A survey of the literature on challenges to safety posed by outsourcing or subcontracting of critical tasks

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A survey of the literature on challenges to safety posed by outsourcing or subcontracting of critical tasks

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The purpose of this document is to report on a review of the literature on the relation between safety and outsourcing or subcontracting. The review seeks to identify the problems and solutions that have been identified and described in the literature concerning outsourcing and subcontracting.

The report, being the first of three reports that comprise Deliverable D1.4.1, describes results of an extensive review of the literature that has been referenced in science and engineering databases.

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Executive summary – specific ERRA deliverable

Title:	A survey of the literature on challenges to safety posed by outsourcing or subcontracting of critical tasks				
WP:	1.4	**Task:**	1.4.1	**Deliverable:**	1.4.1.1
Authors:	J. Thommesen, HB Andersen(DTU)				

1. Problem description

A number of reports and papers have been published about possible relations between outsourcing /subcontracting and industrial safety and occupational health. While summary reports exist for the railway sector, no review exists that looks at all industries and summarises results from a wide range of engineering / science papers.

2. Terminology (most important concepts)

Term or expression	Definition	Synonyms	Ref. *	Related terms	Formula **
Outsourcing	Acquiring a service from others that has until now been delivered internally				
Subcontracting	As in outsourcing, except that it includes services that have not recently been performed internally, and may not realistically be in-sourced				

** Referring to the classification in item 10; ** Mathematical formulation (if any)*

3. Definition of the emerging risk issues

The emerging risk issue focused on in this deliverable concerns, first, the identification of outsourcing and sub contracting arrangements that are particularly liable to raise safety problems, and second, identification of recommended practices that appear to be successful in reducing risks involved in these work arrangements.

Outsourcing and subcontracting are emerging risk issues because the fragmentation of work and work coordination involved in the increasing use of outsourcing and subcontracting *appears to pose specific challenges* to safety management

4. Status description

No prior survey exists that summarises the scientific and engineering literature on outsourcing and subcontracting risks and safety solutions.

5. Approach or method used

A search has been performed (Feb. 2010) in the ISI World of Knowledge and Science Direct (Elsevier) databases using the search string: < safety AND (outsourc* OR subcontract*)>. The search yielded 133 non-overlapping records. After a first screening, non-relevant records were eliminated as judged by title or abstract, leaving 46 items which were retrieved in full-text format and subjected to review of each paper to capture relevance. Finally, 33 papers were identified as being of central relevance.

After detailed study, properties of each article was entered into a template based in part on a template developed in the iNTeg-Risk project for capturing information from industrial interviews about risks involving subcontracting

6. Parts of the iNTeg-Risk framework covered by the results (marked with X)

	Pre-assessment	Risk Appraisal	Tolerability & Acceptability Judg.	Risk Management
T				
C				
H	x	x		x
R	x	x		x

7. Results

The results presented in this report are mainly based on a literature review focusing on scientific papers. However, we have also taken into account known accidents related to subcontracting and existing guidelines on HSE management of contractors (appendix).

The papers under review point to a number of characteristics associated with elevated risks, and the review suggests that the following risk issues are of particular importance: contract management, subcontractor staff, small subcontractors, safety management across interfaces, and regulation by authorities.

A number of issues are related to contract management. There is thus a risk that the awarding process will focus on price and lead to the choice of a subcontractor with minimal consideration for safety and a 'relaxed' attitude to safety rules etc. Once a subcontractor is chosen, there is a risk that the incentive schemes in the contract will be biased against safety and encourage the subcontractor to disregard safety rather than production measures such as deadline when conflicts arise. There are also risks associated with pyramid subcontracting when responsibility for and control of employees for 2nd level subcontractors is blurred.

Besides these issues related to contract management there are also a number of risks related to subcontractor staff. They may have inadequate safety competence, for instance if they are new or only part-time employees, and for the latter it may be difficult to control their total working hours, thus increasing the risk of exceeding fatigue limitation regulation, and undermining competence management systems.

There are also risks associated with the use of small subcontractors, since they will have fewer resources for safety investments and may be less motivated to make such investments.

Safety management across organizational interfaces also involves risks, notably since the allocation of responsibility may be unclear – and difficult to establish in a fair and manageable way.

Finally, subcontracting arrangements also pose a challenge to regulation by authorities, both because of unclear responsibilities, and because they have inadequate resources to directly control an increasing number of companies.

8. Extent to which the results can be generalized

Some of the problems identified in some of the studies may possibly not be pervasive, nor may all recommendations be effective or useful or cost-efficient or feasible. However, results such as those summarized above may apply widely across industries, countries and different owners and applications.

9. Need for further work

Since the sampling and the screening and analysis methods used in this survey appear to be reliable and reasonably productive, further work efforts should be targeted at collecting evidence about experiences with and performance data about actual safety management practices and arrangements directed at outsourcing/ subcontracting. The next subtask (D1.4.1.2) goes some way toward fulfilling this requirement.

Classification of deliverable

ERRA Topic:	C
Industry:	Primarily, Oil & Gas; Construction; but any industrial domain included in survey
Keywords:	Subcontracting, Outsourcing; Safety; Risk; Safety management
Other:	

1. Problem description

1.1 Background

Industries that run large and complex operations - such as construction or oil and gas – are typically relying on a large number of specialized subcontractors performing interdependent activities. Hence, safety must be managed and coordinated across organizational boundaries. At the same time, the drive to outsource non-core business tasks is a trend that is visible across all industries, prompted by globalization and owners' requirements to reduce costs. Outsourcing therefore introduces new organizational barriers in processes that previously were carried out internally.

Subcontracting and outsourcing are overlapping but not identical phenomena. They both involve the challenge of organizing and managing safety-critical process across organizational barriers, but there are also different challenges characteristic of each phenomenon. In the following, the terms will often be used interchangeably, unless specific characteristics are emphasized.

Many observers have raised concerns over the effects of outsourcing on safety (Ale 2005;van Wagner 2007), and such concerns seem confirmed by a few prominent accidents in which outsourcing have been a contributing factor. Both the Valujet plane crash (van Wagner 2007) and the Hatfield rail crash (Cullen 2001) were due to failures in outsourced maintenance operations, as well as to inadequate management by the ordering party.

1.2 How to tackle the problem

This task will identify, generalize and describe recommendations and good practices concerning those parts of safety management that address outsourcing and subcontracting. The recommendations and good practices are intended to be applied by an "Ordering Party" who seeks to maintain and improve safety for subcontracted tasks. The recommendations and good practices are based on (a) issues and solutions described in the science and engineering literature and (b) interviews with companies that have wide experience with ordering and monitoring subcontracting arrangements.

In general, we assume that ordering parties are motivated to achieve safety when subcontracting, either because they will bear a considerable part of the costs associated with accidents, or because their reputation may suffer the most damage. However, there may be a range of concrete cases where this assumption does not hold; and one should be cautious and not accept a simple, one-sided perspective: that ordering parties are by definition well-intended defenders of safety, while contractors and subcontractors are more willing to sacrifice safety to gain profit. It is worth remembering that unsafe behavior by contractors are often triggered by contractual conditions or conditions otherwise provided by the ordering party, and by the ordering party's original selection among bids.

The T1.4.1 task has been divided into three sub-tasks and similarly the deliverable D1.4.1 is divided into three reports as described below. Prior to engaging in the subtasks a preliminary search and study was made by the partners of particularly salient examples of industrial accidents in which outsourcing or subcontracting have been cited in accident analyses and reports as causally involved. Among these accidents were: the accident involving Valujet Flight 592 (May 1996), the Tornio industrial accident (stainless steel production, 1997); and a number of rail accidents in British Rail following a process of deregulation (1990's). Results from this survey and analysis of reports produced the beginnings of the conceptual framework applied for preparing the interview survey and subsequently the integrative model described below.

