systems in Foundries.

The guide recommends that "simplest way of gathering information about environmental effects is to consider each department or section within a department, in turn. Some issues, e.g. land contamination, will have to be examined for the site as a whole". This concurs with the recommendations of other authors.

An environmental effect may be considered significant if it:

- is controlled by legislation
- has the potential to cause demonstrable damage to the environment
- is of concern to interested parties (these include environmental regulators, local residents, the workforce, investors, insurers, customers, environmental interest groups and the general public)

The scoring system has been developed with advice from the Institute of Environmental Management and is a two step approach using checklists (examples are in Appendix C).

For normal operating conditions, each effect is awarded a score to reflect the relative importance of:

- legislation (both current and forthcoming)
- environmental damage (e.g. toxicity, acidity, greenhouse gas emissions, ozone-depleting substances)
- interested parties
- quantity (e.g. the volume of the waste stream or the frequency of occurrence at the facility)

The scores are multiplied by a weighting factor that reflects the overall importance of the criterion at a particular site. The guide recommends that the factors should be adjusted as necessary to reflect the particular concerns of the organisation. Adding the criteria products together produces a total score for this environmental effect under normal operating conditions. This total score is then used to rank the particular environmental effect under normal operating conditions (see Table 4.23)

	Score				Weighting Factor			
	3	**2**	**1**	**0**				
Legislation	Existing	Impending		None	x	2	=	a
Environmental damage	Known detriment	Possible detriment	Limited detriment	No detriment	x	3	=	b
Interested Parties	Considerable interest	Moderate interest	Little interest	No interest	x	2	=	c
Quantity	High	Medium	Low	Nil	x	3	=	d
Normal operating conditions total score = (a + b + c + d)								

TABLE 4.23: Checklist from Environmental Technology Best Practice Programme: Guide GG43

The same environmental effect is also awarded a numerical score (see Table 4.24) under other operating conditions such as:

- abnormal operations (e.g. factory start-up after a holiday shutdown)
- accident/ emergency (e.g. fire, accidental damage)
- past activities (e.g. activities of former site occupants, burial of waste etc.)
- planned activities (e.g. new product or production line, site development)

	Score					
	12	**6**	**3**	**0**		
Abnormal operations		Increased environmental impact	No change	Reduced environmental impact	=	a
Accident / emergency		Increased environmental impact	No change	Reduced environmental impact	=	b
Past activities	Evident / requires action	Possible damage / difficult to evaluate		No damage	=	c
Planned activities		Increased environmental impact	No change	Reduced environmental impact	=	d
Other operating conditions total score = (a + b + c + d)						

TABLE 4.24: Checklist from Environmental Technology Best Practice Programme: Guide GG43

Significance is an aspect that scores more than a certain number of points either under normal or other operating conditions. Some effects are significant in only one category, others in both. No specific number is given but this has to be decided by each site on the basis of their own concerns and the technology which is being employed.

This system is one of the simplest for both normal and abnormal conditions. With the simplicity comes a high degree of subjectivity. for example, 'Known Detriment' is the highest scoring for 'Environmental Damage' and many aspects will score the maximum. This is of a higher weighting than legislation and could cause legislation related impacts to be scored lower than those which are used in large quantity without legislation.
This is a clever approach and the idea of scoring abnormal, emergency, past and planned activities only on the basis of the increased or decreased environmental impact is interesting. However, the nature of the emergency must have an input into the scoring system and it is difficult to accept that, for example, the quantity of a spill does not influence the scoring (surely, there must be some distinction between the rupture of a storage tank and a minor spill?).

4.9.2 ISO/TR 14061: Information to assist forestry organisations in the use of Environmental Management System standards ISO 14001 and 14004 (1998).

In this report, the systems used by forestry groups in several countries are examined. The most fully explained is the Brazilian case study in which each significant aspect is evaluated by using a so called 'significance index'. This index is calculated by considering the factors in tables 4.25 and 4.26.

Table 4.25 indicates the magnitude of the impact consisting of 'frequency' (low, medium, high) of its occurrence and the 'severity' (low, medium, high).

Table 4.26 indicates the importance of the impact consisting of the 'intensity' and the 'extent' of the impact. The impacts associated with each aspect must be measured. In considering significance, the following criteria are used:

a. whether or not legal or regulatory requirements exist.
b. whether or not other requirements that the organisation subscribes to exist.
c. whether or not the impact is related to the organisation's policy commitments
d. the views of interested parties
e. whether or not the impact is related to the organisation's strategy on the short/medium or long term.

For each of these factors, numerical values on a relative scale have been established. The calculated Significance Index results in an overall score for each environmental aspect and this is shown on Table 4.27.

Is = ((F x SEV) + (IN x EXT)(A1 + A2 + A3 + A4 + A5))

Is = significance index	SEV = severity	EXT = Extent
F = frequency	IN = Intensity	A = a significance factor

Frequency	**Scale**
Low	<2 occurrences per year
Medium	Other
High	Continual or 1 occurrence per week
Severity	**Scale**
Low	Changes reversible immediately
Medium	Changes reversible in the medium/long term
High	Changes irreversible

TABLE 4.25: Magnitude of Impact *(ISO 14031:1998)*

Intensity	**Scale**
Low	5% of emissions based on mass flow analysis
Medium	20% - 75% of emissions bases on mass flow analysis
High	>75% of emission based on mass flow analysis
Extent	**Scale**
Low	Confined within companies bounds or local
Medium	Regional
High	Global

TABLE 4.26: Importance of Impact *(ISO 14031:1998)*

Calculation factors	**Example 1**	**Example 2**
Environmental Aspect	Water used in nursery	Harvester / Forwarder machines in harvesting
Potential impact	Depletion of natural resources	Soil Compaction
Frequency factor	3 (continual)	3 (trucks continual)
Severity	2 (reversible in long term)	2 (reversible in short term)
Magnitude	*3 x 2 = 6*	*3 x 2 = 6*
Intensity	2 (medium)	1 (low)
Extent factor	2 (regional)	2 (regional)
Importance	*2 x 2 = 4*	*1 x 2 = 2*
A1: legal	1.3 (covered by law)	1.3 (covered by law)
A2: Other	0.8 (covered buy other req.)	0 (not covered)
A3: Policy	1.3 (covered by policy)	0 (not covered)
A4: Interested parties	0.6 (found by workshop)	1.3 (found by workshop)
A5: Strategy	1.0 (part of short term strategy)	0.5 (part of medium term strategy)
OVERALL SIGNIFICANCE	**50**	**28.4**

NOTE 1: Maximum Significance Index is 100

NOTE 2: The maximum sum for the factors A1 to A5 is 5.56. the factors have been weighted by the judgement of our specialists and may very from company to company. For some factors, however, only a 'yes' or 'no' response is possible. For example, the legal requirements score is 1.3 if there is applicable legislation and 0 if it is not covered by legislation. On the other hand, the affects of views of interested parties is weighted subjectively on the judgement of specialists and may vary from 0 to 1.3.

TABLE 4.27: Example of Significance Index *(ISO 14031:1998)*

This example shows a very well developed system where the magnitude and importance of the aspects is calculated and then weighted according to business considerations. Interestingly, the regulated issues do not automatically become significant and although it is policy to comply with legislation, the legal weighting alone will not be sufficient to push any legally binding requirement into the category of significant impact. Each criteria is scored from a three options which is modest and makes it easy to use; the descriptions are good which reduces the subjectivity.

Interestingly, each aspect is examined on its contribution to the mass flow of the emission. This would allow each aspect which, say, affects run-off and silting of rivers to be ranked within the whole system. In many systems, this ranking of aspect is done during the formulation of targets to meet defined objectives (which come from the significant impacts) but here it is inherent in the significance assessment. It is similar to the approach of 'contribution' advocated under FMEA; the aim is, whilst not diluting the impact score, to point to the most prominent aspects which contribute to the aspect being considered as significant.

Materials and Methods / 5

5.1 Introduction

The review of actual practice has been divided into two sections.

- Procedures which organisations who are registered to ISO 14001 employ.
- Non-conformances which have been raised at registration assessments by the National Standards Authority of Ireland (NSAI) during the period from 1996 to the end of 1999.

5.2 Procedures Review

The procedures have been obtained from two sources:

- publications
- NSAI clients

5.2.1 Procedures from publications

Those obtained from publications may not be complete and may not have examples of how they are actually used in practice. They have been included to show the diversity of approach rather than to show the particular strengths or weaknesses of application. The author is not familiar with the companies and has taken information given at face value.

5.2.2 Procedures from NSAI registered companies

Procedures obtained from NSAI clients are complete with examples of use and, because of the author's familiarity with the business and systems used by the client, include additional insight into strengths and weaknesses. Initially, it had been intended to include examples from many business types and only from Ireland. However, because the diversity of approach exists across all industry rather than necessarily between industry sectors, it has been easier and just as satisfactory to collect data from organisations with which the author has contact. Similarly, it has not mattered whether the examples are from Ireland or abroad since the approach taken does not appear to be characterised by nationality.

In most cases, the procedures have been written in English but all examples are given in English in the Appendix A. Companies who participated in the study have not been identified but represent a wide range of size and sophistication. Confidentiality has been

maintained and certain words, products or chemicals which might identify a particular organisation have been changed to a generic form to preserve anonymity.

Procedures have not been quoted in their entirety but tables and scoring systems have been copied directly. Having said that all examples come from companies registered with NSAI, it does not imply that they all comply fully with the requirements of ISO 14001 Clause 4.3.1: some of the examples contain minor flaws which the companies are addressing. The procedures have been evaluated by attributes with the intent of explaining what the company has sought to achieve and of illustrating the strengths and weaknesses of the approach.

5.3 Non-conformances Review

The non-conformances that have been analysed in the second part of the study are from registration and pre-registration assessments by NSAI. The files examined feature companies who have undergone registration between 1996 and the end of 1999. The survey excludes companies who were assessed to I.S. 310.

Again, much effort has been taken to make the survey confidential and anonymous. Names of proprietary products, facilities and chemicals have been removed as well as any reference to procedures or company specific documentation. (see Appendix B). The non-conformances are not necessarily word-for-word from the reports written by NSAI since some simplification has added brevity without compromising nature of the non-conformance itself.

The non-conformances were categorised by specific areas and, again, sub-divided within these areas to establish the type of problem overlooked by the organisation. No notice has been taken of the grade (major / minor / comment) of non-conformance since this is situation specific: the study just looks at the non-conformance description without considering whether it had a major impact on the user's system; in the majority of cases the non-conformances were minor in nature. In some cases, there was difficulty in classifying the issue(s) represented by the non-conformances without better knowledge of the circumstances. In cases of difficulty in classification, the non-conformance (as written in the report) and the author's judgement decided the category.

Review of Typical Procedures / 6

6.1 Introduction

With the help of organisations registered with the National Standards Authority of Ireland (NSAI) to ISO 14001, copies of 'live' procedures were obtained. There are 10 examples from Ireland and 4 examples from elsewhere in the world. Each is individual and none use the same method although all aim at compliance with ISO 14001 Clause 4.3.1. Some of the companies are large (divisions of very large organisations) and others are small (less than 50 staff). Some have very evident environmental issues (e.g. wet, chemical, manufacturing) and others have less evident environmental issues (e.g. dry, assembly, handling).

Each methodology is given in Appendix A with details of application and use. The first section of this review examines each methodology for its strengths and weaknesses:

6.2 Methodologies Examined (14 No.)

EXAMPLE A

This method uses Frequency, Likelihood and Severity as the main criteria. Frequency and Likelihood are derived quite simply by a single set of questions. Severity is decided after a detailed examination of legislation, community and employee sensitivity, the impact on air, land and water, cost benefit, resources depletion and the accident and emergency aspect. Before awarding any scores, a detailed analysis is recorded which covers the uses, risks, handling, history and HAZOP for each aspect.

This is a very thorough methodology with good records to support decisions. Severity, which is the most difficult criteria to define, is looked at in sufficient detail to ensure the eventual score well founded. The organisation used a cross-functional team to develop the analysis (comprising about 200 pages).

Interestingly, the organisation did not approach the analysis from the process / activity point of view but from the consideration of aspect categories. This has the advantage that the cumulative effects of uses of chemicals in different locations can be assessed as a whole. The disadvantage is that, when writing operating procedures, a separate "where used" analysis is required to ensure that operations are covered. It is unclear how any positive aspects would be scored.

Legal requirements, on their own, can not make any aspect or impact significant from this FMEA approach. However a particular aspect will attract higher ratings for legal compliance requirements even if only isolated emissions / materials are regulated; this does give a better 'feeling' for the class of aspect considered. The organisation does, of course, control and monitor all its legal requirements but this is as a consequence of identification through the legal register and not necessarily through the significance analysis.

EXAMPLE B

This method, again, uses Frequency, Likelihood and Severity as the main criteria and an FMEA style matrix to calculate the resulting significance score. The definitions for Frequency are good but those for Severity and Likelihood / Loss of Control are more subjective.

Severity is broken down, in the FMEA table, for the particular concern (air pollution, global warming, ozone depletions, stormwater contamination, groundwater contamination, soil contamination, landfill usage, depletion of natural resources, consumption of natural resources, negative affects on humans). This allows the severity to be apportioned to different impacts. The aspects are categories of environmental issues and, again, this allows the cumulative effect of impacts to be considered.

Legal requirements are automatically ranked No. 1 and are not scored; this draws justifiable attention to the premise that ISO 14001 requires legal compliance as its starting point. The next item, recycling, is taken to be most severe and scores maximum under 'depletion of natural resources' which makes it the second highest impact. However, this is not using the scoring system as it is intended and shows the 'hand of management' who obviously regard recycling as a positive and important initiative. Positive aspects are not scored differently to negative aspects.

One difficulty with this system is that the scores across the columns are added to get the final significance. A very significant single media impact can only score 1000 points whereas a more insignificant impact, but one which scores across many impacts, might get similar attention even though it is less on an individual concern basis (e.g. 1000 = 200 + 200 + 200 + 200 +200). It might be an improvement to give two thresholds for

'significance': (a) the single issue (max. 1000 points) and (b) the sum of the individual issues.

EXAMPLE C

Another example of an FMEA approach with the same criteria, Severity, Control and Frequency. Scoring is similar to example A in that each is marked from 1 to 5 and the three scores multiplied to achieve significance.

Although the highest score is 125, anything rating greater than 25 is regarded as significant. This compensates for the subjective nature of the scoring that, particularly in the area of significance, needs better definition. The subjectivity of the scoring is likely to have a marked effect on the resulting significance score and, although no 'live' examples were supplied by the organisation, the procedures do not give enough guidance to ensure the uniform application of the methodology.

Although there are five bands of priority rank, it is worth noting that only one score (5x5x5) can achieve Rank A and only two scores (5x5x4 or 5x4x4) can achieve Rank B. It might improve the scheme is a single rank was given to 76+.

EXAMPLE D

This organisation uses a simpler system with two principal criteria – Severity and Probability. Each is scored 1 to 5 and the multiplied result (max. 25) is the significance score. The method approaches each aspect with a thorough examination to give the basis for the scoring.

The system need better explanation of how scoring is applied since it would seem rather arbitrary. The 'probability of occurrence' for the solvent tanker deliveries which are every 8 weeks is given the highest score but the fugitive emissions which occur daily during the process are given a score of 1 which is the lowest; it is unclear how an event which occurs once every two months can score so much higher than an event which occurs daily / continually. In this context, the frequency and magnitude of the event need to be considered and it is not clear whether these are factored into the severity of consequences.

The organisation is not happy with this methodology and is moving to an FMEA approach.

EXAMPLE E

This organisation uses an approach that rates Probability and Severity. Severity comprises flammability, explosivity, toxicity, scope, duration and ecology. Probability looks at both the normal and the 'worst case' (which includes incidents and start-up / shut-down) for air, land, water and ecology.

There is a good description of what aspects and impacts are considered for each of the identified aspects.

The significance comes from a balanced look at the severity, probability and regulated status. The judgement is subjective and decided by a cross-functional team. There is guidance on the severity of impacts but the system could be improved if further guidance was given on how any impact might achieve the given probability ratings ('low' for air means …). The definition 'worst case' needs further explanation.

EXAMPLE F

Each aspect is given a very thorough 'essay type' examination of the legal impacts, significance of discharges, scientific evidence and public attitudes. This is then used to award category scores (1 (low) to 4(high)) for legal compliance, stakeholder/public opinion, potential local impact, potential global impact and scientific evidence.

The category scoring is subjective but it is noteworthy that 'significant' is a scoring of '3' whereas 'major' is a scoring of '4': 'significant' is not the ultimate score. Better guidance would be helpful to illustrate what is meant by 'negligible', 'minor', 'significant' and 'major'.

The category scores are added and any final score more than 10 is 'significant' from ISO 14001's standpoint. This means that anything that is 'significant' in three categories will be 'significant' in the end as will a mean score of '2'. However, the final verdict on significance could depend on interpretation and the example introduces a scoring of 'N/A' which is not explained and, one could argue, should be on the table as a rating of '0'

EXAMPLE G

This organisation has examined its operations and has determined the relevant aspects. For each aspect, it has given a threshold limit for 'significance', some are precise (e.g. when

vehicle fleet exceeds 5 vehicles) and others are, to a degree, subjective (e.g. when there is an off-site complaint). Each of the organisation's operations are examined against the twelve criteria and, when significant, an operational procedure is referenced (thus demonstrating that there is operational control of significant aspects).

Assuming that the impacts are not specific to activities, there is not guidance on how the cumulative effects of certain impacts are to be considered (e.g. generation of non-hazardous waste - does this mean that every operation is allowed to generate up to 1 Tonne of waste per year or is the 1 Tonne a site total?)

Interestingly, there is no scoring system so there is no prioritisation. This is not required by ISO 14001 so is satisfactory and does simplify the system.

EXAMPLE H

This system considers regulations, business concerns, emergency status, impact and severity. Frequency and quantity are not considered directly but are subjectively included in the 'Impact' score. Likelihood of loss of control is indirectly reflected in 'Emergency status'.

Interestingly, severity is related to BATNEEC but it is not clear how items which are not the subject of BATNEEC can be considered (e.g. energy use).

The significance threshold is 18. This can be achieved by maximum score on either Regulations/Business/Emergency or Impact/Severity. However, if one takes a minor legislative requirement with reporting necessary but no emergency status, it will take global impact and >1.0 BATNEEC to achieve 'overall significance'; this would mean that some legislative requirements would rank as insignificant.

It is also unclear how, in this facility, energy would be ranked significant. Energy use is known to be very significant (the major user in the town in which the facility is located) but it would seem likely that subjective decisions could relegate this impact to insignificant.

EXAMPLE I

The system used by this organisation immediately assigns significance to any impact or aspect that is the subject of legislation. The 'significance' is calculated by considering severity, frequency, potential for the environmental impact occurring, the likelihood of loss of control and the likelihood of early detection.

Each is scored from 10 (high) to 1 (low) with some scores not being available (e.g. likelihood of loss of control can only be 1, 5 or 10). The scoring is explained to reduce the element of subjectivity. Severity is scored using many inputs which are found on a specially designed form; these are well set out and the calculation is straightforward.

At first glance, the 'likelihood of loss of control' and the 'potential for the environmental impact occurring' appear to have the same meaning. However, the 'potential for environmental impact occurring' covers whether the impact occurs normally, in abnormal situations or only in incidents.

The system is well designed and the threshold of 100 (with a maximum score of 10000) means that it catches all of the actual and potential significant impacts.

EXAMPLE J

The scoring system used examines several criteria: significance of the impact (scale, duration/frequency, probability of impact occurring, severity), risk level and timing.

The scores and guidance on awarding scores are given in detail and the result, the environmental score, is the product of the three figures. A score of 2000 or over is regarded as significant (maximum would be (5x3x3x10 = 450) x 3 x 4).

There is some doubt in the example about the application of scoring for risk level (procedure states, for example, that the risk scores should be averaged but the example shows no averaging) but, with this exception, it appears practical to use.

EXAMPLE K

The organisation first examined the aspects that were relevant to their organisation. Interestingly, they decided that some aspects were so minor that they were automatically insignificant and did not merit further review. Of those that required further review, each

was scored and the average of all the scores was considered to be the 'significance threshold'.

One good point about this method is that the threshold automatically reduces as the impacts are ameliorated through continuous improvement. Although subjective (metrics are not used to decide on whether an impact is 'negligible' or 'moderate'), the system does achieve reasonable results; it could be improved by including metrics. Some of the definitions are difficult to understand (land use) and some of them are unconventional (metal being renewable – here the organisation has taken the view that renewable means recyclable).

This system needs more work to reduce objectivity and to ensure that all impacts / aspects are well decried. The organisation is acting on this currently.

EXAMPLE L

This organisation has a procedure that describes a scoring system considering legislation, quantity/impact, possibility of reducing the impact, views of interested parties, frequency, sensitivity of environment and global environmental issues. Initially, the system evaluates only the first three points and the reasons for this are explained.

The activities have been broken down into equipment and processes and, if there is an environmental effect, each has been scored. The scoring is 0, 5 or 10 with a maximum score of 30. Every score of15 or more is significant.

The weakness with this system is in the justification for giving certain scores to certain impacts. Without any quantitative assistance, it is very hard to objectively determine whether an impact is 'low' or 'intermediate' (for example).

The inclusion of 'possibility for reducing the impact' is an interesting scoring criteria and is certainly of assistance in deciding on objectives and targets. It might, however, make some otherwise 'significant' impacts 'insignificant' just because management decide that there is no way of reducing the impact.

EXAMPLE M

This example uses an FMEA approach with the factors considered being Severity, Occurrence and Aspect (which means chance of early detection). Each scores form between 1 and 10 with a possible maximum score of 1000.

As with other FMEA approaches, it does not cover positive aspects and, in this example, there is no consideration of anything other than 'failure' (e.g. use of resources and energy is not considered). The other weakness of this example is that, because the examination was driven by activities within the facility, some of the site issues (such as the care of the aquifer from which the organisation and the town draw their water) were inadvertently omitted.

On the positive site, the organisation has very good checklists that it uses to obtain the information that it uses in the FMEA. This provides very good objective input.

EXAMPLE N

Activities have been identified and the aspects of these activities have been identified. The impact on air, water, fauna, odour, land/soil, waste and fire/emergency are then considered under three headings – severity, quantity and consequences.

Each was scored as 'high', 'medium', 'low, or 'not applicable' and the cross-functional team then decided on whether the impact was significant or not.

This system is very subjective and it is doubtful whether the same scoring of significance could be repeated. The methodology should be improved by basing it on metrics or fuller qualitative descriptions. It is not clear how cumulative effects are tracked (e.g. use of chemicals).

6.3 General Observations

The methodologies examined show that organisations have given considerable thought and consideration to devise systems to identify significant aspects which are appropriate to their own businesses. The majority have given scores and ranked the impacts at the end of the exercise. This implies that there is a value in ranking, say, energy use against the disposal of hazardous waste. For companies aspiring to EMAS, this is required but in the

ISO 14001 forum, ranking is additional to the requirements or the guidelines on the standard.

The examples given in Appendix A, O to V are from published sources which, because of that, are older. This shows that there has been some advance in the techniques used. The scheme developed by Lucas (Example S) would seem to be ahead on its time in so far that it has identified five criteria that it scores in a detailed and methodical fashion. In the Lucas example, a single subjective criteria is unlikely to make a change in the final scoring.

The scoring mechanisms are based on various arithmetic manipulations; some are added, some are multiplied and some are a combination of multiplication and addition. Whether criteria are multiplied or added appears to be a matter of personal choice. Those adopting the FMEA approach would expect to be multiplying the factors (as this is the standard FMEA approach) but other hybrid schemes appear to be used as well.

Most of the approaches use the advice published in the standards but the aspects recommended by ISO 14004 are sometimes used in determining the priorities with regard to Objectives and Targets rather than in the analysis of significance. This approach is not incorrect. Positive aspects are not a 'comfortable' area of the standard and few procedures advise how this should be handled. Positive aspects could be the provision of a bus service or car pooling to reduce private vehicle use or, in some semi-conductor applications, the water leaving the facility is purer than the water source.

Very few of the systems reviewed are entirely 'home grown' and many organisations take advice. The quality of advice is not always appropriate since advisors tend to use a 'template' approach. Systems do not need to be the most beneficial to the organisation for the organisation to succeed in registration. Organisations do not challenge advisors sufficiently and as a result, of the adequate systems that exist, many could be improved so that they:

- can be maintained more easily
- can be understood by more of the staff
- have a better integrity of evaluation
- are less subjective.

Review of Non-Conformances / 7

7.1 Introduction

50% of the companies that Grimes (1999) surveyed stated that their aspects and impacts identification procedures were found non-conforming during the registration process. This survey covers 94 companies who went through the ISO 14001 registration process before January 1st, 2000. These companies are not exclusively Irish but are all registered with the National Standards Authority of Ireland (NSAI).

Number of companies surveyed	94
Number of non-conformances raised against clause 4.3.1	635
Issues covered in non-conformances	722
Number of companies surveyed who received no non-conformances against clause 4.3.1	4 (4.2%)

TABLE 7.01: Outline statistics (from this study)

The non-conformances are given an 'action code' to reflect the severity. Non-conformances can either be 'major', minor' or 'comment' ('comment' is sometimes referred to as an 'observation'). No regard has been given to the severity of the non-conformance since this depends on particular circumstances. For example, if a non-conformance reads "No evidence that the aspect of noise has been evaluated", this might be a major non-conformance for an organisation with big compressors located at the boundary of a residential area but a minor non-conformance for an organisation with a small compressor in an industrial estate with high ambient noise levels. This survey has not looked at the context of the non-conformance since this would be hard to cover unless each of the 94 organisations was visited.

