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HAZARDS, RISKS AND CAUSES

Marcogaz Report On Occupational Health & Safety In The European Gas Industry

Working group on Health and Safety

D513

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1. SUMMARY

This report details the work undertaken on occupational health and safety in the European natural gas industry by the Working Group on Health and Safety of the Marcogaz/Eurogas Joint Group.

The objectives of this study were to gather general information related to occupational health and safety to analyse the results and to draw conclusions and make recommendations.

The group started with an inventory of all the H&S-activities done by the members present at the kick-off meeting and decided to focus on the following subjects: statistical data and risk inventory.
The output of the data was used for comparison. In general, based on the data of a period of three years, the number of accidents with lost time showed a slight tendency to decrease. The group established that the available data is not consistent and not complete.
The output of the risk inventory was a list of identified risks and a ranking system for the European gas industry. Related to the top 7 risks the group collected the best practices.
In the report the group standardized the direct causes of accidents because of the great relevance of the assessment of accidents.
The group recognises the limitations of this study and the need for more accurate and consistent data to improve the analysis in the future.

The group recommends to investigate the health and safety of contractors, the training of employees and contractors, collecting data on the additional risks and on indirect causes of accidents and incidents.
The study should be extended to all members of the Joint Group.

2. INTRODUCTION

In most countries, data concerning work related accidents are collected in line with national legislation. Sometimes these data are grouped by major industry sectors, e.g. oil, chemicals, agriculture etc., but there are no data available on occupational safety specifically for the gas industry at the international level.

Although the intrinsic properties of gas are hazardous (explosive, flammable and conveyed at high pressures) the safety record of the gas industry world-wide seems to be good compared to other industries.
However, there is no room for complacency and the group firmly believes that it is important that data should be collected and analysed on those accidents that do occur so that trends can be identified and lessons learned for the future. With that in mind, the Marcogaz Board has decided that the scope of the Marcogaz/Eurogas Joint Group on Environment should be extended by subjects on health and safety. Therefore a working group was established to study if there are data and information on health and safety interesting for comparing, exchanging and standardizing on a European level. And if so, what are these topics and how they should be covered. This working group had the following objectives:

1. to collect data to have an overview of accidents/incidents and the health of employees in the gas industry;
2. to compare the methodologies used by different companies for presenting data on accidents/ incidents and health of their employees;
3. to inventories and to evaluate hazards and risks;
4. to collect the best practices concerning risk prevention.

To give this study context, the group believed it was important to collect general information relating to the main activities of the companies providing information. Recognising the widespread use of contractors in the industry, the group thought about collecting information relating to accidents involving the employees of contractors. However, accidents involving contractor's employees are not routinely reported, so it was decided to look at this subject in a later stage.

It is important to stress that the information received from individual companies has been dealt with confidentially, and the data are reported anonymously.

The group hopes this report will help encouraging information exchange between different Marcogaz members on occupational health and safety performance so that lessons can be learnt with the aim of reducing the number of accidents by adopting proven technical, organisational or other measures based on best practice.
It is important to note that these investigations and recommendations represent a qualitative overview of the natural gas industry.

3. METHODOLOGY

In order to compare safety data used by different companies, it was necessary to seek relevant information so that analysis and comparisons could be made. However, the group recognised that data might not be readily available in a structured, systematic or meaningful form.
In a special workshop as a kick-off the working group spent some time on discussing the strategy and the steps to be taken.

Common topics
The group started with an inventory of all H&S activities currently done by the Marcogaz/Eurogas members present at the meeting. This resulted in an overview of common H&S topics in the gas industry. Also the existing annual HSE reports of the member companies of the group were analysed in order to find comparable data and methodologies.
This included searching for commonly used definitions (see chapter 4).

Risk Inventory and Evaluation
A pro-active method to rank hazards and their possibility of occurrence is a so-called Risk Inventory and Evaluation (RIE). The working group assessed a general list of 50 possible occupational hazards in the industry. This RIE was used to develop a list of specific hazards (risks) to link to the gas industry and to make a risk classification.

Direct causes
Because country members use different kinds of direct causes of accidents, the group made a short list of standardised direct causes. These standardised direct causes were described so they could be used in the further analyses.

Questionnaire
To extend the study a questionnaires was sent to Marcogaz members. The questionnaire also attempted to capture information on the causes of accidents, to identify best ways of reducing both the number and severity of accidents in the future.
The data requested concerned the calendar year 2002, which was the last full year before this work started. For the analysis, additional information for the years 2000 and 2001 was collected.
Based on this risk classification and the results of the questionnaire, a relationship was made between the actual hazard at the time of a lost time accident and the classification of that hazard in the risk evaluation.

Best practices
Finally, a top 7 list of risks in the gas industry was made and the best practices of the gas industry for accident prevention was collected.

4. DEFINITIONS

Accident	An unwanted situation that has caused injury to people.
Frequency Rate (FR)	An expression relating the number of LTA to the number of man-hours worked per year: $$FR = \frac{Total\ number\ of\ \ LTA\ x\ 1{,}000{,}000}{Total\ number\ of\ \ man-hours\ worked}$$
Hazard	The property or quality of a specific factor (e.g. material, tools or procedures) that could cause harm to a person.
Incident	An unwanted situation that has caused damage to material, but not to a person.
Lost Time Accident (LTA)	A work related accident with injury resulting in incapacity for work for at least one full day.
Man-hours	Hours worked by own employee of the company.
Near miss	An unwanted situation that did not cause any injury to people or damage to material, but it had the potentiality to do it.
Risk	The likelihood that the harm will arise coupled with the consequences and taking into account the exposure during occupation.
Risk Inventory and Evaluation (RIE)	A method for relative ranking of risks.
Severity rate	Number of lost days (x 1000) devided by the sum of hours worked
Sickness rate	The absence caused by all types of illnesses as a percentage of the total working time.
Tripod Delta	A method for analysing of underlying factors for accidents and incidents.