The three sub-tasks and their specific reports are:

D1.4.1.1 This report [the present report] describes a literature review that has been conducted to assess what is known in the literature about challenges to safety posed by outsourcing and subcontracting of critical tasks. The review results in a preliminary synthesis of challenges as well attempted solutions to such challenges. It produces an inventory of existing rules and organizational schemes, such as new incentive schemes, joint safety meetings, training and certification etc., to deal with safety related to outsourcing.

D1.4.1.2 Based on a structured catalogue of issues and challenges an interview survey has been conducted with safety management representatives of companies that have a

wide experience with the safety management of subcontracting arrangements. The purpose of the interviews was to capture risk issues and good practices related to outsourcing and subcontracting. Interviews were conducted with selected companies across different safety-critical industries (oil & gas, construction, rail, shipbuilding, chemical, energy), and from different European countries. The selected companies are known to have initiated specific programmes to deal with outsourcing threats, and the interviews inquire about practical application of existing measures in unforeseen situations, as well as about new practices. The survey also includes a number of interviews with subcontractors

D1.4.1.3 Based on the results of the literature survey and the interview study results have been integrated into a model of good practices aimed at managing industrial risks related to outsourcing and subcontracting of safety-critical tasks. The model is based partly on the results from the literature review and largely on a generalization of the results from the conducted survey.

2.Terminology

In this section we describe and define key terms and concepts used in the deliverables of this task. When no reference is given, the term is used by a large number of sources and, in some cases, an attempt at making the term precise has been developed by the task group.

Good practices

The report will present good practices from the interviews and the literature, but will refrain from using the term 'best practices'.

Ordering Party (OP)

In a contractual relation, the OP is the party that defines (scope, schedule…), finances, monitors, and assesses the work to be done. Furthermore, the OP chooses the contractor (i.e. the party that carries out activities) according to its own criteria.

Contractor, Subcontractor (SC)

The terms contractor and subcontractor are used interchangeably, since some of the companies interviewed emphasize that they, according to standard terminology in their industry, use contractors, not subcontractors. In this report, the term subcontractor does not denote a secondary level of contracts. In that case, we will instead use the term cascading contracts.

Services, not products

This report focuses on providers of *services*, not suppliers of (standardized) *products*. In principle, the safety and quality of supplied products can be controlled simply by examining those products, while the safety and quality of services are more complex and difficult to monitor. The distinction between products and services tends to fade for non-standardized products, however.

Subcontracting vs. outsourcing

Outsourcing: acquiring from others what has until now been done internally. Considering safety related to outsourcing also includes the question whether it is safe to outsource, or whether it would be safer to keep the operation internally. In other words, outsourcing hinges on the '*make* or *buy'* decision – the choice between *hierarchy* (internal) and *market* (external) (Williamson 1990)

Subcontracting: also includes services that have not recently been performed internally, and may not realistically be in-sourced. Considering safety and subcontracting will primarily look for better ways to control subcontracting, and not consider the option of avoiding it.

Cascading or pyramid contracts

When the main contractor delegates tasks to other contractors (often termed subcontractors).

Globalization (not included)

This study does not consider the problems that arise when companies outsource production to countries with weaker regulation. Focus is on the problems associated with using the market for safety-critical services, rather than producing the service internally.

Economic motives for safety (Savage 1999):

Safety requires an extra investment, whether in the form of direct costs, or indirectly by moving resources from production to safety (Reason 1997). A company invests in safety to reduce the risk of accidents. Safety is a non-event, and the benefits of safety investments are difficult to observe directly. It is thus an investment characterized by several uncertainties. *First*, the benefit depends on the probability of the accidents to be prevented by the investments. Normally, safety investments – especially for low probability/high consequence risks – do not pay off for individual or even few transactions (e.g. a short-term contract), but only in the long run. For small companies safety investments may be relatively larger, and the likelihood of the events to be avoided will be smaller. *Second*, the benefit depends on the costs of an accident, and besides the *direct* costs in the form of damaged production material and production losses, the additional *indirect* costs associated with fatalities/injuries to staff, and effects on the environment or 3rd parties depend on the extent to which the company is held responsible by regulation.

The uncertain price of safety:

It is difficult to specify the safety level in a contract – and difficult to estimate the price of that safety. For highly standardized services, safe working procedures and the use of certain types of safety equipment can be equally standardized, which at least makes it possible for specific safety precautions to be included in a specification of the work. For non-standardized work however, a precise description of safety precautions becomes intrinsically difficult. Changes in regulation may also complicate the price of safety: Over the past decades the legislation philosophy has been changing from a prescriptive approach (a *prescribed manner* to carry out the work safely, with relatively well-defined costs in the form of procedures and equipment) to a performance (e.g. the work *must be carried out* "safely") or to a process approach (a *management system* must be in place to ensure that the work is carried out "safely") – where the required costs are much more uncertain. The difficulty of specifying and pricing safety in a contract works both ways: it is difficult for the ordering party to specify exactly what the required level of safety is; it is difficult for the contractor to understand the exact required safety level; it is difficult for the ordering party to check the actual level of safety provided by the winning contractor.

2.1 Why outsourcing?

There are two main economic) reasons given both in the literature but also repeated during the interviews conducted by the partners (D1.4.1.2) for outsourcing: **capacity** and **specialty**.

Capacity: When the OP does not have adequate capacity of required resources (equipment, skills) the services are outsourced. This reason is also related to **flexibility**: OP does not wish to build up/maintain 'surplus' capacity that may be excessive in other periods. By contracting, the OP also avoid overhead costs associated with a large internal staff, including usual employer obligations such as termination and dismissal procedures, employments rights, severance payments, administrative burden. Investing in internal dedicated staff/resources for periodic/non-permanent tasks poses a challenge to coordination: how to allocate those dedicated resources for similar tasks in 'idle' periods. Subcontracting/outsourcing transfers that problem to the market: subcontractors now have to plan the allocation of their resources to various clients – they have to bid for a large number of contracts at the risk of over-stretching. If they win too many contracts, they will have to hire new or temporary staff. On the other, the advantage for the subcontractors – compared to internal departments – is that they are free to bid for outside jobs and thus optimize the use of their dedicated resources.

Expertise/specialty: The OP does not have the required expertise 'in-door'; other companies already have the expertise and can provide the services better, faster or cheaper. And the OP does not want to build up or maintain the required expertise internally, e.g. because it cannot be done at reasonable costs, or because the tasks are considered to be beyond the OP's 'core business'.

2.2 Abbreviations

OP: Ordering Party.
SC: SubContractor.

2.3 Theoretical perspectives on the choice of outsourcing

As a supplement to these basic motives for outsourcing, some theoretical perspectives can help understand some of the dynamics behind the choice of outsourcing.

2.4 Principal-Agent relation:

According to this theory, subcontracting introduces two partly adversarial roles when a Principal delegates work to an Agent1. The contract relation involves a conflict of interest (partly differing goals), since the Principal wants the Agent to perform as much as possible for the price he pays, and the Agent wants to fulfill the contract (and perhaps increase the chance of future contracts) by performing at the lowest cost possible. This conflict of interest constitutes a challenge to the Principal when the work is performed under conditions of asymmetrical information that make it difficult to control whether the Agent has performed appropriately. The principal can use various incentive mechanisms to align the Agent's interests with his own, but these mechanisms all tend to also have unintended consequences.

