COMMISSION OF THE EUROPEAN COMMUNITIES

EIGHTH REPORT
OF THE
MINES SAFETY AND HEALTH
COMMISSION

YEAR 1970

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CONTENTS

LIST OF ANNEXES

INTRODUCTION

The Eighth Report of the Mines Safety and Health Commission contains:

1. A synopsis of the activities of the Mines Safety and Health Commission and its Working Parties for 1970.
2. A recapitulation of the accident statistics for the years 1958 to 1970 with comments on their trend.
3. A list of new official regulations brought into force in 1969 and 1970.

Since Government action in implementing the recommendations of the Mines Safety and Health Commission is only reported on every two years, this does not feature in this report.

The items listed on the preceding page have been relegated to the annex.

SECTION I

ACTIVITIES OF THE MINES SAFETY AND HEALTH COMMISSION

On 3 November 1970 the Commission of the European Communities appointed Mr. Coppé, member of the Social Security Commission, Chairman of the Mines Safety and Health Commission in place of Mr. Levi-Sandri, Vice-Chairman of the Commission, who left the Communities on 1 July 1970. At the meeting on 26 June 1970 Mr. Levi-Sandri said farewell to the Mines Safety and Health Commission, of which he had been Chairman since 7 December 1967 replacing at that time Mr. Coppé, who had been Chairman since June 1965.

In 1970, the Mines Safety and Health Commission held two meetings, the Restricted Committee two, the Working Parties and their Sub-Committees 40. In addition, the Secretariat of the Mines Safety and Health Commission organised or gave its support to five information meetings for interested persons from the trade unions and from management. The overall total therefore increased to 49 (47 in 1969).

The breakdown of the meetings of the Working Parties and their Sub-Committees is as follows:

Rescue arrangements, Mine Fires, Underground Combustion:	2
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In the course of this activity, the Mines Safety and Health Commission was able to give final approval to certain items, notably:

- in the field of health; 2 Recommendations and the adoption of a position on methods of combatting dust formation in underground workings (Annex VI), the special departments responsible for monitoring the dust formation (Annex VII) and on the collaboration between machine constructors, operators and research departments to reduce the dust formation resulting from the use of winning and road-heading machines (Annex VIII),

- in the field of electricity, a Recommendation on the characteristics and electrical protection of cables supplying mobile machines (Annex IX),

- in the field of rescue arrangements, a Report on the results of joint research into improving the physiological conditions of closed-circuit breathing apparatus (Annex IV) and a Report on the instructions for a new method of hydromechanical construction of plaster stoppings (Annex V).

The Mines Safety and Health Commission, at its meeting on 26 February 1970, took note of the Resolutions adopted by the European Parliament at its session on 27 November 1969 after it had considered the Sixth Report on activities of the Mines Safety and Health Commission for the year 1968 *(1)*.

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(1) The Seventh Report for activity in 1969, adopted by the Mines Safety and Health Commission on 26 June 1970, could not be considered in full session by the European Parliament until February 1971.

In response to the wishes of the European Parliament, within the limits of the powers of the Mines Safety and Health Commission the Secretariat prepared the draft terms of reference for the Mines Safety and Health Commission in 1969: study of environmental factors, medical aspects of dust suppression methods and the problems involved in the safety-training of foreign workers. It also prepared the draft terms of reference required by the Mines Safety and Health Commission in February 1970, with respect to the activities of the three Working Parties to be created, both to comply with the wishes of the Parliament and to take into account the following major factors:

- frequency of individual accidents including accidents caused by falls of ground (40% of deaths): new Working Party "Roof control";
- increasing mechanisation of the workings, involving, as shown by the statistics, an increasing number of serious injuries: new Working Party "Mechanisation";
- concentration of work in larger and larger units, causing increasing formation of dust and liberation of firedamp: new Working Party "Ventilation and Firedamp".

At its meeting on 23 November 1970, the Restricted Committee studied this new orientation of work. Knowing the effective strength of the Secretariat, fully occupied with its present activity, the Restricted Committee reviewed the terms of reference of the existing Working Parties, established the priorities and decided on the limitations which would enable the new terms of reference to be put into effect without increasing the total volume of its activity.

This adoption of position by the Restricted Committee was not able to be considered by the Mines Safety and Health Commission during 1970 *(1)*.

Within the framework of the exchange of information provided by the Commission of the European Communities, the Secretariat of the Mines Safety and Health Commission gave its support, by giving the latest results of its work, to information conferences: for interested trades unions officials at Merlebach (France) on 29 May 1970 and at Heer-Agimont (Belgium) on 13 June 1970 and for British student mining engineers at Luxembourg on 9.April 1970. It participated at a colloquium of the Mine Fires Commission of Charbonnages de France, held at Albi on 6, 7 and 8 October 1970, where recent work of the Working Party on Rescue Arrangements, Mine Fires and Underground Combustion was discussed *(2)*.

Lastly, on 14 and 15 September 1970, it organised in the Sulcis basin in Sardinia, international information conferences on safety and health in coalmines, for 70 representatives of miners' trades unions in the Community and the United Kingdom. The subjects discussed related, in the medical field, to research work on pneumoconiosis; in the technical field, to a review of the work of the Mines Safety and Health Commission, to the results of technical dust research and to the lessons to be drawn from the accident statistics.

As in previous reports, this first section sets out to survey, as concisely as possible, Working Party by Working Party, the origin of the work, development of the work during the meeting in 1970 and any results obtained in certain work, together with the outstanding problems.

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(1) Position approved by the Mines Safety and Health Commission on 26 March 1971.

(2) Technical Publications, Charbonnages de France, 1971, no. 2.

I - TECHNICAL PROBLEMS

A. Rescue arrangements, Mine Fires, Underground Combustion

The Working Party held one Plenary Meeting and one Restricted Meeting. At the Plenary Meeting, it visited the Cerchar laboratories at Verneuil, where it studied the possibilities of using tracer gases to detect ventilation leakages, which could be the cause of spontaneous coal heatings. As a restricted group, it met in the laboratories of SMRE at Buxton to take note of work and research relative to foamed polyurethane, specially employed for reduction of these leaks.

The rescue experts who were members of this Working Party held four meetings, two of which were devoted to the determination of criteria for fire-resistant clothing to be used by rescue workers.

Sixteen meetings of experts were held on the stabilisation of ventilation, fire-resistant fluids and shaft fires.

This work had the object of completing the terms of reference of those Sub-Parties which later had to be put into operation following on the decision of the Restricted Committee of 23 November *(1)*; the Sub-Committee on Fire-Resistant Fluids achieved this objective after nine meetings.

The work is reported on below in the order utilised previously.

1. Shaft fires

In 1969, a Sub-Committee of experts carried out water-injection tests in shafts about to be abandoned at Ressaix with the object of correcting, if necessary, the Recommendation of the Mines Safety and Health Commission of 8th April 1960 regarding the extinction of shaft fires and, particularly, the graph of the value of the aeromotor effect of water falling down shafts, since subsequent tests had shown discrepancies in the results.

The evaluation of the results of the latter tests was completed in 1970 and led to an expert report, which had not been placed before the Working Party during the year covered by this report *(2)*.

It followed from these expert conclusions that the values of the graph should be reduced by 10 to 30 % (10 % for clear shafts and 30 % for obstructed shafts) when the quantity of air injected has reached its steady state, which takes 5 to 10 minutes for an air intake shaft, during which the aeromotive effect is clearly lower. It has been shown that water falling in the shafts reaches a depth of 800 m after 1 to 1.5 minutes in an air intake shaft, and fifteen minutes or more in a return shaft, depending upon the ascent velocity of the air. The experts could not give more precise values without a supplementary theoretical and experimental study.

2. Fire-resistant fluids

The experts of the Sub-Committee have completed the work of revising the third report on the specifications and conditions relative to fire-resistant fluids for mechanical transmission.

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(1) And of the Mines Safety and Health Commission of 26 March 1971.

(2) Submitted to the Working Party on 26 February 1971.

The fourth report prepared in this way will be submitted to the Working Party and to the Mines Safety and Health Commission during 1971.*(1)*

Numerous comparative tests have been carried out in specialist test and research stations to find joint criteria and test procedures (equipment and working parameters) in various tests, such as:

- that defining the flammability criterion by determining the propagation of the flame in a mixture of coaldust and oil.