5. MAIN TOPICS ON H&S OF THE EUROPEAN GAS INDUSTRY

Within the organization of a company Health, Safety and Environment (HSE) activities have different scopes but the approach and the solutions are often linked to common topics.
Considering health issues from various points of view, such as asbestos, noise, dangerous substances, one can say that they represent the link between environmental and safety issues. For example, when a noisy activity effects the environment, also the impacts to the workplace have to be considered, in order to avoid bad health conditions and possible personnel accidents.
The gas industry, such as most of other industries, normally links together the organization of Health, Safety and Environment activities into a single framework called HSE. However there are differences between companies in HSE organization.

HSE departments of the working group companies were analyzed and the most important activities were compared in search for common and different subjects. The most important H&S topics in the gas industry, assigned to Health and Safety Departments were listed. In the table below these activities are shown. Activities listed in the column "Some HSE departments", if not worked out by HSE departments are carried out within the company itself, by another department.

Table 1: Main topics in HSE departments in the European gas industry

Activity	*Every HSE department*	*Some HSE departments*
Data collection of accidents	To collect and process statistical data about frequency rate, severity rate, lost time accidents, sickness rate.	To collect and process statistical data on no lost time accidents (NLTA), near misses, dangerous situations.
Technical safety		To deal with technical safety.
Hygiene of work	To deal with aspects concerning hygiene of work.	
Contractors activity		To collect information on accidents of contractors personnel. To evaluate and qualify contractors (safety plans)
Risks analysis	To inventory risks in gas activity in order to reduce their quantity, size and consequences. To define operating procedures, tools and equipment in order to reduce potential hazards.	To detect and to evaluate former hazards.
Accident analysis	To analyze accidents in order to determine causes.	To analyze and investigate specific accidents in order to determine causes.
Legislation analysis	To analyse and investigate new national legislation and standards. To maintain contact with Enforcement National Authority.	To monitor and influence (lobbying) national legislation.
HSE policy		To make HSE policy (in some Companies could be the President or a special Committee).
HSE system	To manage and update the HSE system. To define and to assign HSE targets and objectives.	To do operational audits on HSE systems to Operational Areas and Group Companies.
HSE report	To write the HSE annual report.	

Activity	*Every HSE department*	*Some HSE departments*
Training and information	To support personnel department in training documents and stages. To write safety instructions in order to spread necessary information.	
Standards		To write and spread internal standards.
Emergency plans		To write, co-ordinate and check emergency plans for buildings evacuation.
Support	To advise management about main facts and changing in legislation and standards. To support Operational Areas for HSE activities.	To support in HSE legal liability and requirements.
Various	To manage internal communications. To perform external benchmarking.	To run internet communications.

Some of the above mentioned topics were considered relevant for information exchange or for more detailed study on European level. The most important topics for the working group are shown by order of priority in the following short list, together with an indication of the possible output:

1. Collecting and processing statistical data on HSE
   - Possible data: frequency rate, severity rate, lost time, sickness rate
   - Data must be based on the same basis and definitions
   - Collection of common accident causes and categorising all accidents

   Output: statistics, data for comparison (benchmark)

2. Risk (or hazard) inventory
   - Sharing the risk in the gas industry (including offices and traffic)
   - Inventory is input for risk-based management

   Output: list of identified risks (hazards) and a ranking system

3. Management of contractors
   - Pre-tender selection
   - Safety Checklist Contractors (SCC)
   - Field inspection
   - Internationalisation of bidding and contractors

   Output: best practice methodology

4. Training of employee
   - To influence the safety attitude, behavioural training
   - To decrease the number of accidents/incidents
   - In accordance with the Joint Statement with the workers unions

   Output: overview of training modules

5. Sensoring and influencing EU legislation
   - Monitoring new laws/legislation
   - Only HSE relevant for the gas industry
   - This activity on ad-hoc basis

   Output: position paper or proposal

It was decided that the working group should start with item 1 and item 2. To prepare the content of the questionnaire the group first studied information on hazards (chapter 6), on risks (chapter 7) and on direct causes of accidents (chapter 8).

6. HAZARDS IN THE GAS INDUSTRY

To define the risks in the gas industry, the group collected a list of potential hazards that is relevant for all industries.
It is well known in the science of safety that hazards are most of the time linked to the presence of a high level of energy (for example electric energy, kinetic energy, thermal energy and chemical energy).
This energy, “contained” or stored with al kinds of safety devices, can accidentally be released by some kind of failures of a (part of) the system.
One can say that the presence of energy could potentially be a hazard.

The hazards are divided in 12 main groups as follows:

1. mechanical hazards;
2. electric hazards;
3. chemical hazardous material;
4. road traffic;
5. fire and explosion;
6. thermal risks;
7. physical hazards;
8. workplace environment;
9. ergonomic aspects;
10. information and aggravating use;
11. falling;
12. other risks.