This theory is relevant, since safety concerns tend to involve asymmetrical information in the sense that it is difficult to monitor how safely a task is performed.

While principal-agent relations certainly also exist within a company, between different roles, they may be moderated by a strong safety culture. With contracting, however, the ordering party must accept that the contractors (by design) are not "company men" impregnated with the ordering company's culture and shared values; contractor employees may not know or not care much about the ordering party's vision and long term business objectives. Contractors have, at best, a divided loyalty towards the ordering company and the mother company.

2.5 Two economic aspects on outsourcing:

Classical economic theory offers two explanations of why a contractor may perform more effectively: 1) Economies of scale: they may benefit from performing a larger amount of the same type of work. 2) Economies of scope: they may already use the same resources (expertise, equipment) for related tasks (Prager 2008). These reasons are already implicit in the capacity and specialty motives mentioned above.

Transaction cost theory (Caniels & Roeleveld 2009;Williamson 1990), on the other hand, points out that gaining benefits from the market rather than internal production requires a well-functioning market where it is possible to compare products and prices – thus with no or few 'market failures'. In that case, competition among bidders, and even between external bidders and internal departments, reveal and reduce the costs required. But in many cases the prices are less transparent. Transaction costs are thus the costs of using the market – comparing prices, managing contracts etc. – and they increase with *asset specificity* (when the job requires dedicated resources that cannot be used elsewhere) and *uncertainty*, and decrease with transaction *frequency* (since more transactions increases knowledge about the other part and thus reduces uncertainty). It can be argued that the safety element of a task represents a high degree of uncertainty that makes it difficult to specify and control in a contract.

3.Definition of emerging issue(s), including the emerging risk character

The emerging risk character is stated (in Section 3.1), and the emerging risk attributes presented (in Section 3.2).

3.1 Emerging risk character

According to OSHA[2] an emerging risk is a risk that is both "new" and/or "increasing". It is "new" if and only if:

(a) the risk was previously unknown and is caused by new processes, new technologies, new types of workplace, or social or organizational change; **or**

[1] Wikipedia on the Principal-Agent problem: http://en.wikipedia.org/wiki/Principal-agent_problem.

[2] http://osha.europa.eu/en/campaigns/riskobservatory/risks/intro/index_html#what (Note that OSHA is focusing on Occupational Risk, whereas the iNTeg-Risk project focuses on Major Accident Risk. Thus, the OSHA definition of emerging risk is adapted to fit the scope of iNTeg-Risk.)

(b) a long-standing issue is newly considered as a risk due to a change in social or public perceptions (e.g. stress, bullying); **or**

(c) new scientific knowledge allows a long-standing issue to be identified as a risk.

The risk is "increasing" if and only if

i) the number of hazards leading to the risk is growing, **or**

ii) the likelihood of exposure to the hazard leading to the risk is increasing, (exposure level and/or the number of people exposed), **or**

iii) the effect of the hazard on workers' health is getting worse (seriousness of health effects and/or the number of people affected).

Outsourcing and subcontracting are work arrangements that have been used for centuries and probably millennia. But nevertheless, they may also be considered to involve emerging risks in the sense of the OSHA definition.

They have an emerging risk character, because

- first, there is growing recognition that the fragmentation of work and work coordination involved in outsourcing and subcontracting *may pose specific challenges* to safety management – so the risk is "new" in the sense of (b); in addition, one may also say the risk character is to some extent "new" in the sense of (a), in so far as outsourcing and subcontracting are used increasingly in some domains;
- second, it is "increasing" in the sense of subpoints (i) and (ii) in so far as there are some domains in which safety critical tasks that were previously carried out by "mother company" will now be delegated to subcontractors.

3.2 Emerging risk attributes

The "types" of risks associated with outsourcing and subcontracting can be characterized only at a general level, since the concrete risks depend entirely on the industry targeted.

In Table 3.1 we depict the general attributes

Table 3.1 Risk attributes

Type of risk attribute	ERRA specific risk attributes
Source of hazard	Inadequate safety management
Element at risk to hazard	Production facilities and built environment Natural environment Human health
Hazardous situation	Depends on industry and specific application
Main stakeholders	Ordering party (contract awarding company) Subcontractor(s) Depending on industry and specific application: *various*

4. Status description

No general treatment exists of the challenges to safety management posed by outsourcing and subcontracting focusing on health, safety and environment issues. However, “Guidelines for managing risk in outsourcing utilizing the AS/NZS 4360:2004 process” (HB 240—2004) published by Australian Standards (Autralian Standards, 2001) is in fact a general guideline about risk management. However, this report addresses primarily risk management in the framework of business risks. Risk is thus defined as "the chance of something happening that will have an impact on objectives”, where of course concerns about “health, safety and environment” from only a minor part of the objectives behind running a business. Other relevant contributions are found in reviews of industrial accidents or risks and subcontracting in specific domains, such as the Ladbroke Railway Accident Inquiry (Cullen, 2001).

No literature review seems to have been performed of the risk issues and possible solutions identified concerning outsourcing and subcontracting. Therefore, the results of the survey performed in this subtask appear to fill out a lacuna in current knowledge.

5. Methods

A search has been performed (Feb. 2010) in the ISI World of Knowledge and Science Direct (Elsevier) databases using the following search string: “ safety AND (outsourc* OR subcontract*)”. The search yielded 133 non-overlapping records. A two-stage screening was then applied to the records retrieved. At the first screening, irrelevant records were eliminated as judged by title or abstract. This left 46 items which were retrieved in full-text format and subjected to the second screening involving full review of each paper to capture relevance. Finally, 33 papers were identified as being of central relevance.

After detailed study, properties of each article was entered into a template based in part on a template developed in the iNTeg-Risk project for capturing information from industrial interviews about risks involving subcontracting.

5.1 Inclusion and exclusion criteria

The terms ‘subcontracting’ and ‘outsourcing’ are largely overlapping in their meaning, though not entirely. We shall also use the terms as largely interchangeable.

‘Outsourcing’ suggests, and ‘subcontracting’ does not, that the activity or service that is now contracted out or outsourced has previously been managed by the outsourcing part. ‘Subcontracting’ implies that there is contractor and a subcontractor. In construction, the roles are usually distinct and clear: an owner hires a contractor to perform an activity and the contractor in turn hires subcontractors to perform part activities. In some contexts, the owner becomes the contractor, so ‘subcontractor’ comes to refer to any party who supplies a service for an owner or contractor.

In addition, ‘outsourcing’ is often used to refer to services or lines of production that a ‘contracted out’ to parties in countries with low levels of wages and other costs. In this paper, we do not address this aspect except when it relates to HSE aspects.

6.Parts of the framework covered

The parts of the iNTeg-Risk framework covered by this deliverable are illustrated in Figure 6.1.

iNTeg-Risk Framework	IRGC			
ERMF	Pre-assessment	Risk Appraisal	Tolerability & Acceptability Judgment	Risk Management
T				
C				
H	**D1.4.1.1**	**D1.4.1.1** **D1.4.1.2** **D1.4.1.3**		**D1.4.1.1** **D1.4.1.2** **D1.4.1.3**
R	**D1.4.1.1**	**D1.4.1.2**		

Figure 6.1 Indication of ERRA C1 deliverable D1.4.1.1 contribution to the iNTeg-Risk framework

This deliverable (D1.4.1.1) reporting on the results of literature survey covers largely the Human (C) dimension and, for the pre-assessment phase, also the regulatory (R) dimension of the ERMF framework.