  This criterion has been defined more precisely with regard to its working parameters and the evaluation of the test has been made less stringent, the length of propagation accepted under the specified conditions having been increased from 7 cm to 10 cm, this latter length being the arithmetical mean of two series of 10 measurements, with a tolerance of 3 cm;

- that relating to protection against wear: the four-ball test has been supplemented by a test with a Vickers type vane pump, which takes better account of the practical conditions of use. However, these two tests are not of themselves sufficient to define the very complex phenomenon of wear and are to be considered as experimental methods.

- those defining the health criteria relative to the determination of certain forms of acute toxicity. For anhydrous fluids, type D, an enquiry in the coalmines of the Community is still in progress with regard to the toxicity of aerosols. Even now, it is being found that the irritating capacity of aerosols and thermal decomposition products of these fluids on the mucous membranes, the epidermis and the eyes, as for the other fire-resistant fluids, does not pose grave problems if certain simple precautions, reviewed in the Fourth Report of the experts, are taken.

Lastly, again with respect to certain of these products of type D, research is at present being carried out in the Hamburg Pharmacological Institute as to their possible chronic tonic effect.

3. Foamed polyurethane seals

At its meeting of 26 February 1970 the Mines Safety and Research Commission adopted a Note on the use of foamed polyurethane in underground workings.

Because of its great interest, and to hasten its distribution, this Note has already been published in Annex VI of the Seventh Report.

Among other matters, it discussed the precautions which must be taken when using this product and enumerated, for the benefit of the chemical industry, the improvements which must be made to polyurethane or to a material with similar properties to permit its use without reservations underground.

Following on the disaster at the Michael Colliery in Great Britain, the SMRE carried out tests with foamed polyurethane and other substances serving the same purpose.

A representative group of the Working Party met in the laboratories of the SMRE at Buxton to be informed of this work. Up to the present, no foamed polyurethane which satisfies the requirements made in the tests has been found and the SMRE is continuing research into other materials which do not contain more than 3 to 4 % of organic substances.

(1) Adopted by the Mines Safety and Health Commission on 26 March 1971.

4. Rescue by means of large-diameter boreholes

Following on the proposal of the Mines Safety and Health Commission (1968), research has been carried out by Cerchar and the Steinkohlenbergbauverein into problems in the drilling of large-diameter boreholes, to be driven from the underground roadways, for the rescue of trapped men.

This research work has developed in accordance with the conditions defined and recommended by the Mines Safety and Health Commission and has progressed very favourably, particularly in the Lorraine Coalmines. Progress has been made in the field of detecting trapped men, in perfecting a first contact hole and a rescue hole 50 m long, driven at a rising angle, both with and without tubing.

The Secretariat has completed the list of specialists in drilling and of drilling equipment available within the Community for the rescue of trapped men. This list was only approved by the Mines Safety and Health Commission on 26 March 1971, but figures in Annex III of this report, to hasten its distribution in accordance with the wishes of the Mines Safety and Health Commission.

It will have to be reviewed periodically and, in any case, as soon as the aforementioned research has been completed.

5. Ventilation

With regard to the application of the practical conclusions relative to the stabilisation of the ventilation in the case of fire *(1)* in a working with ascensional ventilation (Seventh Report, page 11), a second meeting took place at Essen between the Sub-Committee on Ventilation and the Ventilation Committee of the Steinkohlenbergbauverein, where computer experiments had been carried out. The Ventilation Sub-Committee, itself convinced of the usefulness of computers and ventilation simulation systems, considers that the shemes recommended in the practical conclusions constitute an indispensable complement to these machines and that the two methods have to be associated; where the collier does not possess a computer, the use of these schemes and the application of the principles following from the study of the Mines Safety and Health Commission are the only means which permit the problem of stabilisation of the ventilation to be solved rationally and rapidly. A final meeting should take place in 1971, at the Computer Centre of Louvain University.

In addition, the Committee of experts continued, without being able to complete, the study of problems still to be solved: stabilisation of the ventilation in the case of a fire occurring in a working with descensional ventilation; stability of diagonal ventilation roadways.

6. Fire-resistant clothing

Following on the Mont-Cenis disaster at Herne-Solingen and on the terms of reference given to the Working Party, (Seventh Report, page 12), the Working Party and a restricted group of experts studied the question taking into account tests carried out at the Rescue Centres at Essen-Kray, Merlebach and Hasselt.

These tests had the object of perfecting clothing resistant, on the one hand, to the flame of a comparatively slight explosion (1300°, 6 seconds duration and 0.5 kg/cm^2 pressure), whilst, on the other hand, permitting the rescuer to work, which implies the conduction of heat to the exterior.

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(1) See the Sixth Report of the Mines Safety and Health Commission (Annex III).

The experts considered the results obtained to be inadequate and estimated that the work could only be completed if further financial support were made available. They therefore drew up a programme of joint research to be carried out in the institutes listed above and in the Liege Institute of Social Medicine. The Mines Safety and Health Commission will consider this position in 1971.

Meantime, requests for financial aid have been sent to the Commission of the European Communities and the process of approval is in hand. *(1)*

7. Results of research into the physiological conditions of closed-circuit breathing apparatus

Since 1960, the Mines Safety and Health Commission has been aware of the necessity of improving closed-circuit breathing apparatus, so as to lessen the physiological burden on the wearer particularly in fairly prolonged rescue operations at high temperature.

The Working Party considered it necessary to propose to the Mines Safety and Health Commission a research programme, of which it defined the component elements.

It was necessary to study the relative importance of the parameters of the apparatus, such as its resistance to breathing, the temperature, humidity and CO_2 content of the inspired air, the O_2 consumption and the weight of the apparatus. For this purpose, subjects carrying out, in a reproducible manner, the activities of rescue work had to be subjected to tests.

It was subsequently found expedient to study the possibilities of eliminating the tests on human subjects and replacing them by simulated tests on an artificial lung, with the object of ascertaining whether the new breathing apparatus units satisfy the technological requirements which follow from the research.

This research project, approved by the Mines Safety and Health Commission on 27 November 1962, was entrusted to three institutes:

- Institute of Physiology of the University of Liege,
- Hauptstelle für Grubenrettungswesen at Essen-Kray (Main Mines Rescue Centre)
- Rescue Co-ordination Centre of the Campine Basin at Hasselt.

The work was commenced on 1 July 1964 and was completed at the end of 1968. Since the reports of the Institutes were very long (about 600 pages), the results have been summarised by the reporter of this research; this summary is reproduced in Annex IV.

From these reports it can be concluded that:

- the closed-circuit breathing apparatus units at present in use in the Community and in the United Kingdom have given good results with regard to those characteristics which affect the physiological behaviour of the rescue worker;
- however, an improvement would be desirable for a number of designs with regard to the CO_2 absorption cartridge, which should give better absorption of CO_2 and liberate less heat;
- cooling devices should be created to facilitate work in a hot environment;
- on the other hand, it has been possible - in very broad outline - to express the total physiological effort of the wearer of a breathing apparatus as a function of the stresses to which he is subjected;

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(1) This request for financial aid was approved by the Commission in 1971.

- a method has been perfected for measuring the mechanical ventilatory characteristics of breathing apparatus units, so as to avoid prolonged and arduous tests on human subjects when testing new units.

The Mines Safety and Health Commission decided to communicate the results of this research to the manufacturers of breathing apparatus, to central rescue services, to mines inspectorates, and to industries outside the mines which are also interested in this subject.

It directed the rescue experts to follow up progress in practical achievements in this field, particularly with regard to the improvements listed above as desirable.

8. Hydromechanical method of constructing plaster stoppings

On 26 June 1970, the Mines Safety and Health Commission adopted the opinion of the Working Party on this question, already raised in the Seventh Report (page 12) and decided to give suitable distribution to the instructions for the construction of plaster stoppings by the hydromechanical method, developed by the Rescue Centre of the Saarbergwerke AG (See Annex V).

It should be remembered that as a result of tests financed by the High Authority and subsequently confirmed in practice, the Mines Safety and Health Commission had previously approved in 1964 the directives of the Essen-Kray Centre regarding the construction of plaster stoppings.

With this method, normal dry plaster is transported pneumatically through flexible tubes from blowing tanks and is brought into contact with the water only at the site of the stopping; in the hydromechanical method a special plaster is used, which is converted to a thin mortar by addition of water in a continuous mixer and is pumped to the site of the stopping through flexible tubes.

This method has the following advantages over the earlier method:

- rapidity of erection of the stopping;
- safety of the men working on the construction, since most of the equipment is located close to the mixer at an increased distance from the stopping;
- impermeability and resistance to explosion are obtained more rapidly.