7.2 Review of Data

Issues are the points raised in the non-conformance. As different environmental auditors have different styles, the number of non-conformances has been taken to mean the number of non-conformances or parts of no-conformances that address separate issues. The example in Table 7.02 would be regarded as three non-conformances and, as RH1(b) covers noise, odour, vibration and visual impact, this would be regarded as covering six issues. Table 7.03 shows that the most common failures are (1) omitting to show that all aspects have been addressed and (2) failings in the methodology or the ability to support the methodology or its findings.

Ref.	Clause	Description	Action required	Action Code
RH1	4.3.1	ASPECTS AND IMPACTS		
		a. The methodology used to prioritise impacts is not explained.	Explain.	Minor
		b. It is not evident that the aspects of noise, odour, vibration and visual impact have been considered.	Address	Minor
		c. The score of '45' for the impact of the compressor is not explained.	Justify	Minor

TABLE 7.02: Example of a typical non-conformance.

HEADING	Number	Percentage
System: Failure to meet the basic requirements of Clause 4.3.1	34	4.7
Methodology: Problems with the methodology including absence, lack of explanation, lack of supporting information.	248	34.3
Aspects Omitted: :Lack of evidence to show that aspects which should have been considered were, in fact, reviewed.	328	45.5
Data: Lack of data in areas where data needed to be supplied to support impact assessment.	52	7.2
Impacts: Impacts not adequately reviewed having identified the related aspect.	58	8.0
Other: Non-conformances which could not be fitted into the above categories.	2	0.3
TOTAL:	717	100

TABLE 7.03: Analysed of issues raised.

The first major cause of deficiency, "missing aspects", is a combination of lack of:

- knowledge
- thoroughness
- evidence

Lack of thoroughness can be solved by using a good checklist. Lack of evidence can be solved by keeping the checklists on file. Lack of knowledge can only be solved by selecting environmental managers who acknowledge their limitations, by using cross-functional teams in the review process and external assistance if necessary. Examples of lack of knowledge might be:

- Unaware the cooling towers can cause *legionella*.
- Unaware that hydraulic fluid from presses is changed annually
- Unaware that the dead vegetation at the rear of the site should be investigated

The second major cause of deficiency, "methodology", is a more difficult area to solve.

Methodology Problem	Examples	No.	%
Flawed methodology, application or no methodology.	No description of methodology. Results show that there are issues with the methodology.	61	24.6
Methodology explained but not followed in some places	Impacts which have been handled subjectively rather than by using the methodology / rules adopted.	20	8.1
Methodology not explained sufficiently or lack of records to support results.	Insufficient backup for results. Unclear whether scores are multiplied or added.	117	47.2
Lack of clarity or definition of terms. Arithmetical errors	2+2 = 5. No explanation of what "Quite Frequent" means.	50	20.1

TABLE 7.04: Breakdown of methodology issues,

Table 7.04 demonstrates that few organisations fail to follow their methodology (8.1%) but that they can not always back-up their decisions with evidence from surveys, audits or other investigations (47.2%). Arithmetical errors and poor description of terminology (implying that the review could not necessarily be repeated with similar results) occur frequently and, while this may be very minor, sometimes it can destroy the validity of a scoring system. In a high number of cases (24.6%), the methodology itself was flawed to the extent that the results are suspect or of reduced value. Typical examples of this would be:

- Chemical Company A rates the use of hazardous chemicals as significant "score 255" but also the use of paper in the office as significant "score 245". On detailed examination, the chemicals are both hazardous and derived from non-renewable resources whereas the paper used in the office is modest in quantity and, as well as being renewable, is also non-chlorine bleached and is 5% post-consumer recycled.
- Metal processing Company B has a scoring system which gives high scores to impacts which can be quickly detected and low scores to impacts which are likely to be undetected. However, the impact of an aspect which is difficult to detect should be rated worse than one which is easier to detect since there is potential for greater damage before detection.

There would seem to be some value, therefore, in taking a proven approach since this avoids the likelihood of many of the methodology failures. Part of the problem in this area must be attributed to the "reinventing of the wheel" which most companies do when they write their procedures for analysis of significance. The lack of a "road map" for

aspect / impact assessment is the cause of the difficulty. This is the subject of section 8. Discussion.

Other areas of shortcomings found during the assessments comprise the remaining 20% of issues. Some of these are basic failures to address the requirements of ISO 14001 Clause 4.3.1 (the "shalls") such as the lack of evidence that the review of significant impacts has been used to develop the objectives and targets for improvement. Others are in the inability to provide sufficient data to support the impact analysis (for example, no groundwater survey has been conducted or, despite a 45dBA / 55dBA boundary sound level limit, no readings have been taken). In other instances, impacts of aspects have not been fully developed (for example, a cooling tower may have been identified as having a potential for *legionella* but the other impacts such as use of water, use of dosing chemicals, disposal of chemically dosed water etc. may not have been identified).

During any assessment there is bound to be a difference in the view of the assessor (or the assessment team) and the organisation. Any assessment of aspects and impacts can only be objective to a certain degree. The following "Golden Rules" should be observed.

- Check that the results of the review include the aspects and impacts which are obvious
- Check that the 'top ten' (and possibly the 'bottom ten') impacts (as per analysis) are consistent with a common-sense view of the likely top/bottom impacts
- Follow the methodology selected
- Check the arithmetic
- If subjective words or conditions are being used, explain how you would decide between options (e.g. 'frequent' / 'almost continuous')
- Use a cross-functional team, consultant or a method of ensuring that a comprehensive view is taken and that all scientific data is known (consistent with a precautionary approach)
- Devise or obtain a good checklist
- Keep all records of calculations, basis of decisions etc so that these can be reviewed

7.3 Checklist

Assuming that the assessment results show the kinds of items which organisations forget to include (by name) in their review and assuming that this reflects the lack of thoroughness in their checklist, Table 7.05 lists the most commonly omitted aspects:

Aspect	Percent Omitted
Emergency situations (fire, explosion, spills and leaks)	9
Past Activities	7
Raw Materials and Natural Resources	7
Some Gaseous Emissions including fugitive emissions	6
Odour	6
Noise and vibration	4
Dust and particulate	3
Some chemicals	3
New equipment, chemicals and development	3
Ground and Groundwater contamination	3
Some solid waste sources	3
Transportation / Traffic	3
Visual Impact	3
Residues and spills around the site	3
Product / Consumer Packaging / Design	3
Cooling Towers	2
Energy / Electric Power	2
Fire water contamination / containment	2
Positive Aspects	2
Oil, Gas and fuels (general)	2
Decommissioning	1
Accidental damage to facilities by vehicles	1
Off-site Activities (general)	1
Use of Engineering Gases	1
Paper	1
Radiation (including isotope-type smoke detector heads)	1
Refrigerant	1
Asbestos	1
Discharges to rivers and waters	1
Storage	1
Site Incineration / Combustion of waste	1
Administration	1
Other / Business Related	1
Tanker Filling	1
Tenants' Activities	1
Chiller, AHU and other facilities maintenance	1
Storm / Surface water drainage	1
Bund drainage / Integrity	1
The following aspects were omitted less than 1%: Normal operations, oil spillage, Fauna/Flora, underground pipework integrity, clean-room supplies, biological/GMO, cleaning activities, vehicle washing, contaminated run-off, facilities, PCB, laboratory chemicals, eco-system, fumigation, reject product, steam use, compressed air use, waste batteries, blow down, heavy metals in additives, sewage, fluorescent lamps, spray irrigation	
NOTE: Failure to address requirements in legislation, regulations, building permits, leases and other binding requirements is covered under non-conformances against clause 4.3.2. The above addressed operational issues only.	

TABLE 7.05: Frequently omitted aspects

8.1 Introduction

The aim of any company implementing ISO 14001 must be to do it successfully but with the minimum amount of effort needed to achieve a system which adds real management value. The difficulty is that the system must be audited before registration to ISO 14001 can be granted; the system will have to stand up to scrutiny by an audit team. However hard the organisation has worked and however thoroughly the system has been implemented, there is still an anxiety that something will be found lacking (and possibly something which will amount to an impediment to registration).

Whilst much of this anxiety is based on needless worry, it is always possible that the person who creates the system gets too close to the system to see the failings which an outsider may spot immediately. Clause 4.3.1, Planning – Environmental Aspects, has been identified as one which causes special concern and the different approaches discussed in literature and existing in practice only serve to make the issue more confusing..

The starting point is to understand what the standard requires as against what seems like a good idea or what one considers to be the ultimate methodology. As well as the requirements in the standard, there are also implied requirements. Implied requirements include making the system as objective as possible and, where there are subjective elements, giving guidance so that the process is as repeatable and reproducible as possible. The system must be thorough and must show evidence that all possible aspects have been considered (even if it has been decided that the organisation does have or can have little influence over them).

8.2 Preparation Stage

In order to start the review the following points have been raised in the study:

CROSS-FUNCTIONAL: The review should be a team effort. The people who know most about the processes are the operators and the people who maintain the equipment. Process engineers and managers will also be necessary to ensure that technological and business issues are addressed. The environmental manager is normally the team leader and will collate the information and, possibly, chair meetings, resolve differences of opinion

and challenge assumptions and opinions. It is necessary to understand when additional information or knowledge is required: specialists may be employed to assist.

TRAINING, EDUCATION AND AWARENESS: The people involved in the review need to understand the reasons why it is being undertaken and appreciate the issues. Awareness and job specific training is all that is required of the cross-functional team but the environmental manager (at least) should have had sufficient education to understand the environmental issues which might be involved.

CHECKLISTS: As the study has identified, almost half the non-conformances during assessments come from the failure to conduct a thorough review. A good checklist should be developed which ensures that adequate information is gathered and that there is suitable factual information to make the review objective.

TASKING: The literature advocates splitting the organisation into activities and developing reviews of all the aspects which affect each component of the organisation's activities. This approach has several dangers in that (a) issues concerning the site in general may be overlooked and (b) it may not be possible to see the whole picture regarding an aspect if it is fragmented by activities. It is the job of the environmental manager to ensure that coverage is complete.

Site issues may require a checklist is made for the whole of the site to consider the meta-aspects of the organisation (which might include traffic access, security, past activities (where there is no activity at present), gardening, neighbouring water-courses and drains etc.)

A spreadsheet or database may be of assistance so that it is possible to look at the information by aspect rather than only by activity. This format will have the advantage of providing clear linkages to operational controls, objectives and targets.

8.3 Information Gathering

A comprehensive checklist that does not require much data entry is a good starting point. It is not be worth gathering too much information immediately and accurately quantifying data (e.g. material use and energy consumption) may unnecessarily protract the process.

This checklist is to provide an overview of the environmental aspects as a scoping exercise which will to be able to demonstrate that none have, apparently, been neglected.

It should then be possible to eliminate all the aspects that are trivial and not worth further consideration. For example, some materials may be used in such small amounts and be of such low value and environmental impact that further quantification will only result in confirming what is already self-evident. Using the precautionary principle, any aspect which in an unknown (such as ground / groundwater contamination from past activities, fugitive emissions etc.) should not be eliminated without data; lack of information should be treated with caution. Care should also be taken to avoid the elimination of any aspect which may be significant for the site as a whole but of small significance at each point of use. A decision must be taken on how to score positive impacts (if any); commonly these are flagged by a '+' or '-' sign.

The second round of information gathering will be more detailed and supported by data. This only need cover those aspects / impacts which the initial survey has identified as worthy of further quantification. The checklist should look, in particular, at those aspects which are listed in ISO 14001 Annex A3. This period of data gathering will take longer than the initial review since boreholes, noise surveys, emission sampling, energy use surveys etc. will all take time to organise

8.4 Significance Analysis

It can now be assumed that all the information is available and that surveys and investigations have been made as appropriate.

The significance analysis can now proceed. There are two alternative courses of action:

1. Assigning significance without ranking
2. Assigning significance with ranking.

As previously noted, there is no requirement in ISO 14001 to rank significance.

Companies may chose to rank significance for one or more of the following reasons:

- It helps manage continuous improvement and objectives/targets
- It helps show management which criteria have to be reduced to lower the significance
- It helps demonstrate clearly which criteria are considered to derive significance

- It allows the most objective methodology to be employed
- It is required by EMAS and the company ultimately intends to be accredited to EMAS
- It is a corporate requirement
- It is a feature of the software being used

Companies may also chose not to rank significance because it is:

- Not a requirement
- Too time consuming
- Difficult to find a system which works in all cases
- Only giving the appearance of objectivity
- Not necessarily linked to ranking of objectives and targets

Although ISO 14001 gives no guidance on methodology, 'significance' links to other areas of the standard; one of the principal links is with clause 4.4.6 (Operational Control). Operational Controls refer to "significant aspects". "Significant aspects" is not defined by ISO 14001/14050, but it can be implied that a significant aspect is one that results in a significant impact.

The identification of the significant impacts is linked directly with the operational procedures that will be implemented; if an error is made in identifying the significant impacts, the operational system will be deficient.

The standard requires that the most important impacts of the system be determined in order to place effective controls to ensure compliance and improvement. An organisation needs to determine the principle environmental risks without being distracted by the success of its existing systems of control. The wording "have or can have" implies that aspects which do and those which, if the controls were removed, could have a significant impact be the reason for having operational procedures.

Many systems look at Severity, Likelihood of Loss of Control and Frequency (for example) so that good existing controls reduce the significance to the point where the impact may become insignificant and there is no further requirement to impose controls. This is an example of positive feedback as, by considering the effectiveness of controls when examining significance of impact, the decision on the requirement for controls can be affected. ISO 14001 requires that "Organisations may also take into account the degree

of practical control they have over the environmental aspects being considered" but this only means that organisations should recognise when they are unable to control impacts solely through their own procedures. ISO 14004 suggests that organisations ask "What are the significant environmental aspects; considering impacts, likelihood, severity and frequency". Are companies who consider the effectiveness of their own controls only doing what is recommended?

The FMEA would appear to address the requirements of the standard well. This technique asks "What could go wrong?" and the QS9000 FMEA handbook requires that companies attach importance to both high severity and to high RPN (Risk Priority Number). No organisation surveyed considered high severity (by itself) to be significant and this is a flaw with all of the environmental FMEA examples. It is not sufficient to look only at the RPN (combination of criteria) but also at the inherent severity of the aspects (without controls). It is important, in an environmental management system, not to confuse environmental risk assessment, which considers the effectiveness of controls, with the evaluation of impact significance which considers the need for controls.

Essential elements in the scoring systems, whether used for threshold assessments or ranking systems, can be divided into two categories: the 'severity' of the aspect / impact and the 'management' which the organisation has in place.

Severity is the inherent nature of the environmental aspect / impact in the local context taken together with the intensity, magnitude, persistence and frequency (the given data from the activities).

1. **Properties:** hazard type (e.g. poisonous, flammable, explosive, combustible, oxidant, acidic, basic, pathogenic etc.), phase (gas, vapour, solid or liquid), the classification on the substance (UN number, CAS number, hazardous designation), effect of the substance in the context of global or transboundary influence (e.g. acid rain, ozone depletion, transboundary pollution etc.) or other characteristics (in the case of noise, frequency, tone, impulsive etc.)
2. **Context:** sensitivity of the environment (e.g. zoning, receiving waters, ambient air quality, aquifer etc.).

3. **Quantity:** the amount of the substance stored or used. This can be influenced by legislation such as the Seveso II Directive and the USA's RMP legislation (Risk Management Planning).
4. **Frequency:** the frequency of various environmental events which may include deliveries, emissions, blow-downs, washings, noise and vibration events (such as generator tests).
5. **Persistence:** the length of time the effect of the effect will be noticeable in the environment. This can include issues such as reversibility of effect, bio-magnification, accumulation, combination with other effects, sustainability and renewability of resources etc.

Management is the handling of the environmental aspect / impact. This will be company or industry specific issues which include efficiency of processing, handling, incident history, technology options, commercial options and public and stakeholder opinion.

1. **Efficiency:** is the organisation's ability to achieve optimum or theoretical efficiencies. This can be represented as yield, emission control effectiveness, fugitive waste quantities, recycling effectiveness etc.
2. **Handling:** is housekeeping (in certain contexts) but it also concerns the observance of best practices within the organisation. In this context it can mean the provision of suitable bunding (BS 8007) and the use of grounding when transferring solvents etc.
3. **Detection:** is the ability of the organisation to detect changes in the environment or emissions / wastes and reaction time.
4. **History of Incidents:** an 'incident' is an unplanned event and is therefore a sign of lack of control. Although not in direct control of the organisation, incidents are an indicator of the level of confidence in the controls. Minor incidents of little environmental impact can be used as precursors of more major events which, if action is taken, can be prevented.
5. **Technology and Commercial Options:** is the degree to which the latest technologies (e.g. BATNEEC) for controlling emissions, consumption and the management of waste are being employed and the cost of making changes to improve the technology employed.
6. **Public and Stakeholder Opinions:** is the degree of influence exerted by the views of the public and stakeholders on the organisation's activities. This may mean the increase in significance of items which might not necessarily merit

environmental 'significance' otherwise (for example, visual impact or employee traffic).

7. **Training Effectiveness:** is the degree to which the company can demonstrate effective training (in particular, in areas where required to avert incidents)

This breakdown allows the 'management' of the environment to be reviewed as well as the nature of the environmental hazard, 'severity'. The probability of occurrence is not considered under 'severity' because it is a management issue and concerns the degree to which the organisation is successful in putting into place effective controls which includes training of operatives. This is not unlike the distinction in ISO 14004 between 'Environmental Concerns' and 'Business Concerns'; is the guideline actually advising the Severity / Management distinction? It is not clear.

If your objective is to identify the significant aspects without a ranking, it will only be necessary to decide on what makes any aspect significant.

For most organisations, an aspect becomes significant when:

1. It is the subject of a permit, lease, permission or regulatory instrument
2. It is your own policy
3. It exceeds guide limits (even if not imposed)
4. It is a global concern and the EU have a stated aim to control emissions or degradation (see Dobris Assessment for issues which are regarded as critical)
5. It is a local concern (e.g. salt water incursion into aquifer, tropospheric ozone etc.)
6. It is a stakeholder or business concern
7. There have been complaints
8. There have been previous incidents
9. The amount, frequency, or characteristic is of concern
10. It involves a hazardous substance.

Significance is an organisation's own view but it has to be supported by logical argument. The result of the assessment should result in the identification of some significant impacts / aspects. No number is specified in the standard but there would be little point in implementing ISO 14001 unless the organisation was intending to designate at least one significant impact. Furthermore, the threshold of significance will is likely to need

lowering over time as a result of continuous improvement; setting the threshold based on the average significance score is an effective method of doing this.

The starting point for most significance assessments is to include, as significant, all requirements of legislation that are identified from the clause on "Legal and other requirements" (4.3.2).

There are many arguments to support this approach. Legal requirements are very important to the organisation since, if they are not met, the company may face fines, imprisonment of its officers or even closure. At best, failure to comply with its obligations will cause bad publicity and a the attention of enforcement officers. However, legal requirements are political and are themselves part of a separate significance assessment process that involves lobbying by environmentalists, media exposure as well as the inherent severity of the aspect. There is a merit in not including legal requirements in the assessment under clause 4.3.1 since this is the output of a separate clause (4.3.2).

The merit in this approach is that, in trying to include legal requirements, companies are forced to devise schemes of ranking that automatically raise all legal requirements to the threshold of significance. This can and often leads to very contrived systems where the rankings are contorted to ensure that anything that is part of a license or a regulatory requirement gets to be significant.

Significance can therefore be defined something that is:

1. a legal or regulatory requirement
2. a high severity impact
3. a high management priority

and, at the discretion of the organisation and based on the drive for continual improvement and environmental risk assessment,

4. the product of pending legislation, severity and management issues.

8.5 Methodology

Based on the needs of the organisation, it is a matter of choice whether to use a threshold method (significant = description of threshold = yes/no) or a scoring method.

If a scoring method is used, it would appear that there are two options:

1. The checklist method
2. The multiple threshold method (including FMEA)

The checklist method uses individual questions which each attract a score. The addition of all the individual scores gives the final score.

An example of this is seen in the "Significance Wizard" but this would be better if it was particular to the media or aspect being appraised. A hypothetical example is shown in Table 8.01.

#	**CATEGORY: NOISE / SEVERITY** Question	Yes Continually Don't Know **SCORE 1**	Slight Occasional Rarely **SCORE ½**	No Never None **SCORE 0**
1	Are noise levels at the boundary between 2200h and 0600h >45dBA?			
2	Are noise levels at the boundary >55dBA?			
3	Is the noise impulsive?			
4	Is the noise tonal?			
5	Is the noise from the organisation heard over other ambient noise at 0.5 km?			
6	Is the area around the plant residential or recreational?			
	TOTAL FOR EACH CATEGORY			
	SCORE FOR EACH CATEGORY			
	TOTAL SCORE			
	AS PERCENT OF MAXIMUM (6)			

TABLE 8.01: Scoring type checklist.

This method uses questions that are very particular to the aspect: it can be scored without difficulty, can ask any number of questions to suit the aspect being examined and demonstrates the precautionary principle – if no measurement can be taken, the score is automatically higher. The score does not take into account the legal or management issues as these would be the subject of separate screening.

The multiple threshold method is the method that is familiarly used in many systems which include the FMEA approach (see Table 8.02)

Severity = Property + Context + Quantity + Frequency + Duration

Properties	Context	Quantity	Frequency	Duration	Score
The noise is impulsive, tonal and without warning	The organisation is a neighbour of a recreational or residential area.	The noise level exceeds 55BA by day and 45dBA by night (2200h – 0600h)	Continuous during plant operation	Continuous	10
The noise is impulsive or tonal and without warning	The organisation is within 0.5km of a recreational or residential area.		Heard at least once every 5 minutes	Can last for over 30 minutes	8
The noise is impulsive or tonal with build-up	The organisation is within 1 km of a recreational or residential area.	The noise level exceeds 55BA by day or 45dBA by night (2200h – 0600h)	Heard at least once every 30 minutes	Can last for over 5 minutes	6
The noise is not impulsive or tonal but comes without warning	The organisation is within 5 km of a recreational or residential area.		Heard at least once every day	Can last for over a minute	4
There is no noticeable character to the noise.	The organisation is over 5 km from a recreational or residential area.	The noise level does not exceed 55BA by day and 45dBA by night (2200h – 0600h)	Heard less frequently than daily	Isolated or none	2

TABLE 8.02: Severity scoring for noise.

Each of the criteria are scored and then added together to get a total for severity. Each of the aspects will be scored using a similar matrix and there is no need to develop a percentage as scores can be used directly. It is not necessary to have five scores or to have the range from 2 to 10; these decisions are a matter of individual taste and do not influence the method or the result.

Subjective words like "seldom", "often" etc. are not used (for frequency) as they are unambiguous and unmeasurable. The scoring system will also identify when more data is required and will define the minimum quantification required for environmental management. Care has to be taken to use a good knowledge base from which to develop the matrices and it will be necessary to review both the matrices and the scoring at intervals (usually annually or when work practices change).

If an FMEA approach is considered, consideration should be given to reverting to first principles: source, pathway and target. Table 8.03 shows an illustration on how it might be constructed. The target is, in essence, the same as the impact while the source concerns the amount, occurrence and frequency of the pollutant being studied. The result of the environmental FMEA (eFMEA) is to produce a "risk priority" which is the foreseen exposure with controls in place and the "control priority" which is the significance rating. The significance rating / control priority shows the need for controls to be implemented to protect the environment. The risk priority is used by management to set objectives for

improvement (Objectives and Targets). Legal issues are not considered on the eFMEA. There need be no consideration of 'contribution' as a separate score as this will be considered under 'source'.

MEDIA	ASPECT	SOURCE		PATHWAY *MANAGEMENT*		TARGET		RPN	NEED FOR CONTROL
		A		B		C		***PRIORITY***	
								RISK	***CONTROL***
e.g. Raw material use, Air, Water, Solid Waste, Liquid Waste, Energy, Ground / Soil	e.g. Consumption, SO2, NOx, CO2, BOD, S/S, HazChem, Heavy Metals, VOCs, spills etc.	What is known about the source of the pollutant? Frequency, quantity, normal, abnormal		How does the pollutant get to the receiving media? What abatement, detection What record of incidents? Training?		What IMPACT does the pollutant have? How severe is / would be the IMPACT on the media reviewed?		A x B x C	A x C
		OCCURRENCE		DETECTION		SEVERITY			
		Details	#	Details	#	Details	#	#	SIGNIFICANCE RATING

TABLE 8.03: Environmental FMEA (eFMEA).

8.6 Significance Scoring

Scoring systems will eventually produce results such as:

NOISE (SUMMARY SCORES)	
Legislation	None
Severity	45% or 23 points
Management	50% or 25 points

How does that define "significance"?

It is important not to let the scoring system take over from what is self-evident. A foundry which is known to be the cause of visible air pollution would be expected to rate air emissions as a significant impact/aspect. The use of paper in the offices would not be expected to be more significant than the use of chemicals in a plating works. Scoring

systems can produce some surprises but normally they quantify and define why aspects are significant. They are normally self-are evident to at least one stakeholder function (accounts / production / technical / operator / neighbour / regulator etc.).