In each group subcategories are defined. Based on that general list, a list specific for the gas industry was derived. This list of potential hazards for the gas industry is presented in appendix 1.

7. RISK INVENTORY AND EVALUATION (RIE)

7.1 Introduction

In performing its activities the gas industry prevents accidents and health risks to their own employees and those of third parties.

This means that management of health and safety constantly receives a great deal of attention within the organization (in a proactive way).
In order to facilitate the activities in this field, the gas industry has uses some kind of Health and Safety Management System. This is essentially a quality system geared to monitor and improve the company's attention to health and safety. These systems are based on the "quality" loop principle, which involves four stages, namely: plan, do, check and act.
Most of the Safety Management Systems are based on risk inventory instead of risk evaluation. Our working group has combined inventory and evaluation and which makes it possible to compare several types of risks. Such a Risk Management System or Risk Assessment is a practical, systematic approach to identify hazards and evaluating the extend of risks taking into account existing precautions

The benefits of a risk assessment are:
- reduction in injuries and illness;
- reduction in lost time;
- reduction in claims;
- reduction in insurance premiums;
- improved employee morale;
- more efficient processes;
- increased productivity;
- customer satisfaction;
- prestige;
- legal compliance.

In this system risk is a combination of likelihood, exposure and possible consequences.

7.2 Risk inventory

The risk inventory starts with collecting all kind of hazards concerning health and safety. This list of hazards is shown in the appendix 1. For recognizing the hazards, available information can be used, such as:
- classification of work activities;
- type of tasks and duration/frequency;
- workplace visits and interviews with managers, employees and technical experts;
- annual plans and reports;
- reports of incidents, accidents and dangerous situations;
- health checks;
- reports of occupational investigations (noise, dangerous substances, etc.);
- reports of sickness absence;
- applicable legislative requirements;
- designs and ground plans;
- licences;
- work instructions;
- registers of toxics;
- information related to branches;
- etc.

7.3 Risk evaluation

The RIE method as used by experts consists of the "Relative Ranking" method. It is especially suitable for an adequate risk evaluation. In the Relative Ranking method risks are expressed as numerical values that have no absolute but only a relative meaning.
The advantage of this method is its easy applicability and the fact that it clarifies the starting points for action and it enables a discussion on the assumptions used.
The risk, that is calculated as a score, is the product of likelihood, exposure and possible consequences. The likelihood parameter indicates how likely the effect occurs, given the hazardous situation. The exposure parameter indicates how often people are exposed to specific hazard. The consequences parameter indicates the severity of the effect.
At the assessment of the risks the measures to avoid the hazards were taken into account.

To judge the variables the following categories are used by the model:

Likelihood

0.1	Virtually impossible
0.2	Practically impossible
0.5	Very unlikely
1	Possible only remotely
3	Unusual but possible
6	Quite possible
10	Might well be expected

Exposure:

0.5	Very rare (< yearly)
1	Rare (yearly)
2	Unusual (monthly)
3	Occasional (weekly)
6	Frequent (daily)
10	Continuous

Possible consequences:

1	Noticeable (e.g. minor first aid (accident))
3	Important (sickness absence)
7	Serious (irreversible injury)
15	Very serious (1 fatality)
40	Disaster (few fatalities)

The risk is calculated as the product:

$$Risk = (Likelihood)x(Exposure)x(Possible\ consequence)$$

During the determination of the likelihood and possible consequences the group took into account the affecting factors on the worker, like knowledge/skills, training and experience and factors on the task like workload/work patterns, procedures, instructions, personal protective equipment, etc.
All the above mentioned factors have influence on the risk score.
To analyse the results, the risks were classified in five categories, depending on the score:

Table 2: Risk classification

Category	*Classification*	*Risk score*	*Action needed*
A	Acceptable risk	$R \leq 20$	No
P	Possible risk	$20 < R \leq 70$	Needs attention
M	Important risk	$70 < R \leq 200$	Measures should be taken
H	High risk	$200 < R \leq 400$	Needs improvement immediately
VH	Very high risk	$R \geq 400$	Stop activities or change organisation, if possible

7.4 Results of risk evaluation

An exercise was done by the group to calculate the risks from the total list of hazards that resulted in condensed list (see appendix 2 and 3). During discussion in the working group meetings a final list of "top 7" risks was established and shown in table 3, where the figures show the mean value of the evaluation by the members. This "top 7" list was used to gather information on the best practices for prevention of the risks (see chapter 10).

Table 3: Top 7 risks in the European gas industry (mean values of the members)

Potential hazards	*Likelihood*	*Exposure*	*Consequences*	*Risk*	*Classification*
1. Work related traffic	4,3	7,1	15	437	VH
2. Home-work itenary	4	6,6	15	386	H
3. Stumbling and tripping	5,1	5	4,1	109	M
4. Explosive atmosphere	0,7	4,9	40	109	M
5. Mechanical handling	2,7	5,1	8,7	104	M
6. Current	2	4	14	93	M
7. Risk of fire by liquids, gases and solids	0,9	4,4	21	75	M

8. DIRECT CAUSES OF ACCIDENTS IN THE GAS INDUSTRY

The assessment of the causes of the accidents is very important. If the right causes of accidents are known, suitable preventive measures can be taken in order to avoid that the same accidents will happen again. Therefore it is necessary that after every accident a survey is carried. Such survey should be carried out as soon as possible and should contain all the relevant aspects at the moment of the accident to assess the causes that have generated the accident.