The performances mentioned in Annex V (pages V,5 and V,6) and summarised in the Seventh Report (page 13) have in the meantime been confirmed and even improved; at the Charbonnages de Lorraine, in particular, the distance between the stopping and the mixer has been increased to 950 m with a difference in level of 25 m and a throughput of 7 m^3/hour.

B. Winding ropes and shaft guides

A request for financial aid in respect of a test programme on the study of dynamic effects on shaft guides and other winding installations was sent in 1967 by the Versuchsgesellschaft mbH, Dortmund, to the Commission of the European Communities. The competent authorities of the Commission have been reminded of the opinion of the Mines Safety and Health Commission. *(1)*

In addition, the Mines Safety and Health Commission approved new terms of reference which differ from the old terms by an extension of the work of the Working Party to haulage ropes and shaft guides in roadways.

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(1) Request granted in 1971.

This extension was justified:

- by the large number of accidents caused, particularly in the Ruhr, by haulage ropes in roadways;
- by the connection between tests and research relative to these latter ropes and winding ropes in shafts, since the information drawn from studying haulage ropes can be extrapolated to winding ropes;
- lastly, by the competency of the members of the Working Party in this field.

The Working Party has continued to study the regulations at present in force with regard to cage suspension gear and examined a report from the Rope-Testing Station at Bochum on accidents occurring in suspension gear and rope fastenings and on tests of rope balancing gear in multi-cable winding installations. *(1)*

It also studied the circumstances, the probable causes and the preventive measures relative to an accident which occurred on 24 March 1969 at Escarpelle Pit No.10 of the Douai Group, where a cage carrying 5 men in a staple pit fell, causing the death of the occupants. The Working Party study is in hand.

Lastly, it took note of the recent results obtained in dynamic stress testing of ropes at the Rope-Testing Station (Institute of Transport Techniques and Material Testing Techniques of the Westfälische Berggewerkschaftskasse) Bochum.

It met in the Testing Station on 27 October 1970 to examine, among other things , the dynamic stress testing equipment a new rope-inspection appliance operating on the principle of magnetic induction, in a flame-proof version, and equipment for inspecting shaft guides.

C. Electricity

On 26 June 1970, the Mines Safety and Health Commission approved the "Comments and recommendations following from the Report which it adopted on 20th June 1969 *(2)* with respect to the characteristics and electrical protection of cables supplying mobile machines (coal-cutters, loading machines, etc.) used underground in coalmines in the various Community countries" (see Annex IX).

This is a Report of practical conclusions forming a supplement to the aforementioned documentary study (Annex V of the Seventh Report), which was, by reason of its technical nature, destined primarily for the experts. It proved possible for the Mines Safety and Health Commission to identify certain minimum precautions taking into account the relative importance of the many faults to which cables subject to heavy mechanical stresses are prone.

These precautions, summarised on page IX,5 of Annex IX, concern, in particular, circuit-breaking on the first phase-screen fault, the use of screens and amperometric protection, permanent monitoring of the insulation and the use of a safety block.

These Recommendations have been sent to the Governments for action and also to interested persons and bodies.

The Working Party met on 17 and 18 June 1970 in the Yorkshire coalfield, where it visited, in the National Coal Board workshops, an exhibition, prepared for its benefit, of modern electrical material employed in the faces and roadways; it made a very instructive visit to a modern face at Silverwood Colliery where the same equipment is used with numerous forms of electrical protection; a very high output has been achieved there for a number of years without any accidents.

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(1) This Report will be given as an Annex to the Ninth Report of the Mines Safety and Health Commission.

(2) See Seventh Report of the Mines Safety and Health Commission - Annex V.

The Working Party was unable to commence examination of the documentary material assembled by the Secretariat *(1)* for the study of the design of high-voltage cables (up to 6000 volts) used underground and their protective devices.

It has worked at fulfilling its terms of reference 4, 6 and 7 *(2)* already mentionedin the Seventh Report (page 14) on saline pastes, trolley locomotives and surges due to lightning. Notes were presented to the Mines Safety and Health Commission on these three terms of reference in 1971.*(3)*

D. Flammable dust

As indicated in the Seventh Report (page 14) the Working Party met to examine the results of research at the Tremonia experimental mine, Dortmund and the Cerchar Test Station, Verneuil, with the financial support of the Commission, taking into account the joint programme developed by the Working Party and approved by the Mines Safety and Health Commission in 1968 (Annex VIII, page 21, Seventh Report).

The tests carried out in Germany have advanced knowledge on water barriers, particularly on divided water barriers, and on the use of hygroscopic pastes and powders to fix dust. The Cerchar tests dealt especially with tripped water barriers, which are also being studied in Germany.

These tests are still being continued, but the results obtained with respect to water barriers, concentrated and divided, and the use of saline pastes and powders are sufficiently significant for them to be exploited by the Mines Safety and Health Commission.

To be able to prepare a note, and possibly recommendations, on these processes, the Working Party plans to meet in 1971 at the Tremonia experimental mine and at neighbouring mines to see projects actually put into effect.*(4)*

The Working Party studied two explosions, one at the Varenne colliery, already studied by the Mines Safety and Health Commission, and the other at the Sophia-Jacoba colliery (without casualties). The conclusions will be communicated to the Mines Safety and Health Commission in 1971.

E. Joint accident statistics

The Working Party again made certain more precise adjustments to the synthesis document recording the joint definitions used to draw up the statistics, the interpretation relating to each definition and observations on the discrepancies found between the national and joint definitions.

It reviewed two tables mentioned in the Seventh Report (page 15); one relates to the breakdown of accidents according to causes, as in the earlier survey, but has been extended to show to short-term incapacity (from 4 days) and to the places at which the accidents occurred; the other, which is new, will give the breakdown of victims according to the site of the injuries, the nature of the injuries and the gravity of the accident; more than 56 days absence or fatality.

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(1) Examination commenced in 1971.

(2) See Annex II of this report.

(3) Reports on terms of reference 4 and 6, adopted by the Mines Safety and Health Commission on 29 June 1971.

(4) Made on 19 and 20 April 1971.

However, this new survey can only be made in 1971, since the Mines Safety and Health Commission still has to approve these extensions of the existing statistical survey. *(1)*

On the other hand, the Working Party has made certain mathematico-statistical studies to determine to what extent the differences verified in the rates of frequency, when they are compared chronologically or country by country, are significant from the statistical point of view.

Assuming a Poisson distribution of the rates of frequency, the Working Party has reached certain conclusions, but considers that it must ask for more precise terms of reference from the Mines Safety and Health Commission to continue this comparative study of the development of safety in the coalmines of the Community.

F. Study of accidents

In 1970, a single collective accident, that of Fouquière-lez-Lens, was brought to the knowledge of the Mines Safety and Health Commission. They also studied supplementary reports on three other accidents which occurred in 1967, 1968 and 1969.

a) Accident at the site of Fouqière-lez-Lens, Nord et Pas-de-Calais coalfield, 4 February 1970: firedamp and coaldust explosion (16 killed).

This accident was the subject of a provisional report to the Mines Safety and Health Commission.

While waiting for the final conclusions of the enquiry, the main circumstances can be summarised as follows:

The explosion took place in a development roadway which had reached a length of 285 m from the foot of a dip road 150 m long.

After a final round of shots at 3.15 a.m. and loading of the dêbris, the men left the development road at 5.00 a.m. and the electric current was switched off, shutting off the secondary ventilation, to carry out certain work, including the replacement, by a more powerful ventilator, of the blower situated in an air-intake cross-cut, close to the entry of the dip road.

At 6.45 a.m., the workers of the first shift waited for the new ventilator to be started up to enter the dip road and go to work.

As other workers passed, at 7.00 a.m., the explosion occurred killing 16 and injuring 11 others by mechanical effect.

This was a firedamp explosion, with some slight involvement of dust, the analysis of which makes it possible to assume that the explosion originated some 40 m from the face. The presence of an accumulation of firedamp was possible after a shutdown of ventilation for two hours. The causes of ignition of the firedamp are being studied and tests are in progress at Cerchar. It has been definitely established that the personnel were absent from the site and that the electrical equipment was switched off. One promising hypothesis is that of spark formation by friction: these sparks could have been produced when the monorail pulley block was wrenched free, since the monorail, driven by a compressed-air engine, located at the top of the dip road, could have been set in motion at the time of the accident.

(1) These extensions and the more precise joint definitions were adopted by the Mines Safety and Health Commission on 29 June 1971.

