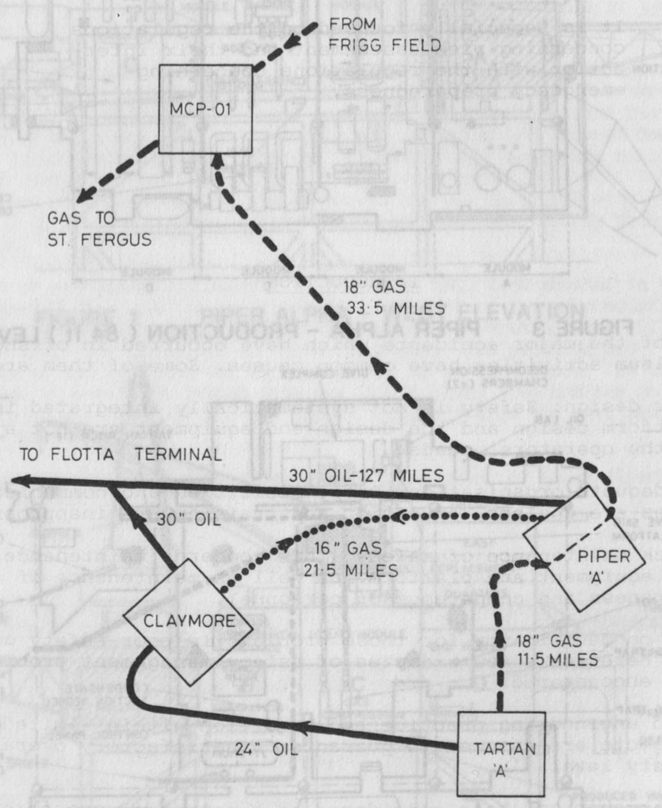

FIGURE 5 PIPER ALPHA – OIL & GAS PIPELINES

THE NORWEGIAN REGULATIONS CONCERNING RISK ASSESSMENT AND THEIR IMPLICATIONS IN EMERGENCY PLANNING

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The philosophy which forms the basis of the future legal hierarchy concerning safety in Norwegian petroleum activities is presented.

It is especially focused on the regulations concerning risk assessment and their interaction with the regulations concerning emergency preparedness.

INTRODUCTION

Most of the major accidents which have occurred in offshore petroleum activities have common causes. Some of them are:

- Poor design: Safety is not systematically integrated in the platform design and the design and equipment are not ajusted to the operators' needs.
- Inadequate organisation: Responsibilities and communication lines are unclear, education and training are inappropriate.
- Slack maintenance of safety: This concerns maintenance of the equipment and platform, as well as maintenance of safety awareness and competence of personnel.

A common denominator for those problems is poor safety management. Here are a few examples of safety management problems often encountered:

- Good engineering practice and tradition within limited subjects are assumed to guarantee a satisfactory overall safety level.
- Safety has not been considered as a potential economical benefit and a quality element and is therefore not naturally integrated in a project or in day to day operations.

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- Safety is managed as though it were a static concept which is achieved at one point, once and for all.

The Norwegian Petroleum Directorate (NPD) has been acutely concerned about safety management and a major goal has been to develop rules and regulations which would cater for a global approach to safety.

The topic of this presentation is the philosophy which forms the basis of the future legal hierarchy concerning safety in petroleum activities on the Norwegian shelf. To illustrate this philosophy it shall be focused especially on the content of the new regulations concerning risk assessment. Their interaction with the future regulations concerning emergency preparedness shall also be discussed.

THE TOP OF THE LEGAL PYRAMID

In 1985, 3 fundamental documents came into force:

- the Petroleum Act, replacing the Act of 1963
- the safety regulations, replacing the regulations issued in 1976
- the internal control regulations, replacing the guidelines of 1979

On the basis of those 3 documents, 4 fundamental elements in safety administration can be emphasized:

- It is the licensee that has the overall responsibility to ensure that all rules and regulations are at any time fullfilled. The licensee must therefore establish an internal control system, and integrate this system in a total quality assurance system.
- The authorities have the duty to supervise that the licensee's internal control system is implemented and adequate, and to control major decisions of the licensee at appropriate milestones in the licensee's activities .
- The safety concept is defined as the operational, technical and emergency preparations, significant for protection of people, environment and assets, herunder production.
- Safety must be planned, maintained and developed concurrently with technological development.