For a good understanding how accidents happen one should realise that there are already precursors that occur before accidents happen. If these precursors are detected and eliminated in time, the accident would not have happened. Accidents happen if the barriers, that might have stopped wrong actions or dangerous situations, have failed.

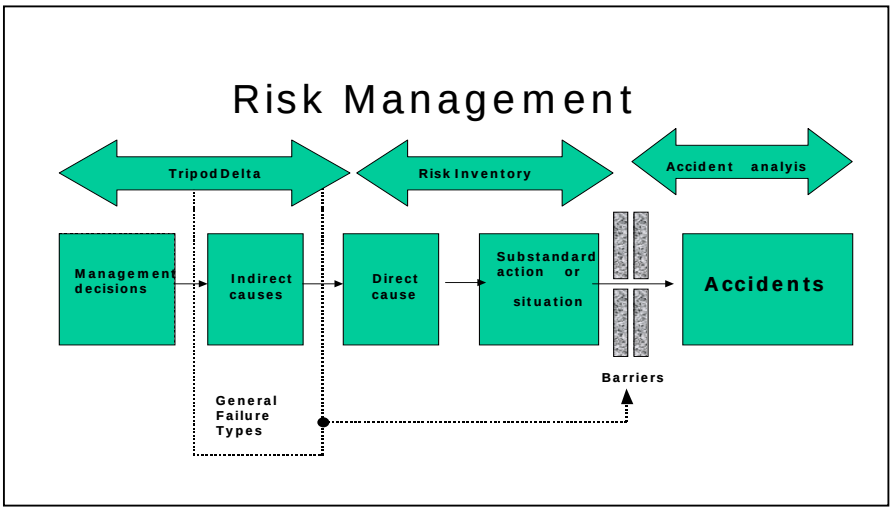
The risk management model used by the group consists of five steps (backwards):

- an accident happens because the last barrier that could have prevented the accident fails. Examples of barriers are personel protection, emergency exits, fire protection, etc.;
- an accident happens because a person takes the wrong action (failure, misstake, fault) or there is a substandard situation (unfavourable condition, stress);
- such an action or situation has always a direct cause why the person made that mistake;
- indirect causes;
- almost all indirect causes like lack of budget, bad training, unsufficient planning etc. are based on bad management decisions.

In the following graph the risk management model is shown with the five steps. As can be seen on the top of the graph, there are three different ways of investigating part of so called accident-chain:

- accident analysis is done after the accident already has happened;
- the Risk Inventory and Evaluation (RIE) is a pro-active model, because it is possible to find the potential risk in an organisation;
- the Tripod method is meant for finding the indirect causes of possible risks and for recommendations for the management.

Figure 1: Risk Management model



The working group has limited their work to the direct causes of accidents. The reason for this was that most companies only investigate the direct causes. Indirect causes are hardly reviewed. The following elements have to be looked at during investigating the direct causes:

- the workplace (design, ergonomics, housekeeping, safety signals, etc.);
- the organization of the job (number and function of the workers, procedures, instructions, etc.);
- the human behavior (communication, training-education, errors, careless, inconsulte actions, etc.);
- the job equipments (electrical tools and not, crane, pressure vessels, etc.);
- the safety devices (fire alarm, gas detectors, extinguishers, showers and ocular washings, etc.);
- the Personal Protection Equipment (safety shoes, caps, gloves, ear plugs, etc.);
- the environment (climatic condition, microclimate, etc.);
- the third party actions.

As a consequence of the above elements and to standardise the causes of accidents, the working group characterized the following main direct causes of accident:

1. *Safety devices*
   The cause of accident may be attributable to no use or incorrect use of safety devices as: ocular washing fountain, insulating dais, fire extinguisher, flameproof cover, hand protection for chisel, vapour-proof lamp, safety ladder, safety belts, etc.

2. *Personal Protection Equipment*
   The cause of accident may be attributable to no use or incorrect use of Personal Protection Equipment as: safety shoes, ear protectors, gloves, etc.

3. *Tools/Equipment*
   The cause of accident may be attributable to incorrect use or use of defect tools as: drilling machine, disk sander, portable electric drill, gas flow stopping equipment, etc.

4. *Safety signals*
   The cause of accident may be attributable to insufficient safety signals or no signals as: road yard signals, radioactivity, prohibition signals, etc.

5. *Procedures/Instructions/Codes*
   The cause of accident may be attributable to insufficient follow up of procedures, instructions, codes or transgression of them as: working instructions, safety procedures, general codes, etc.

6. *Actions*
   The cause of accident may be attributable to incorrect actions as: violation, unconscious, mistake, carelessness, etc.

7. *Housekeeping*
   The cause of accident may be attributable to: unclean areas, incorrect storages, garbage, wastes, etc.

8. *Third parties*
   The cause of accident is attributable to: pipelines failures, hit by cars, trains or other subjects.

9. *Others*
   The cause of accident is not attributable to one of previous step as: presence of obstacles, accidental, others.

9. DATA COLLECTION

9.1 General

As already mentioned in the introduction, each company collects their own data concerning work related accidents. Until today, no exchange of statistical information has been organised on a European level within the gas industry.
All statistic material of each company was reviewed in order to check for common grounds. The group discussed which data could help to identify and to control more efficiently the common risks. It was decided to focus on the following common data:

Table 4: Common data requested

1	Number of accidents	Number of accidents with at least one lost day
2	Frequency rate	Number of accidents with lost days (x 1,000,000) divided by the sum of hours worked by the company.
3	Lost days	Number of lost days.
4	Severity rate	Number of lost days (x 1,000) divided by the sum of hours worked .
5	Overview of hazards	Number of accidents related to the hazard that caused the accident.
6	Overview of direct causes	Number of accidents with lost days related to the direct cause of the accident.