It is useful to write down the expected significant aspects/impacts before using any scoring system; these can be used as a 'reality check' when the scoring system results are reviewed. Any aspects that score higher or lower than expected should be critically reviewed. The scoring system should be aspect based and not operation or activity based since the cumulative effects of any aspect need to be scored; breaking down by activity at the scoring stage can cause the significance of multiple occurrences to be rated too low for the organisation as a whole.

Significance is not absolute so each organisation must set its own definition using the data available. In the example of rating for noise, a company with a number of higher scoring aspects might score the example, at the head of this sub-section, as "not significant" since the criteria might be 'legal requirements' or ≥70% 'severity' or ≥70% 'management'. A company which has fewer high scores might decide that noise (even at 0/45%/50%) would be "significant" with criteria of 'legal requirements' or ≥50% 'severity' or ≥50% 'management'.

A company must have some significant impacts/aspect as there is no need for operational controls and there is no driving force to develop objectives and targets and to continually improve. A company which has a great number of significant impacts/aspects may wish to prioritise action for improvement and objective and target setting by using the results of the scoring.

8.7 Summary

It is easy to understand why this clause of the ISO 14001 standard has caused organisations such difficulty in practice. The guidance in the standard is helpful but does not include sufficient practical direction. Much of the advice available is misleading (for instance, many consultants would not advise clients that the standard does not require a scoring system or would advocate a scoring system without advising of alternative approaches). Many organisations get too involved with the scoring system that they lose sight of the overall aims (the 'wood from the trees' syndrome).

It is easy to see how this problem arises since there are many choices of criteria and many different mathematical options. Where and how should one include the local context of an impact and how should this be seen relative to global issues? Local issues are obviously very important to the organisation since environmental impacts can have a marked effect on recreation / tourism and lifestyle / residential aspects in the community but how are global concerns (e.g. greenhouse gases, acid rain, ozone depletion, transboundary pollution etc.) to be considered? In this study, the global and local issues concerning the media or substance under consideration are looked at under 'properties' since these are very specific to chemicals or media. However, the balance between them has to be determined by the organisation from the best information available at the time.

It is important that the mathematics does not dictate the result. It is a personal preference whether to multiply, add or use percentages. The system should not become so sensitive to mathematical manipulation that a relatively insignificant decision in awarding a single score could have a very marked effect on the result with respect to significance. Multiplication is a more dangerous tool since it exaggerates the scoring (1 x 15 = 15, 2 x 15 = 30 whereas 1 + 15 = 16 and 2 + 15 = 17); it is necessary to test the sensitivity of the scoring system and the reaction to minor changes.

The guidance on the standard recommends that the probability of occurrence be used as a determinant of significance. The danger is that many organisations have developed very good controls that they believe to be adequate and this can cause some complacency. Despite controls, there have been major incidents such as Bhopal, Chernobyl, Seveso, Flixborough and Enschede and countless minor incidents that attract less attention. These show that 'foolproof' controls are only waiting for a new fool. Care must be taken that the controls that an organisation uses do not detract from the essential severity of the processes and substances which they are using. Controls and likelihood of loss of control are essentially a management issue. Management issues need to be seen as distinct from the severity of the aspect being addressed; good management practices should be encouraged but the severity rating should emphasise the need to maintain good management practices and this underscores the intent of the Operational Control clause, 4.4.6.

Definitions

ABNORMAL OPERATING CONDITIONS	• Planned deviations from normal procedures such as start-up, shut-down, blow-down etc. *(Environmental Technology Best Practice Programme: GG43: 1996)*
BATNEEC	• Best Available Techniques Not Entailing Excessive Cost. An objective established by UK Environmental Protection Act 1990, Section 7. *(Environmental Technology Best Practice Programme: GG43: 1996)* • Best Available Technology Not Entailing Excessive Cost. *(EC Directive 84/360/EEC and Irish Environmental Protection Act 1994).*
CEE	• Central and Eastern Europe (all central European Countries, the Baltic States, Turkey, Cyprus and Malta). Albania, Bosnia-Herzegovina, Bulgaria, the Czech Republic, Croatia, Estonia, FR of Yugoslavia, FYROM, Latvia, Lithuania, Hungary, Poland, Romania, Slovak Republic, Slovania and Turkey, Cyprus and Malta. *(European Environment Agency)*
CONTINUAL IMPROVEMEMT	• Process of enhancing the environmental management system too achieve improvements in overall environmental performance in line with the organisation's environmental policy. *(ISO 14001: 1996)* • Year-on-year enhancement of overall environmental performance (not necessarily in all areas of activity) resulting from continuous efforts to improve. Achieved by measures such as: – enhanced product quality, operational efficiency and resource utilisation. – developments in products, services, processes and facilities – improved waste management. *(Environmental Technology Best Practice Programme: GG43: 1996)*

DIRECT EFFECTS	• The direct effects of an organisation are those under the direct management control of that organisation. They do not include the use of sub-contracted services that in turn affect the environment (e.g. electricity supply, water services, decorators etc.). *(Environmental Advice Centre: 1997)*
ENVIRONMENT	• Surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelation. (NOTE: Surroundings in this context extend from within an organisation to the global system). *(ISO 14001: 1996)*
ENVIRONMENTAL ASPECT	• Element of an organisation's activities, products or services that can interact with the environment (NOTE: A significant aspect is an environmental aspect that has or can have a significant environmental impact). *(ISO 14001: 1996)*
ENVIRONMENTAL EFFECTS REGISTER	• A list of significant environmental effects, known or suspected, of the activities, products and services of the organisation. *(BS 7750:1994)*
ENVIRONMENTAL IMPACT	• Any change to the environment whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services. *(ISO 14001: 1996)*
ENVIRONMENTAL MAMAGEMEMT SYSTEM	• That part of the overall management system that includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, achieving, reviewing and maintaining the environmental policy. *(ISO 14001:1996).*
ENVIRONMENTAL REVIEW	• An initial comprehensive analysis of the environmental issues, impact and performance related to activities at a site: *(EMAS: 1836/93: 29 June 1993)*
ENVIRONMENTAL PERFORMANCE	• A measure of the organisation's achievements in protecting the environment by reducing the environmental impact of its activities (e.g. by reducing pollution through better waste management practices). When environmental performance fails to meet specified requirements, the occurrence(s) which caused this are referred to as non-compliances. *(Environmental Technology Best Practice Programme: GG43: 1996)*

INCIDENT	• Unplanned events having effects beyond those normally encountered *(Environmental Technology Best Practice Programme: GG43: 1996)*
INDIRECT EFFECT	• Indirect effects are effects which arise as a consequence of that organisation's activities but are not directly caused by that organisation. Indirect effects may occur as a result of the use of sub-contractors, courier services, electricity use etc. *(Environmental Advice Centre: 1997)*
INTERESTED PARTY	• Individual or group concerned with or affected by the environmental performance of the organisation. *(ISO 14001:1996).* • Those with an interest in the environmental effects of an organisation's activities, products and services. Includes environmental regulators, local residents, the workforce, investors, insurers, customers, environmental interest groups and the general public. *(Environmental Technology Best Practice Programme: GG43: 1996)*
NIS	• European Newly Independent States (not including the Baltic states) Armenia, Azerbaijan, Belarus, Georgia, Moldova, the Russian Federation, the Ukraine. *(European Environment Agency)*
NORMAL OPERATING CONDITIONS	• Routine operation according to normal procedures *(Environmental Technology Best Practice Programme: GG43: 1996)*
NUISANCE	• An infringement on the right of a person to enjoy the use of his or her land or property *(Environmental Advice Centre: 1997)*
ORGANISATION	• Company, corporation, firm , enterprise, authority or institution, or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration. *(ISO 14001:1996)*
POTENTIAL EFFECTS	• Those effects which may occur due to a particular incident taking place. *(Environmental Advice Centre: 1997)*
PREVENTION OF POLLUTION	• Use of processes, practices, materials or products that avoid, reduce or control pollution, which may include recycling, treatment, process changes, control mechanisms, efficient use

	of resources and material substitution. *(ISO 14001: 1996).*
REGISTRAR	• A body accredited to assess organisations for compliance with a standard and to award certificates of conformance to organisations which meet the requirements of the standard assessed.
RECYCLING	• The reuse of a material or resource following the reprocessing of that material or resource. *(Environmental Advice Centre: 1997)*
RESOURCE	• Any substance (gas, liquid or solid) which society uses and upon which society places a value. *(Environmental Advice Centre: 1997)*
REUSE	• The use of a used product for the same or different purpose without any kind of pre-processing. *(Environmental Advice Centre: 1997)*
SCARCE	• A resource is considered scarce when, at zero cost, the demand would exceed the supply. *(Environmental Advice Centre: 1997)*
SME	• Small and Medium-sized Enterprises *(EEA: 2000)*
SUSTAINABILITY	• Meeting the needs of present society in a way that does not diminish the potential of future generations to meet their needs. *(Environmental Advice Centre: 1997)*
VOC	• Volatile Organic Compounds. Released from the use of paints and solvents and vehicle use, VOCs can react with oxides of nitrogen in the presence of ultraviolet light to produce (tropospheric) ozone.*(Environmental Advice Centre: 1997)*
WASTE	• Technically seen from the point of view of the producer, waste is any substance which the producer no longer has a use for and is required to dispose of. *(Environmental Advice Centre: 1997)*
WESTERN EUROPE	• (EU+EFTA+Switzerland) Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, United Kingdom + Iceland, Liechtenstein, Norway, Switzerland. *(European Environment Agency)*

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- UK QUALITY NETWORK
  http://www.quality.co.uk/quality/
- ENTROPY INTERNATIONAL
  http://www.entropy-international.com
- MANAGEMEMT ALLIANCES
  http://www.mgmt14k.com/awma96.htm
- ENVIRONMENTAL TECHNOLOGY BEST PRACTICES PROGRAMME
  http://www.etbpp.gov.uk/
- QUALITY DIGEST MAGAZINE
  http://www.qualitydigest.com/

APPENDICES

EXTRACTS FROM SYSTEMS USED BY COMPANIES WHO CONTRIBUTED TO THE RESEARCH

Company A

EAC Code: 12. (Chemicals, Chemical Products and Fibres) (large size)

Each aspect is assigned a significance based on:

- Frequency of Occurrence (F)
- Likelihood of Loss of Control (L)
- Severity of Consequences (S)

Aspects scoring less than 350 points are not deemed significant.

An FMEA approach is used. Ratings are give between 10 (most significant) and 1 (least significant). The Severity of Consequences is based on the following criteria:

- Legislative and Regulatory Compliance
- Community / Employee security
- Impact on air, land or water
- Cost benefit reasons (e.g. insurance liability, strategic concern)
- Potential for resource depletion
- Accident and emergency situations.

SCORING SYSTEM FOR SEVERITY

Legislative and Regulatory Compliance	
Not regulated / no legislative requirements	1
Moderately regulated and compliant	2
Strictly regulated / legislated and compliant	3
Strictly regulated / legislated and occasionally non-compliant	4
Strictly regulated / legislated and consistently non-compliant	5
Community / Employee Sensitivity	
No observed reaction	1
Sporadic complaints	2
Widespread complaints	3
Vigorous community / employee action	4
Permanent injury or death caused	5
Impact on Air, Land and Water	
No measurable impact on environmental media	1
Local nuisance (e.g. dust, odour)	2
Short term adverse impact on environmental media (e.g. fish kill)	3
Long term adverse impact on environmental media	4
Permanent damage to environmental media or ecosystem (e.g. irrevocable damage to potable groundwater)	5

Cost Benefit Reasons	
Minor financial saving to the company	1
Minor financial saving to the community	2
No financial cost to the company	3
Minor financial cost to the company	4
Major financial cost to the company	5
Potential for Resource Depletion	
No depletion of natural resources	1
Some depletion of **renewable** natural resources (e.g. paper / water use)	2
Some depletion of **non-renewable** natural resources (e.g. gas and oil usage)	3
Large scale depletion of **renewable** natural resources	4
Large scale depletion of **non-renewable** natural resources	5
Accident and Emergency	
No risk / trivial risk (low probability and low environmental load)	1
Minor Risk (low probability and medium environmental load or medium probability and low environmental load)	2
Moderate Risk (High probability and low environmental load, or medium priority and medium environmental load or low probability and high environmental load)	3
Substantial Risk (High probability and medium environmental load or medium probability and high environmental load)	4
Intolerable (High probability and high environmental load)	5

EXAMPLE: HAZRDOUS MATERIALS

A detailed written analysis of the company's position with respect to:

1. Detailed inventory of chemicals
2. Risk phrases for each chemical
3. Quantity consumed per month (top ten)
4. Hazard Class (by EC Directive 67/548/EEC – Dangerous substances directive)
5. CAS Number for each substance
6. Physical state
7. Storage type
8. Pollution Emissions Register (Mass Balance)
9. Protection systems installed (bunds to BS8007, bonding to BS 5958, gas detectors and shut off valves etc)
10. Past incidents
11. Audit results (from authorities and internal/corporate)
12. Firewater interaction
13. HAZOP
14. Severity categories (see above)

RESULT

				Severity of Consequences						
#	**Environmental Impact**	**F**	**L**	**a**	**b**	**c**	**d**	**e**	**f**	**TOTAL**
1	Hazardous Materials	10	7	4	4	3	5	5	4	1750

Company B

EAC Code: 19: (Electrical and Optical Equipment) (medium sized)

A review is conducted and the impacts are scored on the basis of:

- Frequency (F)
- Severity (S)
- Likelihood (L)

The input comes from operating procedure risk assessment and from internal audit data. A cross-functional team is employed and an FMEA process is used. The impacts and aspects are ranked and the register is created / up-dated as appropriate.

Each aspect is evaluated using the highest rating from any one operation as the score for the aspect. (For example, if air emissions from Process A are daily, Process B weekly and Process C monthly, the aggregate frequency for the aspect is daily).

SCORING

FREQUENCY		**SEVERITY**		**LOSS OF CONTROL**	
10	Daily	10	Irrevocable damage / benefit	10	Certain to occur
8	Weekly	8	Serious damage / benefit	8	Very likely
6	Monthly	6	Some damage / benefit	6	Probable
4	Quarterly	4	Minor damage / benefit	4	Unlikely
2	Annually or less	2	No damage / benefit	2	Almost impossible

IMPACT (Actual or Potential)															
Aspect	Area	Activity	Air Pollution	Global Warming	Ozone Depletion	Stormwater contamination	Groundwter contamination	Soil contamination	Landfill usage	Natural Resources Depletion	Natural Res Con Resources	Negative Human Affect	Total	Rank
Compliance with Regulations	Environmental and safety	Compliance with regulations								< 10x10x10			Mandatory	1
Recycling	Facilities	Office Products					< 8x6x4=192	< 8x6x4=192	< 8x6x10=480	x	< 8x4x2=64		1000	2
	Facilities	Fl. Lamps								x				
	Facilities	PC Boards								x				
	Facilities	Old equipment								x				
Hazardous Waste Generation	Assembly	Off spec chem					x	x	x		x		(192+192+480+64)= 928	3
	Assembly	Maintenance					x	x	x		x			
	Assembly	Extract maintenance					x	x	x		x			
	Manufacturing	Stencil cleaner					x	x	x		x			
	Manufacturing	Vapour phase					x	x	x		x			
	Manufacturing	HEPA Filters					x	x	x		x			
	Manufacturing	Point solder					x	x	x		x			
	Manufacturing	Wave Solder					x	x	x		x			
	Manufacturing	Hand solder					x	x	x		x			
	Facilities	Boiler and compressor maintenance					x	x	x		x			
	Facilities	Spill clean-up waste					x	x	x		x			

Company C

EAC Code: 19. (Electronic and Optical Equipment) (large sized)

The following areas are reviewed:

- Waste
- Hazardous substances
- Water (trade, effluent, drainage)
- Air (gaseous, boiler and vehicle)
- Noise emissions (process and facilities)
- Raw materials and natural resources (process / other)
- Product (assembly/ use)
- Other

Data is collected and forms completed
An assessment of the significance is calculated by procedure.

Priority Rating	**Score**	
A	101 – 125	High Impact
B	76 – 100	
C	51 – 75	
D	26 – 50	
E	1 – 25	Low Impact

A significant aspect is any aspect scoring A, B, C or D.

Significance may arise from one or more of the following:

- Waste resources
- Break in Regulatory Requirements
- Be likely to give rise to a nuisance
- Cause evident damage to flora and or fauna
- Impact on views of interested parties or stakeholders.

SCORING

Frequency x Control x Severity = Significance Score

Frequency		**Control**		**Severity**	
1	Rare	1	Good	1	Negligible
2		2		2	
3		3		3	
4		4		4	
5	Continuous	5	Bad	5	Severe

Company D

EAC Code: 12. (Chemicals, Chemical Products and Fibres) (small sized)

Basis: Evaluation based on scale, severity, probability of occurrence and duration.

These become two factors C = Severity of Consequence (1 (low) – 5 (high))
and P = Probability of Occurrence (1(low) – 5 (high)

Significant aspect Established by S(ignificance) = C x P

Method: Air Emissions

(1) Detailed Evaluation – Essay type

Reference to survey of fugitive and exhaust emissions to establish compliance to TA Luft Standard (for solvents). Sampling via tenax tubes with gas chromatography analysis (for VOCs) and ion conductive plasma with liquid chromatography analysis (for airborne metalics). Dust also analysed.

(2) Summary Table

Emissions to Air									
No.	Issue/ Aspect	Impact	Condition	C	P	S	Ref. to Objectives	Control Mechanism	Comments
Air 1	Fugitive VOC emissions from process	Global warming. Impact on local air quality.	Normal	3	1	3	Reduce VOC emissions.	Covers to process vessels	Monitoring and visual observations have shown reduction in solvent losses
Air 2	Extracted air prom process	As above	Normal	3	1	3	Reduce VOC emissions.	Covers to process vessels	Stack monitoring has shown that VOC emissions are within legal limits
Air 3	Solvent discharge from tanker during deliveries	As Above	Normal	2	5	10	Reduce VOC emissions.	No abatement on vent. Direct supervision on delivery	20 Tonnes are used every 8 weeks

Company E

EAC Code: 38. (Health and Social Work) (large sized)

Aspects were identified during a systematic review. Operations were inspected and then broken down into sub-processes. Indirect and direct aspects were examined.

Evaluation was carried out on the data collected on the worksheets. An initial review was carried out to eliminate all impacts that were obviously insignificant (items which were not reactive and those which, even if mismanaged, would have little environmental effect, were eliminated).

Worksheets are broken into Activity/Product/Service. Each analysis is given a reference number.

EXAMPLE

Aspect: Canteen waste

Potential Impact: Waste Disposal
Aspects:
Canteen waste is domestic waste which consists of drinking cans, packaging materials, disposable teaspoons, plastic cups, napkins, food etc. Some arise from vending machines and others from employees.

Impacts:
At present there is no segregation for any of the materials thus the recyclable materials are lost for recovery. The whole volume is disposed of with the main waste stream to deep burial increasing disposal costs and using up disposal ground.

Quantity
70 Kg per day

Probability of Impact

	Actual	**Worst Case**
Air	Low	Low
Water	Low	Low
Land	Certain (100%)	Certain (100%)
Ecology	Low	Low

No mitigation. Overall probability 100%

Severity of Impacts – Worst Case Review

Flammable/Explosive	**N/A**	**Duration of Impact**	**Low**
Toxicity	**N/A**	**Ecological Impact**	**Low**
Scope	-	**Others**	-
Others	-	**Others**	-

No mitigation: Overall severity **Low**

Significance of Impact

Overall severity	Overall Probability	Regulated	Initial Impact Rating
Low	Certain (100%)	No	Low

No mitigation:

Overall Significance: **Low**

Improvement Analysis

Opportunity for Improvement

- [ ] **Replace**
- [ ] **Reduce**
- [x] **Recycle**
- [ ] **Other**
- [ ] **None**

The following guidelines on severity are given to the expert panel:

Flammable/ Explosive:	High	Material is flammable or could explode under normal plant usage conditions
	Medium.	The threat is not significant. Some extraordinary event would be required.
	Low	No hazard
Toxicity	High	A poisonous substance
	Medium	Reduced threat of poisoning
	Low	No threat
Scope	High	Global
	Medium	Regional
	Low	Local
Duration of Impact	High	Lasting more than 10 years
	Medium	Less than 10 years
	Low	Less than 1 year
Ecological Impact	High	Damage severe and long lasting
	Medium	Not high and not low
	Low	No impact on an ongoing basis
Other	This field is to consider other hazards such as thermal pollution, pH, radiation, ozone depletion, global warming, noise etc.	

Company F

EAC Code: 14. (Rubber and Plastic Products) (medium sized)

Each impact is addressed by an:

- introductory page
- assessment summary sheet

INTRODUCTORY PAGE

Oil / Chemical Discharges

Legislation:

a. No effluent discharge license
b. EC Waste Oil Regulations 1984 – 1992
c. EC Toxic and Dangerous Waste Regs 1982

SUMMARY SHEET

Significance of Discharges	Scientific Evidence	Public Attitudes
Under normal conditions there are no discharges. Only in the event of an accident or spill would there be a direct environmental impact. All oil cleaning is carried out in a degreasing unit. All oil is stored in bunded pallets and waste oil is removed by a licensed operator. One exception is YYY which is fully biodegradable and is stored in building C. Minor fugitive emissions from vehicles may go to drain. These fugitive emissions may cause depletion of dissolved oxygen which is necessary for aquatic life. there may also be affects on dissolved salts causing water hardness.	Oil products may cause harm to aquatic organisms by physical fouling, smothering or by forming a blanket on the water disrupting the oxygen supply on which the organisms depend. Toxicology studies show that repeated contact can lead to defatting of the skin. It is dangerous to the environment as it is bioaccumulative and not readily biodegradable. Levels at which oils biodegrade vary: Magmas Multi: 50% @21 days Gulf Security: 60% @ 21 days Super Diesel: 60% @ 21 days EP Lubricant: 36% @ 21 days Hydrasil: 50% @ 21 days EP Grease: Little degradation	People are very conscious of oil discharges to water systems and the damage it can have on flora and fauna. The media attention connected with such Environmental disasters as the 'Sea Empress' creates awareness and a very low tolerance among the general public for discharges, however small, to our waterways. No complaints have been received regarding discharges from the site.

NUMERICAL EVALUATION

Each impact is considered under five headings

1. Legal compliance
2. Stakeholder / public opinion
3. Potential Local Impact
4. Potential Global Impact
5. Scientific Evidence

Rating basis:

1	Negligible	2	Minor
3	Significant	4	Major

Chemical/Oil Discharge	**Rating**	**Qualification**
Stakeholder Opinion	2	In the event of an incident, stakeholders concern would be a factor
Potential Local Impact	3	Quantity: No incidents Frequency: No incidents Control: Documented emergency plan Good bunding / containment. Hazard analysis undertaken
Potential Global Impact	1	No threats other than local identified.
Legal	N/A	None identified
Scientific Evidence	N/A	Not applicable

The five inputs are added. Any impact with greater than 10 points is significant.

Company G

EAC Code: 12. (Chemicals, Chemical Products and Fibres) (medium sized)

Each area is sub-divided into activity or process and evaluated for overall environmental effects. Indirect effects are evaluated in accordance with purchasing procedures..

There are legal, corporate and industry sector codes appropriate.

The following headings were used to identify impacts throughout the organisation:

	ASPECT	SIGNIFICANCE
A1	Contravention of any regulatory requirement	Any instance is significant
A2	Generation of non-hazardous waste	Significant when it exceeds 1000 Kg / annum
A3	Generation of hazardous waste	Significant in any quantity
A4	Release of pollutants to controlled waters, sewer or open ground including storage of chemicals for leak potential.	Significant where pollutants are in any other than negligible quantities.
A5	Emissions to air of any toxic, poisonous, noxious, corrosive or global warming gases.	Significant in an emergency situation where there is potential for off-site impact.
A6	Releases of ozone depleting substances	Significant in any quantities
A7	Emissions to air of non atmospheric gases	Significant when in any other than negligible quantities and there is an environmental impact.
A8	Use of raw materials	Significant when the materials are from non renewable resources
A9	Use of any form of energy	Significant when the site demand exceeds 250 kW average from all energy sources.
A10	Use of road vehicle fuel	Significant when the fleet exceeds 5 vehicles
A11	Creation of off-site nuisance from noise, dust, smell, vibration and visual impact.	Significant when there is the potential for off site complaint.
A12	Environmental incidents arising from accidents / emergencies on site.	Significant when there is a potential loss or impact to the environment such as major fire or explosion, major release of pollutants to controlled waters, major leak of toxic gases.
B	Past activities which have caused any of the above effects.	

EXAMPLE: PROCESS X

#	OBSERVATION	CONTROL
A1	Planning permissions for all construction are retained	P-005
A2	Not significant	-
A3	During maintenance, waste oil will be generated. To minimise this impact, maintenance activities are only carried out on an annual basis and all waste oil is collected and disposed of by a company that recycles.	W-003
A4	Storage of water treatment chemicals has the potential to cause significant ground and surface water contamination. All bulk storage is within secondary containment. Dosing pumps are retained within bunded areas and transfer pipes are double walled and subject to integrity testing.	W-008
A5	The cooling tower generates significant water vapour which has the potential to spread air-borne legionella. The chemical dosing and regular maintenance checks ensure this risk is eliminated.	Risk assessment safety statement.
A6	Not applicable	
A7	Not applicable	
A8	Not applicable	
A9	The use of electrical energy in this process is, perhaps, the most significant impact on the site. However, energy usage is stringently monitories to ensure optimum usage. Energy usage targets are set for the process which aims to completely eliminate downtime.	P-007
A10	Not applicable	
A11	The equipment is capable of causing considerable off-site nuisance from noise. Noise emission limits have been set in the permissions and licences. The use of silencers and acoustic enclosures for plant ensure that legal requirements are met.	P-009
A12	The major potential significant environmental hazard associated with the process is fire and explosion due to the combustible gases used.	Risk assessments in Safety Statement
B	No previous site use to consider in this area.	