Apart from other measures, which are being studied, work requiring shut-down of the secondary ventilation should be carried out over the week-end, wherever possible.

b) Accident at the Varenne Colliery in the Loire coalfield (3 May 1968) firedamp and dust explosion: 6 killed (Sixth Report, page 12, Seventh Report, page 17).

This accident has been the subject of a final report already examined by the Restricted Committee in 1969.

In addition to the information given there, one can mention that the explosives used in the various countries are difficult to compare from the point of view of their safety, but that this question is the subject of subsidised Community research in the Research Institutes of the Community, which, in this field, are in close collaboration with Research Institutes in the United Kingdom.

The Mines Safety and Health Commission has instructed the Working Party on Flammable Dust to continue the study of this accident.

c) Accident at the Minister Achenbach Colliery (Ruhr) (4 October 1968) firedamp and coaldust explosion: 17 killed (see Sixth Report, page 13 and Seventh Report, page 16).

The Mines Safety and Health Commission has taken note of a supplementary report on this accident.

It will be recalled that this accident took place in a caved face in a level seam, which had been started up 4 days previously and in which shot-firing had been carried out in the roof to initiate caving; this caused a violent roof fall in the caving zone and a high pressure on the face, particularly in the lower part of the face, which had advanced 15 m in relation to the original rise heading, slewing around the upper part.

The accumulation of large amounts of firedamp could be explained by the presence, 20 m inside the roof of the "Ida" seam, in which the accident occurred, of a worked seam, and by the presence of gas-filled cavities in the roof of the Ida seam and in its floor, where another seam had been worked.

As to the ignition, its most probable cause is the formation of sparks produced by the impact of the upper section of a light-alloy prop (aluminium-based alloy with zinc and magnesium) on the lower section of a steel support, with a slight rust deposit.

Examination of the preventive measures envisaged by the Mines Inspectorate is not yet completed.

However, the following proposed measured can be mentioned:

- To prevent accumulations of firedamp, when starting a caved face it is necessary to control lowering of the roof by means of wooden chocks filled with stone and left in place.

- It will also be necessary, when planning to open workings, to choose the support system appropriate to the release of CH_4 to be expected. If the expected content is more than 0.50 % CH_4 in the ventilation current in a working, the use of suitable supports other than those light alloy must be considered.

- It is proposed henceforward to tighten up the official inspection of work projects for workings, to ensure adequate and continuous ventilation. Pressure measurements at the boundaries of the working will make it possible to verify that there is no risk of reversal of the ventilation current.

- It is also intended to calculate the gas emission in advance, to ascertain whether the workings pass into a zone where a greater amount of gas is released.

- Moreover, the extent to which it would be useful, to prevent firedamp accumulations, to install methane drainage lines or to fix a maximum daily production figure at the outset is being studied.

Finally, the similarity of the presumed causes (friction or impact sparks) in the accidents at Minister Achenbach and Fouquière-lez-Lens, has stimulated the Government representatives of the two countries concerned to exchange information on the test results obtained in their research centres on the subject of these accidents.

d) Accident at the Michael Colliery, United Kingdom (9 September 1967) fire: 9 killed.

This accident was the subject of a final report on the part of the British Government Representative on the basis of the report of the public enquiry into this accident.*(1)*

This was a violent fire, initiated by spontaneous ignition of coal at the crown of a roadway which was covered with foamed polyurethane, the combustion of which, together with that of a conveyor, caused the release of a considerable quantity of fumes with low oxygen content.

The Inspector of Mines and Quarries has made certain recommendations which are to be respected.

They relate to the alert of the general rescue services, checking on the presence of personnel underground, the "sign-posting" and periodic inspection of the escape routes and, in particular, to the use of polyurethane foam underground; the use of polyurethane foam has been prohibited as a consequence of tests carried out in the experimental roadway at Buxton.

Further tests and research have also been made in an attempt to find another product which has similar properties, but does not have the danger of rapid flame propagation, particularly when it is sprayed on to the walls of a roadway (tunnel effect).

The Working Party on Rescue Arrangements, Mine Fires and Underground Combustion has made considerable use of the lessons learnt from these tests in the issue of a note on the use of polyurethane (Annex VI to the Seventh Report).

II - HUMAN FACTORS

A. Health

The Working Party met three times.

The Mines Safety and Health Commission adopted two Recommendations and an opinion in the field of dust prevention in underground workings:

- a Recommendation dealing with methods of dust suppression (Annex VI)
- a Recommendation on the organisation of special departments for monitoring dust build-up (Annex VII)

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(1) Doc. 2624/68 Report on the causes and detailed circumstances of the fire at the Michael Fife Colliery, on 9 September 1967 by H.S. Stephenson (available from the Secretariat in French and German).

- an opinion recommending collaboration between constructors and operators and research departments in the construction of coal-winning and road-heading machines (Annex VIII).

These documents, already described in the Seventh Report, page 18, will not be explained in greater detail here. They have been sent to the Governments for action and distributed to the organisations concerned.

The third document was entitled "Opinion" and not "Recommendation" because it would be difficult to introduce it into the official regulations, but it will be followed by a specification for the use of mine managements, to assist them in formulating, in collaboration with manufacturers, requirements in the field on dust suppression.

A restricted group of experts is engaged in drawing up this specification.

The Restricted Committee *(1)* has decided to continue the work of the Working Party on Health (Annex II,6) by the terms of reference B2 and 3 on dust measurement and categories of dustiness and has also decided to extend these terms of reference to medical problems, with priority for environmental factors; mine climate, noise, vibration, lighting, gas, etc. Headings for other medical problems have been proposed by the Secretariat in collaboration with the Occupational Medicine Division selected from suggestions which were supplied by the various delegations in the course of an enquiry made in 1966. The choice was dictated by the state of progress of research in this field. It was approved by the Restricted Committee on 23 November 1970. *(1)*

Progress in the subsequent preparation of this work will depend on the assistance which the Secretariat receive from the Occupational Medicine Division.

B. Psychological and sociological factors affecting safety

The Working Party held two plenary meetings and a restricted meeting.

With respect to the preparation of joint safety campaigns, the Working Party took note of the work of the experts, of the documentary material prepared, of the draft of the detailed programme of necessary operations. The Working Party approved the choice of the first subject of these campaigns: "Continuous Transport Systems," but did not agree that these campaigns should be started simultaneously in all the Community countries, despite the psychological impact resulting from this, which could be an advantage. It preferred that the campaigns be carried out, on the precise subject chosen, in rotation in each of the coalfields of the Community, so as to gain the maximum benefit from actual experience, both in organisation and in the choice of the documents and material which will be used - to some extent - in all the coalfields.

The first of these campaigns will start in 1971, with Community aid. *(2)*

In addition, the national authorities responsible for the local organisation of these campaigns have been designated.

The Working Party has started its study, under its terms of reference regarding the employment of foreign workers, by establishing the elements of an enquiry into the conditions of employment of foreign labour which could affect safety, the conditions covering the measures taken and the practical application of these measures at pit level.

It also decided on a survey of serious and fatal accidents underground, occurring in coal-winning workings, distinguishing foreign labour from national labour, to ascertain the relative frequency of accidents happening to foreigners.

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(1) And the Mines Safety and Health Commission on 26 February 1971.

(2) Decided on in 1971

The Working Party took note of the summaries of brochures on the result of research financed by the High Authority of the CECA on Human Factors in respect of Safety in Mines and the Steel-making Industry.

With the object of obtaining rapid results, the Working Party decided to restrict itself to the practical incidence of the psychological and sociological aspects of safety and, in the light of this, has established the lines of an enquiry to be proposed to the Mines Safety and Health Commission on psychological factors affecting the use of individual methods of protection.

SECTION II

JOINT ACCIDENT STATISTICS

As in previous reports, the statistical tables reporting serious and fatal accidents which occurred in the various Community coalfields in 1970 have been placed in a separate Annex; they are, as usual, classified by cause of accident for the various coalfields, the member countries and the Community.

The presentation of the recapitulatory information reproduced below is also identical with that used in previous years. In Tables A and B, the information is grouped by cause of accident for the Community countries from 1958 to 1970; Table C, using the same sub-divisions, shows the fatalities and seriously injured *(1)* from 1960 to 1970 for group accidents, i.e. those which cause death or serious injury to more than five victims.

The graphs E to K present the data mentioned above for all accidents, including group accidents.

It should be noted that these Tables are drawn up in the same way as in previous years, since the new surveys, extended by the accidents mentioned in Section I to E can only be put into effect in 1971 at the earliest.