The comparison of the different companies is not easy because of the differences in type of activities, ground, climate, unions, law and insurance.

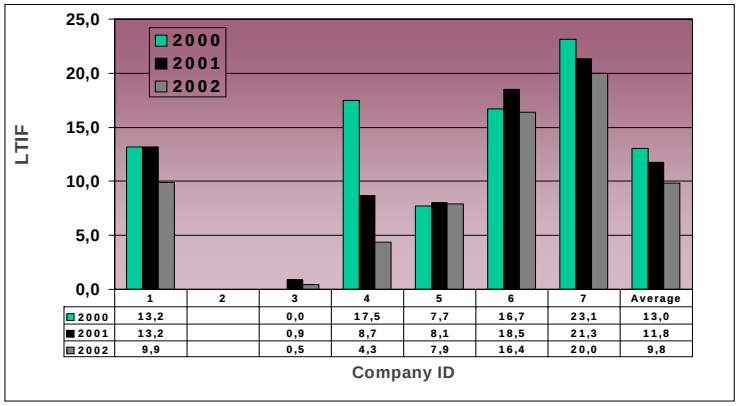
9.2 Results from the questionnaire

A questionnaire was sent to collect data and to try to make a database on safety.
A total of 7 Marcogaz companies returned the questionnaire (see appendix). Due to lack of sufficient data, the total lost days and the severity rate could not be calculated.

9.2.1 *Frequency rate*

For reasons of confidentiality, all companies were given a specific company number. In the graph below the frequency rate of the companies are shown.

Figure 2: Frequency rate 2000 - 2002



	1	2	3	4	5	6	7	Average
2000	13,2		0,0	17,5	7,7	16,7	23,1	13,0
2001	13,2		0,9	8,7	8,1	18,5	21,3	11,8
2002	9,9		0,5	4,3	7,9	16,4	20,0	9,8

1

9.2.2 *Hazards at the time of LTA*

It was also asked by the questionnaire to indicate the type of hazard at the time of the lost time accident (LTA). In table 5 is shown the number of accidents caused by a specific hazard. Based on these numbers, a ranking of hazards was made. This ranking was compared with the ranking already made by the RIE.

Table 5: Hazards at time of accident versus risk classification

Hazards Top 7	*Total number of accidents from questionnaire in 2002*	*Hazard ranking based on the questionnaire*	*Risk ranking from RIE*
Road traffic (work related)	95	1	1
Stumbling, tripping	76	2	3
Road traffic (home-work itenary)	27	3	2
Mechanical handling	23	4	5
Risk of fire by liquids, gases, solids	3	5	7
Electricity,current	0	6	6
Explosive atmosphere	0	6	4

Although not classified in the RIE (medium, high or very high risk), the following hazards were also mentioned in the questionnaire as hazards at the time of accidents:

- Projection of material :13
- Hard dynamic work/manual handling: 12
- Aggravating use of tools: 25
- Personal protective equipment: 15

9.2.3 *Direct causes at the time of LTA*

Overview of direct causes of accidents is showed in the following table for the annual statistic:

Table 6: Direct causes at the time of the LTA

Direct causes of the LTA	*Total*
Safety devices	6
Personal Protection Equipment	10
Tools/Equipment	3
Safety signals	0
Procedures/Instructions/Codes	12
Action	88
Housekeeping	6
Third parties	30
Others	164
Total	319

9.2.4 *Health*

The questionnaire also asked for the sickness rate. The answers we received did not show relevant information. It is clear that no meaningful analysis could be made because of the lack of information.

9.3 Analysis of the questionnaire

Frequency rate
Although it can be seen in figure 2 that there is a slight decrease in the average frequency rate, it is clear that the FR. in the different companies is still rather high. The average LTIF of 10 means 10 accidents with lost time per 1 million hours worked (625 employees). The group thinks that there is certainly necessary to improve these performance.

Hazards at the time of the accident
Comparing the **theoretical** risk ranking from the RIE (top 7) with the **actual** hazards at the time of the accident, it can be concluded that there is a very good resemblance. The only remarkable difference is that there were no accidents related to electricity and explosive atmosphere.

Direct causes
Because almost 50% of the direct causes was classified in the category "others", no meaningful analyses could be made.

10. BEST PRACTICES

For the risks of the top 7 list the group collected information on what is the best practice in the gas industry to avoid or prevent such risks or even to reduce or to eliminate such risks:

1. Road traffic (work related) (4.1)

- According to the activities, detailed procedures defining standards for vehicles, their kind (type, power, etc.), safety and emergency accessories (air bag, extinguisher, air-vents, system of air conditioning, fog light, snow chains, etc.) are established. Appropriate procedures, besides, criteria for the routine maintenance and the substitution of the vehicle are defined.
- Staff attends training courses on the “Safe driving” held by qualified teachers and is informed on the risk connected to driving cars and Bonus procedures are introduced (e.g. no accident/ incident during 1 year) in order to reward workers who don’t cause road accident or incident.
- The use of company cars is reduced, privileging public service vehicles, railways or air service.