Company H

EAC Code: 17. (Basic Metals and Fabricated Metal Products) (medium sized)

Aspects are each examined and broken into activities or sub-sections. Each sub-section, in turn, is analysed under the following headings:

A. Regulations
B. Business Concerns
C. Emergency Status
D. Impact
E. Severity

Final Score for Significance = (A + B + C) x (D + E)

SCORING

Regulations	0	None applicable
	1	Minor regulation applicable or regulations will become applicable with a greater than 75% probability
	2	One regulation applicable but able to operate with a deviation
	3	One significant or two or more regulations applicable. Necessary to change/ provide abatement within a given time scale.
Business Concerns	0	Zero concern
	1	Minimal risk
	2	Reporting necessary or risk unknown
	3	Strategic decision necessary
Emergency Status	0	Not applicable
	1	Notify emergency services
	2	Emergency plan required
	3	Potential major incident training in necessary on a regular basis
Impact	0	No impact
	1	Impact on plant only
	2	Impact on local community
	3	Global impact
Severity	0	< 0.1 BATNEEC limit
	1	0.1 – 0.5 BATNEEC limit
	2	0.5 – 1.0 BATNEEC limit
	3	>1.0 BATNEEC limit

Significant Impacts are those with a score in excess of 18.

EXAMPLE OF SCORE SHEET

	ENVIRONMENTAL ASPECT PRIORITY RATING SYSTEM				Regulations	Business	Emergency	A+B+C	Impact	Severity	D+E	Significance
	Page											
#	**Aspect**	**Activity**	**Event**	**Impact**	**A**	**B**	**C**		**D**	**E**		
4	Caustic Soda	Storage	Spill	to floor	3	2	2	7	1	2	3	21
				Health issue	3	2	2	7	1	2	3	21
		Transport	Bag tear	Health issue	3	2	2	7	1	2	3	21
				to sw drain	3	2	2	7	2	3	5	35
		Dispensing	Spill	Health issue	3	2	2	7	1	2	3	21
				to drain	3	2	2	7	2	2	4	28
			Splash	Health issue	3	2	2	7	1	2	3	21
				to drain	3	2	2	7	2	2	4	28
		Process	Extraction	Air emission	3	2	2	7	1	1	2	14
			Overflow	Health issue	3	2	2	7	1	2	3	21
				to drain	3	2	2	7	2	1	3	21

Company I

EAC Code: 19 (Electrical and Optical) (medium sized)

Method: Either significant because of

- IPC License
- Significance from calculation

Included points are:

- Energy consumption
- Natural resource depletion
- Emissions to air
- Emissions to water / sewer
- Emissions to soil / ground / groundwater
- Nuisance caused by noise, vibration and dust
- Waste products to be recycled, landfilled and incinerated
- Raw material usage.
- Visual impact
- Environmental regulations (any requirement is automatically significant)

Formula: $C = S \times F \times P \times L \times D$

C= Coefficient of environmental significance
S = Severity of consequence
F = Frequency of occurrence
P = Potential of environmental impact occurring
L = Likelihood of loss of control
D = Likelihood of early detection of loss of control

S: SEVERITY OF CONSEQUENNCE: Evaluation of severity form used:

F: FREQUENCY OF OCCURENCE:

1	Annually or less	6	Weekly
2	Quarterly	7	Daily
3	-	8	Once per shift
4	Monthly	9	Hourly
5	-	10	Continuous

P: POTENTIAL FOR ENVIRONMENTAL IMPACT OCCURING:

10	Impact occurs under normal operating conditions
5	Impact occurs under certain operating conditions (e.g. lapses in control)
1	Impact occurs under extreme condition (e.g. emergency situations)

L: LIKELIHOOD OF LOSS OF CONTROL:

1	Highly Unlikely	Controls stemming from preventive measures (i.e. control and detection). These include: • Control / abatement systems: bunding, alarms (interlocked or otherwise) • Training • Preventive maintenance programmes • Procedural and material specification
5	Unlikely	Controls stemming from monitoring (i.e. reactive measures). These include: • Monitoring and measurement – audits, calibration, monitoring of emissions. • Daily production meetings • Monthly management review meetings • Trouble reports
10	Highly likely	No preventive or reactive controls.

D: LIKELIHOOD OF EARLY DETECTION

10	Immediately	5	-
9	Within 30 minutes	4	Within one month
8	Within an hour	3	-
7	Within a day	2	Within 3 months
6	Within a week	1	Greater than 3 months

If C >= 100, the item is significant.

Evaluation of Severity Form

Process / Activity	Environmental Impacts:
Injection Moulding (6 machines)	Energy consumption, natural resource depletion (electricity) Waste plastic (purgings, sprues, substrates) for recycling General exhaust emissions to atmosphere Waste tooling and parts Waste oil for disposal

Significant	Score					Insignificant
	5	4	3	2	1	
High volume (>10T/a)	1					Low volume (<100kg/a)
Toxic material					1	Non-toxic material
Hazardous material					1	Non-hazardous material
Non-renewable material	1					Renewable / reusable material
High level of waste (>10T/a)	1					Low toxic level of waste
Toxic or hazardous waste product					1	Non toxic or hazardous waste product
Non-renewable waste stream					1	Renewable / reversible waste stream
Major impact emissions					1	Minor impact emissions
High risk of water/ground pollution					1	Low risk of water/ground pollution
Subject to regulation					1	Not subject to regulation
High energy usage (power>100kVA)	1					Low energy use (<1kVA)
Non-renewable energy	1					Renewable energy
Major natural resource consumption						Low resource consumption
High level of water use		1				Low level of water use
Nuisance noise levels					1	Low noise levels
Nuisance vibration levels					1	Low vibration levels
Nuisance dust levels					1	Insignificant dust levels
Odorous					1	Non-odorous
Highly sensitive eco-system / habitat					1	Non-sensitive eco-system / habitat
Significant visual impact					1	Visual impact non-significant
TOTAL NO. OF TICKED BOXES	5	1	0	0	14	
Weighted Totals	25	4	0	0	14	

Grand weighted total	43
Total possible score (5X no of ticked rows)	100
% SEVERITY (GWS/TPS)	43%

Comments:
Energy consumption = 31kVAx 6 m/c = 186 kVA
45l/m water flow x 6 lines @ 200l/line = 1200 l consumed
Assume general exhaust as minor impact emissions
Assume noise levels are contained within building
Assume vibration contained

Signed by person performing evaluation

Date:

Ratings	5	4	3	2	1	
Material consumption	>10000	1001 - 10000	501 - 1000	100 - 500	<100	Kg
Water use	>10000	1001 - 10000	501 - 1000	100 - 500	<100	l
Waste generated	>10000	1001 - 10000	501 - 1000	100 - 500	<100	Kg
Electric Power	>100	51 - 100	11 - 50	6 - 10	1 - 10	kVA

A revised evaluation is carried out after any material change in the activity / process / service

Company J

EAC Code: 3 (Food . Beverages and Tobacco) (large sized)

Methodology:

Identification of parameters using reference numbering:

Atmospheric emissions	1
Aqueous emissions	2
Waste management	3
Soil, groundwater etc.	4
Noise	5
Natural resources	6
Materials Management	7

Where there is more than one aspect in a category, 1.1, 1.2, 1.3 etc

Scoring System

Scale

Score	Scale	Description
1	On-site	Impact affecting the environment on site
2	Local	Impact affecting the environment within 1 km
3	Regional	Impact affecting the environment between 1 km and 20 km
4	National	Impact affecting the environment greater than 10 km but within Ireland
5	Global	Impact affecting the environment beyond Ireland

Duration / Frequency

Score	Scale	Description
1	Short	Impact will affect the environment for 0 – 5 days Frequency is not daily
2	Medium	Impact will affect environment for between 5 and 30 days Frequency is almost on a daily basis
3	Long	Impact will affect the environment for longer than 30 days Frequency is continuous

Probability of Impact Occurring

Score	Scale	Description
1	Low	No or little possibility of impact occurring There are procedures / equipment in place to adequately control
2	Medium	There is some possibility of impact occurring Procedures and equipment do not control all areas of the aspect
3	High	There is a high possibility of the impact occurring Procedures / equipment are inadequate or absent

Severity of Impact

Score	Scale	Description
1	Low	Where the impact's affects are noticeable but only cause a small change in the environment
5	Medium	Where the impact's affects cause considerable change in the environment either as high volume/low risk or low volume/high risk impact.
10	High	Where a section or part of the environment is irreparably damaged or where the company is/may be in breach of regulations or its licence.

The significance of the impact = Scale x Duration x Probability x Severity

Risk Level is calculated as follows:

Normal

Score	Scale	Description
1	Low	The consequence of the impact is low under normal op. conditions
2	Medium	The consequence of the impact is medium under normal op. conditions
3	High	The consequence of the impact is high under normal op. conditions

Abnormal

Score	Scale	Description
1	Low	The consequence of the impact is low under normal op. conditions
2	Medium	The consequence of the impact is medium under normal op. conditions
3	High	The consequence of the impact is high under normal op. conditions

Incidents

Score	Scale	Description
1	Low	The consequence of the impact is low during incidents
2	Medium	The consequence of the impact is medium during incidents
3	High	The consequence of the impact is high during incidents

Risk level = (Normal + Abnormal + Incidents) / 3

Timing Score

Timing

Score	Scale	Description
1	N/A	It never happened, it may never have happened, it isn't happening, it may not be happening it won't happen again, it may not happen again.
2	N/A	It happened in the past, it may have happened in the past.
3	N/A	It is currently happening, it may still be currently happening
4	N/A	It will continue to happen in the future, it may continue to happen in the future.

Timing Score = Past x Current x Planned

Environmental Score = Significance x Risk x Timing

A score of 2000 or over is regarded as significant.

Each worksheet consists of three parts e.g.

A. Justification (5.1(a))
Noise is an environmental pollutant, it is a waste that is produced as well as a result of various activities at the plant including manufacturing and the operation of the WWTP. Noise which extends beyond the boundaries of the site is define as ambient noise. This type of emission is viewed as a nuisance on a local scale because of the nature of noise. Etc.

B. Register (5.1.(a))

Register Section: 5: Noise Emissions						
ID	Effect N=negative P=positive	Activity	Aspect	Impact	Concerns	
					Environmental	Business
5.1 (a)	N	General site operations	Operation of Equipment	Noise pollution to nuisance level	Lack of knowledge of legislation. Intrusiveness of noise. Physiological and psychological effects in humans	Breach of legislation. Personal liability. Mitigation costs.

C. Scoring (5.1(a))

Register Section: 5: Noise Emissions												
ID	SIGNIFICANCE				RISK LEVEL			TIMING			Score	Docs
	Scale	Duration / Frequency	Probability	Severity	Normal	Abnormal	Incidents	Past	Current	Planned		
5.1(a)	2	3	3	10	3	3	3	2	3	4	12960	AB01 AB45

Company K

EAC Code: 33 (Information Technology) (medium sized)

Methodology:	Questionnaire and analysis
Aspects identified:	Energy Use (electric and gas) Chemical and raw material use Water use Clean room supplies Office products Packaging and Transportation
Impacts Identified:	Solid waste disposal Hazardous waste disposal Air emissions Waste water Renewable resources / Non-renewable resources Human interaction Land use
Impacts divided by:	P= potential (abnormal and emergency) A= actual
Categorisation:	**High Impact:** When compared to other aspects, the aspect has a high volume of emissions, use of resources and/or a medium frequency of occurring (i.e. daily). **Medium Impact**: When compared to other aspects, the aspect has a medium volume of emissions, use of resources and/or a medium frequency of occurring (i.e. monthly) **Low Impact:** When compared to other aspects, the aspect has a low volume of emissions, use of resources and/or a negligible frequency of occurring (i.e. less than once a year).
Area of Impact:	**Local:** Water emissions, solid waste disposal **Distance**: Hazardous waste disposal, chemical use. **Global:** Air emissions that cause global warming.
Significance:	Any impact score greater than the average.

NOTE: At this stage, noise, visual impact, odour and electromechanical issues have been screened and assessed to be insignificant and will not be evaluated in detail until a later date.

IMPACT	ASPECT								
	Energy Use		Water Use	Chemical Use			Clean Room Supplies	Office Products	Packaging and Transport
	Electric	Gas		Raw	Cleaning	Media			
Solid Waste	3	3	3	0	0	15	3	15	15
Hazardous Waste	9	0	9	0	90	0	3	0	0
Air Emissions	0	15	0	10	3	0	0	0	15
Water Pollution	0	0	45	3	30	30	3	0	15
Renewable Resources	15	15	15	0	15	0	3	15	75
Non-renewable Resources	0	75	30	3	30	15	3	0	9
Human Interaction	0	0	0	10	1	0	0	0	3
Land Use	3	0	1	10	1	0	0	0	3
SCORE	30	108	103	36	170	60	15	30	135

Average = 76 (Therefore, significance to all aspects > 76)

Scoring system:

IMPACT	Actual	2
	Potential	1
SIGNIFICANCE	High	10
	Medium	5
	Low	1
LOCATION	Local	1
	Distant	3
	Global	5
SIGNIFICANCE	**Impact x Significance x Location**	

Example of worksheet: OFFICE PRODUCTS

Impacts

Solid waste	moderate
Hazardous waste disposal	negligible
Air emission	negligible
Water pollution	negligible
Renewable resources	
wood	low – mostly recyclable
metals	negligible
recyclable	moderate
Non-renewable resources	
water	negligible
petroleum	-
Human interaction	negligible
Land use	negligible

Scoring

	Significance				Location				Impact			TOTAL
	H	M	L	score	H	M	L	score	Act	Pot	score	
	10	5	1		5	3	1		2	1		
Solid waste		X		5			X	1	X	X	3	15
Hazardous waste			0	0			0	0	0	0	0	0
Air emissions			0	0			0	0	0	0	0	0
Water pollution			0	0			0	0	0	0	0	0
Renewable Res			X	1	X			5	X	X	3	15
Non-renewable Res			0	0			0	0	0	0	0	0
Human interaction			0	0			0	0	0	0	0	0
Land use			0	0			0	0	0	0	0	0

TOTAL 30

Company L

EAC Code: 14. (Rubber and Plastic Products) (medium sized)

Methodology: The following criteria were considered when scoring for significance:

CRITERIA	GRADES OF SCORING		
	NONE / LITTLE (0 POINTS)	**SOME** (5 POINTS)	**MUCH** (10 POINTS)
1. LEGAL REQUIREMENTS.	No legal requirements.	Some legal requirements but no defined emission levels	Legal requirements with emission levels or potential serious consequences
2. MAGNITUDE	Small amount of emission (Kg/year) or non-toxic contamination or small amounts of energy, heat, noise or vibration emissions.	Intermediate levels of emissions	High level of emissions (T/year) or toxic contamination or large amounts of heat, energy, noise or vibration.
3. POSSIBILITY OF REDUCING IMPACT	No technology exists to reduce the impact or quantity of emission.	There are better technological options but this source is not the principal source of the specified emission.	There are better technological options and this source is a principal source of this emission
4. INTERERSTED PARTIES	There is no interest in this aspect / impact.	There is some interest in this aspect / impact but most interest is elsewhere.	There is much interest in this aspect /impact of the operations.
5. FREQUENCY	Low (Rare occurrence)	Intermediate.	High (A continuous emission)
6. SENSITIVITY OF LOCAL ECOSYSTEM	Not sensitive	Sensitive areas / subjects within 1 Km.	Sensitive areas / subjects nearby (people, agriculture, clean water, natural vegetation etc.)
7. GLOBAL ENVIRONMENTAL PROBLEMS	There is no impact of a global nature	Intermediate (There might be an impact of a global nature or a small impact)	The emission is identified as one with a primary contribution to a global issue.

It was decided, initially, to rank the aspects / impacts on the basis of three criteria, the most relevant being 1, 2 and 3. Magnitude, to a certain extent, can reflect frequency. Views of interested parties are largely covered by legislation. The facility is within a kilometre of three foundries and would not have the primary impact on local or global eco-systems. Local and global eco-systems will benefit from the focus on magnitude and legislation.

EXAMPLES FROM REGISTER

A Legal requirement
B Magnitude of environmental impact
C Possibility of reducing the impact

10 Very significant
5 Some significance
0 Little or no significance

No.	DESCRIPTION OF THE ASPECT	IMPACT	A	B	C	TOTAL
1	Combustion gases from the postcure oven #501 34Kw	Air	10	0	0	10
2	Combustion gases from the postcure oven #502. 50Kw	Air	10	0	0	10
3	Combustion gases from the paint curing oven	Air	10	0	0	10
4	Combustion gases from the factory and office heating boilers	Air	0	0	5	5
5	Gases from the electric ovens used for adhesive cure	Air	0	0	5	5
6	Equipment X electric oven and extract	Air	0	0	5	5
7	Paint curing electric oven	Air	0	5	5	10
24	Waste adhesive falling into drainage channel	Liquid Waste	10	0	10	20
26	Cleaning waters going into the sewer	Liquid Waste	10	0	0	10
27	Dangerous waste: more than 50T/year	Solid Waste	10	10	5	25
28	Inert waste: more than 50T/year	Solid Waste	10	10	5	25
30	Municipal waste less than 10T/year	Solid Waste	10	5	0	15
31	Skip of inert waste which is outside and uncovered	Water Run-off	10	5	5	20
32	Skip of scrap metal which is outside and uncovered	Water Run-off	10	5	5	20
33	Skip of paper in the yard.	Water Run-off	10	0	5	15
39	Spillage or leakage to ground from oil in the oil storage area	Ground Contamination	0	5	0	5
40	Spillage or leakage from containers of waste oil and waste chemicals in the chemical store	Ground contamination	0	5	0	5
48	Cooling towers and compressors	Noise	10	5	5	20
49	Air extract fans on the roof	Noise	10	0	5	15
62	Oils and greases 11T/year	Raw materials	0	5	10	15
63	Chlorinated solvents: less than 100Kg/year	Raw materials	10	0	0	10
64	Non-chlorinated solvents: 49T/year	Raw materials	0	5	5	10

Company M

EAC Code: 12. (Chemical, Chemical Products and Fibres) (large sized)

Methodology: FMEA

Collection of data: Form with 15 sections

RPN > 50 = significant aspect

Revised: After achievement of each objective but not less than once per year.

SEVERITY

Will hardly be noticeable. Very low to negligible impact on the environment	1
Non-compliance with company policy. Low to very low impact on the environment.	2 – 3
Non-compliance with legal and regulatory requirements and possible damage to the company. Moderate damage to the environment.	4 - 6
The heath of people living in the surrounding area could be threatened. Serious damage to the reputation of the company. Serious damage to the environment.	7 - 8
Endangers the lives of people living in the surrounding area. The future existence of the company is endangered. Very serious damage to the environment.	9 – 10

OCCURENCE

Remote. Highly unlikely condition will occur.	No record of occurrence	1
Low. The condition occurs in isolated cases but chances are low	Less than 6 times per year	2 - 5
Moderate. The condition has a reasonable chance to occur (could be at start-up or shut down)	Once every other month	6 - 7
High. The condition occurs very regularly and/or during a reasonable amount of time.	Once per month	8 - 9
Very High. The condition will inevitable occur during long periods (typical for normal operating conditions)	Once a week or more often	10

ASPECT

The current controls will almost certainly immediately defect the aspect and reaction can be instantaneous	1
Chances are high that the aspect will be detected shortly after occurrence and a quick reaction is possible.	2 – 5
There is a moderate chance that the aspect will be detected in a reasonable time frame and /or it will take some time to react.	6 – 8
It is unlikely that the aspect will be detected or it will take a fairly long time before action can be taken and results seen.	9
The aspect will not be detected in any reasonable time frame or there is no reaction possible (normal operating conditions).	10

The form used for determination of the aspects identified in the area is similar to the following (constructed from memory).

AREA/OPERATION:	DATE:
1	HAZARDOUS RAW MATERIALS USED (Note description and amount used)
2	NON-HAZARDOUS RAW MATERIALS USED: (Note description and amount used)
3	AMOUNT OF WATER USED (Amount and where used (e.g. 100 gal/month Cleaning tanks))
4	EMISSIONS OF WASTE TO DRAIN (Treatment Plant) (Quantity and Source)
5	EMISSIONS OF AIR THROUGH DEFINED POINTS (Quantity and Source)
6	SOURCES OF FUGITIVE EMISSIONS (Source)
7	HAZARDOUS WASTE - LIQUID (Quantity, Source and Nature)
8	HAZARDOUS WASTE – SOLID (Quantity, Source and Nature)
9	NON-HAZARDOUS WASTE – SOLID (Quantity, Source and Nature)
10	STORAGE: HAZARDOUS MATERIALS - SOLID (Quantity, State, Storage type)
11	STORAGE: HAZARDOUS MATERIALS - LIQUID (Quantity, State, Storage type)
12	STORAGE: NON-HAZARDOUS MATERIALS – SOLID (Quantity, State, Storage type)
13	STORAGE: NON-HAZARDOUS MATERIALS – LIQUID (Quantity, State, Storage type)
14	NOISE / DUST / ODOUR: (Sources and quantity if known, Abatement in place)
15	INCIDENTS WHICH HAVE OCCURRED WITHIN THE LAST LEAR

Company N

EAC Code: 19 (Basic Metals and Fabricated Metal Products) (large sized)

Evaluation teams (cross-functional) meeting quarterly or more frequently.

Use worksheet scoring each either

- H High
- M Medium
- L Low
- N/A Not applicable

Team award a Y/N to whether the aspect is considered significant.

Worksheet:

ENVIRONMENTAL ASPECT AND IMPACT WORKSHEET																								
Operation: Date																								
Team: Number																								
			Environmental area of impact and rating																					
Com-ponent	Aspect	Significant?	Air Pollution			Water Pollution			Fauna			Odour			Land Pollution			Potential Fire			Solid Waste		
			S	Q	C	S	Q	C	S	Q	C	S	Q	C	S	Q	C	S	Q	C	S	Q	C
Ship Waste	Skids	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L	L	M	M	M	H
	Plastics	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	M	H	H	H	H
	Card	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	M	H	H	H	H
Receive Waste	Skids	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L	L	M	M	M	H
	Plastic	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	M	H	H	H	H
	Card	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M	M	H	H	H	H
	Chems	N	L	L	M	L	L	M	-	-	-	L	L	L	L	L	M	L	L	M	-	-	-
Chem Store	Leaks	Y	L	L	M	M	L	M	L	L	H	L	L	M	L	L	M	H	L	M	-	-	-
	Spills	Y	L	L	M	M	L	M	L	L	H	L	L	M	L	L	M	H	L	M	-	-	-
	Fire	N	H	M	M	-	-	-	-	-	-	-	-	-	L	L	M	-	-	-	-	-	-
	Explode	N	L	L	M	L	L	M	-	-	-	-	-	-	L	M	L	-	-	-	-	-	-
	Weather	N	-	-	-	L	M	L	-	-	-	-	-	-	L	L	M	-	-	-	-	-	-
Fork Trucks	Battery	N	-	-	-	M	L	M	-	-	-	L	L	L	M	L	M	-	-	-	-	-	-
	Hydraulic	N	-	-	-	L	L	L	-	-	-	-	-	-	L	L	L	L	M	H	-	-	-
	Fluids	N	-	-	-	L	M	H	-	-	-	-	-	-	L	M	H	L	L	H	-	-	-

Company O: EG+G SEALOL (EMAS) (source: ENFO Library)

EAC Code: 17 (Basic Metals and Fabricated Metal Products) (Medium Sized)

The environmental effects are categorised into:

- Class A: Major environmental effect
- Class B: Intermediate environmental effect
- Class C: Minor environmental effect

Class A are considered significant for the purposes of EMAS

Direct and Indirect effects are on separate registers:

Process	Effect	Class	Addressed	Ref
Metal machining	Metal swarf and bar ends	B	Collected for recycling by Heggarty Hammond	EP-3 and EP-6
	Mineral Gear and Hydraulic Oil	A	Collected by Atlas Oil and Used as fuel for incineration purposes	EP-2
	Machine Coolant	A	Water and oil phases are separated. Water is re-used as a dilution medium for fresh coolant. Oil is collected by Atlas Oil and used as a fuel for incineration purposes.	EP-3
	Water based oil condensate.	A	As above	EP-3
Metal Pressing	Metal Foil Waste	B	Collected for recycling by Heggarty Hammond.	EP-6

INPUTS	IMMEDIATE SUPPLIER / AGENT	INTERMEDIATE SUPPLIER / AGENT	ORIGINAL SOURCE
Metal	Impact Metals, Dublin	Starkeys Technicast Foundry	Various sources. Information not available
		Wisco Espanola SA	Various sources. Information not available
Oils	Tedcastles Oil, Cork	Whitegate Oil Refinery	Various sources. Information not available
	Houghton Oils, Meath	Whitegate Oil Refinery	Various sources. Information not available
	Shannonside Oils, Shannon	Whitegate Oil Refinery	Various sources. Information not available
Acids	J & T Chemicals, Cork	Information not available	Information not available
Corrugated Board	Smurfit Paper Mills, Dublin	Information not available	Information not available

Company P: Aquarius Metals (Margetson: 1999)

EAC Code: 17. (Basic Metals and Fabricated Metal Products) Small sized.