Most items in the IRGC framework are potentially relevant to the safety management challenges raised by outsourcing and subcontracting – potentially relevant because each of the items (listed in the below) may well appear to be of central importance for a specific domain and specific application.

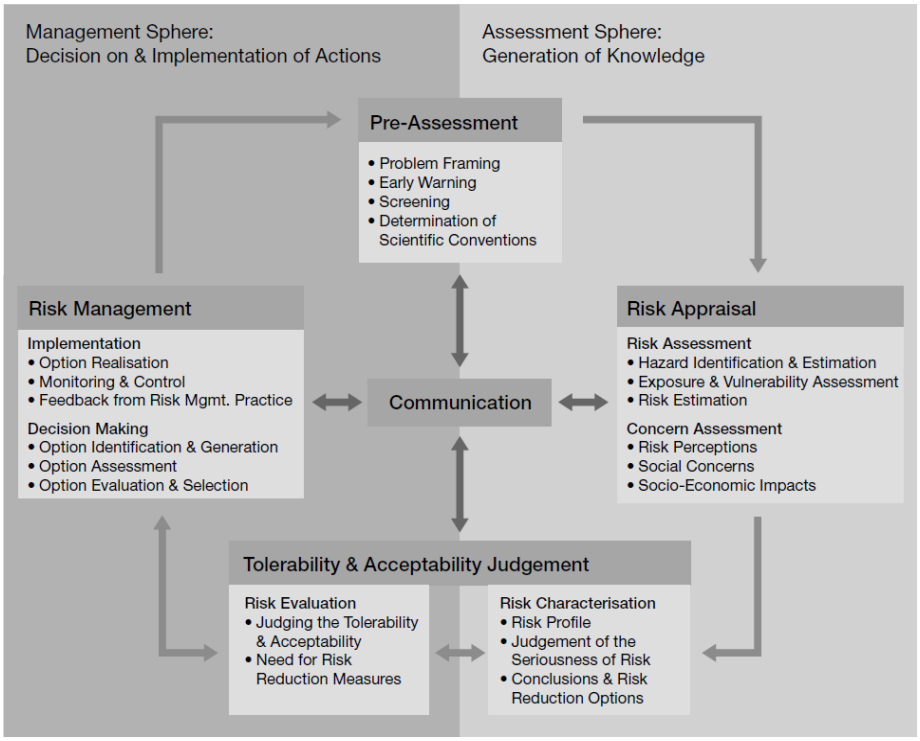

Table 6.1	
Pre-Assessment	
Problem framing	x
Early warning	x
Screening	x
Determination of Scientific Conventions	
Risk Appraisal	
Risk Assessment	
- Hazard identification & Estimation	x
- Exposure & Vulnerability Assessment	x
- Risk Estimation	x
Concern Assessment	
- Risk Perceptions	x
- Social Concerns	x
- Socio-Economic Impacts	x
Tolerability & Acceptability Judgement	
Risk Characterisation	
- Risk Profile	
- Judgment of the Seriousness of Risk	
- Conclusions & Risk Reduction Options	
Risk Evaluation	
- Judging the Tolerability & Acceptability	
- Need for Risk Reduction Measures	
Risk Management	
Decision Making	
- Option Identification & Generation	x
- Option Assessment	x
- Option Evaluation & Selection	x
Implementation	
- Option Realisation	x
- Monitoring & Control	x
- Feedback from Risk Mgm't Practice	x

7. Results

Many of the reviewed papers agree that there is a tendency toward increasing outsourcing. What are the 'drivers' behind this? Of course, the wish to reduce costs is an often cited reason for outsourcing. But there are other and forceful reasons: Thus, companies may outsource certain tasks to achieve *flexibility* (also termed *capacity* subcontracting) (Arnold & Bowie 2003). This allows the company to achieve extra capacity in peak periods.

Another reason for subcontracting is to acquire relevant expertise from a specialized subcontractor, e.g., in the form of specialized equipment or specialized labor (*specialty* subcontracting). When outsourcing a hitherto internally managed function, a company recognizes the potential of another company to accumulate more expertise by *specialization* (Kartam, Flood, & Koushki 2000), by performing similar tasks for other companies. This corresponds partly to the traditional economic argument emphasizing economies of *scale* and *scope* (Prager 2008): in order to capitalize on dedicated resources, it is necessary to apply them to a large 'volume', or to various similar tasks where the same resources are required.

Some authors have suggested a further motivation for subcontracting: *risk transfer* (Loosemore & Andonakis 2007). Thus, responsibilities for occupational health and safety (OHS) are handed over to subcontractors, along with the burden of understanding and complying with regulation. Similarly, subcontractors are often assigned to particularly dangerous tasks (Deutsch, Adler, & Richter 1992;Kenny & Bezuidenhout 1999), and carry higher risk of accident (Salminen et al. 1993).

However, benefits of outsourcing and subcontracting depend on the existence of a well-functioning *market* for the services to be outsourced, i.e., the *transaction costs* associated with the contracts must not be too high. If a high degree of *uncertainty* is implied, or the services require dedicated assets (*asset specificity*) that cannot be applied elsewhere (Caniels & Roeleveld 2009;Nunez 2009;Williamson 1990), prices can be difficult to assess and compare, and a large amount of resources must be spend on managing and monitoring the contract (Prager 2008). In fact, the aspect of uncertainty explicitly counterbalances the wish to transfer risk, since one may have to pay a higher price for high risk operations (Nunez 2009).

Besides concerns for the efficiency of price mechanisms, companies may also be discouraged from outsourcing, if this increases their *dependency* on critical resources from a particular supplier (Caniels & Roeleveld 2009;Pfeffer & Salancik 1979).

7.1 Process of awarding contracts

Several authors point to the risk that the ordering party focuses on price rather than safety when selecting among bids. For instance, it has been argued that public construction projects, due to the competitive bidding process, are "frequently awarded to contractors without regard to their ability to deliver a safe project" (Huang & Hinze 2006). Obviously, this selection may give priority to cost-efficient, but unsafe subcontractors.

Table 7.1 Problems and recommendations concerning contract issues

Problems	Recommendations
Awarding of contracts merely based on cost without regard for safety (Gochfeld & Mohr 2007;Hasle 2007;Huang & Hinze 2006)	Taking OHS and safety into consideration when choosing among bids (Busck 2007;Hasle 2007)
Hard contracts hardly compatible with establishment of safe working conditions (Busck 2007)	Bids should include safety measures to be 1) approved and probably 2) rewarded with points (Hasle 2007)
Tight deadlines may not allow time for safety preparation (Cullen 2001;Loosemore & Andonakis 2007)	Selection of subcontractors should also be based on past safety performance:
Subcontractor pressed by productivity measures to sacrifice safety (Loosemore & Andonakis 2007;Mayhew & Quinlan 1999;Mayhew, Quinlan, & Ferris 1997)	1) EMR (Experience Modification Ratings) (+/-) (Glazner et al. 1999;Huang & Hinze 2006)
Pyramid contracting increases risk of noncompliance (Loosemore & Andonakis 2007)	2) Sickness absenteeism and staff turnover (+/-) (Hasle 2007)
	3) Safety climate
	Create long-term relationships and relational contracts (+/-)(Busck 2007;Glazner, Borgerding, Bondy, Lowery, Lezotte, & Kreiss 1999;Molenaar, Park, & Washington 2009)
	Avoid pyramid contracting (Loosemore & Andonakis 2007;Molenaar, Park, & Washington 2009)

Various countermeasures are suggested – and sometimes implemented – that emphasize safety in the bidding process. One is to include *safety as a parameter in the bid*, requiring bidders to state safety measures such as safety plans and relevant safety equipment – and possibly to reward such measures with points that are taken into account in combination with price when selecting the best (Hasle 2007). Another solution is to consider the bidders' *past safety performance* when selecting among subcontractors, for instance by looking at Experience Modification Ratings (EMR) (Glazner, Borgerding, Bondy, Lowery, Lezotte, & Kreiss 1999) – although this indicator has also been criticized as lagging and inaccurate (Huang & Hinze 2006) – or by keeping track on the ordering party's own past experiences with particular subcontractor.