On the other hand, the same reservations always arise if it is wished to compare the rates of accident from one year to another or from country to country. Instead of comparing the actual magnitudes of accident frequency rates - which is an unsuitable procedure - one should assign to these rates a certain range or confidence interval. The increases or reductions found as the figures stand are, therefore, not necessarily significant from a statistical point of view.

Let us first examine, as in previous reports, the number of fatalities and serious injuries per number of metric tons extracted (Table D), this being done purely for indicative purposes, as has been stated previously, the level of safety being determined rather by the rates of frequency per million hours worked, as will be seen below.

As this Table and graphs I and K show, production in the Community dropped by 3.6 % in 1970 (as against 2 % in 1969) and the number of hours worked by 8 % (9 % in 1969) whilst the o.m.s. rose by 5.4 % (6.5 % in 1969).

The number of fatalities per million tons fell from 1.18 in 1969 to 1.10 in 1970 (more than 3 in 1958); the rate for serious casualties, after falling by one-third from 1958 to 1967 and a levelling-off in 1968 and 1969, underwent a reduction of 5.4 % in 1970 (38.63 as against 40.82 in 1969).

Let us now examine the number of fatalities per million working hours (Tables B, D and graph E).

The rate of fatalities, which has dropped constantly since 1958, reached its lowest level in 1970: 0.429 per million hours. In absolute figures, the number of fatalities dropped from 209 in 1969 to 188 in 1970, i.e. a reduction of approximately 10 % (13 % in 1969) whilst the number of hours worked also dropped from 476 million to 438 million, i.e. by approximately 8.1 %. In 1970, the accidents classified under headings I to V (Table B and graphs E and G) caused 83 % of the total fatalities (94 % in 1969) and are distributed as follows: Cause I (roof falls) 31 % (40 % in 1969); causes II and III (haulage and transport and movement of personnel) 40 % (42 % in 1969); causes IV and V (machinery, handling of tools and falling objects) 12 % (12 % in 1969).

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(1) The expression "seriously injured" means "victims incapacitated for more than 56 days".

The number of serious casualties per million hours worked appears in Table A and graph F. The rate of incidence, after reaching, in 1969, its highest level since 1958, has levelled off (15.022 as against 15.160). As before, there will be noted the same predominance of the accident rates for categories I to V; which alone total approximately 97 % of serious casualties, distributed in three roughly equal parts; category I (roof falls) 27.6 %, categories II and III (haulage and transport and movement of personnel) 34 % and categories IV and V (machinery, handling of tools and falling objects) 35.2 %. As shown by graph H, roof falls are still the most important cause of accidents. Their rate of 4.144 for 1970 is 7.8 % lower than in 1969; with the 1967 rate, it is the lowest achieved since 1958.

Apart from category II, the rate for which dropped by 5.14 % as compared to 1969, categories III, IV and V continued, as in previous years, to show rises of the order of 2 to 6.8 %.

A. Comparative Table of

numbers of persons incapacitated by underground accidents

for eight weeks or longer

years 1958-1970

per '000,000 man-hours

CAUSE (1958-1964)	Germany							Belgium						
	1958	1959	1960	1961	1962	1963	1964	1958	1959	1960	1961	1962	1963	1964
1) Falls of ground	4.843	4.779	4.886	4.797	4.682	4.663	4.894	5.911	4.294	4.324	4.071	4.439	4.432	4.417
2) Haulage and transport	2.550	2.569	2.445	2.458	2.501	2.433	2.385	4.132	2.979	2.709	2.770	3.331	3.565	3.419
3) Movement of personnel	2,497	2.463	2.348	2.512	2.608	2.646	2.744	1.354	0.998	1.008	1.062	1.136	1.066	0.961
4) Machinery, handling of tools and supports	0.767	0.914	0,920	0.867	1.046	1.213	1.242	2.804	2.085	2.386	2.097	2.461	2.414	2.310
5) Falling objects	2.537	2.719	2.738	2.945	3.077	3.038	3.242	0.414	0.371	0.354	0.301	0.445	0.547	0.397
6) Explosives	0.015	0.011	0.010	0.009	0.008	0.006	0.006	0.027	0.007	0.032	0.018	–	0.019	0.018
7) Explosions of firedamp or coal dust	0.011	0.016	–	0.002	0.123	0.010	–	–	–	–	–	–	–	0,009
8) Sudden outbursts of firedamp, suffocation by natural gases	–	–	–	–	–	–	–	0.011	–	–	–	–	–	–
9) Underground combustion and fires	–	–	0.003	0.002	–	–	–	–	–	–	–	–	–	–
10) Inrushes of water	0.004	–	–	–	–	0.004	–	–	–	–	–	0.010	–	–
11) Electricity	0.010	0.014	0.012	0.014	0.006	0.012	0.009	0.011	–	0.016	0.018	0.010	0.009	–
12) Other Causes	0.487	0.522	0.457	0.503	0.488	0.473	0.477	0.260	0.255	0.260	0.301	0.351	0.198	0.268
TOTAL	13.721	14.007	13,819	14.109	14.539	14.499	14.999	14.924	10.989	11.089	10.638	12.161	12.250	11.799
(1965-1970)	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
1) Falls of ground	4.732	4.721	4.524	4.618	4,736	4,321 $		3.574	3.568	3.850	3.676	5,075	4,673	
2) Haulage and transport	2.411	2.067	1.913	1.994	2,195	2,007		2.866	3.269	2.960	3.220	3.169	3,018	
3) Movement of personnel	3.032	2.852	2.974	3.300	3.399	3,370		0.771	0.936	0.903	1.122	1.186	1,144	
4) Machinery, handling of tools and supports	1.234	1.244	1.124	1.396	1.291	1,382		2.126	2.146	2.265	1.903	2.353	1,801	
5) Falling objects	3.344	3.272	3.642	3.773	4,036	4,166		0.292	0.349	0.459	0.358	1.244	1,242	
6) Explosives	0.005	0.005	0.017	0.011	0,007	0,008		–	0.013	0.056	0.049	–	–	
7) Explosion of firedamp or coal dust	0.014	0.013	–	0.004	0,004	–		0.031	–	–	–	0,019	–	
8) Sudden outbursts of firedamp, suffocation by natural gases	0.005	–	0.003	–	–	–		–	0.013	–	–	–	–	
9) Underground combustion and fires	–	–	–	0.004	–	–		0.021	–	–	–	–	–	
10) Inrushes of water	–	–	–	–	–	–		–	–	–	–	–	–	
11) Electricity	0.002	0.010	0.006	0.011	0,026	0,012		0.010	0.013	–	0.016	0,019	–	
12) Other Causes	0,354	0.414	0.396	0.429	0,402	0,532		0.333	0.362	0.278	0.228	0,175	0,195	
TOTAL	15.133	14.598	14.599	15.540	16,096	15,798		10.024	10.669	10.771	10.572	13.240	12,097	