Methodology: Matrix

Basis of RPN Scoring: Four categories in pairs: Likelihood and Extent
Severity and compliance

The highest score in each set of three is taken to give a sub-total score which is then multiplied and used to give a total score.

Example: Use of Jizer Degreaser

	Likelihood			Extent				Severity			Compliance					
Direct Impact	Frequency of Occurrence	No of near miss conditions	Level of control	Resource type	Resource quantity	Extent of recovery/recycling	**Matrix Score**	Degree of toxicity/harm	Effect of removal abstraction	Scarcity of resource	Legislated/regulated (LA/LF)	Other legislation	Incur external taxes/levies	**Matrix Score**	**Direct Impact**	**Indirect Impact**
Forms emulsion with water	C	D	B	D	B	D	10	D	D	C	D	D	D	10	100	
Harmful fumes	C	D	C	A	C	D	10	D	D	D	D	D	D	10	100	
Fire hazard	D	D	C	D	B	D	10	D	D	C	D	D	D	10	100	
Hydrocarbon solvent	C	D	C	A	C	D	10	D	D	D	D	D	D	10	100	
Delivery of Jizer	B	B	D	D	B	D	10	D	D	B	D	D	D	10	100	
Danger to skin contact	C	C	C	D	B	D	10	D	D	B	D	D	D	10	100	

The scores are derived from the tables beneath. A score is first derived from the following matrices for each of the three factors of each of the four criteria (likelihood, extent, severity and compliance). The worst 'lettered' scores from 'Likelihood and Extent' and 'Severity and Compliance' are then given a numerical value (from the matrix below) and these are multiplied together to get the impact score (either indirect or direct).

These are then summarised and put into a table for setting objectives and targets.

Likelihood				
	A	B	C	D
Frequency of Occurrence	Never	Annual or rare	Monthly or weekly	Daily
No. of near misses	None	Occas-ional	Regular	Frequent
Level of control	High	Med	Low	None

Severity				
	A	B	C	D
Degree of toxic/env.harm/ nuisance	None	Low	Medium	High
Effect of removal/abstraction	None	Low	Medium	High
Scarcity of resource	Plentiful	Medium	Low	Scarce

V V

Likelihood					
		A	B	C	D
Extent	A	0	1	2	3
	B	1	2	3	5
	C	2	3	5	7
	D	3	5	7	10

X

Severity					
		A	B	C	D
Compliance	A	0	1	2	3
	B	1	2	3	5
	C	2	3	5	7
	D	3	5	7	10

^ ^

Extent				
	A	B	C	D
Type of resource	Re-newable	Recycled/reused	Re-covered	Exhaust-able
Quantity of resource or waste stream	None	Low	Medium	High
Extent of recovery/recycling	High	Medium	Low	None

Compliance				
	A	B	C	D
Legislated by EA/LA	Not covered	Unlikely to be covered	Likely to be covered	Covered
Other applicable legislation	Not covered	Unlikely to be covered	Likely to be covered	Covered
Incurs external taxes/levies	Not taxed	Unlikely to be taxed	Likely to be taxed	Taxed

SUMMARY SHEET

Process	Legal Register Code	Impact Register Code	Total Score
Use of water	L101	101	270
Use of Aquarius's Lorry	L102	102	240
Transportation of used Dromus Oil	L103	103	140
Disposal of Steel banding by HGVs	L104	104	280
Use of Jizer Degreaser	**L105**	**105**	**600**
Disposal of Packaging Paper	L106	106	440
Disposal of Office Paper to Landfill	L107	107	440
Disposal of Waste Plastics to Landfill	L108	108	340
Cutting of Aluminium	L109	109	320
Transportation of Aluminium	L110	110	390

Company Q: Autosmart (Margetson: 1999)

EAC Code: 31. (Transport, Storage and Communications)(Medium sized)

Methodology: Frequency and Consequence are multiplied to give a risk rating.

Collection of data: Step-by-step Checklist

Each 'hazard' is given a score of between 1 and 5 for 'probable frequency' and consequence'. These are multiplied together and give a 'risk rating'; from this a 'high' (15 – 25), 'medium' (5 – 15) or 'low' (1 – 5) rating is given

ENVIRONMENTAL ASPECTS CRITERIA FOR IDENTIFICATION & ASSESSMENT OF SIGNIFICANCE

CRITERIA FOR DATA CAPTURE

When carrying out an initial review or assessing a new area of the site, thoroughly review the area to see if there are any potential direct or indirect aspects in line with those criteria laid down on the form (i.e. water, land, air, waste and resource use). Do not include any health and safety issues.

ALSO BEAR IN MIND THE FOLLOWING POINTS:

1. Raw material usage (e.g. components and cutting fluids).
2. Use of utilities (e.g. water and gas)
3. Waste (e.g. scrap and swarf)
4. Testing (e.g. oils and solvents)
5. Nuisance (e.g. noise and odour)
6. Special processes (e.g. rubber moulding and deburring)
7. Maintenance (e.g. Cleaning and shutdown)
8. Training (e.g. new staff and contractors)

Company R: SUA (Margetson: 1999)

EAC Code: 17 (Basic Metals and Frabricated Metal Products) (large size)

ASSESSMEMT OF SIGNIFICANCE

Identify the environmental concerns as high, medium or low from the severity / likelihood table

HIGH SEVERITY: Major environmental incident / concern or legislative breach likely to result in prosecution

MEDIUM SEVERITY: Concern incident or legislative breach likely to result in a warning

LOW SEVERITY: Minor concern or no legislative breach.

HIGH LIKELIHOOD: Will definitely occur within a year

MEDIUM LIKELIHOOD: Will be likely to occur within the year

LOW LIKELIHOOD: Is unlikely to occur within the year.

		LIKELIHOOD		
		HIGH	**MEDIUM**	**LOW**
SEVERITY	**HIGH**	HIGH	MEDIUM	MEDIUM
	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	LOW	MEDIUM	MEDIUM	LOW

SIGNIFICANCE: A significant aspect is one with a High/High score. An insignificant aspect is one with a Low/Low score. All other aspects are medium rated (these are environmental aspects and therefore remain on the register).

Ref.	Environmental Aspect	Legal Compliance	Future Legislation	Hazard Potential	Receptor Risk	Nuisance	Perception	Cost Saving	Env. Policy	Liability Risk	**SIGNIFICANCE**
01	Fire promotion by oxidising agents	M/H	L/L	M/H	L/L	L/L	L/L	L/L	M/H	M/H	**M**
02	Contamination of water or land from process waste (Sodium Nitrate)	L/M	L/L	L/L	M/M	L/L	L/L	L/L	L/M	L/L	**M**
03	Contamination of water (surface, ground and sewers) by cutting oils	H/H	M/M	H/H	H/H	L/L	M/M	M/M	H/H	H/M	**H**
04	Land contamination at SUA site.	H/H	M/M	M/M	M/M	L/L	M/M	L/L	H/H	H/M	**H**
05	Waste energy and resources (emulsion spillage / oil disposal)	M/M	M/M	M/H	L/L	L/L	L/L	H/M	M/M	L/L	**M**
06	Air contamination from production oil disposal	L/L	L/L	L/L	L/L	L/L	L/L	L/L	L/L	L/L	**L**

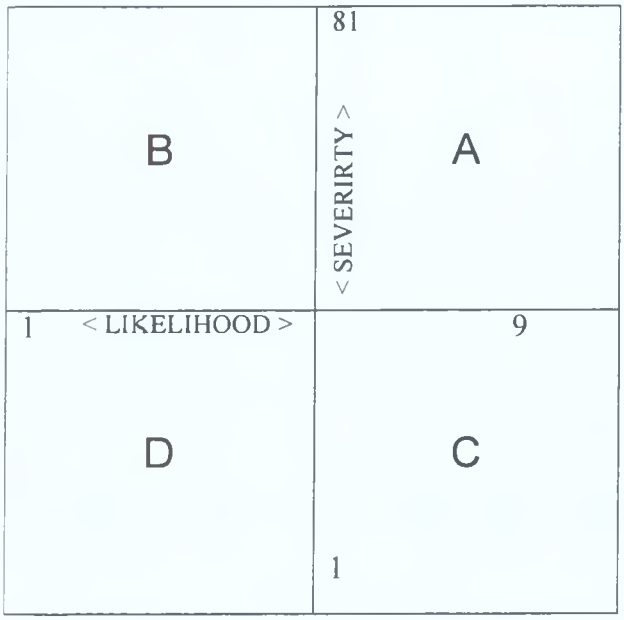
Company S: Lucas (Margetson: 1999)

EAC Code: 19 (Electrical and Optical Equipment) (large size)

The aim of the system is to suit all Lucas facilities and is therefore developed for both manufacturing and non-manufacturing site.

	Manufacturing	Non-Manufacturing
Likelihood Maximum score 9	Quantity of Substance	Quantity of Personnel
	Risk Assessment	Risk Assessment
Severity Maximum score 81	Legislation	Legislation
	Toxicity Impact Assessment	Process Impact Assessment
	Business Impact	Business Impact
	Site Vulnerability	Site Vulnerability

Each of the categories can score from 1 (low) to 3 (high) and these are multiplied for each category (likelihood and severity). These are plotted on a Boston Matrix as follows:



BOSTON MATRIX

A = HIGH PRIORITY

B = MEDIUM PRIORITY

C = MEDIUM / LOW PRIORITY

D = LOW PRIORITY

As guidance into the awarding of scores, tables have been created for each of the sub-categories:

SITE VULNEARABILITY

	HIGH	MEDIUM	LOW
Land Contamination	History of remediation	Brownfield site	Greenfield site
Groundwater	Major aquifer	Minor]Aquifer	Non-aquifer
Public Boreholes	Within a 5 mile radius	5 – 10 mile radius	Outside a 10 mile radius
Sites of Special Scientific Interest	Within a 5 mile radius	5 – 10 mile radius	Outside a 10 mile radius
Local Residential Areas	Adjacent to the perimeter of the site.	Within a 2 mile radius of the site	Outside a 2 mile radius of the site.
TOTAL			
Score	3	2	1

Company T: Nortel (IEM: 1996)

EAC Code: 33 (Information Technology) (large size)

Nortel use a form of FMEA with 7 factors of equal weighting – each has a score of between 1 (good) and 5 (bad). The 7 factors are:

1. Regulatory / legislative issues
2. Cost implications
3. Level of importance to customers
4. Level of importance to insurers
5. Potential for environmental damage on local community
6. Potential for environmental damage on employees.
7. Effectiveness of implemented controls

There is no distinction given to 'indirect' and 'direct' impacts since the control imposed depend on the 'significance' irrespective of whether it is a Nortel or vendor issue.

Each is scored on the following sheet:

SIGNIFICANT ENVIRONMENTAL ASPECTS SHEET: TRANSPORTATION Date compiled: 11/10/96 REF. NO. SEE-001	
Description	Company transport arrangements • business travel • employee travel • delivery logistics
Reasons for being defined as significant	• Energy consumption • Use • Exhaust emissions • Effect on local community • Cost implications • Control system needs improvement
Reference to environmental objectives and management programme	• EO 96 006: Develop a site transport policy and management programme • EO 96 007: Carry out a Transport Survey • EO 96 020: Construct new access road
Significance rating	864: Ranked 1st.
Applicable legislation	• EPA 1990 Pt. 111 – Statutory Nuisance • Motor Fuel (Consumption and Content) Regs • Proposed Carbon / Energy Tax • Air Quality Standards Regs 1989
Details of abnormal conditions	• Traffic density at shift changeover, site entrance • Bottleneck in residential area • Traffic delays during new access construction
Details of emergency	• Potential road accidents
Further Information	• Environmental Burdens and Effects sheet EB-001
FMEA Environmental burden matrix Burden description: • Compliance with legislation • Cost Implications • Customer concerns • Importance to insurers • Potential environmental damage – effect on local community – effect on employees • Effectiveness of control system	 2 3 1 3 3 4 4
	TOTAL
Rating scale: good = 1 poor = 5	

Company U: Carson Office Furniture (IEM: 1996)

EAC Code: 23 (other manufacturing) (large size)

Each aspect is classified as being between –10 and +10 on the following scale:

SCORE	DESCRIPTION
-10	Non-compliance with regulation or policy
-8	High levels of emissions / discharges / waste / landfill / energy use
-6	Medium levels as above / non recyclable materials
-4	Medium energy / water consumption. Start-up/ Close-down environmental risk.
-2	Low profile activity / minor adverse effect of waste / energy / resource
0	
+2	Low profile activity / minor beneficial effect of waste / energy / resource
+4	Environmental BATNEEC. Control procedures in operation. Training implemented
+6	Best practical environmental option. Third party recycling.
+8	Energy reclamation. Recycling on site
+10	Major environmental benefit.

Any aspect outside the +4 to –4 range is considered significant. Priority is given to low or negative environmental scores.

Activity, Aspects and Impacts Table

Activity	**Aspect**	**Impact**
Wood burning furnace	• Emissions of CO2 to atmosphere • Reduction in landfill (fuelled by wood residues) • Avoidance of fossil fuel	• Contribution to global warming • Reduction in effects of landfill – methane emissions, potential groundwater pollution. • Reductions in fossil fuel depletion

Company V: Polarcup (IEM: 1996)

EAC Code: 14 (rubber and plastics) (large size)

The aspects and impacts are assessed based on the following criteria:

1. Regulatory requirements
2. Demonstrable / potential environmental effect (location, time, duration, quantity, frequency, toxicity, exposure to receptor, management control, normal and abnormal conditions and the consequences of change / inaction).
3. Stakeholder interest (regulatory bodies, neighbours, customers, employees, financial and insurance interests and the "market place" in general).
4. Environmental policy.

These are assessed through an EFMEA (Environmental Failure and Effect Analysis) where three headings are used – 'Likelihood', 'Severity' and 'Operational Control'

Each of the three headings is scored for each aspect/impact from 1 (good) to 5 (bad) and the three numbers are added together (score from 1 to 15). Any score in excess of 10 is considered significant. After any programme to abate or ameliorate an impact, the score is recalculated.

EFMEA EXAMPLE

Initial evaluation date: 15/3/96 (re-evaluated on 12/12/96)												
Aspect	Potential Risk	L	S	O	RPN	Corrective Action	New Risk	L	S	O	RPN	New action
Use of energy from motors on extruder	**Global warming**: excess contribution from uncontrolled use. **Investor interest**: minimising costs, loss of competitiveness	5	5	3	13	Develop operator work instruction. Train operator Re-evaluate	**Global warming:** remains an issue. **Operators trained:** 5% reduction in kWh/ton	5	5	1	11	

Analysis of Non-conformances / APPENDIX B

	Non-conformance
1	No register of impacts
2	The aspects have not been related to the company's activities, products or services
3	The current list of environmental aspects does not relate to the company's activities, products and services.
4	The EMS manual does not address the aspects which can have an impact
5	The EMS manual does not adequately address aspects that can or can have a significant impact
6	The EMS plan does not reflect the aspects that 'can have' an environmental effect.
7	The environmental aspects procedure does not address aspects that "can have" a significant environmental impact on the environment.
8	The environmental manual does not reference clause 4.3.1
9	The prime manual does not address potential impacts
10	The prime manual does not address potential impacts
11	Linkage between aspect / impact identification and objectives could not be established.
12	The interaction between controls referenced in company impacts register and operational control procedures in place is unclear in a number of places
13	The linkage between activity, impact, control, monitoring and record is not clear.
14	The linkage between significance and specific impacts is not clear in all cases.
15	There is no cross reference between the aspects documents and the energy and waste spreadsheets.
16	There is no clear linkage between the issues identified in the Initial Environmental Review and those evaluated in the register of effects
17	There is no evident link between aspects and controls.
18	There is no linkage between significant aspects and associated operational controls.
19	There is no linkage of operational procedures to the aspects identified as significant.
20	Capital expenditure evaluation has not taken place as stated in the Policy Manual.
21	Current methodology for impact assessment as described in the EMS Manual is no longer valid
22	Existing controls are considered when rating impacts but this is not stated in the procedure.
23	No evidence of procedures to address the aspect / impact assessment process.
24	Procedure XXXX does not specifically refer to impacts / potential impacts.
25	Process does not tally with Policy Manual
26	Statement made that exhaust emissions are not significant but score for vehicle exhausts is shown as high.
27	The EMS plan does not address aspects that can have an impact
28	The linkage between aspects / impacts and objectives and target could not be established.
29	The linkages between the identification of the aspects / impacts and the evaluation is unclear.
30	The procedure does not state when the aspects will be reviewed.
31	The review procedure for environmental aspects is unclear
32	The scope of procedure XXXX does not clearly indicate that it addresses the evaluation of impacts and aspects.

33 There is no clear definition of what purpose the initial environmental review serves nor how it relates to the register of aspects / Impacts and associated evaluation process.

34 There is no procedure to describe the current environmental aspect identification and impact assessment

35 2500 tonnes of cardboard is generated annually. It is not clear why this impact is not considered significant.

36 Confusion between emergency conditions and normal

37 Consider giving higher ratings for water use and air quality which are specific local concerns.

38 Criteria for significance is based on business concerns only and does not include the environment.

39 Degree of Control rating results in suppliers (indirect) being rated higher than direct impacts such as effluent.

40 Evaluations of significant impacts are complete as aspect evaluation is not based on the sum of the burden (e.g. utilities, scrap metal, IPA etc.)

41 Given that 80,000 gallons of fuel oil are consumed per year it is not clear why this consumption is "insignificant" for non-renewable resources.

42 Given the nature of some of the hazardous waste on the site it is unclear why hazardous waste generation is not evaluated for significance.

43 Impact of failure of scrubbers and incinerators is not considered

44 Impacts evaluation does not in all instances clearly show how quantities and toxicity impinge on significance.

45 In many cases "Aspects" had been listed under "Activities"

46 In the context of atmospheric and resource aspects, it is unclear why oil usage is deemed significant.

47 Insufficient weighting is given to legislation / regulatory issues in the scoring system for impacts / aspects

48 It is unclear why two sites have evaluated aspects differently using the same system given that both sites are very similar.

49 It was unclear how the accumulative effects of the use of lead were addressed.

50 Maintenance and cleaning operations are incorrectly identified as abnormal.

51 No consideration of volume when assessing waste

52 No cross-referencing between different buildings ... some inconsistencies

53 No evidence that any form of evaluation process had taken place to identify significant aspects

54 Noise, identified by survey as significant, has not been considered as significant in the aspects assessment

55 Procedure XXXX requires clarification with regard to how resource use, recyclable and other management issues impinge on the impact evaluation process.

56 Quantity and toxicity determination is not referenced in the procedure

57 Rating depends on number of questions asked

58 Review the adequacy of assigning the significance threshold at 25 when most of the aspects / impacts are under this figure.

59 Review the merit of examining aspects under normal, abnormal and incidents together. Refer also to current, past and future situations.

60 Review the system of evaluating significance to ensure that impacts have been correctly identified as significant or insignificant. For example, electricity which is considered significant, has not been rated as significant.

61 Review the usefulness of the Lotus Notes Impact Evaluation Tool given that the scores are not used when determining the significance of an aspect.

62 Review why electricity which is continually used is not considered as significant whereas waste water discharge which is only intermittent is classed as significant,

63 Risk assessment needs to be modified to include energy use / consumption.
64 Scoring system flawed (e.g. landspreadinig said not to have a significant impact)
65 Significance is determined without taking control measures into account
66 The aspect / impact spreadsheet does not have a column for control which may have a bearing on the determination of significance.
67 The aspects list has not been evaluated to determine which are significant
68 The company's impact evaluation system (based on quantity, frequency/potential occurrence, magnitude/severity of impact does not include a factor for ease of detection..
69 the criteria for determining significance should be reviewed.
70 The cumulative effects of impacts has not been clearly established (e.g. various energy uses)
71 The cumulative effects of impacts is not addressed
72 The impact evaluation process does not reflect that the total burden has been the subject of focus for all aspects identified (e.g. air emission total burden)
73 The impacts have been assessed individually but the sum of the burden has not been considered.
74 The influence of controls is not evident in the significance weighting system
75 The matrix does not appear to allow any aspects and impact combination to have both and actual and a potential impact (e.g. waste water (normal) and waste water (from fire fighting)).
76 The method of evaluation of aspects / impacts does not allow for the determination of aspects which do not have 'toxicity' significance (e.g. energy consumption)
77 The methodology used to determine impacts weighting is not sufficiently controlled.
78 The procedure calls for the evaluation of business and environmental realities when developing significant impacts but there is no evidence to show how this was done in practice.
79 The procedure does not specify which rating level is "significant"
80 The resources used by moulding (utilities) should be significant but this is not reflected in the register.
81 The scoring for floor soap storage is given a rating of 100 but the use of electricity has been given a score of 75. As electricity is used daily and floor soap storage is only every two months, the methodology appears flawed.
82 The significance of water use / hazardous water is considered low as it is described as 'one per year' but the operation connected with this is daily. Explain.
83 The top three ratings are deemed to be considered significant but this is not objective enough.
84 The weighting evaluation should be the subject of further challenge as it is not clear how quantity, frequency, toxicity are included.
85 The weighting for some aspects (like the use of toilet tissue) is too high.
86 The weighting for some aspects (like the use of toilet tissue) is too high.
87 The weighting system for determining significance does not give clear insight into how quantity and control impinge on impacts.
88 There are a number of anomalies in the company's rating system
89 There is an incorrect statement concerning waste, noise, odour and energy as environmental media.
90 There is no documented procedure to describe in general terms how impact evaluation / assessment is carried out
91 There is no procedure outlining how an aspect / impact is deemed significant
92 Unclear how design impacts on the environment

93 Unclear how positive impacts are scored.
94 Unclear how positive impacts are scored.
95 Unclear why the disposal of plastic bags scored differently in different areas.
96 Although argon storage scored 25 in the aspect/impact evaluation process (i.e.. Greater than the 22 and so a significant impact by the organization's criteria) this impact did not result in the setting of an objective nor the implementation of an environmental management programme
97 An incorrect value has been assigned to legal exposure (non-hazardous waste)
98 Arithmetic errors found in calculations of impact significance.
99 Aspect refers to natural gas but none used on site
100 Aspects available to the public does not include packaging and ground water.
101 Aspects which are 'permitted' are significance but one item which is subject to a permit is not significant
102 Differences between scoring for similar aspects/impacts
103 Hazardous waste has not been rated for significance.
104 Insufficient weighting is given to legislation / regulatory issues in the scoring system for impacts / aspects
105 Scoring system not followed
106 Section on 'local community' is not completed for energy use, solid waste, liquid waste and non-haz-waste
107 Similar aspects/impacts scored differently
108 Solid waste values have not been given to S and L
109 Some arithmetic is incorrect
110 Some aspects have been shown as significant although analyzed as insignificant.
111 The aspects and impacts model has not been used on all aspects.
112 The procedure indicates that business concerns are included in the evaluation but this is not evident.
113 The scoring for R22 leak is incorrect
114 Use of water has not been evaluated for significance.
115 Wrong score given to legislation for hazardous waste
116 A justification sheet has not been completed for items X, Y and Z.
117 Actual local/global effects have not been defined
118 Basis for categorization at level 1,2 and 3 is not explained
119 Calculation methodology is unclear with respect to quantity, frequency and control factors.
120 Co2, SO2 and CO values are not stated to be calculated rather than measured/.
121 Column headings are not explained
122 Comprehension of weighting assignment / rationale of impact registers is not clearly understood in some instances.
123 Criteria for defining significance unclear
124 Different scoring system used for hazardous waste - unclear why
125 Does not describe how outputs from the review are used
126 Does not explain how impacts are determined as significant
127 Environmental aspects and impacts identification procedure does not state that the criteria volume, degree of hazard and process control are used when determining significance.
128 Environmental Aspects have not been clearly identified on the table.
129 Evaluation that solvent vapour is insignificant needs to be further clarified.
130 Evaluation that trichloroethylene vapour released to air is insignificant needs to be further clarified.
131 Headings: scale of impact, duration of impact, probability of occurrence, legal exposure are not defined.
132 Impact work sheet does not call-up / reference relevant procedure; particularly where assigned value for control is high.