A third solution is to build *long-term relationships* with subcontractors in order to cooperate and build trust regarding safety. It has thus been argued that a regime of 'hard' contracts will decrease OHS, as opposed to 'relational' contracts based on mutual commitment and trust (Busck 2007). Long-term contracts will also allow the subcontractor to accumulate safety expertise, build safety culture and make appropriate investments in safety (Cullen 2001). However, there are also some evidence indicating negative consequences of cooperative relationships which one study found to be associated with higher injury rates (Glazner, Borgerding, Bondy, Lowery, Lezotte, & Kreiss 1999).

7.2 Measure of performance

Contracts with subcontractors are often designed with a strong focus on production performance in terms of productivity, deadlines etc. As mentioned before, the very advantage of using an external subcontractor is the opportunity to reduce prices by competition among bidders, and incentives and penalties based on productivity are included to ensure the realization of those benefits.

However, such measures, if unchecked by similar safety measures, may also put a pressure on subcontractors to make unsafe choices, both in their preparations – training and equipment – and in unforeseen situations that threaten to cause delays.

This problem also concerns contracts with individual part-time workers based on piecework wages, which are associated with more accidents (Mayhew & Quinlan 1999).

7.3 Size of subcontractors

In some industries, a large number of small subcontractors, sometimes based on part-time labor, may offer a high flexibility for larger companies. However, small subcontractors tend to have more accidents than larger ones (Salminen, Saari, Saarela, & Rasanen 1993;Yamataki et al. 2006). There are several reasons why smaller subcontractors have more difficulties in complying with safety regulations. First, they do not have the resources required to keep track of changing regulations, control safety expertise of their employees and make larger investments in safety, such as equipment or training (Loosemore & Andonakis 2007;Mayhew, Quinlan, & Ferris 1997).

Second, small companies are less susceptible to some of the external mechanisms that enforce or encourage compliance. They are difficult to control by authorities (see below), may be more evasive (Haines 1996) and they may avoid problems of liability and reputation by going out of business (Azari-Rad, Philips, & Thompson-Dawson 2003).

Table 7.2 Problems and solutions concerning small subcontractors

Problems	Recommendations
More accidents and higher injury rates (Salminen, Saari, Saarela, & Rasanen 1993) More evasive (Haines 1996;Yamataki, Suwazono, Okubo, Miyamoto, Uetani, Kobayashi, & Nogawa 2006) Limited resources to invest in safety (Azari-Rad, Philips, & Thompson-Dawson 2003;Kartam, Flood, & Koushki 2000;Mayhew, Quinlan, & Ferris 1997) Less motivated by traditional incentives to invest in safety (Azari-Rad, Philips, & Thompson-Dawson 2003;Haines 1996) Uncertain availability of subcontractor resources (eg. when allocating among different projects) (Zou, Zhang, & Wang 2007)	Subcontractor selection (see Table 1) Subsidising small companies for the costs of training (Loosemore & Andonakis 2007) Better integration of OHS training into general skills training (Loosemore & Andonakis 2007)

7.4 Multi-layer or pyramid subcontracting

Safety also tends to decrease when a project involves several layers of subcontractors, i.e. when one subcontractor on its part acquires services delivered by other subcontractors or by self-employed workers – so-called ‘pyramid subcontracting’. Several layers of contracts will increase the number of organizational interfaces and blur the roles and responsibilities for the various employers involved (Haines 1996;Mayhew, Quinlan, & Ferris 1997;van Wagner 2007).

As a solution it is often stated or implied that the number of levels should be reduced, and one paper recommends that “pyramid contracting should be reduced and parallel contracting encouraged” (Loosemore & Andonakis 2007).

7.5 Safety expertise required

Employees' safety expertise includes two distinct aspects: general expertise based on training and experience, and knowledge of the particular work site.

Subcontractor staff may be young and inexperienced (Gochfeld & Mohr 2007), not be properly trained and supervised to work safely (Darragh et al. 2004;Loosemore & Andonakis 2007), or fail to have the qualifications to produce a safe result (van Wagner 2007). This holds in particular for smaller companies, to whom the costs associated with training constitute a significant barrier, as argued previously.

Table 7.3. Problems and solutions concerning qualifications of subcontractor staff

Problems	Recommendations
Inadequate skills/training/experience (Darragh, Stallones, Bigelow, & Keefe 2004;Deutsch, Adler, & Richter 1992;Gochfeld & Mohr 2007;Zou, Zhang, & Wang 2007)	Short-term permits for hazardous activities (Huang & Hinze 2006)
Lack of site-specific knowledge (Salminen, Saari, Saarela, & Rasanen 1993)	Better integration of OHS training into general skills training (Loosemore & Andonakis 2007)
Scarcity of skilled/trained labour (Zou, Zhang, & Wang 2007)	Subsidising small companies for the costs of training (Loosemore & Andonakis 2007)
Difficulties in allocating subcontractor resources among different projects (Zou, Zhang, & Wang 2007)	Subcontractor should be responsible for worker's training (+/-) (Toole 2002)
	Occupational licensing for safety-critical tasks (+/-) (Haas 2008)
	Temporary training prior to work (Zou, Zhang, & Wang 2007)
	Long-term planning to secure availability of qualified labour (Zou, Zhang, & Wang 2007)

Several measures are suggested to reduce problems with inadequate expertise: better monitoring and control of employees' expertise, short-term rather than long-term permits (Huang & Hinze 2006), clear responsibility for training (Toole 2002), and subsidizing companies for the costs of training (Loosemore & Andonakis 2007).

Some of the challenges can be summarized in the dilemma faced by the European aircraft maintenance industry, when choosing between *company-led training* and (individual) *occupational licensing* (Haas 2008). Eventually, the choice fell on the latter option, partly based on the concern that companies may be tempted to cut back on investments in training during economic crises, as long as the negative consequences are not expected in the immediate future.

The safety of subcontractor staff may also suffer from inadequate knowledge of the specific work site. This is obvious for both construction workers (Salminen, Saari, Saarela, & Rasanen 1993) and maintenance subcontractors in most industries (Lind 2008), who often work on new and unknown locations. Countermeasures exist to make up for lack of site knowledge, including adequate prior site visits.

7.6 Employment status

A number of challenges are associated with the often tenuous employment status of subcontractor staff. Subcontractors typically achieve their flexibility by hiring part-time workers who may also be employed by other companies, either simultaneously or in different periods. At the other extreme, a subcontractor may in fact inherit the working staff from the previous contract holder of a contract (Hasle 2007).

The use of part-time employees or self-employed workers pose a number of challenges to safety, as expressed in the *Dual Labour Market Theory* that regards this work force as more exposed to various hazards and insecurities (Mayhew, Quinlan, & Ferris 1997). But their employers also face difficulties in controlling their part-time staff's qualifications, experience and working hours.

7.7 Working hours

Subcontractors, and sometimes their clients, are required to maintain a log of their employees' working hours, both to ensure and document that they do not exceed fatigue limitation regulation, but also to monitor their level of experience with particular types of tasks. In some cases, a certain number of working hours is required to maintain a particular level or rise to another level.