2. Road traffic (home-work itinerary) (4.2)

- Staff attends training courses on the "Safe driving" held by qualified teachers and is informed on the risk connected to driving cars.

3. Stumbling, tripping (11.1)

- All involved staff is informed on the risk of stumbling or tripping, in particular for all the activities carried out "in the open air" (pipeline surveys on uneven lands, in mountain, inspections on systems, jobs in the yard).
- According to the type of activity, appropriate safety shoes are supplied, while Company vehicles are equipped with a first aid package and proper telecommunication devices.
- For some specific activities (approaches at, or walking through tunnels, pipeline surveys on mountainous areas, etc.) teams with more than one worker are scheduled and phone contacts among the interested staff is continuously assured.
- Good house keeping and paving footpaths of work environment are maintained.

4. Explosive atmosphere (5.2)

- The areas where explosive atmospheres can exist, in agreement to the enforced norm, are characterized and classified.
- Explosive atmospheres areas are marked out with safety signals “EX” or yellow lines painted on the pavement.
- Technical solutions are taken to avoid accumulation of explosive atmospheres, such as to build structures, if possible, on the open air or to realise an effective ventilation of work environment.
- While staff is working in areas where explosive atmospheres can be formed, the continuous monitoring of atmospheres is assured by fixed and/or portable gas detectors.
- Personnel involved is informed on the specific risks associated to work in explosive atmospheres through meetings with safety technicians. Specific procedures and operational manuals, besides, establish the correct use of right tools and PPE (like antistatic suits, gas detectors, no sparking tools, anti flame blanket, anti heat blanket and so on), professional demeanour, etc.
- Periodic survey by walk, car, helicopter are carried on to avoid risks by third party works, in order to locate not authorised works in proximity of company pipelines or plants.
- Security installations are provided in order to avoid the not authorized access of people to company plants.

5. Mechanical handling (1.3)

- Operations of mechanical maintenance are carried out following specific procedures or operative instructions which define the frequency and the kind of activity to perform, the interested staff and the equipments to use.
- Staff involved in mechanical maintenance attend theoretical-practical training courses where the installations, the characteristics of the equipments to be used and the main maintenance activities carried out in the workshop and in the field are analysed. Such formative periods are supported by parallel expert staff before being able to operate in an independent way.
- Personnel involved is informed on the specific risks associated to the work conditions through meetings with safety technicians. Such activity is repeated in case of modifications of the maintenance cycles, use of new equipments, etc.
- Standard PPE (Personal Protective Equipment) and proper working suits, chosen according to a careful evaluation of the risks associated to their activity, are available.
- Plants are provided with safety signals to alert the workers about the presence of risks, the fire equipment, the emergency paths and exits.
- Activity of mechanical maintenance is optimised in order to reduce at the lowest level all working risks, by actions on personnel, plants and environment.
- Tasks for every worker, before every activity, is correctly defined and distributed and tools are easy accessible to use.
- Staff equipment is safe, certified and inspected.
- The choice of the contractors is carried out taking into account professional qualification, also depending on the job to carry out and contractors are opportunely controlled during the development of the activities.
- Pocket handbooks are elaborated and distributed to workers involved in particularly complex activity of maintenance.

6. Current (2.1)

- Personnel working outdoor follows particular procedures especially written to avoid current risks (like to check the presence of buried cables before starting to work or to beg working permission to their boss before working close to electrical towers.
- Personnel directly involved (e.g. cathodic protection or electric devices maintenance) is informed on the specific risks associated with current through meetings with safety technicians. Specific procedures and operational manuals, besides, are written to establish the correct use of the right tools and PPI, professional demeanour, etc.
- Only specialised staff is involved in electrical devices maintenance and specific and detailed procedures are written and explained to the workers concerned.
- Working areas and electrical devices are well indicated and very well signalised.

7. Risk of fire by liquids, gases and solids (5.1)

- Areas with liquids, gases and solids easy to burn are well marked out and very well signalised. Fire extinguisher are easily available in case of fire.
- To handle with flammable substances specific and detailed procedures are written and explained to the involved staff, in order to establish the correct use of the right tools and PPE (like antistatic suits, gas detectors, no sparking tools, anti flame blanket, anti heat blanket and so on) and also to avoid actions that may induce fire triggering. Specific procedures are also easily available on working areas about the first action to take in case of fire.
- Safety cards of inflammable substances are easily available for references and are explained to staff involved in handling.
- Operations of managing and pouring of inflammable substances (e.g. odorizer) are carried out, if possible, with closed circuits.

11. CONCLUSIONS

General

The Working Group on Health and Safety has made a start on a very important area. There are clear advantages (economic and other) in reducing accidents and occupational ill-health to as low as reasonably practical. The group made suggestions in this report and recommendations are given for further work . There is clearly a lot more that could and should be done and the group strongly believes that there is a case for collecting and analysing accident data on an annual basis so that lessons can be learned and trends clearly identified. The group also believes that it is essential that there should be proper reporting arrangements for accidents involving contractors so that the full picture can be obtained.

Specific

1. Based on the model of risk inventory and evaluation risks in the gas industry were established and ranked according a theoretical model. With these results a comparison was made with the actual risks as they occur during a lost time accident were. This means that the model is very suitable for prediction of the risks and defining the best practices to prevent accidents.
2. A top 7 of risks in the gas industry was made and the present best practices to prevent these risk was inventorised.
3. It became clear that safety investigations and safety data was mainly based on LTA's and the direct causes. Indirect causes were seldom collected and reviewed.
4. Almost all member companies limited their safety data collection to own employees. Not much attention was paid to contractor safety.
5. The number of answers to the questionnaire was quite low, so the reliability of the conclusions is limited to that.
6. From the data that was received from the years 2000 – 2002 it can be concluded that there is a slight tendency for the frequency rate to decrease.