133 Impacts protocol / procedure does not clearly indicate how quantity, frequency, toxicity etc. impinge on weighting.
134 In the minutes of the Management Review, the reasons for re-scoring some of the aspects is unclear.
135 In the ratings table, the significance of ratings are assigned to the listed aspects however, the basis for assigning the significance ratings has not been explained
136 Insufficient explanation of points awarding
137 It can not be demonstrated that all aspects have been reviewed as not all have been given a rating.
138 It could not be demonstrated (i.e. no records or worksheets) how the significance weighting - low, medium, high, was established for the environmental concerns considered.
139 It could not be established how the significance weighting was calculated as no records / worksheets were evident.
140 It is not clear from the register of aspects whether energy use is significant or not.
141 It is not clear how the arithmetic in reaching the significance rating is to be conducted.
142 It is not clear how the arithmetic in reaching the significance rating is to be conducted.
143 It is unclear from the aspects Register and associated procedures how decisions were arrived at to categorize aspects as A, B or C.
144 It is unclear how quantity / control etc. impinges on impacts evaluation for oil, gas, water, chemical waste etc.
145 It is unclear if noise and dust are significant.
146 It is unclear why "Management System" has an environmental impact rating of 13.
147 It is unclear why impact X has been assigned a rating of 18
148 Lack of clarity
149 Linkage between Chemical List and Impacts is unclear
150 Means of ongoing review of register is not described
151 Mechanism for deciding whether an impact is significant has not been described
152 Mechanism for weighting impacts has not been described
153 More detail required concerning scale of impact, severity, probability of occurrence and permanency of impact.
154 No definition of what score = significant
155 No worksheets have been retained to support significance ratings.
156 Noise has been identified as significant but there is no supporting evidence.
157 Not all the impact evaluation worksheets reviewed clearly demonstrated the reasoning for the conclusions reached.
158 Occurrence in the context of potential impacts is unclear.
159 Perceived environmental impact definitions are unclear.
160 Procedure XXXX does not adequately emphasize that environmental weighting should take precedence particularly where business weighting deflects significance determination downwards.
161 Process of evaluation of impacts is not outlined
162 Rating of frequency is specified as 'never, rarely, more frequently, constantly are not clearly defined for normal and potential impacts (e.g. annual, monthly, weekly, daily and impossible, unlikely, possible, probable, certain)
163 Reasons for assigning non-significance of items in cylinder test shop are not given
164 Reasons for assigning significance are not given
165 Records are not available to show how the environmental aspects were evaluated under the three criteria (volume, degree of hazard and process control).

166 Records are not maintained to explain the rationale with regard to impact assessment.
167 Scoring system is not explained in context of prioritization
168 Scoring system not explained
169 Section XXXX does not explain how significance (yes/no) is determined from weighting evaluation.
170 Several instances of lack of clarity in applying the scoring system
171 Severity of consequences is not adequately defined
172 Some areas have been said to have no significant impact but the reason for this is unclear.
173 The basis for assigning a significance value of 12 for item XXX is unclear.
174 The basis for assigning significance rating is unclear.
175 The basis for concluding if an impact is significant or not has not been explained.
176 The basis for concluding that CO2 emissions are not significant is unclear
177 The basis for concluding that medical waste impact is significant is unclear.
178 The criteria and method for determining significant impacts lacks clarity
179 The criteria applicable, e.g. quantity, frequency, severity and control, have not been specified in the procedure.
180 The criteria for risk assessment have not been set out
181 The evaluation of ethanol and methanol usage were not available
182 The FMEA method is not adequately described in the procedures.
183 The impact evaluation process does not clearly define the criteria for establishing whether or not aspects identified have a significant aspect.
184 The links between impact and aspect are not clear on the matrix used.
185 The method of determining significance is not documented.
186 The methodology for significance rating is not fully explained.
187 The noise data indicates values in excess of the IPC schedule but it is not clear how this data was used in determining significance.
188 The PCB status could not be supported by documentation.
189 The procedure does not explain how that significance is broken-down into low, medium and high categories.
190 The procedure does not explain that significance is broken down into low, medium and high categories.
191 The procedure does not explain that the overall score is based on the highest individual score.
192 The procedure does not give details of the method of assigning significance
193 The procedure does not show how aspects are deemed as significant.
194 The procedure does not state that the overall score for an aspect is based on the individual component with the highest score.
195 The rating scheme is not fully described.
196 The rationale behind the allocation of significance has not been explained.
197 The rationale for awarding significance is not described in the procedures.
198 The rationale for determining that energy usage is not significant is unclear.
199 The register reflects the sum of the impacts but it is not clear which activities or processes contribute.
200 The source of material for the aspects evaluation is not clearly identified.
201 The statement with regard to used cooking oil is incomplete
202 The worksheet is unclear for pallets.
203 There is insufficient linkage between aspect headings and the analysis sheets.
204 There is no clear definition of what constitutes significant as opposed to an insignificant impact.

205 There is no evidence of records maintained to indicate how the figures for impacts weighting significance were reached.
206 There is no evidence to show how the figures for impacts weighting significance were reached.
207 There is no justification / score sheets to support values assigned to significance rankings.
208 There is not a clear link between the aspect headings used in the aspect analysis sheets and those in the procedure.
209 There is some confusion between the criteria for an aspect to become significant.
210 There was no evidence that activities other than those in building A, B and C had been assessed for the environmental aspects / impacts.
211 Threshold for emissions to become significant is not addressed
212 Unclear definition of normal and abnormal activities.
213 Unclear how 2,3 and 4 are assigned under occurrence, loss control, severity of consequences and scores of 4 and 5 for risk/toxicity.
214 Unclear how activities which do not give rise to certain emissions can be evaluated under that heading.
215 Unclear how combustion gases give rise to solid waste
216 Unclear how impacts have become to be considered as significant
217 Unclear how significance scoring applies to noise
218 Unclear how use of raw material can become significant
219 Unclear if the impacts X and Y are significant under normal operating conditions.
220 Unclear that incidents arising from emergency situations have been classified as 'abnormal'
221 Unclear what records support the assignment of Low, medium or high classification.
222 Unclear which aspects are significant
223 Unclear why cardboard waste is considered as non-significant
224 Unclear why energy is minor when so much spent on it
225 Unclear why glycerin has been given 45 points
226 Unclear why hazardous waste transportation is not a significant aspect.
227 Unclear why ozone depletion has been given a low score
228 Unclear why similar aspects are rated differently.
229 With regard to acetic acid emissions to air, assessment sheet does not refer to controls n place.
230 With regard to impact, it is not clear why quantity weighting has an evaluation level (L) and control level (H)
231 With regard to transportation, it is unclear why it has been assigned a severity of 2.
232 Worksheets or related records do not detail / outline weighting rationale (e.g. quantities, frequency, severity data, nature of controls etc.)
233 A comparison of data under "Quantities" and "Analysis" indicated some anomalies between sections of Waste Management / Downstream Effects and Emissions to Water, Air and Land.
234 aspects register is incomplete
235 Aspects X and Y are no longer current activities.
236 Concentrations above which gases give rise to impact is unclear
237 Conclusion 'non significant' is unclear from argument
238 Energy evaluated as 'spillages during handling and use of solvents' = unclear why.
239 It is not clear hoe quantity, frequency and control are incorporated into impact analysis.
240 It is not clear how 'procedure' and 'cost' relate to significance.
241 It is not clear how 'procedure' and 'cost' relate to significance.
242 It is not clear that "Thermal" related to occupational rather than environmental impacts.
243 It is unclear how the control measures for dust / odour impinge on the impact rating.

244 It is unclear why energy consumption is deemed not to be significant.
245 It is unclear why hazardous waste, noise and visual have been assigned environmental impact of '8'
246 It is unclear why the impacts associated with ground and surface water have been combined.
247 Many instances activities associated with an environmental aspect have not been defined.
248 No definition of indirect effects
249 No description of how solids are described
250 No evidence of what the severity of impact is based upon.
251 No limits have been set for boiler emissions (significance)
252 Rating justification for emission to ground does not show how quantity impinges on environmental impact weighting value of '6'.
253 Significant impact is not defined.
254 The aspect / impact sheets are not titled which makes them difficult to reconcile with other documentation
255 The criteria for the selection of significant impacts which will result in the setting of objectives and targets has not been clearly defined.
256 The definition of 'local upset' is unclear.
257 The definition of significant is not given in the procedure
258 The heading of the aspects sheet is labeled 'categories', this is incorrect.
259 The meaning of 'risk factor' is unexplained.
260 The method of identifying significant aspects is not sufficiently objective.
261 The painting activity has ceased yet the table shows this to be an on-going activity.
262 The quantities for paper usage are not adequately explained
263 The register of aspects includes equipment which has been removed from the site.
264 The register shows that X waste goes to landfill but this practice has been discontinued
265 The scoring in document XXX is unclear for location D
266 There are a number of errors in the Register of Aspects e.g. emission points
267 There is no documentation to describe what the company considers a 'minor' or 'major' emission point.
268 There is no evidence why activity X calls for operating procedure Y.
269 Unclear from register whether coal is used as a fuel
270 Unclear how air testing gives rise to environmental impact.
271 Unclear what diverted groundwater means
272 Unclear what energy types are being considered
273 Unclear what is meant by 'land use' impact when 'solid waste' is said to mean landfill disposal.
274 Unclear what is meant by 'loss of control when wastes are disposed of off site".
275 Unclear what is meant by storage of chemicals with leak potential
276 Unclear whether energy and resources is just for normal or whether emergency is included in rating
277 Unclear whether packaging and paper give rise to significant aspects.
278 Unclear why "Burner Exhausts" scores 45
279 Unclear why emissions to atmosphere are significant
280 Unclear why impacts of waste solvent and atmospheric emissions are the same.
281 Unclear why Y is an aspect.
282 Waste filters are not included under hazardous waste.
283 Aspects / impacts assessment does not focus on energy (motive, heating, lighting), logistics ((transport, noise), chemical and resources such as water, surface and groundwater.
284 It could not be demonstrated that all possible aspects had been addressed: dust, odours, transport, visual, packaging and specific emergency situations.

285 The list of environmental aspects does not include: use of electricity and gas, potential emergencies such as fire, explosion or chemical emergency, past activities products, tenants etc.

286 Aspects were not all considered: groundwater consumption, raw materials, CIP chemicals, impacts on the eco system, visual impact, refrigerant (R22).

287 It is not clear that the aspects / impacts evaluation has addressed past activities, land use, odour, visual, dust and groundwater.

288 Procedure does not clearly identify the scope of evaluation of noise, odour, visual, land contamination and past activities.

289 The following aspects are not considered: facilities, energy, PCB, noise and asbestos

290 The scope of the aspects review does not show that dust, energy, noise, past activities and raw materials have been included

291 Aspects do not include noise, dust, odours and administration activities.

292 Boiler blow down, storm water, sewage and bund drainage not considered.

293 It is unclear why the aspects of odour, dust, noise, radiation have been omitted.

294 Some aspects are not included in the register: goods transport, use of paper in offices, noise, bussing of workers (positive) etc.)

295 Some aspects are not included in the register: goods transport, use of paper in offices, noise, bussing of workers (positive) etc.)

296 There is no evidence that the following aspects were addressed: dust, odours, noise, vibration, visual, potential impacts from fire, explosion or chemical spillage.

297 Not all potential aspects have been considered such as silo collapse, R22 refrigerant and dust explosion.

298 Odour, noise and fugitive emissions has not been the subject of review.

299 Register does not include paper, lab chemicals, lab gases, engineering gases and materials which are outsourced.

300 There is insufficient evidence of the consideration of dust, odour, surface water etc.

301 Unclear that all aspects had been considered (e.g. noise, visual, energy use) for all areas.

302 Aspects / Impacts evaluation does not focus on metal usage (raw material), soil or ground water aspects.

303 Cooling tower and fumigation not considered

304 Emission point for spark erosion activities is not included

305 Evaluation of environmental aspects / impacts did not consider potential emergency conditions such as fire or explosion, or the release of R22 refrigerant from the cooling system

306 No evidence that groundwater and past activities on the site were reviewed.

307 No reference to CH4, NOX, VOC and particulates

308 No significance assigned to water, gas, utilities etc.

309 Odour and visual aspects have not been considered

310 Odours and dust from vehicle maintenance is not considered

311 The aspects / impacts assessment does not adequately address fugitive emissions, potential impacts associated with radioactive materials or atmospheric emissions associated with energy usage.

312 The aspects / impacts evaluation process does not show sufficient evidence that noise, vibration, use of electricity, illumination (energy/motive) and visual impact have been addressed.

313 the potential impact on flora / fauna and groundwater is not considered.

314 The use of resources such as raw materials, chemicals, packaging and water have not been considered.

315 Unclear whether odour and lighting have been considered as aspects.

316 Tanker filling has not adequately been reviewed

317 Accidental release of CFC is not considered

318 Acetone is not considered in evaluation
319 Air emissions in spray booth are not considered
320 Air emissions omits the boiler, emergency generators and the quantities of volatile chemicals.
321 An impact evaluation is not always done before purchasing items of new equipment.
322 AOT surfactant chemical has not been considered
323 Asbestos not considered as an aspect
324 Aspect of past activity (discharge of cooling water to sewer) has not been considered.
325 Aspects / Impacts associated with the chiller operation / maintenance has not been considered
326 Aspects and impacts associated with the product have not been considered
327 Aspects of emergency situations are not considered
328 Aspects of storage of chemical in XXX location had hot been considered as an aspect.
329 Atmospheric discharges does not include the discharge from the cooling towers.
330 Atmospheric sources of emissions have not been considered
331 Clean room supplies are not considered as an aspect.
332 Cooling tower is not addressed as an aspect.
333 Cooling water discharge to river has not been considered
334 Decommissioning of equipment is not covered by system
335 Decommissioning of plant is not addressed
336 Design element of the business activity does not have an environmental dimension
337 Diesel consumption not considered under Resource Use
338 Difficult to understand why no emergency conditions associated with transport given that dangerous goods are shipped.
339 Disposal of shot blast residues is not considered
340 Doc XXXX does not include an evaluation of past activity - waste treatment on site.
341 Does not describe why no emergency conditions associated with contractors
342 Does not identify impacts arising from normal operations
343 Emergency aspects have not been identified
344 Emissions from boilers have not been specified
345 Emissions from the boiler have not been considered
346 Energy use is unclear as it does not take into account the various contributing factors such as electricity, gas, etc.
347 Environmental aspects / impacts did not consider the consumption of materials (e.g. metal, plastic etc.)
348 Environmental aspects and impacts identification did not consider the consumption of raw materials in parts.
349 Environmental aspects arising from potential emergency situations have not been identified and evaluated for significance.
350 Environmental aspects of cooling tower operation have not been considered
351 Environmental impacts of past activities have not been considered
352 Failure to identify emergency impacts (spills etc.)
353 Failure to review the impact of a silo toppling - one found to be improperly secured
354 Fire runoff is not addressed
355 Fire water containment has not been addressed.
356 Fire water containment has not been considered
357 Fire water retention adequacy has not yet been fully addressed.
358 Fluorescent tubes omitted
359 Fugitive emissions have not been addressed sufficiently
360 Fugitive emissions have not been specifically addressed

361 Gaseous emission are not identified
362 Has not considered CO2 discharges from cylinder filling
363 Hazardous waste generation has not been adequately considered.
364 Hazardous waste has not been addressed as an aspect
365 Heavy metal in inks has not been considered.
366 Hydraulic oil leakage has no been considered
367 Impact of deposited residues around the site has not been considered.
368 Impact of refrigerant leakage is not considered
369 Impact of spray irrigation on soil has not been evaluated
370 Impact of trucks reversing into pipes has not been considered
371 Impacts associated with explosion / overfilling during off loading are not reflected in the register.
372 Impacts associated with past activities have not been evaluated.
373 Impacts associated with the cooling tower operation have not been evaluated / established.
374 Impacts associated with the use of chemicals for cleaning purposes has not been evaluated.
375 Impacts associated with waste glue is not included.
376 Impacts from accident and emergency situations have not been identified.

377 Impacts of fire, explosion etc have not been considered
378 In a number of instances there was evidence of oil deposition (e.g. on the soil)
379 In the context of water conservation, the means of dealing with the leak from the bunded area is inadequate
380 Indirect aspects associated with process design are not included in the evaluation.
381 Integrity of underground pipework is not considered
382 It could not be demonstrated that aspects associated with the irradiation chamber activities were considered in the impact evaluation process (i.e.. Potential impacts associated with emergency situations)
383 It could not be established that the impact identification process had identified potential risks from fire, explosion etc.
384 It is unclear that the evidence of various spoils around the site has been addressed as an aspect.
385 It is unclear whether the aspects connected to emergency situation has been considered.
386 It was not clear that past activities were considered when performing the impact evaluation process.
387 Leaks of product were observed. These had not been addressed in the review.
388 Metal vapours from wave soldering have not been identified as an aspect
389 No documented review of resource use (electricity, oil etc.)
390 No evidence of consideration of solvent odour.
391 No evidence of environment considered in design practice.
392 No evidence of review of old soak pit (past activity)
393 No evidence of the policy for spent lead acid batteries
394 No evidence that all production materials have been reviewed (e.g. sodium hydroxide, sprays, lubes. Coating, borax, engineering sprays)
395 No evidence that customer disposal of waste packaging has been considered
396 No evidence that malfunctioning of drains has been considered
397 No evidence that new equipment is evaluated for environmental significance.
398 No evidence that odour has been considered
399 No evidence that oil spillage (seen on site) has been considered as an aspect.
400 No evidence that the potential for spillage within the solvent store has been considered.
401 No noise measurements have been carried out at the boundaries.

402 No reference made to business development
403 No reference to diesel under energy use
404 No reference to the diligence report (past activity)
405 No review of administrative facilities
406 Noise from vehicles not considered
407 Not all raw materials considered
408 Not all sources of solid wastes have been identified.
409 Observed oil spills do not appear to have been considered as an aspect.
410 Odour aspect has not been evaluated
411 Odour has not been adequately addressed
412 Odour has not been adequately considered.
413 Odour has not been adequately considered.
414 Odour has not been considered
415 Odour has not been considered as an aspect
416 Off-site storage has not been clearly evaluated as an aspect.
417 Oil spillage not subject to review
418 Oil was observed leaking from a transformer. This aspect has not been considered in the review.
419 Orthophosphoric acid is not considered
420 Past activities are not subject to focus
421 Past activities are not subject to review
422 Past activities has not included the use of heavy fuel oils before gas introduced.
423 Past activities were not included in the review.
424 Past activity has not focused on the backfilling at the far end of the site.
425 Past use of gases is not considered
426 Policy is to reduce consumption of precious natural resources but this is not evident in the aspects evaluation.
427 Potential impacts from emergencies and fire have not been considered
428 Potential impacts from fire-water run-off have not been addressed.
429 Potential impacts from on-site accident and emergency situations have not been considered.
430 Raw material use (packaging, chemicals et.) not considered
431 Raw materials have not been considered in the review
432 Register of impacts did not include an assessment of potential environmental impacts arising from a fire emergency on site - firewater run off, release of chemicals formed during combustion
433 Reject epoxy is not considered
434 Reject lenses are not considered
435 Releases of gas (isobutane) during testing of cylinders is not considered.
436 Resource utilization has not been considered
437 Review does not include the disposal of smoke detectors (radioactive).
438 Review the potential leakage of R22 refrigerant as a significant aspect.
439 Significance of odours from DA production is not addressed
440 Some raw materials have not been included in the register.
441 Spills around the building had not been the focus of aspect / impact evaluation.
442 Storage with proximity to stormwater drains has not been addressed as an aspect.
443 Sump integrity is not considered as an aspect.
444 Tenant activities have not been included
445 The air aspects summary sheet does not adequately reflect the scope of atmospheric emissions with variable impacts e.g. dust, CO2, alcohol, paint solvent.
446 The aspect / impact assessment does not focus on odour.
447 The aspect / impacts associated with pallet burning have not been addressed.
448 The aspect / impacts associated with used cooking oil had not been subject to focus.

449 The aspect of combustion of 'waste' on the site has not been adequately addressed
450 The aspect of groundwater contamination from sludge spreading activities has not been evaluated.
451 The aspect of introduction of new chemicals has not been considered a an aspect.
452 The aspect of introduction of new chemicals has not been considered a an aspect.
453 The aspect of river spill strategy has not been addressed.
454 The aspect of the disposal of cooling tower water to the stormwater drain and to the lake is not addressed.
455 The aspects / impacts analysis does not include positive impacts such as pallet re-use etc.
456 The aspects / impacts assessment did not address fire, chemical emergency or explosion.
457 The benefits of associated re-use strategies is not explored as a positive aspect.
458 The composition of run-off water from the dumpster is not included in the review.
459 The cracks in the chemical store walls should be reviewed.
460 The dosing of inhibitor into the cooling water system has not evidently been considered as an environmental aspect.
461 The environmental aspects of off-site activities is not considered
462 The environmental aspects of the radiation sensitive dyes in the used pieces of dosimeter have not been assessed.
463 The halon fire suppression system is not included in the register of aspects.
464 The impact of past activities is addressed but not in sufficient detail as regards impacts.
465 The impact of the cooling tower operation has not been fully evaluated.
466 The impact of traffic has not been fully considered
467 The impacts arising from emergency situations have not been identified and evaluated for significance.
468 The impacts associated with cleaning materials is not considered.
469 The impacts associated with handling and disposal of adhesives are not fully evaluated.
470 The impacts of storing drummed diesel on pervious ground should be reviewed.
471 The Manual does not address how the impacts from new or modified activities , products or services are addressed.
472 The manual does not give consideration to site location and past activities.
473 The means of disposal of contaminated rags is unclear.
474 The new plans for the building are completed but there is no evidence that environmental aspects were formally reviewed.
475 The oil contaminated rubble at the rear of the building is not considered as an aspect.
476 The policy with regard to transport is not addressed.
477 The possibility of ground contamination (base-line monitoring) has not been considered as an aspect despite evidence of old bulk oil storage tanks.
478 The potential for a dust explosion have not been reviewed.
479 The potential of accidental leak of cooling fluid should be considered as an aspect.
480 The procedure does not specifically refer to land/ soil impact.
481 The recovery operation has not been addressed in the register
482 The register does not consider wood products and kitchen waste.
483 The review does not consider the use of propane for heating.
484 The risk of explosion is not considered.
485 The risk of leak of R11 refrigerant has not been considered.

486 The run-off from the compactor has not been considered as an aspect.
487 The segregation of reactive gases has not been addressed as an aspect.
488 the storage of bacterial culture plates should be reviewed
489 the storage of chemicals (maintenance) near to a surface water sewer should be reconsidered
490 The storage of chemicals on a pervious hardstanding should be considered

491 The storage of compressed gases has not been addressed
492 The strategy for re-use / recycling has not been addressed.
493 the transportation of raw materials and product deliveries have not been considered
494 The use of plastic strapping, timber, shrink wrap and raw materials have not been addressed as an aspect.
495 The use of thinners has not been considered as an aspect
496 The visual aspect has not been identified.
497 The visual impact has not been considered
498 The visual impact, site housekeeping is not subject to adequate focus.
499 The waste spreadsheet does not include shrink wrap.
500 There has been no focus on the aspect of waste segregation
501 There has been no quantification / analysis of the stormwater discharge.
502 There is evidence of an oil leak which has not been identified as an aspect.

503 There is evidence of oil leakage that has not been addressed in impacts / aspects
504 There is evidence of oil spills round the site which have not been addressed in the system.
505 There is no evidence of environmental review of equipment prior to rental
506 There is no evidence that past activities have been a subject of focus.
507 There is no focus on impacts associated with the products.
508 There is no focus on indirect aspects such as services and transport.
509 There is no system in place to ensure that an environmental impact evaluation is carried out before purchasing major items of equipment
510 There was no evaluation of whether energy, dust, odour and emissions were significant from the new BBB item of equipment.
511 Transport is not considered
512 Unclear if an impact assessment is carried out on large items of equipment before purchase.
513 Unclear if heating oil is included
514 Unclear whether on site incineration has been considered
515 Use of housing has not been considered
516 Use of raw materials is not considered
517 Use of raw materials were not considered
518 Use of silver and gold is not included
519 Used filters from soldering units is not addressed as an aspect
520 Utilities wastes (lube oil and condensate) are not considered in aspects
521 Vehicle maintenance consumption of raw materials is not considered
522 Vehicle washing operations have not been addressed as an aspect.
523 Visual impact has not been considered
524 Visual impact has not been the subject of focus.
525 Waste oil inputs not fully considered
526 Water reduction strategy is not addressed
527 Air emissions does not identify specific characteristics
528 Anomalies found in figures on water consumption
529 CO2 emissions have not been calculated under all conditions
530 Data for noise levels at night conflict (40/45)
531 Difficult to assess impact of acetone emission as there has been no measurement.
532 Electricity use (6m kW/year) scored too low re: engineering gases etc.
533 Emissions to atmosphere exceed Batneec limits but these are not quantified and reasons not given

534 Errors in figures for electric consumption
535 Factor of 10 difference on energy consumption between two tables
536 Figures quoted for cardboard to landfill are incorrect
537 No noise monitoring carried out
538 Noise analysis is not measured in a way that the true impact can be recorded
539 Qualities of solder, flux etc. have not been considered
540 Quality of gas has not been considered
541 Quantities of effluent have not been reviewed
542 Quantities of raw materials used, wastes produced and energy consumed are not established.
543 Quantity is not taken into account
544 Quantity of nitrogen used has not been given
545 Solid wastes not quantified therefore difficult to establish significance.
546 The means used to control and verify adequacy of oil separators is not defined.
547 The significance of wastewater discharge has not been quantified
548 There is no evidence that monitoring of air emissions has taken place in order to quantify impact.
549 Unclear that water usage in the Canteen is actually 4000l/day
550 Water use has not been quantified
551 Aspects register does not contain soil analysis
552 Assessment sheets not completed for every area
553 Boiler emissions not rated as 'continuos' although this is the case in fact
554 Claim on 'non-significance' not backed-up by evidence
555 Corporate risk assessment not available
556 Does not identify the processes contributing to global warming and ozone depletion etc.
557 Groundwater pollution not fully evaluated to establish the extent of pollution
558 In all instances, the impacts evaluation does not clearly make reference to the quantity concerned.
559 It is not clear whether fumigation impact has been quantified using scientific data.
560 No atmospheric monitoring has been carried out
561 No baseline monitoring has been carried out with respect to air emissions; therefore no clear significance can be assigned.
562 No clear link between sludge analysis and spreading plan
563 No reuse data is available for packaging
564 Not clear whether impact on flora and fauna
565 Packaging usage has not been adequately reviewed for significance. Lack of data.
566 Resource utilization is seen as too generic and can not be attributed to sources etc
567 Review the statement that cooling water discharges are insignificant in view of MSDS data (LC50 = 16.9 mg/l at 96 Hrs)
568 Surface water is said drain through storm water drain but this is incorrect
569 The different energy types have not been identified or quantified.
570 The hazardous wastes need to be better identified
571 The nature of the air emission from X is unclear.
572 The significance of effluent volume has not been considered
573 The tracking of water and power usage is not formalized.
574 Trace hydrocarbon data for well water is not current
575 Unclear if transformers contain oil
576 water usage has not been adequately reviewed for significance. Lack of data.
577 Heading in effects register incorrect
578 The frequency and methodology for verifying integrity of sumps should be clarified

579 Activities at the various sites have not been identified as pertaining to the relevant site
580 Air emission have not been identified as either continuous or fugitive.
581 Clarify no emergency conditions with regard to solid waste
582 Environmental impacts of raw material use have not been addressed
583 Impact evaluation did not consider air emissions from solder wave process.
584 Impact noted on site has not been evaluated under 4.3.1
585 Impact of spill of solvent in yard is unclear
586 Impacts / potential impacts of degreasing operation are not addressed in DOC XXXX
587 Impacts associated with a aspects have not been clearly defined.
588 Impacts associated with aspects have not been clearly defined.
589 Impacts associated with biohazardous waste has not been outlined.
590 Impacts associated with disposal of aluminium have not been addressed.
591 Impacts associated with Helium and Sure Flow bulk breaking have not been considered
592 Impacts associated with raw materials have not been adequately identified.