CAUSE (1958-1964)	France (1)							Italy						
	1958	1959	1960	1961	1962	1963	1964	1958	1959	1960	1961	1962	1963	1964
1) Falls of ground	5.027	4.665	4.774	4.416	4.222	4.177	4.308	1.355	1.378	1,808	–	0.792	0.366	0,893
2) Haulage and transport	1.980	1.695	1.920	2.106	2.196	2.364	2,278	1.335	0.984	1.205	0.676	1.847	1,465	1,787
3) Movement of personnel	1.505	1,118	2.873	2.334	2,458	2.368	2.383	0.668	0.394	1.005	1.578	1.056	0.732	1,787
4) Machinery, handling of tools and supports	0.914	1,022	1.621	2.523	2.991	3.096	3.042	1.169	0.984	0.603	0.902	1.584	1.465	3.127
5) Falling objects	1.890	2.187	1.893	2.292	2.073	2.278	2,074	1.169	1.698	1.808	2.029	2.375	3,296	3.574
6) Explosives	0.043	0.051	0.031	0,017	0.051	0,009	0.013	0.167	–	–	0,225	–	0.366	–
7) Explosions of firedamp or coal dust	0.047	0.088	–	–	0.004	–	–	–	–	–	–	–	–	–
8) Sudden outbursts of firedamp, suffocation by natural gases	0,004	–	–	–	–	–	–	–	–	–	–	–	–	–
9) Underground combustion and fires	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10) Inrushes of water	–	–	–	–	–	–	0.018	–	–	–	–	–	–	–
11) Electricity	0.014	–	0.004	0.029	0.004	0,014	0.009	–	–	–	–	–	–	–
12) Other Causes	2.956	2.768	0.793	0.362	0.240	0.354	0.227	0.334	0.591	0.603	0.451	–	–	–
TOTAL	14.380	13.594	13.909	14.079	14.239	14.660	14.347	6,197	6.299	7.032	5.861	7.654	7,690	11,168
(1965-1970)	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
1) Falls of ground	3.941	3.927	3.634	4.162	4.044	3,761		5.572	6.360	5.580	0.812	3.656	–	
2) Haulage and transport	2.153	1.858	1.918	1.946	1.556	1,666		–	0.707	0.797	0.812	–	–	
3) Movement of personnel	2,087	2.239	2.174	2.815	3.226	3,372		–	0.707	1.594	0.812	1.462	–	
4) Machinery, handling of tools and supports	2,272	2.639	2.773	3.016	3.070	3,332		7.164	7.067	13.552	7.304	8.043	6,896	
5) Falling objects	1.839	1.785	2.114	2.386	2.537	2,515		0.796	–	6.377	6.493	3.656	–	
6) Explosives	0.037	0.010	0.011	–	0.050	0,016		–	–	–	–	–	–	
7) Explosion of firedamp or coal dust	–	0.029	–	–	–	0,087		–	–	–	–	–	–	
8) Sudden outbursts of firedamp, suffocation by natural gases	–	–	0.005	–	–	–		–	–	–	–	–	–	
9) Underground combustion and fires	–	–	–	–	–	–		–	–	–	–	–	–	
10) Inrushes of water	–	0.005	–	0,006	–	0,032		–	–	–	–	–	–	
11) Electricity	0.014	–	0.005	0.006	0.014	0,024		–	–	–	–	–	–	
12) Other Causes	0.174	0.200	0.185	0,233	0,291	0,294		1.592	3.360	3.189	0,812	–	5,172	
TOTAL	12.517	12.692	12.819	14.570	1.788	15,099		15.124	18.201	31.089	17.043	16.817	12,068	

CAUSE (1958-1964)	Netherlands							Community						
	1958	1959	1960	1961	1962	1963	1964	1958	1959	1960	1961	1962	1963	1964
1) Falls of ground	1.326	1.464	1.305	1.829	2.238	1.742	2,017	4.846	4.490	4.571	4.434	4.387	4.337	4.509
2) Haulage and transport	1.511	1.562	1.898	1.924	2,590	1,826	1.952	2.602	2.347	2.310	2.371	2.521	2.520	2.346
3) Movement of personnel	0,324	0.386	0.187	0.514	0,580	0.630	0.472	2.003	1.823	2.185	2.185	2.282	2.261	2.326
4) Machinery, handling of tools and supports	0.617	0.402	0,780	0.915	1.015	1.050	1,094	1.098	1.064	1.264	1.423	1.712	1.818	1.848
5) Falling objects	0,401	0,515	0.492	0.819	0.642	0.630	0.923	1,962	2,161	2.105	2.353	2.375	2.406	2.442
6) Explosives	–	–	–	–	–	–	0.021	0.023	0.020	0.017	0.012	0.018	0.010	0.011
7) Explosions of firedamp or coal dust	–	–	–	–	–	–	–	0.017	0.030	0.010	0.001	0,071	0.006	0.001
8) Sudden outbursts of firedamp, suffocation by natural gases	–	–	–	–	–	–	–	0.002	–	–	–	–	–	–
9) Underground combustion and fires	–	–	–	–	–	–	–	–	–	0.002	0.001	–	–	–
10) Inrushes of water	–	–	–	–	–	–	–	0.002	–	–	–	0.001	0.002	0.003
11) Electricity	–	–	–	–	0.021	–	0.021	0.010	0.008	0.010	0.018	0.007	0.012	0.008
12) Other Causes	0.262	0.161	0,390	0.210	0.497	0.147	0,129	0,985	1.012	0.513	0.428	0.404	0.390	0.364
TOTAL	4.441	4.490	5.051	6.212	7.583	6.025	6,629	13.551	12,954	12.986	13.227	13.781	13.781	13.861
(1965-1970)	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
1) Falls of ground	1.923	1.688	2.466	2.450	2,737	2,964		4.215	4.186	4.060	4.261	4.492	4,144	
2) Haulage and transport	2.808	2.621	1.866	2.407	2.562	2,388		2.416	2.173	2.037	2.139	2.118	2,009	
3) Movement of personnel	0.774	0.605	0.766	1.160	1.165	0,823		2.364	2.320	2.354	2.795	3.023	3,082	
4) Machinery, handling of tools and supports	1,282	2,066	0.833	1.031	1.689	1,153		1.773	1.815	1.790	1.945	1.865	1,991	
5) Falling objects	0.862	0,958	0.866	1.590	1.106	0,576		2.415	2.362	2.638	2.858	3.185	3,306	
6) Explosives	–	–	–	–	–	–		0.013	0.007	0.019	0.015	0.019	0,011	
7) Explosion of firedamp or coal dust	–	–	–	–	–	–		0.011	0.016	–	0.002	0.004	0,025	
8) Sudden outbursts of firedamp, suffocation by natural gases	–	–	–	–	–	–		0.002	0.001	0.003	–	–	–	
9) Underground combustion and fires	–	–	–	–	–	–		0.002	–	–	0.002	–	–	
10) Inrushes of water	–	–	–	–	–	–		–	0.001	–	0.002	–	0,009	
11) Electricity	–	–	–	–	–	–		0.006	0.007	0.005	0.010	0.021	0,014	
12) Other Causes	0.088	0.353	0,700	0.301	0.116	0,082		0.289	0.354	0.337	0.341	0.333	0,431	
TOTAL	7.737	8.291	7.497	8.939	9.375	7,986		13.506	13,242	13.246	14.370	15.160	15,022	

(1) Including Provence as from 1970.

B. Underground accidents resulting in death within eight weeks

years 1958-1970

per '000,000 man-hours

CAUSE (1958-1964)	Germany							Belgium						
	1958	1959	1960	1961	1962	1963	1964	1958	1959	1960	1961	1962	1963	1964
1) Falls of ground	0.268	0.290	0.263	0.216	0.280	0.260	0.200	0.223	0.213	0.299	0.266	0.246	0.264	0.222
2) Haulage and transport	0.179	0.169	0.182	0.196	0.149	0.178	0.300	0.101	0.124	0.157	0.168	0.142	0.245	0.166
3) Movement of personnel	0.094	0.097	0.070	0.086	0.059	0.089	0.071	0.011	0.027	0.008	0.035	0.010	0.057	0.028
4) Machinery, handling of tools and supports	0.010	0.027	0.012	0.027	0.037	0.019	0.028	0.005	0.014	0.016	0.027	0.047	-	0.018
5) Falling objects	0.065	0.041	0.039	0.065	0.094	0.072	0.054	0.016	-	0.008	-	0.010	0.019	0.018
6) Explosives	0.009	0.003	0.003	-	0.004	-	0.002	0.011	0.014	-	-	-	-	-
7) Explosives of firedamp or coal dusts	0.011	0.012	-	-	0.660	0.002	0.002	-	-	0.016	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	0.005	0.003	0.002	0.004	0.002	-	-	0.016	0.014	-	-	0.047	-	-
9) Underground combustion and fires	-	0.003	-	0.002	-	0.006	0.009	-	0.007	-	-	-	-	-
10) Inrushes of water	-	0.003	0.002	-	-	0.004	-	0.011	-	-	0.044	0.047	0.019	-
11) Electricity	0.022	0.008	0.002	0.005	0.010	0.002	0.004	0.021	-	0.024	-	-	0.009	0.009
12) Other causes	0.025	0.025	0.036	0.049	0.049	0.025	0.017	0.005	-	0.008	0.009	0.019	0.028	0.009
TOTAL	0.687	0.680	0.611	0.651	1.344	0.657	0.587	0.420	0.413	0.536	0.549	0.568	0.641	0.471
(1965-1970)	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
1) Falls of ground	0.184	0.197	0.206	0.148	0.192	0.113		0.239	0.324	0.264	0.179	0.214	0.268	
2) Haulage and transport	0.191	0.175	0.150	0.126	0.143	0.128		0.166	0.187	0.180	0.114	0.017	0.170	
3) Movement of personnel	0.070	0.094	0.076	0.079	0.056	0.058		0.011	0.025	-	0.033	-	-	
4) Machinery, handling of tools and supports	0.025	0.030	0.020	0.014	0.034	0.031		0.052	0.025	0.028	0.065	-	-	
5) Falling objects	0.058	0.048	0.063	0.051	0.049	0.035		-	-	-	0.016	-	-	
6) Explosives	-	-	-	0.004	-	-		-	-	-	0.016	-	-	
7) Explosives of firedamp or coal dust	0.019	0.056	-	0.061	-	-		0.011	-	-	-	-	-	
8) Sudden outbursts of firedamp, suffocation by natural gases	0.002	0.002	0.007	-	0.004	-		0.041	0.013	-	-	-	-	
9) Underground combustion and fires	0.005	-	-	-	-	-		0.011	-	-	-	-	-	
10) Inrushes of water	-	-	-	-	-	0.012		-	-	-	-	-	-	
11) Electricity	0.005	-	0.003	0.004	0.004	0.004		0.011	-	0.014	0.033	0.019	0.024	
12) Other causes	0.023	0.027	0.017	0.022	0.022	0.027		-	0.013	0.042	-	-	-	
TOTAL	0.582	0.629	0.542	0.509	0.504	0.408		0.542	0.587	0.528	0.456	0.330	0.462	