Yet when subcontractor staff is working for two or more employers, it becomes difficult for each employer to control working hours; this in turn raises the risk of fatigue-induced accidens. The risk is exacerbated by the fact that subcontract workers are already more likely than direct hires to work more than 60 hours per week (Gochfeld & Mohr 2007), regardless of whether their exceeding safe working hours is a deliberate violation or is simply due to inadequate monitoring.

7.8 Safety management across interfaces

A significant challenge associated with subcontracting is the often unclear allocation of responsibility among the different roles involved. This is clearly illustrated by the construction industry, which, as mentioned, typically has an *owner* hiring a *main contractor* who again hires a number *subcontractors* to perform various tasks (Arditi & Chotibhongs 2005). In addition, the *architect* and/or *engineers* responsible for the design of the intended construction may be assigned certain safety responsibilities (Toole 2002).

The allocation of responsibility for various aspects of safety is often unclear in both the relevant standards and regulations, and in the specific contracts, and the division of responsibilities is further challenged by court rulings or researchers (Toole 2002). And even if the legally defined responsibilities should be clear on paper, subcontractors may not always be aware of them (Loosemore & Andonakis 2007).

A solution to the lack of clarity is of course to clarify responsibilities, both in particular contracts and, in some cases, in regulation. Yet there remain some dilemmas in trying to achieve a fair and workable allocation.

On the one hand, it has been argued that too much responsibility has traditionally been placed on the shoulders of the players most directly involved in work, the subcontractor employers who may be under economic pressure from the contract have inadequate resources to invest in safety. Therefore, the argument goes, responsibilities should be pushed beyond the direct employers to the often larger companies further up the contractual 'food chain'. The larger companies have the resources to keep track of regulations and to invest in safety (Loosemore & Andonakis 2007), and this can even be associated with a moral obligation (Arnold & Bowie 2003), as part of their *corporate social responsibility*.

On the other hand there is a risk that these remote employers are then being held responsible for potential accident factors that they cannot control (Toole 2002). For instance, publicly awarded contracts are sometimes criticized for giving inadequate priority to safety, which has led public owners to include more detailed safety requirements in the contracts (Hasle 2007). However, these requirements also tend to reduce the authority and competence of the contractor/subcontractor who is then unable to implement changes and improvements. This dilemma has led some to recommend tripartite coordination and shared responsibility of safety (Hasle 2007), but the appropriateness of the solution will probably depend of the particular constellation of involved players.

Table 7.4 Problems and recommendations concerning responsibility issues.

('vs.' indicates a possible conflict between two recommendations.)

Problems	Recommendations
Outsourcers avoid responsibility (Busck 2007;Deutsch, Adler, & Richter 1992;Haines 1996;Hasle 2007;Loosemore & Andonakis 2007;Salminen, Saari, Saarela, & Rasanen 1993)	Outsourcers should assume responsibility for OHS (Arnold & Bowie 2003;Busck 2007;Haines 1996)
	vs.
Confusion about responsibilities (Kartam, Flood, & Koushki 2000;Loosemore & Andonakis 2007;Salminen, Saari, Saarela, & Rasanen 1993;Toole 2002)	Subcontractors best suited to assume responsibility for OHS (Toole 2002)
	Responsibilities clarified in contract (implicit)
	vs.
Unclear responsibilities for OHS in contract/legislation (Toole 2002)	'Relational' contracts based on trust and dialogue (Busck 2007)
OHS responsibilities allocated to the 'weakest' player (subcontractor) (Haines 1996;Loosemore & Andonakis 2007)	Tripartite responsibility (Hasle 2007)
Subcontractors have inadequate resources to assume OHS responsibilities (Loosemore & Andonakis 2007)	
OHS responsibilities allocated to agents not in position to monitor and control them	
Companies (clients) held legally responsible by courts for OHS (Grossel 2002;Huang & Hinze 2006;Loosemore & Andonakis 2007;Toole 2002)	
Contracts reduce/limit subcontractor's control over OHS factors (Hasle 2007)	
Subcontractors have limited control over important OHS factors (Busck 2007;Hasle 2007)	

7.9 Regulation by authorities

Extensive use of subcontracting presents safety authorities with new challenges. Thus, authorities are criticized for inadequate monitoring of subcontractors (Mayhew, Quinlan, & Ferris 1997), and were regarded as partly responsible for the Valujet accident (van Wagner 2007). It also suggested that authorities should play a more pro-active role vis-à-vis subcontractors, for instance by informing about changes in regulations to small companies that may be less able to keep up to date by themselves.

But the increasing role of small subcontractors constitute an obvious problem to authorities who typically will not have adequate resources to, for instance, make auditing visits to a large number of companies. This may lead the authorities to rely on the larger companies to control the safety measures implemented by their own subcontractors; but such solutions could be compromised by conflicts of interests (van Wagner 2007).

Table 7.5 Overview of reviewed papers. ('*' outsourcing/ sub-contracting and safety are the main focus the paper)	
Paper	Industry
(Arditi & Chotibhongs 2005)	Construction
(Arnold & Bowie 2003)*	Manufacturing
(Azari-Rad, Philips, & Thompson-Dawson 2003)*	Construction
(Busck 2007)*	Waste collection
(Cullen 2001)	Railway
(Darragh, Stallones, Bigelow, & Keefe 2004)	Construction
(Deutsch, Adler, & Richter 1992)	-
(Fang, Chen, & Wong 2006)	Construction
(Glazner, Borgerding, Bondy, Lowery, Lezotte, & Kreiss 1999)	Construction
(Gochfeld & Mohr 2007)*	Chemical; Nuclear
(Grossel 2002)*	Chemical
(Haines 1996)*	Mining; other
(Hallowell & Gambatese 2009)	Construction
(Hasle 2007)*	Public Transport
(Huang & Hinze 2006)	Construction
(Haas 2008)	Air traffic
(Kartam, Flood, & Koushki 2000)	Construction
(Kenny & Bezuidenhout 1999)	Mining
(Lind 2008)	-
(Loosemore & Andonakis 2007)*	Construction
(Mayhew & Quinlan 1999)*	Clothing Industry
(Mayhew, Quinlan, & Ferris 1997)*	Transport; Child care;Hospitality
(Molenaar, Park, & Washington 2009)	Construction
(Nunez 2009)*	-
(Prager 2008)	Public Services
(Quinlan & Bohle 2008)*	-
(Quinlan & Bohle 2009)	-
(Quinlan, Mayhew, & Bohle 2001)	-
(Quinlan, Johnstone, & McNamara 2009)	-
(Salminen, Saari, Saarela, & Rasanen 1993)	-
(Toole 2002)*	Construction
(van Wagner 2007)*	Air traffic
(Yamataki, Suwazono, Okubo, Miyamoto, Uetani, Kobayashi, & Nogawa 2006)	Steel production
(Zou, Zhang, & Wang 2007)	Construction

8. Extent to which results may be generalized

The papers under review point to a number of characteristics associated with elevated risks, and the review suggests that the following risk issues are of particular importance: contract management, subcontractor staff, small subcontractors, safety management across interfaces, and regulation by authorities.

A number of issues are related to contract management. There is thus a risk that the awarding process will focus on price and lead to the choice of a subcontractor with minimal consideration for safety and a 'relaxed' attitude to safety rules etc. Once a subcontractor is chosen, there is a risk that the incentive schemes in the contract will be biased against safety and encourage the subcontractor to disregard safety rather than production measures such as deadline when conflicts

arise. There are also risks associated with pyramid subcontracting when responsibility for and control of employees for 2nd level subcontractors is blurred.