593 Impacts associated with the use / disposal of cleaning materials have not been addressed.
594 Impacts have not been fully identified.
595 Impacts have not been identified for spray lines etc.
596 Impacts of dust emission (in the context of land, and air) is not addressed adequately.
597 Indirect impact of discharges next to site not considered
598 No clear identification of impacts and potential impacts
599 Not all characteristics of wastewater are considered when evaluating impact
600 Not all emission point have been considered
601 Not all impacts associated with a aspects have been addressed (e.g. chemical use - air, soil, groundwater, personnel.
602 Not all impacts identified have been reviewed (e.g. impacts on air, water and land)
603 Not all impacts of air omissions have been considered
604 Not all process operations have been considered under impact assessment

605 Oil and steam, use has not been considered
606 Potential impacts associated with chemical storage are not detailed.
607 Potential impacts from the cooling tower, oil and chemical storage is not outlined.
608 Reactions of exhausted chemical in the air has not been consider
609 Section X only refers to potential impacts but there is no mention of actual impacts.
610 Solvent waste chemicals have not been clearly identified
611 The adequacy of containment of bulk acid / base intake has not been determined.
612 The impact of landfilling has not been fully assessed
613 The impact of untreated solvent emissions has not been considered
614 The impact of used AHU filters is not adequately addressed.
615 The impacts associated with raw material use (e.g. packaging) have not been evaluated for significance.
616 The impacts associated with some aspects is unclear.
617 The impacts associated with some of the aspects are unclear.
618 The impacts of toxic waste disposal are unclear
619 The nature of all impacts not identified
620 The nature of the impact on the environment is not clear for each aspect identified.
621 The scope of the impacts evaluation does not address all areas of the facility

622 The significance of impacts 'beyond the factory gate' have not been identified.
623 Unclear how grind glass is classified when waste
624 Unclear how solvents contribute to global warming and ozone depletion
625 Unclear if impacts associated with halon replenishment and disposal of solder paste packaging have been considered.
626 Unclear that toxicity is included in impact evaluation
627 Unclear what activities give rise to Global Warming and Ozone depletion
628 Unclear what air emissions arise from effluent testing
629 Unclear what aspects were considered in Process A production
630 Unclear what hazardous wastes are associated with Process B production

631 Unclear what impact the inhibitor has on waste water
632 Unclear what substances are ozone depleting
633 Unclear whether material is routinely or infrequently disposed of.
634 Unclear whether the tank farm is included in the impacts evaluation
635 Under surface water, it is unclear if spills are hazardous

Examples of checklists from published sources:

1. Roberts and Robinson (1998)

INDEX	ASPECT	IMPACT
WU	WATER USE	
WU01	Use of water from municipal sources	Depletion of limited potable resources
WU02	Use of water from surrounding water courses	WU01 plus this could have a local effect on environment
WU03	Use of aquifer	
WU04	Other water use	
EU	ENERGY USE	
EU01	Use of natural gas	
EU02	Use of oil	
EU03	Use of coal	
EU04	Use of other fossil fuels	
EU05	Use of fuel for transportation	
EU06	Use of energy from nuclear-generated sources	
EU07	Use of energy from hydro-generated sources	
EU08	Use of energy from wind driven sources	
EU09	Use of energy from solar driven sources	
EU10	Use of energy from mixed sources	
EU11	Other energy use	
CU	CHEMICAL USE	
CU01	Use of restricted chemicals	
CU02	Use of Acidic chemicals (not restricted)	
CU03	Use of basic chemicals (not restricted)	
CU04	Use of solvents (not restricted)	
CU05	Use of hydraulic oils, lubricants etc.	
CU06	Other chemical use	
RU	RAW MATERIAL USE	
RU01	Use of raw materials (hazardous, special or	
RU02	restricted)	
RU03	Use of raw materials (non-hazardous etc.)	
RU04	Use of packaging material	
RU05	Use of office materials	
RU06	Use of construction materials	
	Other raw material use	
ST	STORAGE ON SITE	
ST01	Storage of chemicals	
ST02	Storage of raw materials	
ST03	Storage of hazardous, restricted or special	
ST04	substances	
ST05	Storage of waste (not hazardous, special or	
ST06	restricted)	
	Storage of hazardous, restricted or special waste	
	Other storage	
EW	EFFLUENTS TO WATER	

	EW01	Discharge of effluent to treatment facility	
	EW02	Controlled discharge of treated effluent to water course	
	EW03	Controlled discharge of untreated effluent to water course	
	EW04	Uncontrolled discharge of treated effluent to water course	
	EW05	Uncontrolled discharge of untreated effluent to water course	
	EW06	Discharge of hazardous, restricted or special effluent	
	EW07	Other discharges	
EA		EMISSIONS TO AIR	
	EA01	Emission of process gases/heat within the process (not flue)	
	EA02	Emission of flue gases/heat (not Nox, Sox, particulate)	
	EA03	Emissions of Nox	
	EA04	Emissions of Sox	
	EA05	Emissions of CO2	
	EA06	Emissions of particulate matter	
	EA07	Emission of dust or raw materials from within the process	
	EA08	Emissions of VOC	
	EA09	Emissions of hazardous, restricted or special substances	
	EA10	Emissions from transport	
	EA11	Other Emissions	
DL		DISPOPSAL TO LAND	
	DL01	Disposal to municipal landfill	
	DL02	Disposal to site landfill	
	DL03	Disposal to incineration	
	DL04	Disposal to recycling, reclamation or re-use	
	DL05	Disposal of hazardous, restricted or special substances	
	DL06	Previous site contamination	
	DL07	Other disposal	
OT		OTHER	
	OT01	Vibrations	
	OT02	Noise	
	OT03	Smell	
	OT04	Visual Impact	
	OT05	Radiation	
	OT06	Other	
AB		RISK OF ABNORMAL ACTIVITY	
	AB01	Risk of fire or explosion	
	AB02	Risk of spillage, leakage or uncontrolled discharge	
	AB03	Risk of spill etc. of hazardous, restricted or special substances	
	AB04	Risk to worker health and safety	
	AB05	Other abnormalities	

2. Sheerin (1997)

Water	Groundwater Abstraction Use of water / conservation
Waste Water	Foul and Sewer systems Treatment Petrol Interceptors Grease interceptors Monitoring points Nature of waste water
Air	Motor vehicles Power plants / Generators Incinerators Boilers CFC Solvents Dust Fume Cooling towers Scrubbers Fibers (asbestos, glass etc.) CO Chlorine Fluorine Heavy Metals Organic compounds NOX SOX Sampling points
Soil	Landfiling of wastes Leaking tanks, pipes, drainage etc Overground tanks and storage Hazardous material storage Leaks during filling, unloading and transportation PCBs and capacitor leakage.
Noise	Sources Boundary Readings Abatement measures
Chemicals	Catalogue substances Identify all storage locations Handling and storage methods Disposal of chemical wastes Emergency procedures
Waste	Segregation Classification Characteristics (Flammable, infective, Corrosive etc.) Waste Hierarchy (Prevent/Minimise/Recovery/Reuse/Treatment/Disposal)# Storage Release Contractors

	Packaging wastes Fluorescent tubes
Energy	Use / consumption Compressed Air;
Products and Packaging	Minimisation Recycling / Reuse
Raw Materials	Sustainability Quantity Engineering gases Storage
Emergency	Evacuation Containment (fire water included) Fire fighting Alarm Training Local authority interface
External Contractors	Electricians Mechanical Engineers Construction Waste Handling Canteen Staff Cleaning and hygiene staff Certification and testing Transport Equipment Maintenance
General	Lightning protection Grounding Visual Impact
Legislation	See 4.3.2
Transport	
Smells	
Radiation	

3. Sheldon and Yoxon (1999)

Activity, product or service	**Impact on air**	**Impact on water**	**Impact on land**	**Energy issues**	**Waste Issues**	**Noise Vibration and odour issues**	**Other**
Transport of products and raw materials	*Traffic emission*	*Potential diesel spillage into sewers on site*	*Land use for vehicle park required*	*Use of fossil fuels*	*Waste oil, end of life tyres etc.*	*Increased noise in nearly residential areas.*	*Safety issues for local commun-ity*

4. Hunt and Johnson (1995)

	Effects				
Activities	**On Air**	**On water**	**On Land**	**Resources**	**Nuisances**
Driving Vehicles					
Vehicle maintenance					
Operating machinery					
Installing and maintaining switchgear and transformers					
Laying and maintaining underground cable					
Erecting and maintaining overhead cable					
Tree Cutting					
Gardening and grounds maintenance					
Weed control					
Building operations and maintenance					
Painting					
Civil works					
Catering					
Office Work					
Meter Reading					
Billing Customers					
Meeting Customers					

4. "Significance Wizard" – Entropy International (2000)

Storage on site questionnaires	
1	What raw materials, inputs, outputs, finished or partly finished products are stored in the process step?
2	Where are raw materials, inputs, outputs, finished or partly finished products stored in the process step?
3	Is an inventory list of the items stored in the process step maintained, if so, where and how often is it up-dated?
4	Do any of the items stored in the process require permits, consents or authorisation? If so, what items are they and what are the permits, consents or authorisations required?
5	If special or hazardous products or wastes are stored in the process step, how are they stored and is a storage inventory list maintained?
6	Are any of the items stored in the process step legislated or regulated, if so, what items are they and what is the legislation or regulation?
7	Are any of the items stored in the process step monitored, if so, which ones and how are they monitored?
8	Is any of the monitoring of items stored in the process step mandatory, if so, which items?

9	Is there oil, gas, diesel or fuel stored in the process, if so, what is stored and where is it stored?
Hint	*Don't forget to assess whether substances indirectly associated with a production process – such as oil, gasoline, diesel, lubricants, cleaning solutions etc. are stored somewhere else on site!*

Documents to use for additional information

- Storage inventory lists
- Storage location maps
- storage permits, consents, authorisations
- Storage non-compliance records

• **PULL DOWN MENU FOR ASPECTS**	
Water Use	• Use of water from Municipal Sources • Use of water from surrounding water courses • Other water use
Energy Use	• Use of natural gas • Use of oil • Use of coal • Use of other fossil fuels • Use of energy for transportation • Use of energy from nuclear-generated sources • Use of energy from hydro-generated sources • Use of energy from wind-generated sources • Use of energy from solar-generated sources • Use of electricity from mixed sources • Other energy use
Chemical Use	• Use of restricted chemicals (see reference list) • Use of acidic chemicals • Use of basic chemicals • Use of solvents • Use of hydraulic oils, lubricants etc. • Other chemical uses
Raw Material Use	• Use of raw materials (hazardous, special or restricted) • Use of raw material • Use of packaging material • Use of office materials • Use of construction materials • Use of other raw materials
Storage on site	• Storage of chemicals • Storage of raw materials • Storage of hazardous, special or restricted substances • Storage of waste • Storage of hazardous, special or restricted waste • Other storage
Effluents to water	• Discharge of effluent to treatment facility • Controlled discharge of treated effluent to water course • Controlled discharge of untreated effluent to water course • Uncontrolled discharge of treated effluent to water course • Uncontrolled discharge of untreated effluent to water course

	• Discharge of hazardous, restricted or special effluent • Other discharges
Emissions to air	• Emissions of process gases/heat within the process • Emissions of flue gases/heat • Emissions of Nox • Emissions of Sox • Emissions of CO2 • Emissions of particulate matter (fly ash) • Emissions of dust or raw materials from within the process • Emissions of VOCs • Emissions of hazardous, restricted, special substances • Emissions from transport • Other emissions
Discharges to land	• Disposal to municipal landfill • Disposal to site landfill • Disposal to incineration • Disposal to recycling, reclamation or reuse • Disposal of hazardous, restricted or special substances • Previous soil contamination (actual and potential for) • Other disposal
Other	• Vibrations • Noise • Odour • Visual impact (including light) • Other
Risk of Abnormal Activity	• Risk of fire or explosion • Risk of spillage, leakage or uncontrolled discharge • Risk of spill etc. of hazardous, restricted or special substances • Risk to worker health and safety • Other abnormalities
Past Activities	• Past spills, leaks or accidental discharges • Past fires and explosions • Past accidents, incidents or emergency situations • Past natural disasters • Past contamination of land • Other past aspect

6. Environmental Technology Best Practice Programme: GG43 Guide

CHECKLIST: EMISSIONS TO ATMOSPHERE

AREA: Sheet …… of ……	CONTACT:	DATE:
DESCRIPTION OF PROCESSES:		
QUESTION	RESPONSE	ACTION REQUIRED
What emissions are generated?		
How are they generated?		
Which (if any) are released into the external environment?		
Who monitors emission levels and by what method?		
What data exist and what limits are applicable?		
Do emissions create problems with the local community?		
How could these emissions be reduced (by control at source)?		
Are there any restraints (financial, technical, etc.) preventing a reduction in emissions?		

Checklist from Environmental Technology Best Practice Programme: Guide GG43

IDENTIFYING ENVIRONMENTAL EFFECTS

DEPARTMENT:	DATE: 11 Nov	REF: CS

PROCESS	ENVIRONMENTAL EFFECT	RECEIVING SYSTEM	NOTES / COMMENTS
1 SHELL			
a. Material handling	Dust	Local atmosphere	reduced be sand bulk handing system
b. Core manufacture	Phenol	Local atmosphere	reduced by control of process (e.g. box temperature)
	Formaldehyde	Local atmosphere	
	Ammonia	Local atmosphere	
2 PEPSET			
a Material handling			
i. Silica sand	Silica dust	Local atmosphere	reduced by use of silo system bulk handling
ii. Resins	Solvent fume	Local atmosphere	system reduces effect
	Spillage	Water via drains	bund wall around storage area
b Sand mixing	Solvent fume	Local atmosphere	
c Core manufacture	Pyridine	Local atmosphere	
	MDI	Local atmosphere	
3 COLD BOX			
a Material handling			
i. Silica sand	Dust	Local atmosphere	pneumatic sand system minimised emissions
ii. Resin material	Fumes	Local atmosphere	
b. Core manufacture	MDI	Local atmosphere	effect reduced by use of local ventilation system and monitored on a monthly basis
	Amines	Local atmosphere	
	Aromatic solvent	Local atmosphere	
	Phenol	Local atmosphere	
	Formaldehyde	Local atmosphere	
4 ALKALINE PHENOL			
a Material handling	Dust	Local atmosphere	
b Core manufacture	Phenol	Local atmosphere	
	Formaldehyde	Local atmosphere	

Checklist from Environmental Technology Best Practice Programme: Guide GG43

7. Environmental Effects: A guide to assessing the significance of environmental effects - The Environmental Advice Centre 1997 (BTCV Enterprises)

POLLUTION EVALUATION

Range: The possible area and size of population that could be effected by the pollutant

Toxicity: The potential health hazard imposed or the potential harm to ecology

Interaction: The degree to which a given type of pollution may undergo further reaction to produce another environmental effect. For instance, carbon dioxide undergoes a major interaction by adding to global warming and NOx undergoes moderate interaction by adding tropospheric ozone.

Control: The degree to which an organisation has control over its output of a particular pollutant.

Permanency: The length of time over which a pollutant may continue to be active.

Pollution Effect Evaluation																											
Date:	Range					Toxicity					Interaction					Control					Permanency						
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1		
Ref:	Transboundary	Up to 750 km	Up to 150 km	Local (< 1 km)	Immediate (< 50m)	Severely toxic / harmful	Quite toxic	Long term toxicity	Minor Hazard	Non-hazardous	Major interaction	Moderate Interaction	Accumulative	Minor Interaction	No interaction	Totally uncontrolled	Occasional monitoring	Fixed technology control	Regular Monitoring and control	Full / automatic control	>50 years	10 – 50 years	1 – 10 years	1 month – 1 year	< 1 month	Score	Weighted Score
Table of Pollutant																											

Weighting table

Aspect	Element	1	2	3	4	5
Air pollution	CO2	<10T/yr	10 – 50 T/yr	50 – 200 T/yr	200 – 1000 T.yr	>1000 T/yr
	CO	<120 Kg/yr	120 – 590 T/yr	590 Kg – 2.4T/yr	2.4 – 11.8 T/yr	>11.88 T/yr
	SO2	<60 Kg/yr	60 – 300 Kg/yr	300Kg – 1.2 T/yr	1.2 – 6 T/yr	>6 T/yr
	Nox	<50 Kg/yr	50 – 250 Kg/yr	250 – 950 Kg/yr	950Kg – 4.8T/yr	>4.8 T/yr
	VOC	<45 Kg/yr	45 – 225 Kg/yr	225 – 900 Kg/yr	900Kg – 4.5 T/yr	>4.5 T/yr
	CH4	<83 Kg/yr	83 – 417 Kg/yr	417Kg – 1.7T/yr	1.7 – 8.3 T/yr	>8.3 T/yr
	Black smoke	-	-	-	≤ 10 min/day	>10 min/day
	Dark smoke	-	-	-	≤ 10 min/day	>10 min/day
	Orange smoke	-	-	-	≤ 10 min/day	>10 min/day
	Other smoke	<10 min/day	10 – 30 min/day	30 – 120 min/day	2 – 5 h/day	>5 h/day
	Dioxins	<10ng/yr	10ng – 0.1mg/yr	0.1 – 1 mg/yr	1 – 10 mg/day	>10mg/yr
	Chemical fume	<10min/day	10 – 30 min/day	30 – 120 min/day	2 – 5 h/day	>5h/day
Air pollution (Combustion)	DERV / Petroleum / Solvents	<100L/yr	100 – 1000 L/yr	1000 – 10.000 L/yr	10,000 – 100,000 L/yr	>100,000 L/yr
	Heavy oil	<50L/yr	50 – 100 L/yr	100 – 1000 L/yr	1000 – 10.000 K/yr	>10,000 Kg/yr
	Coal	<1 T/yr	1 – 20 T/yr	20 – 100 T/yr	100 – 1000 T/yr	>1000 T/yr
	Nat. gas / LPG	<500 kWh/yr	500 – 10.000 kWh/yr	10,000 – 100,000 kWh/yr	100,000 – 500,000 kWh/yr	>500,000 kWh/yr
Water Pollution	Cyclic. halogenated and metallic hydrocarbons /mercury / cadmium	<1g/yr	1 – 50g/yr	50 – 500g/yr	500 – 1000g/yr	>1Kg/yr

	Other hydrocarbons / metals / biological material infected with pathogens	<10g/yr	10 – 500g/yr	500 – 1000g/yr	1 – 10 Kg/yr	>10Kg/yyr
	Biological material / nutrients	<1Kg/yr	1 – 10 Kg/yr	10 – 250 Kg/yr	250 – 1000 Kg/yr	>1000 Kg/yr
	Inert solids	<10 Kg/yr	10 – 100 Kg/yr	500Kg – 5T/Yr	5 – 10 T/yr	>10T/yr
	Domestic sewage	<10m³/yr	10 – 100 m³/yr	100 – 500 m³/yr	500 – 1000 m³/yr	>1000m³/yr
Land contamination	Chlorinated or heavily toxic solvent / acid / alkali	<1m²	1 – 2 m²	2 – 5 m²	5 – 10 m²	>10m²
	Heavy metal deposits and other minerals	<1m²	1 – 10 m²	10 – 50 m²	50 – 100 m²	>100m²
	Other solvent / mineral oil	<10m²	10 – 50 m²	50 – 100 m²	100 – 500 m²	>500m²
	Diffuse chemical or biological matter	<10m²	10 – 50 m²	50 – 100 m²	100 – 500 m²	>500m²
	Waste materials	<10m²	10 – 50 m²	50 – 100 m²	100 – 500 m²	>500m²
Emissions to Sewers	Cyclic, halogenated and metallic hydrocarbons / mercury / cadmium	<1g/yr	1 – 50g/yr	50 – 500g/yr	0.5 – 1 Kg/yr	>1 Kg/yr
	Other hydrocarbons / metals / biological material infected with pathogens	<10g/yr	10 – 500g/yr	0.5 – 1 Kg/yr	1 – 10 Kg/yr	>10 Kg/yr
	Biological material / nutrients	<1 Kg/yr	1 – 10 Kg/yr	10 – 250 Kg/yr	250 – 1000 Kg/yr	>1000 Kg/yr
	Inert solids	<10 Kg/yr	10 – 500 Kg/yr	0.5 – 5 T/yr	5 – 10 T/yr	>10T/yrs

WASTE EFFECT EVALUATION

Hazard Nature: the hazard imposed to humans due to the classes of substance within each category:

Very hazardous: Severe toxins, acids/alkalis over 75% vol., radio-isotopes, pathogens, explosive, highly carcinogenic, mutagenic, causes burns.

Hazardous: Toxic, acids/alkalis over 25% vol., low level radioactive material, biologically infected material, mild carcinogens, sensitisers, substances with long term health effects, substances causing immediate ill health or irritation of mucous membranes.

Moderately Hazardous: Mild irritants, substances causing mild dermatitis, physically dangerous (e.g. sharps).

Slightly Dangerous: Substances with a potential to cause harm in certain people such as asthmatics (e.g. fine dusts), substances which may discolour skin and clothing.

Non-Hazardous: No hazard posed to humans

Recyclability: the degree to which the waste can be recycled.

End Point The most likely or known disposal route

Disposal Effects: The most likely environmental effects of the main disposal route.

Control: The level of control the producer has on the waste considering handling, storage, collection, disposal and destiny.

Waste Effect Evaluation																										
Date:	Hazard Nature					Recyclability					End Point					Disposal effects					Control						
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	
Ref:	Very hazardous	Hazardous	Moderately hazardous	Slightly hazardous	Non-hazardous	Not recyclable / reusable	Alternative route possible	Partly recyclable / reusable	100% recyclable	100% reusable	Landfill	Incineration / gassification / fuel	Reclaimed for another use	Recycled	Reused	Airbourne pollution	Water / ground water pollution	Land contamination	Nuisance	No further effect	No management control	Basic management control	Partial control, start or finish	Partial control, start to finish	Full control, start to finish	Score	Weighted Score
Table of																											
Waste Stream																											

Weighting table

Aspect	Element	1	2	3	4	5
Controlled Dry Waste	Volume/yr (Weight/yr)	<10m³ (<500Kg)	10 – 250 mm³ (<0.5 – 25T)	250 – 1000 m³ (255 – 100T)	1000 – 5000 m³ (100 – 500 T)	>5000m³ (>500T)
Controlled Liquid Waste	Volume/yr	<1m³	1 – 50m³	50 – 100m³	100 – 1000m³	>1000m³
Special Waste (dry)	Volume/yr (Weight/yr)	<50L (<1Kg)	50 – 100L (1 – 10Kg)	100 – 1m³ (10 – 100Kg)	1 – 10m³ (100 – 1000Kg)	>10m³ (>1T)
Special Waste (liquid)	Volume/yr	<10L	10 –100L	100 – 1000L	1000 – 10,000L	>10,000L
PCB / Dioxins	Weight/yr	<1g	1 – 5g	5 – 10g	10 – 50g	>50g

NUISANCE EVALUATION:

Category: the type of nuisance

Range: The distance over which the nuisance may be caused

Receiving Area: The sensitivity of the immediate area.

Control: The degree to which an organisation has control over the nuisance source

Occurrence: The typical aggregate time over which the nuisance occurs per working day.