CAUSE (1958-1964)	France (1)							Italy						
	1958	1959	1960	1961	1962	1963	1964	1958	1959	1960	1961	1962	1963	1964
1) Falls of ground	0.235	0.192	0.186	0.219	0.167	0.120	0.127	0.167	-	0.201	0.225	-	0.366	-
2) Haulage and transport	0.115	0.085	0.082	0.122	0.077	0.121	0.141	-	0.197	-	-	-	-	-
3) Movement of personnel	0.007	0.018	0.027	0.008	0.043	0.009	0.009	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	0.018	0.040	0.016	0.008	0.030	0.009	0.036	-	-	-	-	-	-	-
5) Falling objects	0.025	0.007	0.004	0.017	0.030	0.009	0.018	-	0.197	-	-	-	-	-
6) Explosives	-	0.026	-	-	-	0.005	0.005	0.501	-	-	-	-	-	-
7) Explosives of firedamp or coal dusts	0.115	0.121	-	-	0.004	-	-	-	-	-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	0.043	0.026	0.019	0.004	-	0.019	0.009	0.167	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	0.004	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	0.011	0.012	-	0.009	0.024	-	-	-	-	-	-	-	-
12) Other causes	0.036	0.029	0.008	-	0.009	0.014	0.014	-	-	-	-	-	-	-
TOTAL	0.594	0.555	0.354	0.382	0.369	0.330	0.359	0.835	0.394	0.201	0.225	-	0.366	-
(1965-1970)	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
1) Falls of ground	0.164	0.214	0.159	0.177	0.149	0.143		-	-	-	-	-	-	
2) Haulage and transport	0.052	0.126	0.088	0.101	0.186	0.127		-	-	0.797	-	-	-	
3) Movement of personnel	0.042	0.024	0.016	0.025	0.014	0.016		-	-	-	-	-	-	
4) Machinery, handling of tools and supports	0.009	0.015	0.016	0.006	-	0.032		-	-	0.797	-	-	-	
5) Falling objects	0.019	0.015	0.011	0.031	0.014	0.016		-	-	-	-	-	-	
6) Explosives	0.009	0.005	0.005	0.006	-	0.008		-	-	-	-	-	-	
7) Explosives of firedamp or coal dust	0.155	-	-	0.038	-	0.127		-	-	-	-	-	-	
8) Sudden outbursts of firedamp, suffocation by natural gases	-	0.005	0.027	0.019	0.007	-		-	-	-	-	-	-	
9) Underground combustion and fires	-	-	-	-	-	-		-	-	-	-	-	-	
10) Inrushes of water	0.005	-	0.005	-	-	0.016		-	-	-	-	-	-	
11) Electricity	-	0.010	-	-	0.007	-		-	-	-	-	-	-	
12) Other causes	-	0.005	0.005	-	0.007	-		-	-	-	-	-	-	
TOTAL	0.455	0.419	0.332	0.403	0.384	0.484		-	-	1.594	0	-	-	

CAUSE (1958-1964)	Netherlands							Community						
	1958	1959	1960	1961	1962	1963	1964	1958	1959	1960	1961	1962	1963	1964
1) Falls of ground	0.262	0.064	0.034	0.114	0.062	0.084	0.043	0.253	0.242	0.235	0.217	0.234	0.217	0.175
2) Haulage and transport	0.077	0.145	0.067	0.095	0.062	0.105	0.172	0.147	0.141	0.146	0.168	0.124	0.167	0.178
3) Movement of personnel	-	-	-	-	-	-	-	0.057	0.063	0.047	0.056	0.045	0.060	0.045
4) Machinery, handling of tools and supports	0.015	0.016	-	-	0.041	-	-	0.011	0.028	0.012	0.021	0.037	0.013	0.030
5) Falling objects	-	0.016	-	-	-	-	0.043	0.045	0.027	0.024	0.041	0.062	0.046	0.037
6) Explosives	-	-	-	-	-	-	-	0.009	0.010	0.002	-	0.002	0.001	0.002
7) Explosives of firedamp or coal dusts	-	-	-	-	-	-	-	0.032	0.036	0.002	-	0.375	0.001	0.001
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-	-	-	-	-	-	0.016	0.010	0.006	0.003	0.007	0.005	0.002
9) Underground combustion and fires	-	-	-	-	-	-	-	-	0.003	-	0.001	-	0.003	0.005
10) Inrushes of water	-	-	-	-	-	-	-	0.002	0.002	0.001	0.006	0.005	0.005	-
11) Electricity	-	-	-	0.019	-	-	-	0.016	0.007	0.007	0.004	0.008	0.008	0.003
12) Other causes	-	-	0.017	-	-	-	-	0.023	0.021	0.024	0.029	0.032	0.021	0.014
TOTAL	0.355	0.241	0.119	0.229	0.166	0.189	0.258	0.610	0.590	0.507	0.546	0.932	0.547	0.492
(1965-1970)	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
1) Falls of ground	0.044	0.050	0.100	0.172	0.058	0.082		0.177	0.208	0.192	0.160	0.176	0.135	
2) Haulage and transport	0.177	0.126	-	0.086	-	0.165		0.149	0.160	0.128	0.115	0.145	0.132	
3) Movement of personnel	-	-	-	-	0.058	-		0.051	0.060	0.044	0.054	0.038	0.039	
4) Machinery, handling of tools and supports	0.022	-	0.067	-	0.117	-		0.024	0.023	0.024	0.017	0.023	0.027	
5) Falling objects	-	-	-	0.043	-	-		0.037	0.030	0.036	0.040	0.031	0.025	
6) Explosives	-	-	-	-	-	-		0.002	0.001	0.002	0.006	-	0.002	
7) Explosives of firedamp or coal dust	-	-	-	-	-	-		0.053	0.030	-	0.044	-	0.037	
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-	-	-	-	-		0.006	0.004	0.012	0.006	0.004	-	
9) Underground combustion and fires	-	-	-	-	-	-		0.005	-	-	-	-	-	
10) Inrushes of water	-	-	-	-	-	-		0.001	-	0.002	-	-	0.011	
11) Electricity	-	-	-	-	-	-		0.004	0.003	0.004	0.006	0.006	0.004	
12) Other causes	-	-	-	-	-	-		0.013	0.017	0.015	0.012	0.015	0.016	
TOTAL	0.243	0.176	0.167	0.301	0.233	0.247		0.522	0.536	0.457	0.460	0.438	0.429	

(1) Including Provence as from 1970.