Since 1985, detailed regulations behind those 3 major documents were adopted regulations, mostly from maritime authorities. In 1988 the NPD began a total revision of detailed regulations so as to achieve a consistent legal framework for safety in petroleum activities.

The main goals which must be achieved are the following:

- The future regulations have to be consistent with the internal control principle.
- Because each platform or activity is unique, requirements must be functional. They must convey societal acceptance for minimum safety levels, and should therefore express safety objectives, rather than specify means or technical solutions to fullfill those. Issuing functional requirements should thus stimulate the introduction of new technology and new ideas.
- Regulations must be consistent with each other because, safety beeing a multy faceted concept, detailed regulations will have to be used in parallel or in series.

THE REGULATIONS CONCERNING RISK ASSESSMENT

Safety is a complex quality element which the licensee is required to manage systematically and risk assessment can be an efficient tool in that regard.

Risk assessment has been performed in Norwegian petroleum industry since 1981. The NPD's experience is positive in that respect: The difference between platforms built before 1981 and after 1981 is very clear. Risk analyses have also proved to be appropriate as a means of communication between different disciplins and organisational levels.

But we also have experience that the performance and the use of risk analyses could be improved. Risk analyses can be faked, or their value overestimated, or they can be performed as a mathematical game. Risk analyses have sometimes been performed by isolated specialists, in an organisation which was not prepared for inter-disciplinary communication on safety matters, and where safety was not implemented as a line responsibility. It has happened that operating companies have ordered a risk analysis solely to content the authorities, without any intention of using it in a decision making process. The evaluation of the results of risk analyses have not been entirely satisfactory in some cases, partly due to the fact that the presentation of those results was not appropriate.

Based on both the positive and negative experiences, the NPD concluded that risk assessment could be a powerful tool in a safety management context, and decided therefore to develop new regulations concerning risk assessment.

The content of this regulation is limited to requirements concerning risk analyses as safety management tools, their quality and their purpose.

In the new regulations concerning risk analyses, risk is defined as a two-dimentional concept which contains both the frequency of occurrence of an accidental event and the consequences of this event.

The safety concept as defined in the safety regulations has formed the basis of the extent of the definition of risk analysis. In the regulations risk analysis is defined as a general term which includes different analytical methods. Those methods aim at identifying and categorising the risks inherent to technology, operations, organisational structures or people. Thus a risk analysis can be quantitative or qualitative. The operating companies are given the responsibility to identify the methods which are appropriate for the object of their analysis. They are therefore required to establish adequate internal infrastructures to meet this responsibility.

It is furthermore required that the operating company ensures that risk analyses are planned, performed, used and maintained in an systematic and result orientated manner.

Risk analyses must be planned so that they actually are an integral part of the basis for decisions which have an influence on safety in the licensee's activities. This requirement ensures that risk analyses are not solely used to test the adequacy of already taken decisions.

The results of a risk analysis must therefore have the required quality and must be understood so that their real value may be used properly in a decision making process. Quality requirements for risk analysis are included for that purpose in the regulations.

The results of a risk analysis shall be assessed to decide whether the identified risks can be accepted.

The new regulations on risk assessment require that the operating company defines acceptance criteria for risks in its activities. Acceptance criteria can be expressed differently depending for example on the type of risk analysis which has been used, they can vary with the type of values they apply for, the conditions for their validity can vary from one installation to another or during the lifetime of an installation.

At first sight, it might appear naiv to require that the operating company itself shall be responsible to define those acceptance criteria. The fact that the operating company defines those acceptance criteria does not mean that there is any choice in the minimum level of safety that must be achieved. And issuing requirements which reflect the societal acceptance of risk is the responsibility of the authorities.