Nuisance Effect Evaluation																										
Date:	Category					Range					Receiving Area					Control					Occurrence						
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	
Ref:	Noise / Vibration	Odour / dust	Effluvia	Light / solid deposits	Visual	> 1 km	500m – 1 km	100 – 500m	Up to 100m	Only neighbours effected	Residential	Recreational / agricultural	Public services	Commercial	Industrial	Fully controlled	Occasionally monitored	Fixed technology control	Regular monitoring and	Full / automatic control	>18 hours / day	Between 8pm and 7am	10 – 18 hours / day (not at	2 –10 hours / day (not at night)	<2 hours/day (not at night)	Score	Weighted Score
Table of Source																										

Weighting table

Aspect	Element	1	2	3	4	5
Noise, dust, Vibration, Odour, Light	Auditor's perception of potential nuisance level	Very low	Low	Medium	High	Very High
Effluvia	Auditor's perception of potential nuisance level	Barely visible trickle or seepage	Easily visible trickle or seepage	Flow	High flow	Very High Flow
Solids	Auditor's perception of potential nuisance level	Very low	Low	Medium	High	Very High

RESOURCE EVALUATION

Implications: How much of the resource is retained or lost

Scarcity The sustainability of the source of the materials

End Point: The most likely outcome for a resource when it has served its main purpose.

Up-stream: The relative hazards of the main immediate supply chain:

Very High Risk Industry: Extractive / petrochemical/ chemical / cement, lime and soda industries / coke / rubber manufacture.

High Risk Industry: Power generation / metal smelting / plastic moulding

Moderate Risk Industry: General manufacturing and engineering industry / transport / haulage / civil engineering / agriculture.

Low Risk Industry: Service sector / forestry / fisheries

No Supply Chain:

Down Stream: The most likely changes to the customer's environmental effects that the product or material may cause

Resource Effect Evaluation																									
Date:	Implications					Scarcity					End point					Up Stream					Down stream						
Ref:	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1		
Table of	All lost on use	Mostly lost on use	Partly lost on use	Mostly retained on use	All retained on use	Non-renewable	Reclaimed	Recycled	Re-used	Renewable	Destroyed or landfilled	Reclamation	Recycling	Re-use	-	Very high risk industry	High risk industry	Moderate risk Industry	Low risk industry	No supply chain	Increased pollution	Increased energy use	Increased waste production	Increased nuisance	No further effect	Score	Weighted Score
Resource																											

Weighting table

Aspect	Element	1	2	3	4	5
Fuel/ Energy	Electricity	<5000kWh/yr	5000 – 50,000 kWh/yr	50,000 – 100,000 kWh/yr	100,000 – 500,000 kWh/yr	>500,000kWh/yr
	Natural gas	<10,000 kWh/yr	10,000 – 100,000 kWh/yr	100,000 – 500,000 kWh/yr	500,000 – 1,000,000 kWh/yr	>1,000,000 kWh/yr
	Coal	<5T/yr	5 – 50T/yr	50 – 250T/yr	250 – 500T/yr	>500T/yr
	Red Diesel	<50L/yr	50 – 250L/yr	250 – 1000L/yr	1000 – 5000 L/yr	>5000 L/yr
	Heavy Oil	<1T/yr	1 – 20T/yr	20 – 100 T/yr	100 – 500T/yr	>500T/yyr
	LPG	<50Kg/yr	50 – 500 Kg/yr	500 – 1000 Kg/yr	1 – 5T/yr	>5T/yr
	DERV	<500L/yr	500 – 1000 L/yr	1000 – 10,000 L/yr	10,000 – 100,000 L/yr	>100,000 L/yr
	Petroleum spirit	<500L/yr	500 – 1000 L/yr	1000 – 10,000 L/yr	10,000 – 100,000 L/yr	>100,000 L/yr
	Solvent / waste oil	<10L/yr	10 –100 L/yr	100 – 500L/yr	500 – 1000 L/yr	>1000 L/yr
Plastic	Non-biodegradable	<1T/yr	1 – 5 T/yr	5 – 10 T/yr	10 – 50 T/yr	>50 T/yr
	Biodegradable	<5 T/yr	5 – 10 T/yr	10 – 100 T/yr	100 – 500 T/yr	>500 T/yr
Metal	Steel	<10 T/yr	10 – 100 T/yr	100 – 1000 T/yr	1000 – 5000 T/yr	>5000 T/yr
	Aluminium	<10 T/yr	10 – 100 T/yr	100 – 1000 T/yr	1000 – 5000 T/yr	>5000 T/yr
	Brass	<5 T/yr	5 – 10 T/yr	10 – 50 T/yr	50 – 100 T/yr	>100 T/yr
	Bronze	<500 Kg/yr	0.5 – 1 T/yr	1 – 5 T/yr	5 – 10 T/yr	>10 T/yr
	Copper	<250 Kg/yr	0.25 – 1 T/yr	1 – 5 T/yr	5 – 10 T/yr	>10 T/yr
	Lead	<100 Kg/yr	100 – 500 Kg/yr	0.5 – 1 T/yr	1 –5 T/yr	>5 T/yr
	Zinc	<50 Kg/yr	50 – 100 Kg/yr	100 – 500 Kg/yr	500 – 1 T/yr	>1 T/yr
	Tin	<50 Kg/yr	50 – 100 Kg/yr	100 – 500 Kg/yr	500 – 1 T/yr	>1 T/yr
	Chromium	<10 Kg/yr	10 – 25 Kg/yr	25 – 50 Kg/yr	50 – 100 Kg/yr	>100 Kg/yr
	Rare earth	<1g/yr	1 – 10g/yr	10 – 100g/yr	100 – 1000g/yr	>1 Kg/yr
Wood	Ecologically managed source	<10T/yr	10 –100T/yr	100 – 500 T/yr	500 – 1000 T/yr	>1000T/yr
	Other	<0.5T/yr	0.5 – 1T/yr	1 – 5 T/yr	5 – 20 T/yr	>20T.yr
Paper/ card	recycled (75%+) and non-chlorine bleached	<1T/yr	1 – 2 T/yr	2 – 5 T/yr	5 – 10 T/yr	>10T/yr
	Non-chlorine bleached	<250Kg/yr	250 – 500 Kg/yr	0.5 – 1 T/yr	1 – 2 T/yr	>2 T/yr
	Other	<1 Kg/yr	1 – 10 Kg/yr	10 – 50 Kg/yr	50 – 100 Kg/yr	>100 Kg/yr
Ink / dye / pig-ments	Organic	<250g/yr	250g – 1 Kg/yr	1 – 10 Kg/yr	10 – 100Kg/yr	>100Kg/yr

	Inorganic	<250g/yr	250g – 1 Kg/yr	1 – 10 Kg/yr	10 – 100 Kg/yr	>100Kg/yr
Solvent	Crude oil source	<250L/yr	250 – 500L/yr	500 – 1000L/yr	1000 – 5000Kg/yr	>5000Kg/yr
	Other	<250L/yr	250 – 500L/yr	500 – 1000L/yr	1000 – 5000Kg/yr	>5000Kg/yr
Min-erals	Limestone / cement	<10T/yr	10 – 100 T/yr	100 – 1000 T/yr	1000 – 10,000 T/yr	>10,000T/yr
	Rock	<10T/yr	10 – 100 T/yr	100 – 1000 T/yr	1000 – 10,000 T/yr	>10,000T/yr
	Clay	<10T/yr	10 – 100 T/yr	100 – 1000 T/yr	1000 – 10,000 T/yr	>10,000T/yr
	Soil	<10T/yr	10 – 100 T/yr	100 – 1000 T/yr	1000 – 10,000 T/yr	>10,000T/yr
Glass	All	<1 T/yr	1 – 10 T/yr	10 – 100 T/yr	100 – 500 T/yr	>500 T/yr
Water	Public supply	<50 m^3/yr	50 – 250m^3/yr	250 – 750m^3/yr	750 – 1500m^3/yr	>1500m^3/yr

INCIDENT RISK EVALUATION

Range: The likely area which the results of an incident may effect.
Hazard Type: The likely nature of the potential incident
Dose-response: The potential effect of an incident or a particular dose of a released substance may have on humans and the environment.
Remedial Action: The possible action that would be required to clear up after a given incident.
Emergency Controls: The level of control that is placed on a given area of risk.

Incident Risk Evaluation																										
Date:	Range					Hazard Type					Dose-response					Remedial Action					Control Systems						
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	
Ref:																										
Table of																										
Risk Area	> 20 km	1 – 20 km	500m – 1 km	100 – 500m	< 100m	Explosion / radioactive fallout	Toxic gas or dust release	Chem. spillage/harmful future	Fire	Physical hazard / collision	Human death	Human injury / ill health	Pollution of the environment	Damage to property		Ground water sparging	Soil / river bed removal	In situ remediation	Fire extinguishing	No clean-up necessary	No assessment, plans or control	Basic emergency plans	Basic control measures	Basic plans and controls	Full planning and control	Score	Weighted Score

Weighting table

Aspect	Element	1	2	3	4	5
Potential Accidents	Perceived probability	Very low	Low	Medium	Likely	Very Likely
Hazards currently occurring	Possible extent	Very low	Low	Medium	High	Very High

CONTRACTOR EFFECT EVALUATION

Energy: The anticipated energy use of the particular contractor that produces the effect.
Environmental Risk: The level of risk imposed by the particular contracted service.
Principal Resources: The sustainability of the main resource used by the contractor
Nuisance: The type of nuisance that may be caused by the particular contractor.
Waste Production: The likely destiny of the waste from the particular contractor.

Contractor Effect Evaluation																											
Date:	Energy					Env. Risk					Main Resources					Nuisances					Waste Production						
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1		
Ref:	Extremely energy intensive	Very energy intensive	Moderately energy intensive	Low energy use	Very low energy use	IPC / extraction licence	Discharge con. / WMLicense	Commercial vehicle operator	No license requirements	Non-renewable	Reclaimed	Recycled	Re-used	No major resources used	Noise / vibration	Dust / odour / smoke	Effluvia	Light / solid deposits / visual	No nuisance effect	Destroyed or landfilled	Reclaimed	Recycled	Re-used	No or negligible waste	Full planning and control	Score	Weighted Score
Table of																											
Contractor																											

Weighting table

Aspect	Element	1	2	3	4	5
Waste Disposal	Waste volume	<10m³/yr	10 – 100m³/yr	100 – 1000m³/yr	1000 – 5000m³/yr	>5000m³/yr
Transport	Distance	<50Km/yr	50 – 500Km/yr	500 – 1000 Km/yr	10,000 – 100,000 Km/yr	>100,000 Km/yr
Couriers	Distance	<50Km/yr	50 – 1000Km/yr	1000 – 100,000 Km/yr	100,000 – 500,000 Km/yr	>500,000 Km/yr
Cleaning	Volume of hazardous cleaning materials	1L/yr	1 – 10 L/yr	10 – 50 L/yr	50 – 250 L/yr	>250L/yr
Other	% of company workload within a specified area	<1%	1 – 10%	10 – 25%	25 – 50%	>50%

PACKAGING EFFECT EVALUATION

Up-stream Risk: See definition under Resource Evaluation
Recyclability: See definition under Waste Effect Evaluation
Marking: The degree to which the packaging has been marked with recycling information.
% Recycled: The proportion of recycled materiel in that packaging used.
Down-stream: The degree to which the organisation co-operates with its client's requirements for packaging.

Packaging Effect Evaluation																												
Date:	Up-stream Risk					Recyclability					Marking					% Recycled					Down-stream							
	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1	5	4	3	2	1		
Ref:	Very high risk industry	High risk industry	Moderate risk industry	Low risk industry	No packaging supply	Not recyclable / reusable	Alternative route possible	Partly recyclable / reused	100% recycled	100% reused	No markings	Unmarked recycling category	Recycling mark only	Partly marked	Fully marked	0 – 24%	25 – 49%	50 – 74%	75 – 99%	100%	No interaction with customers	Slight interaction	Partial interaction	Moderate interaction	Extensive interaction with customer	**Score**	**Weighted Score**
Table of																											
Package Material																											

Weighting tables

Aspect	Element	1	2	3	4	5
Primary Packaging	Weight/yr	<500Kg	0.5 – 1 T	1 – 10 T	10 – 50T	>50T
Secondary Packaging	Weight/yr	<500Kg	0.5 – 1 T	1 – 10 T	10 – 50T	>50T
Returnable Packaging	Weight/yr	<5T	5 – 10 T	10 – 50 T	50 – 100T	>100T

From Saign, G (1994)

CATEGORY	ASPECT	SOURCES	IMPACTS
Global Issues - indirect	Acid rain	Sulphur dioxide,, Nitrogen Oxides, Industrial chemical use (e.g. Hydrogen Chlorides) and natural sources (e.g. forest fires, volcanic eruptions, sea spray etc.)	Lowered pH – inhibiting breeding of fish and aquatic species; growth of mosses; leaching of minerals, wash off of heavy metals (aluminium, **cadmium**, zinc and **mercury**), plant and tree growth stunted/halted, death of fish from aluminium poisoning, take-up by birds of high aluminium content in food
	Deforestation	Need for farming land (e.g. agriculture, livestock grazing), timber (firewood and lumber), land for development, mining. Dams, disease in trees etc.	Soil **erosion**, water pollution, **greenhouse effect (e.g. Carbon Dioxide balance, methane), particulates, ozone depletion,** weather / micro-climate, water shortages, and flooding
	Ecotourism	Travel, camping, sports etc.	Positive effect (v general tourism) on ecosystems, waste management
	Environmental Disasters	Natural (volcanic eruptions, hurricanes, drought, earthquake, fires etc.) and, to some extent, **global warming, deforestation, wetland destruction,**	Eco-system disruption, fire, **global warming etc.**
	Exotic species	Introduction of foreign species without evaluating all downstream effects.	Potential food chain effects/eco-system imbalance, disease propagation, crop damage
	Extinction	**Deforestation,** habitat loss, human population increase, **agricultural**	Loss of Biodiversity and genetic heritage, effect on food chain,

	practice, toxic chemicals, exotic species, ozone depletion, dams, **overfishing**, natural causes (e.g. ice ages, massive volcanic eruptions etc.)	population imbalance
Freshwater degradation	Cooling water, sewage and industrial waste disposal, agricultural and deforestation run-off, pesticides, air pollution,	Salts, pathogens, suspended matter, eutrophication, warming,
Global warming	**Greenhouse gases, deforestation, ozone depletion, fossil fuel burning** and various feedback loops (effects not clearly established)	Melting of polar ice caps, climate change, erratic weather, pest increases, **extinctions.**
Greenhouse effect	CO2 (fuel burning, biomass burning and deforestation), methane (cattle, termites, wetlands, burning), CFCs, Nox, water vapour, ozone, CO and hydroxyl radicals.	**Global warming.** Indirect effects caused by global warming (such as respiration rates of plants etc.)
Indigenous peoples displacement	Deforestation, population increase, dams, tourism, warfare, disease and overfishing.	**Deforestation and extinction**
Ocean degradation	Environmental build-up and accumulation (pesticide, heavy metal and soil run-off, acid rain, etc). Accidents and garbage. Waste dumping.	Affect on eco-systems including coral reefs and shore-lines.
Overfishing	Fishing – particularly driftnets, trawlers, illegal catches, pollution and dams.	Extinction, food chain imbalance and effect on non-target species.
Ozone depletion, stratospheric	CFCs, Halons, Carbon Tetrachloride, methyl bromide, methyl chloroform, particulates, Nox, natural chlorine (volcanic eruptions and seawater)	Increased UV radiation (UV-B) can affect growth of coral and zooplankton etc. Blindness in some animals. Greenhouse effect exaggeration. Smog Skin cancer. Damage to runner, wood and plastics.

	Population pressures	Better medical care, poverty, family planning availability, education, religion, developing countries, indigenous peoples, poor planning, limited resources.	Air pollution, smog, acid rain, freshwater degradation, soil degradation, deforestation, extinctions, eco-system breakdowns, ozone depletion and climate changes
	Smog	Motor vehicles (50% of contribution), industrial and household sources (ozone, PAN, Nox, hydrocarbons, VOC, CO). Biomass burning. Weather effects.	Damage to vegetation by ozone, Nox and PAN. Greenhouse effect. Acid rain. Toxics. Human health (eye and skin irritation, pulmonary problems).
	Soil degradation	Agriculture, deforestation and overgrazing. Irrigation, dams, mining, acid rain and natural processes (flooding, volcanoes etc.)	Erosion and loss of nutrients. Pollution. Compaction. Secondary effects on waterways and oceans.
	Sustainable development	THREAT SOURCES:: Population increase, poverty, energy use, agriculture, manufacturing, land development / use, transportation, raw material use, meat productions, fisheries, water use etc.	Deforestation, freshwater degradation, ocean degradation, air pollution, ozone depletion, greenhouse gases, over hunting, over fishing, extinction, wetland degradation, residual toxics, soil degradation.
	Warfare effects on the environment	War and munitions.	Wildlife damage. Air pollution. Toxic and hazardous chemicals and waste. Freshwater pollution. Soil degradation.
	Wetlands degradation	Agriculture, urban development, river pollution (carrying toxic waste to wetlands), acid rain, air pollution, dams etc.	Affect on eco-system (drying of habitat, loss of habitat). Extinction. Toxic damage. Erosion. Affects on groundwater.
Air Pollution	Air pollution		
	Dioxins	Incineration, pulp mills (bleaching), PVC manufacture (and other industries such as metal smelting, wood preserving and oil refining),	Persistent, fat soluble, bioaccumulation. Most potent animal carcinogen.

		herbicide production.	
	Methane	Natural gas, digestion of vegetation/animal waste, wetlands, livestock, car emissions, coal mining, atmosphere, environmental sinks (forest soils etc.) and termites.	Greenhouse effect, complicated catalytic effect in 'ozone depletion'. If used as a clean fuel, will give off more Nox (but less soot, CO or hydrocarbons)
	Nitrogen oxides	Fossil fuels, incinerators, biomass burning and natural sources (e.g. lightning)	Acid rain, smog, greenhouse effect, ozone depletion, nitrogen levels in water and soil, lung damage.
	particulates	Dust (mining, burning, forest fires, volcanoes) and particulates (diesel engines)	Synergistic with acid rain. Greenhouse affect through blocking sunlight. Ozone depletion through catalytic effects. Smog. Pulmonary disease
	Sulphur dioxide	Power generation, burning of fuels and ores, transportation, mining of sulphur and natural sources (decaying vegetation, forest fires, bacterial decomposition, volcanoes and lightning.	Acid rain, greenhouse effect, ozone depletion. Synergistic effects with particulates. Smog.
Materials - Gas	Chlorine	Natural sources (seawater, bacterial [organochlorines], volcanic eruptions, biomass burning) industry (PCB, CFC, PVC, DDT) and disinfectants (e.g. in water)	**Ozone depletion, Greenhouse effect,** kills fish, aquatic plants and small organisms.
Materials - Liquid	Organic chemicals, synthetic	Fossil fuels. Products such as pesticides, herbicides, nylon, dry-cleaning chemicals, plastics etc. By-products of other manufacturing.	Persistence, bioaccumulation and toxicity. Birth defects for young animals. Air pollution, including ozone depletion, when burn
Materials – Solid	Asbestos	Building materials (insulation, floor tiles, pipes, roofing) and fabrics.	Lung damage (asbestosis), ingestion through water (cancer), skin damage
	Heavy metals	Mining, manufacturing (batteries, chemicals, fertilisers, tanning, plating, smelting etc.), fossil fuels, sewage and	Non-biodegradable. Bioconcentration. Reproductive problems in fish and animals. Soil

		natural activities (e.g. volcanic activity).	damage and consequent plant and vegetation damage. Interaction with **acid rain.**
	Lead	Mining. Petrol. Industry (paint, ink, alloys, ceramics, batteries, building materials, smelting, fossil fuel burning etc.), incineration and old pipework.	Non-biodegradable. Bioconcentration. Reproductive problems in fish and animals: carcinogen. Blood and bone damage in children. Soil damage. Wind borne distribution of particulate.
	Mercury	Acid rain can leach mercury from the ground. Mining, fuels, incineration, products (batteries, thermometer, level switches, dental amalgams etc.) and seafood.	Non-biodegradable. Bioconcentration/magnification. Bacteria in water convert to methylmercury which is taken up by fish. Reproductive and neurological problems in fish and animals: carcinogen. Wind borne distribution from incineration/burning.
	Pesticides	Agricultural and domestic use. Secondary sources in air or drinking water.	Affect on non-target species (bioaccumulation, extinction, reproductive damage etc.), soil sterilisation, resistance to pesticide, killing of predators causing population explosions, carriage in the wind.
	Toxic chemicals	Numerous examples (VOCs, benzene, pesticides, PAH, PCB, DDT, heavy metals, formaldehyde, synthetic organic chemicals, dioxins etc.). Industry, landfills, mining, incineration, medical waste, energy and military.	Environmental build-up. Effects on food chain. Soil sterilisation. Synergy. Eco-imbalance. Various chemical specific health effects.
Energy and fuels	**Energy conservation**	Energy Use / generation / transportation	Positive impact on **non-renewable fuels, nuclear energy, land use, global warming, ozone depletion,**

			acid rain, ecosystems, mining, ocean degradation and toxic emissions.
	Non-Renewable		
	• Coal	Mining, transport, power generation, industry.	Burning gives off heavy metals (mercury, arsenic, lead and cadmium) as well as CO2, radon, particulates, SO2 and Nox with impact on **acid rain, greenhouse effect, smog and global warming. Mining. Ozone depletion.** Petrochemical manufacturing.
	• Fossil fuels	See coal above	See coal above.
	• Nuclear energy	Industrial (e.g. irradiation source, diagnostic source), power generation and waste handling/dumping. Warfare.	Long term radiation damage. Mutagenic, teratogenic, immune system damage, cancer, death, etc. Mining and treatment of ore.
	• Oil	Burning or use of oil/petrol. Disposal and use of petroleum products.	Greenhouse gases. Acid rain. Particulates catalytic in ozone depletion. Groundwater/ground contamination from leaks. Dioxins from plastic burning.
	Renewable energy	Solar, wind, bio-mass, hydroelectric, geothermal, tidal, wave, ocean current, oceanthermal and hydrogen power	Generally less impact that non-renewable energy but some negative impacts with most energy production.
	• Biomass energy	Decomposing matter(e.g. fuel wood, waste, corn, seaweed, algae, crop waste, peat, paper etc.). Fires.	Products of burning will produce CO2, NOX, **methane**, hydrocarbons, **radon**, sulphur and **particulates** (see **acid rain, global warming, ozone depletion, deforestation).** Biomass ash is cleaner than coal and can be used as a fertiliser. Biomass can

			clean-up sewage effluent. Can be used to produce ethanol and methanol as fuels (sulphur free) Biomass fuels give off aldehydes.
	• Geothermal Energy	Volcanic areas.	Can release minerals and heavy metals from , large water use.
	• Hydroelectric energy	Collection of rainwater run-off or tidal.	Positive impact of 'clean' energy. Flooding, wetland imbalance, methane and CO2, water loss, sedimentation, fish/aquatic life.
	• Solar energy	Sunlight. (Cells, solar panels etc.)	Energy needed to manufacture equipment. Land area used.
	• Wind energy	Wind.	Killing of birds in vanes. Visual. Competition with other uses of high ground.
Biological	Biotechnology	Crops (GMO), animals, vaccines, medical research, biological controls, enzymes, catalysts, bioremediation, biohydrometallurgy and warfare.	Organisms that have better yields or better resistance to drought / pesticides etc. Can cause unforeseen harm (e.g. nutrient imbalance, eco-system imbalance). Less use of agrichemicals.
Waste disposal	Incineration	Burning waste.	Air emissions (mercury, lead, heavy metals, metal chlorides, dioxins, furans, particulates, Sox, Nox, CO2 and other greenhouse gases) and consequent acid rail and global warming. Landfill of ash. Disposal last option for waste.
	Solid waste	Commercial, household, industrial, government, military and medical.	Landfills (and secondary problems of land use, emissions, leachate, and management issues), Incineration (and associated secondary problems), Composting. Visual. Fire. Heavy metal contamination. Groundwater

			contamination. Biocontamination.
	Hazardous waste	Industry, military, energy production, sludge from waste water treatment, municipal solid waste, mining spoil etc.	Poisoning of eco-system (mortality depends on susceptibility of species). Biomagnification and persistence. Groundwater contamination. Wind transportation. Chemical synergies.
Visual	Landscaping problems	Improvement of visual impact (often with disregard to plants which are indigenous). Golf courses.	Pesticides, air pollution (from mowers), fertiliser use, soil degradation, freshwater depletion etc.
Farming	Livestock problems	Overgrazing, manure problems, cattle ranching	Soil degradation, deforestation, erosion, freshwater degradation / eutrophication, greenhouse effect, wetland impact.
	Sustainable agriculture	Farming (organic), Low input sustainable agriculture, previous farming methods.	Erosion, pesticides, fertilisers, wildlife, genetic diversity.
Special Industries	Mining	Mining of fossil fuels, heavy metals, phosphate, rock, asbestos, precious metals, minerals etc.	Soil degradation, freshwater degradation, ocean degradation, air pollution (particulate, radon, gases etc.), deforestation and wildlife habitation loss.
Radiation	EMF	Microwaves, clock radios, computers, electric motors, transformers, power lines and thunderstorms.	Impaired central nervous system development, estrogen production, male reproductive systems.
	Radon	Natural (from natural deposits in the ground), mining and burning of fossil fuels.	Cancer, breathing problems and reduced life span.
Transportation	Transportation	Cars, buses, trucks, aeroplanes, and diesel trains. Fixed engines (generators, compressors etc.)	Air pollution (particulates, CO, Sox, Nox, lead, VOC, hydrocarbons etc.) with consequent acid rain, greenhouse effect, smog and ozone depletion. Wildlife habitat effected by roads.