Besides these issues related to contract management there are also a number of risks related to subcontractor staff. They may have inadequate safety competence, for instance if they are new or only part-time employees, and for the latter it may be difficult to control their total working hours, thus increasing the risk of exceeding fatigue limitation regulation, and undermining competence management systems.

There are also risks associated with the use of small subcontractors, since they will have fewer resources for safety investments and may be less motivated to make such investments.

Safety management across organizational interfaces also involves risks, notably since the allocation of responsibility may be unclear – and difficult to establish in a fair and manageable way.

Finally, subcontracting arrangements also pose a challenge to regulation by authorities, both because of unclear responsibilities, and because they have inadequate resources to directly control an increasing number of companies.

The generalizability of results refers, for this ERRA and this survey, to whether a specific risk issue and / or a specific "solution" that has been identified in a given study that is now reviewed may apply to other industries or perhaps just other applications or sites within the same industry. The short answer is that there is too little evidence to assess in any rigorous way this important issue of generalizability (external validity). The fact that a given arrangement has produced safety problems – or has solved safety problems - for a site in one country for one industry does demonstrate that the same arrangement will produce the same problems (or yield the same solution) for other sites, let alone in other industries and other countries. Nevertheless, the four risk issues in the bullet list cited above are not likely to be merely local concerns.

The question of generalizability (external validity) will be discussed in the third subreport (D1.4.1.3) where the evidence behind a proposed model of good practice for safety management will be summarised.

9. Further work

Upon completing a literature survey results should always be queried in terms of completeness: has the survey sampled wide enough and has it used reasonable inclusion and exclusion criteria? Was the screening procedure reliable?

The authors believe that the databases from which used (ISI World of Knowledge and Science Direct) are representative of the field and are not aware of any key safety or risk journals that are not included in these databases. Informal searches using Google Scholar were also performed, but yielded no further studies to be included.

We therefore also believe that further work should be directed at gaining information about performance of and experiences with actual safety management practices concerning outsourcing and subcontracting. Part of this work was undertaken for the next subtask of this ERRA and is reported in D1.4.1.2.

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Appendix: Guidelines for contractor management

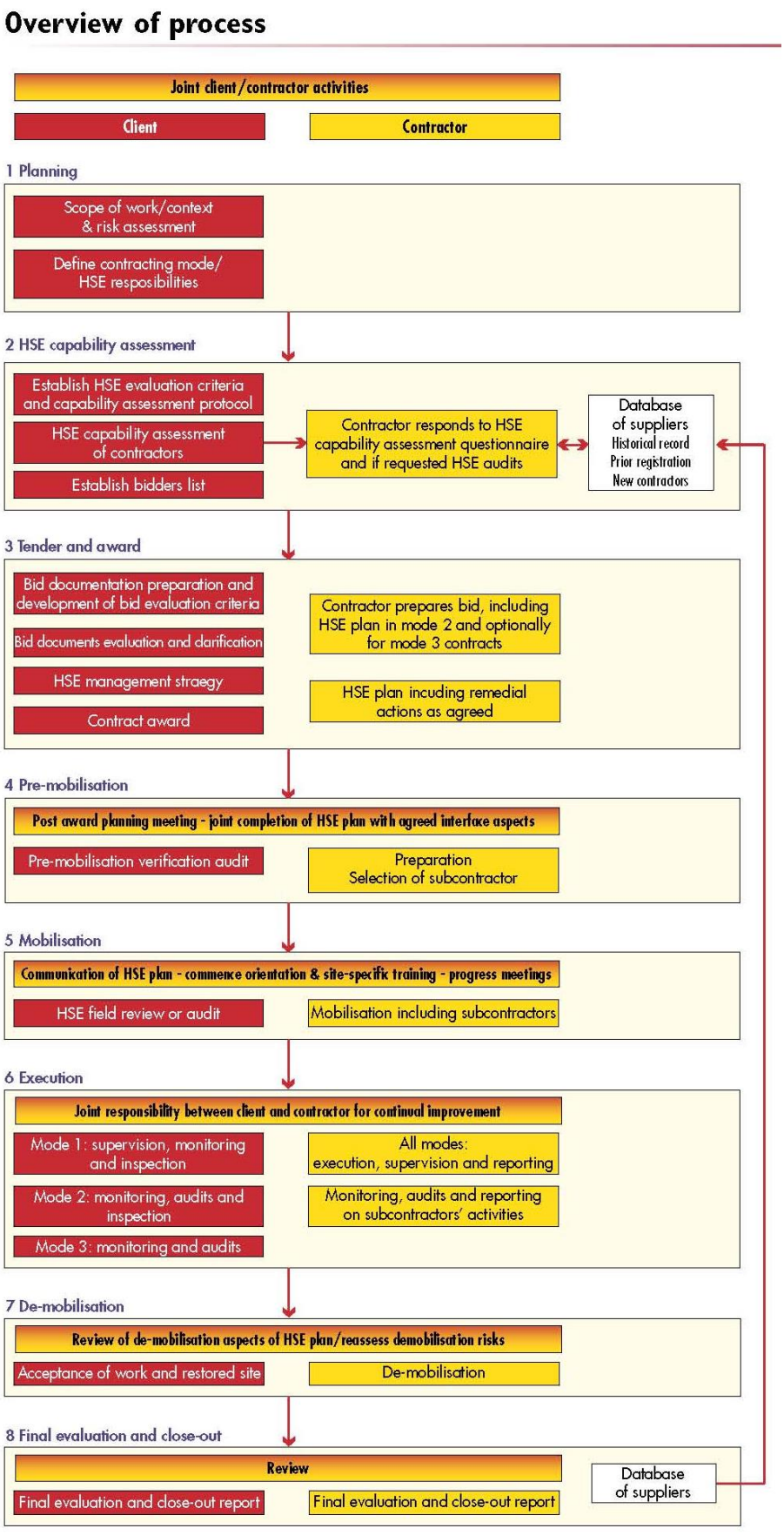
Guidelines for safe management of contractors are normally structured in a number of phases in the contracting process, as illustrated by the more comprehensive guideline in 8 phases provided by the International Association of Oil & Gas Producers (**Error! Reference source not found.**). Other guidelines have fewer phases, but the basic structure is the same. E.g. phase 2 – HSE capability assessment – emphasizes the need for a basic identification of acceptable contractors, and the advantages of maintaining a list of approved contractors based on previous experience: evaluation (phase 8) from previous projects.

The OGP guideline distinguishes between three different *modes* of contracting, basically depending on whether work is executed under the HSE Management System of the client (mode 1) or the contractor's own HSE-MS (mode 2), in some cases without interfaces with the client's HSE-MS (mode 3) (OGP 2010).

A regional guideline from the same industry emphasizes the need for a specific approach to small or short-term contractors, for which it may not be appropriate or economically viable to provide its own comprehensive health and safety program (ARPEL 2003).

Most guidelines emphasize the necessity of defining conditions for the use of (cascading) *sub*-contractors, and one guideline focuses explicitly on this issue – the use of subcontractors for transport in the chemical industry (CEFIC 2005).