The future legal framework concerning safety is thus organised in such a way that minimum safety requirements, herunder acceptance criteria for risk levels, will be found in detailed regulations, behind the regulations for risk assessment.

Detailed regulations will address risks within a determined area of the platform or within a specific subject. On the other hand, the regulations on risk assessment develop only the overall principles which apply for acceptance criteria because it shall mostly apply for low probability/high consequence risks in a global perspective.

In the regulations concerning risk assessment, acceptance criteria are related to risks, that is to a two-dimensional concept including both the frequency of occurence and the consequences. One can accept a risk but cannot accept that an accidental event occurs. Accepting a risk does not mean that one actually expects an accidental event to occur.

The regulations on risk assessment are based on the principle that residual risks in petroleum activities should be as low as reasonably practicable. An operating company must be able to demonstrate to the authorities that this principle has been applied.

There is though a limit where a risk is decidedly not acceptable. Underlying detailed regulations will most probably define those limits for different types of risks, within their respective area of application.

Risk reducing measures shall be implemented when a risk is determined as unacceptable. Those measures can be technical, operational or organisational. On the basis of our experience we have decided to establish a hierarchy between the different categories of risk reducing measures.

- The first priority is to try to eliminate the causes of a potential accidental event. This is often difficult due to technological or economical constraints.
- The second priority is to reduce the probability that an accidental event occurs. One shall in that respect first try to reduce the possibility for a dangerous situation to occur, then try to reduce the possibility for a dangerous situation to develop to an accidental event.
- The third priority is to seek to reduce the consequences of a potential accidental event. There is also a hierarchy between the different types of measures which can have this effect:

    1. Measures concerning platform design, bearing structures and passive fire protection.
    2. Measures concerning safety systems, auxiliary systems and active fire protection.
    3. Emergency equipment and organisation.

The main goals for establishing priorities between the different types of risk reducing measures is to ensure that the design of the installation and of the equipment is as much ajusted to the personnel as possible and that personnel are, as much as possible, protected from accidental loads.

When the necessary risk reducing measures have been implemented, an acceptably low risk level is, theoretically, achieved. The risk of having an accidental event is unfortunately not automatically kept low, because the probability of occurrence of an accidental event is not a static notion.

Furthermore, it is a fact that a probabilistic representation of real life has considerable limitations and that overfocusing on quantitative risk analysis is thus a dangerous exercise.
The regulations on risk assessment have therefore included requirements concerning confirming that the assumptions inherent to a quantitative risk analysis are actually fulfilled in the real life.

In the new regulations, risk analyses are considered as a safety management tool, they must therefore be performed and understood correctly, and their results and inherent assumptions must be followed up in real life.

WHY PERFORM RISK ANALYSES

Risk analyses are performed to identify and understand the conditions and mechanisms which create risks, so that appropriate risk reducing measures can be implemented to control and influence those risks.

Another important area of application of risk analyses is to create a common communication ground for all parties involved in petroleum activities. The operating company is required to use the results of risk analyses to inform operators and their representatives about the nature of the risks with which they work. The results of risk analyses and associated assessments will also form the basis of communications with the authorities, especially when it comes to implement a functional legal framework.

It is furthermore required that those results form the basis of preventive safety work. They can for example be used to target motivation or safety campaigns, education and training of specific groups of personnel, maintenance or operational routines, emergency training, etc.

CONNECTION BETWEEN RISK ASSESSMENT AND EMERGENCY PLANNING

In the Petroleum Act, emergency preparedness is defined as a general term including all the measures which are planned to come into force to protect people, the environment, assets and production when a dangerous situation occurs or when an accidental event occurs. Those measures are technical, operational and organisational measures.

Risk analyses will identify the risks which are associated with an activity. The following assessment of those risks

will determine what are the risks which cannot be accepted, thus the need to implement risk reducing measures. From the definition of emergency preparedness one can derive that some risk reducing measures include emergency measures. Those are the measures which:

- reduce the probability that an accidental event occurs by avoiding that a dangerous situation develops into an accident

- reduce the consequences of an accidental event.