12. RECOMMENDATIONS

1. It is recommended to extend the work of collecting and analysing these data for a longer period of time to obtain a trend (compared to the EGIG database) It is also recommended to extend the study to: indirect causes of accidents, NLTA's (accidents with no lost time), dangerous situations, activities of the victim at the time of the accident.
2. It is recommended to get more commitment of the Marcogaz members to give input on the database, so that the reliability of the data is higher.
3. At the start of the working group relevant topics to be studied were collected. Some of these topics should be studied later on like management of contractors, training of employees and traffic accidents.
4. One can be aware that the data received from different companies are based on individual methodologies. It can be interesting to compare and standardize these methodologies.
5. The evaluation of data shows potential for further improvement. One way to do it is to look at best practice in the gas industry and learn from the best in class.
6. Companies should be aware of the increase of the outsourcing of activities (including outsourcing of risks). It is recommended that more effort should be put in collecting safety data of contractors.
7. Improvement of safety and accident prevention can be based on the top 7 risks as shown in the RIE, including the collected best practices. It is recommended to collect best practices for additional hazards derived from the questionnaires.
8. Safety can also be improved by establishing Task Risk Analysis (TRA) for the most risky tasks and activities in the gas industry. This could be a task for further work.
9. It is recommended not to include in the future data on home-to-work traffic accidents.

APPENDIX 1: OVERVIEW OF POTENTIAL HAZARDS IN THE GAS INDUSTRY

Potential hazards		*Definition*
1.	**Mechanical risks**	
1.1	Unprotected moving parts of machines	Reachable moving parts of machinery, tools and installations can present a risk (sticking, bumping, crushing of amputating) by their kinetic energy when these parts are not effectively screened off.
1.2	Hazardous surface	Rough, hot, cold or sharp surfaces of tools, machinery or the workshop can harm workers.
1.3	Mechanical handling	Mechanical handling using resources as hoists, roller bridges or cranes.
1.4	Pressure vessels	Failing of pressure vessels causing incorrect flows, pressure raising.
1.5	Projection of material	Release of kinetic energy by projection of dust, gas, fumes or solids.
1.6	Ground movement	Ground movement due to unsafe digging of a trench, earthquake or streams of water.
2.	**Electric risks**	
2.1	Current	Electrocution due to insufficient protection against current or electric overload.
2.2	Electric arcs	Electrocution due to electrical arcs during switching, due to an unsafe design of the installation or due to wear of the instrumentation.
2.3	Electrostatic charge	Electrocution due to electrical arcs of electrostatic charges (insufficient earthing).
3.	**Chemical hazardous material**	
3.1	Gases	Health and safety risks due to the nature of the gasses (irritating, toxic).
3.2	Steam	Health and safety risks due to the nature of the steam (irritating, toxic).
3.3	Fumes/dust/aerosols	Health and safety risks due to the nature of fumes, dust, aerosols (irritating, toxic).
3.4	Fluids	Health and safety risks due to the nature of the fluids (irritating, toxic).
3.5	Asbestos	Mesothelioma, cancer and asbestoses due to asbestos fibers in our lungs.
3.6	Other solid material	Health and safety risks due to the nature of other solid materials (irritating, toxic).
3.7	Uncontrolled reactions	Emission, fire or explosion hazard due to uncontrolled reactions of materials.
4.	**Road traffic**	
4.1	Work related	Risks of traffic during work (f.i. patrol).
4.2	Home-work itenary	Risks of traffic during home-work iteary.
5.	**Fire and explosion**	
5.1	Risk of fire by liquids, gases and solids	Fire hazard due to the presents of flammable material.
5.2	Explosive atmosphere	Explosion hazard in zones with possible explosive atmosphere (Ex-zones).
5.3	Explosibles	Explosion hazard due to presents of explosives.
5.4	Risk of fire in buildings	Fire hazard in buildings.
6.	**Thermal risks**	
6.1	Contact with hot media	Risk of burns due to contact with hot surfaces.