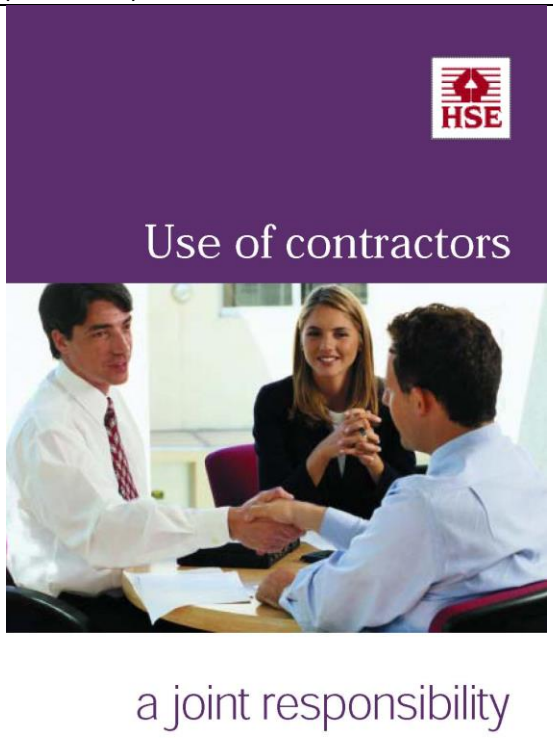
Figure 1. Eight phases of contractor management (OGP 2010).



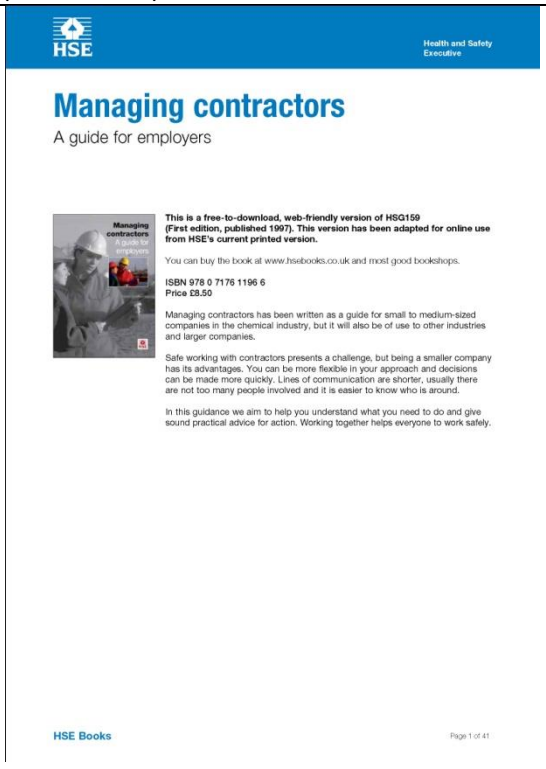
Guidelines identified

(OGP 2010)

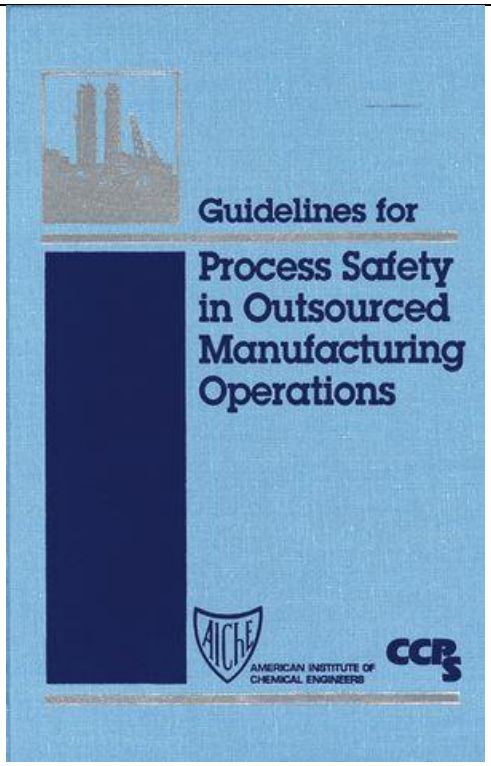
(ARPEL 2003)



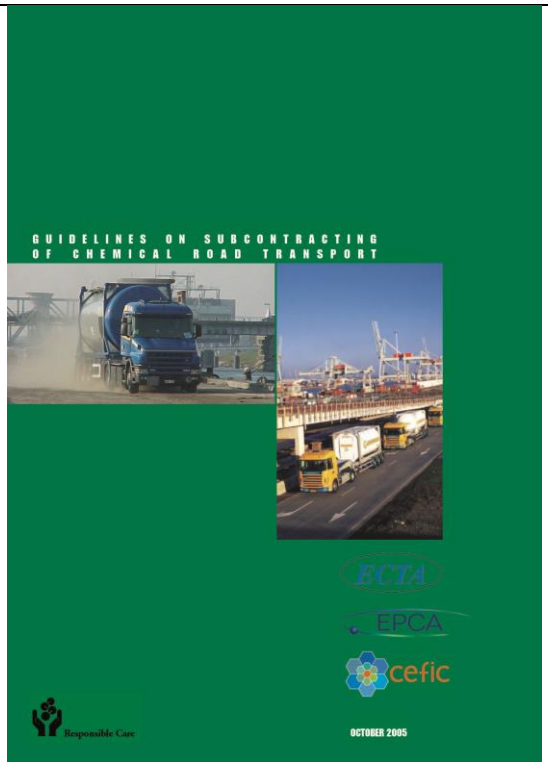
(HSE 2004)



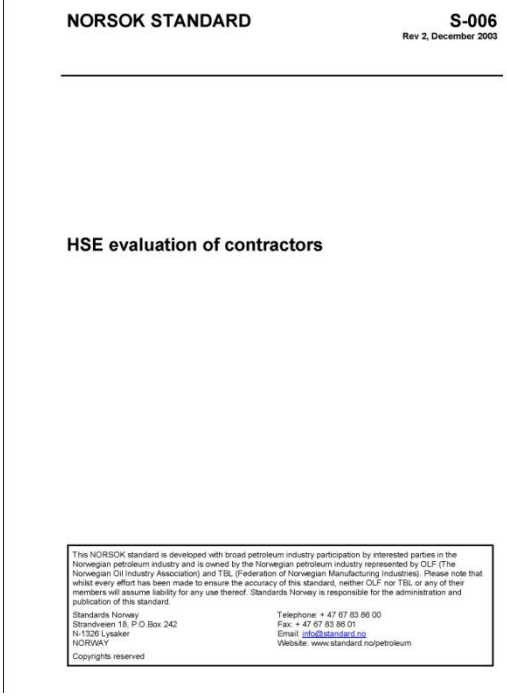
(HSE 1997)



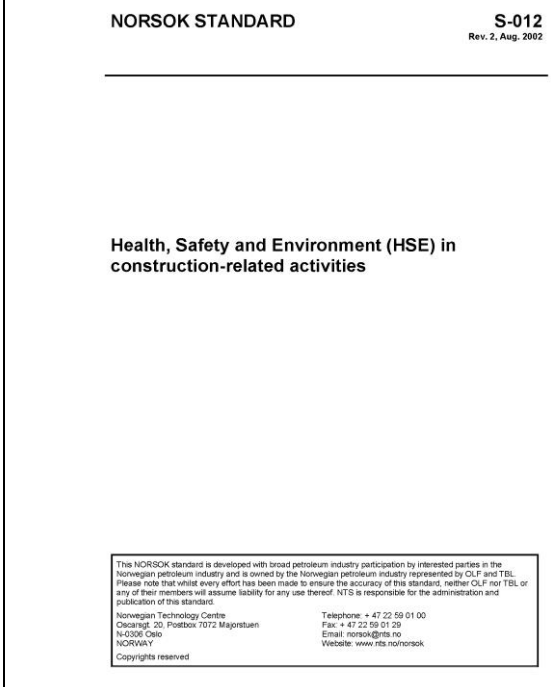
(CCPS 2000)



(CEFIC 2005)



(NORSOK 2003)



(NORSOK 2002)

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