The first part of a risk assessment will thus identify the potential dangers and accidents for which protection must be planned, thereby identifying the specific needs for emergency preparedness for an activity.

The future regulations concerning emergency preparedness, as well as all detailed regulations, are therefore based on overall risk assessments which are included in the regulations concerning risk assessment.

Emergency preparedness concerning health care and services as well as concerning pollution are included in the future regulations.

These regulations will address emergency preparedness as a whole, but will issue detailed requirements only concerning emergency procedures, equipment and organisation, thus refering to other relevant detailed regulations concerning for example passive and active fire protection, safety and auxiliary systems, etc.

The regulations concerning emergency preparedness develop requirements concerning the planning, maintenance and development of emergency preparedness concepts. Those are actually safety management requirements, which emphasize quality assurance and organisational structures.

These regulations will also issue result-orientated requirements concerning technical, operational and organisational measures during the different phases of a dangerous situation or an accidental event. Those phases are:

- alarm
- accident fighting
- rescue, both on the platform and at sea
- evacuation, both on and from the platform
- normalisation, that is rehabilitation of people, environment and production

In that context, technical requirements address especially:

- integration of emergency preparedness in design
- communication systems
- audio-visual signals
- marking
- accident-fighting equipment

- rescue equipment
- evacuation equipment
- stand-by vessel

Administration of the emergency preparedness system concerns mainly the emergency organisation, its competence and awareness, experience feed-back, contingency plans and control of the adequacy of the established system for emergency preparedness.

Emergency preparedness is thus achieved and followed up systematically.

CONCLUSION

As pointed out in the introduction, major accidents in offshore petroleum activities often show common causes, such as poor design, inadequate organisation and slack maintenance of safety.

The NPD has decided to develop a consistent and logical legal framework concerning safety in petroleum activities, based on experience with major accidents, supervisory activities and research development. Safety is addressed as a complex quality concept which involves technology, people, both offshore and onshore, and operations.

Rules and regulations issued by the authorities have their limitations. At their best, they only reflect the risk-limits that the society can accept. In most cases, accidents will show regulations oversights and losses due to those events will be of a wide order for operating companies too.

Risk assessment, if performed seriously and in a safety management context, should allow for a better consciousness about the risk levels one can reasonably and intelligently accept. Risk should therefore be assessed in a wider perspective, especially a longer time perspective, than what is usually the case.

Accepting risks is a necessity, but it does not mean that one must expect an accidental event to occur. Risks have to be kept low and they must remain risks. This is not achieved automatically, solely by using experienced personnel and good engineering practice. Systematic, hard and sustained safety work is the only key.

FLACS AS A TOOL FOR SAFE DESIGN AGAINST ACCIDENTAL GAS EXPLOSIONS

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SUMMARY

Recent accidents offshore and onshore have increased the focus on gas explosion safety. This paper provides an introduction to gas explosions and to R&D work on this subject at CMI.

A major result of CMI's efforts is a numerical tool, known as the FLACS code, for prediction of gas explosions in complex geometries. The code solves the full gas dynamic partial differential equations including the effects of turbulence and chemical reactions. FLACS has been applied in the design of more than 20 offshore platforms and for accident analyses after the West Vanguard and the Piper Alpha accidents. It is being increasingly used also for onshore process areas.

By applying FLACS it may be possible to suggest changes in process area design that will significantly affect explosion behaviour and hence overall safety. Correctly designed explosion venting is often able to reduce explosion pressure appreciably. FLACS simulations, as indeed all safety assessment, should start at an early stage in the design programme so that safety is an integrated part of design, not something that is added on. Simplified explosion calculation methods, in the form of nomograms or simple formulae, should in most cases where complex geometries are concerned not be used, since these do not account for the complex interactions often occurring in a gas explosion.

The layout of offshore modules and platforms is discussed. It is pointed out that explosion pressure depends strongly on the geometry. Some simple guidelines on how to improve gas explosion safety are presented. The most important is that explosion vent areas should be as large as possible. In order to obtain large explosion vent areas gas explosions should be on the design agenda from the start. Areas for further gas explosion research are also referred to.

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