Potential hazards		*Definition*
6.2	Contact with cold media	Risk of burns due to contact with cold surfaces.
7.	**Physical hazards**	
7.1	Noise	Loss of hearing capacity due to noise.
7.2	Ultrasound	Loss of hearing capacity due to noise with a frequency above 20,000 Hz.
7.3	Vibration	Health risks due to global body vibrations and/or vibrations in the hand-arm system.
7.4	Nonionisating radiation	Health risks due to infrared, visible light or UV-light, VDU.
7.5	Ionisating radiation	Health risks due to radiation of particles (alpha, beta, neutrons, protons).
7.6	Electromagnetic fields	Heath risks due to electromagnetic feels (gamma, X-radiation).
7.7	Work under high/low pressure	Risk due to high pressure equipment
8.	**Workplace environment**	
8.1	Climate	Discomfort due to temperature, humidity or a breeze.
8.2	Lighting	Too much or too little lighting related to a specific task.
8.3	Strain noise	Discomfort due to excessive noise related to a specific task.
8.4	Viruses, bacteria and fungi	Health risk due to micro-organisms
9.	**Ergonomic aspects**	
9.1	Hard dynamic work	Health risks from lifting and carrying heavy loads
9.2	Dynamic work to parts of the body	Repetitive work of smaller parts of the muscular apparatus (Fingers, Arms); can cause RSI
9.3	Static work	Discomfort and/or health risks due to the posture during work.
9.4	Confined spaces	Risks due to work in confined spaces (atmosphere, accessibility, evacuation, choice of equipment).
9.5	Office work VDU	Office ergonomics
9.6	Design of workplaces	Risks due to the concept of the workplace (ergonomics, risk of falling).
10.	**Information and aggravating use**	
10.1	Information flow	
10.2	Amount of information	
10.3	Aggravating use of tools	Risks by use of tools from bad design or bad working environment (e.g confined spaces)
11.	**Falling**	
11.1	Stumbling, tripping	Danger for stumbling and/or tripping.
11.2	Falling from height	Danger due to working at heights without protection.
12.	**Other risks**	
12.1	PPE	Risks of not wearing PPE or shortage of right PPE.
12.2	Skin irritation	Health risk due to skin contact with media
12.3	People	Violence, mobbing or sexual harassment.
12.4	Animals	Risks of animals (insects, wild animals).
12.5	Plants	Risks of harmful plants (toxic, irritating).
12.6	Psychological risks (harassment)	Violence, mobbing or sexual harassment.

APPENDIX 2: RESULTS OF RIE

	Likelihood							***Exposure***							***Consequences***							***Risk***							
Opinion of member:>>>	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G	***AVERAGE***	
1.3 Mechanical handling	3	0,5	0,5	3	3	3	6	3	6	3	6	6	6	6	3	15	15	7	7	7	7	27	45	23	126	126	126	252	104	M
1.4 Presure vessels	0,5	0,2	0,5	3	3	0,5	0,5	3	10	10	3	3	10	10	7	15	15	7	15	15	15	11	30	75	63	135	75	75	66	P
1.6 Ground movement	1	0,2	0,5	1	1	0,5	3	3	3	3	1	2	2	3	3	7	15	7	15	7	15	9	4,2	23	7	30	7	135	31	P
2.1 Current	1	0,2	0,5	3	3	3	3	1	10	3	3	6	3	2	15	15	15	15	15	15	7	15	30	23	135	270	135	42	93	M
3.1 Gases	3	0,5	0,5	0,5	3	0,5	0,5	1	6	6	3	6	2	2	7	15	15	7	7	7	7	21	45	45	11	126	7	7	37	P
3.3 Fumes/dust/aerosols	3	0,5	3	1	1	0,5	0,5	2	6	3	2	3	2	1	7	7	7	3	3	3	3	42	21	63	6	9	3	1,5	21	P
3.4 Fluids	0,2	0,5	0,2	1	0,5	0,5	6	1	6	3	2	0,5	2	3	7	7	15	3	3	7	7	1,4	21	9	6	0,8	7	126	24	P
3.5 Asbestos	0,5	0,2	0,2	0,5	0,1	0,1	3	0,5	1	1	1	0,5	0,5	2	15	15	15	15	15	15	7	3,8	3	3	7,5	0,8	0,8	42	9	A
4.1 Work related	3	6	6	6	3	3	3	6	6	6	6	6	10	10	15	15	15	15	15	15	15	270	540	540	540	270	450	450	437	VH
4.2 Home-work itenary	3	6	6	6	1	3	3	6	6	6	6	6	10	6	15	15	15	15	15	15	15	270	540	540	540	90	450	270	386	H
5.1 Risk of Fire by Liquids, Gases, Solids	0,5	0,5	0,5	0,5	3	0,2	1	3	6	6	6	3	6	1	7	7	7	7	40	40	40	11	21	21	21	360	48	40	75	M
5.2 Explosive atmosphere	0,5	0,2	0,5	0,2	3	0,2	0,5	6	6	6	6	3	6	1	40	40	40	40	40	40	40	120	48	120	48	360	48	20	109	M
6.2 Contact with cold Media	0,5	0,2	0	0,5	1	0,5	6	0,5	6	0	3	0,5	3	3	3	7	0	7	3	7	7	0,8	8,4	0	11	1,5	11	126	23	P
9.2 Dynamic work to parts of the Body	1	3	1	0,5	1	0,5	6	3	6	6	3	2	2	2	3	3	7	7	3	7	7	9	54	42	11	6	7	84	30	P
9.4 Confined spaces	1	0,2	1	1	3	1	6	1	2	2	2	6	1	2	3	7	7	7	3	3	7	3	2,8	14	14	54	3	84	25	P
9.5 Office work VDU	3	1	3	3	1	0,5	0,5	6	6	10	6	10	10	10	7	3	3	3	3	7	3	126	18	90	54	30	35	15	53	P
11.1 Stumbling, tripping	6	6	6	3	3	6	6	2	6	6	6	3	6	6	3	3	7	7	3	3	3	36	108	252	126	27	108	108	109	M
11.2 Falling from height	6	0,2	1	3	3	6	6	2	2	2	3	3	2	2	7	7	15	7	7	7	7	84	2,8	30	63	63	84	84	59	P

Classification for risks:	**Acceptable (A)**	**Possible risk (P)**	**Medium (M)**	**High (H)**	**Very high (VH)**
	<20	20 - 70	70 - 200	200 – 400	>400

APPENDIX 3: RISKS IN ORDER OF PRIORITY