C. Comparative Table of underground group accidents (see (1) below)
years 1960-1970

Germany (1960-1965)

CAUSE (1960-1965)	1960			1961			1962			1963			1964			1965		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	2	2	10	-	-	-	1	1	6	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	2	5	14	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-	-	-	-	-	3	62	338	-	-	-	-	-	-	1	4	8
8) Sudden outbursts of firedamp suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	2	2	10	-	-	-	4	63	344	-	-	-	2	5	14	1	4	8

Belgium (1960-1965)

CAUSE (1960-1965)	1960			1961			1962			1963			1964			1965		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	-	-	-	-	-	-	1	2	6	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	33
8) Sudden outbursts of firedamp suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	-	-	1	2	6	-	-	-	-	-	-	2	-	33

France (1) (1960-1965)

CAUSE (1960-1965)	1960			1961			1962			1963			1964			1965		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	-	-	-	1	-	7	1	-	6	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8) Sudden outbursts of firedamp suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	-	-	-	1	-	7	1	-	6	-	-	-	-	-	-	-	-	-

Italy (1960-1965)

CAUSE (1960-1965)	1960			1961			1962			1963			1964			1965		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8) Sudden outbursts of firedamp suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Netherlands (1960-1965)

CAUSE (1960-1965)	1960			1961			1962			1963			1964			1965		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8) Sudden outbursts of firedamp suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Community (1960-1965)

CAUSE (1960-1965)	1960			1961			1962			1963			1964			1965		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	2	2	10	1	-	7	3	3	18	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	2	5	14	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-	-	-	-	-	3	62	338	-	-	-	-	-	-	3	4	41
8) Sudden outbursts of firedamp suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	2	2	10	1	-	7	6	65	356	-	-	-	2	5	14	3	4	41

Germany (1966-1970)

CAUSE (1966-1970)	1966			1967			1968			1969			1970			1971		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	2	5	21	-	-	-	1	-	17	-	-	-	-	-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	2	5	21	-	-	-	1	-	17	-	-	-	-	-	-	-	-	-

Belgium (1966-1970)

CAUSE (1966-1970)	1966			1967			1968			1969			1970			1971		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	1	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	1	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

France (1) (1966-1970)

CAUSE (1966-1970)	1966			1967			1968			1969			1970			1971		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-	-	-	-	-	-	-	-	-	-	-	1	11	16	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Italy (1966-1970)

CAUSE (1966-1970)	1966			1967			1968			1969			1970			1971		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Netherlands (1966-1970)

CAUSE (1966-1970)	1966			1967			1968			1969			1970			1971		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Community (1966-1970)

CAUSE (1966-1970)	1966			1967			1968			1969			1970			1971		
	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b	N	a	b
1) Falls of ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2) Haulage and transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3) Movement of personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4) Machinery, handling of tools and supports	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5) Falling objects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Explosives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7) Explosions of firedamp or coal dust	3	11	21	-	-	-	1	-	17	-	-	-	-	-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10) Inrushes of water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11) Electricity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12) Other causes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	3	11	21	-	-	-	1	-	17	-	-	-	-	-	-	-	-	-

(1) Accidents involving more than five casualities of type (a).
(N) Number of group accidents.
(a) Casualties were unable te resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(1) Including Provence as from 1970.

D. RECAPITULATION: COMMUNITY OVERALL

Year	Extraction (1)	Underground o.m.s. (kg.)	Million man-hours worked	Fatalities	Serious injuries (4) (disablement for 8 weeks or over)	Fatalities per m.tons	Serious injuries (4) per m. tons	Fatalities per m. man-hours	Serious injuries per m. man-hours
1958	252.278	1,634	1.260	770	17,074	3.052	67.68	0.610	13.551
1959	240.602	1,788	1,122	622	14,539	2.585	60.43	0.590	12.950
1960	239.967	1,958	1.037	526	13,459	2.192	56.09	0,507	12,986
1961	235.848	2,100	962	527	12,720	2.235	53.93	0.548	13.227
1962	233.233	2,229	901	840(2) 541(3)	12,418	3.602(2) 2.320(3)	53.24	0.932(2) 0.600(3)	13,781
1963	229.769	2,331	849	465	11,686	2.024	50,86	0.547	13.761
1964	235.007	2,395	841	411	11,726	1.749	49.89	0.493	13.860
1965	224.249	2,461	784	410	10,595	1.828	47.25	0.522	13.506
1966	210.189	2,611	698	374	9,247	1.779	43.99	0.536	13.242
1967	189.484	2,824	587	269	7,781	1.420	41.06	0.457	13.246
1968	181.170	3,065	522	240	7,501	1,326	41.44	0,460	14,370
1969	176,900	3,265	476	209	7,222	1,181	40,82	0.438	15.160
1970	170.355	3,442	438	188	6,680	1.104	38.63	0.429	15.022
1971									

(1) Net extraction, slurry and dust.
(2) Incl. Luisenthal explosion.
(3) Excl. Luisenthal explosion.
(4) Casualties were unable to resume work for at least eight weeks.

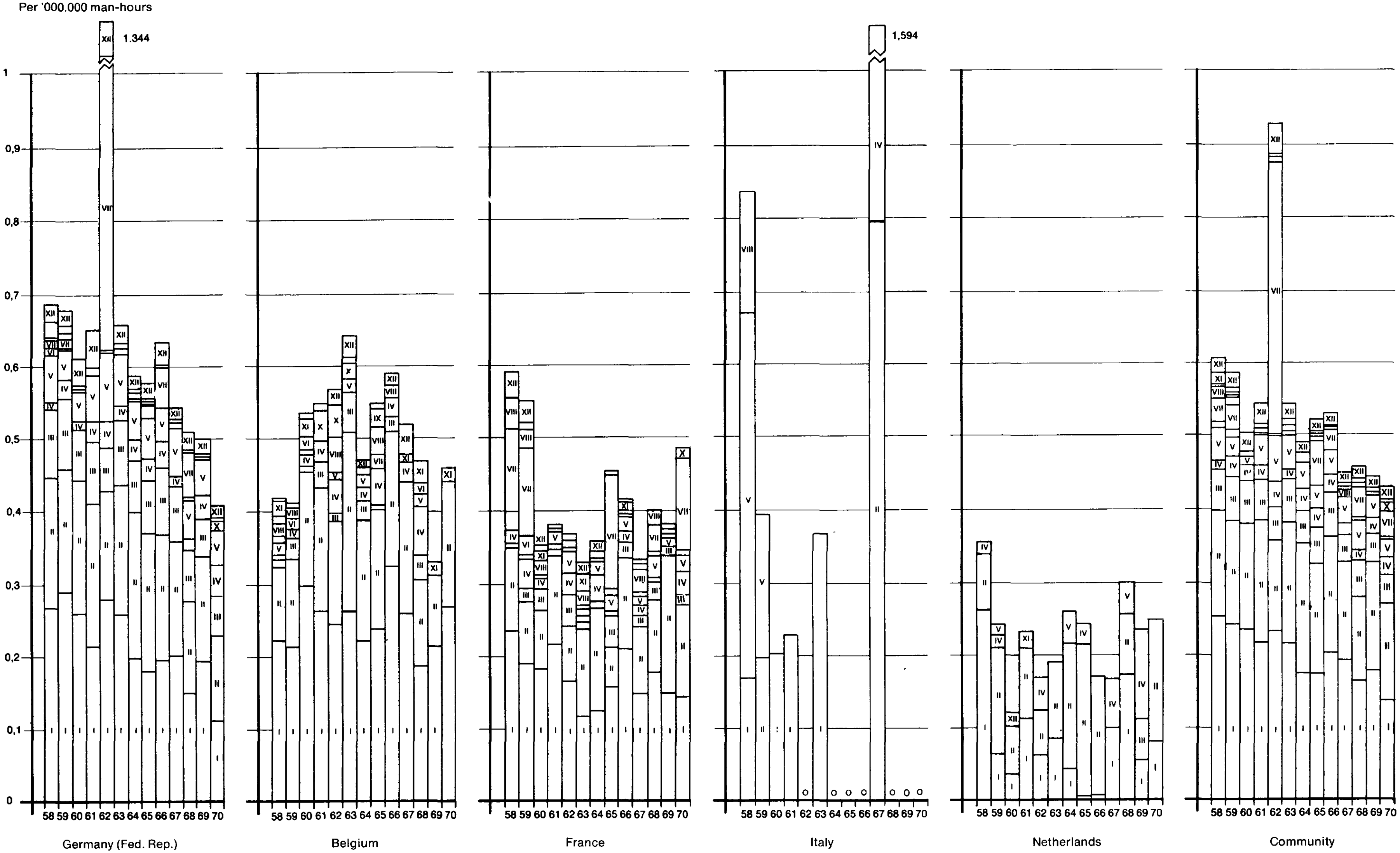
GRAPHS
OF FATAL AND SERIOUS CASUALTIES
IN COMMUNITY COALMINES [1]

KEY
to Roman figures in Graphs

I	Falls of ground
II	Haulage and transport
III	Movement of personnel
IV	Machinery, handling of tools and supports
V	Falling objects
VI	Explosives
VII	Explosions of firedamp or coal dust
VIII	Sudden outbursts of firedamp, suffocation by natural gases
IX	Fires and uderground combustion
X	Inrushes of water
XI	Electricity
XII	Other causes

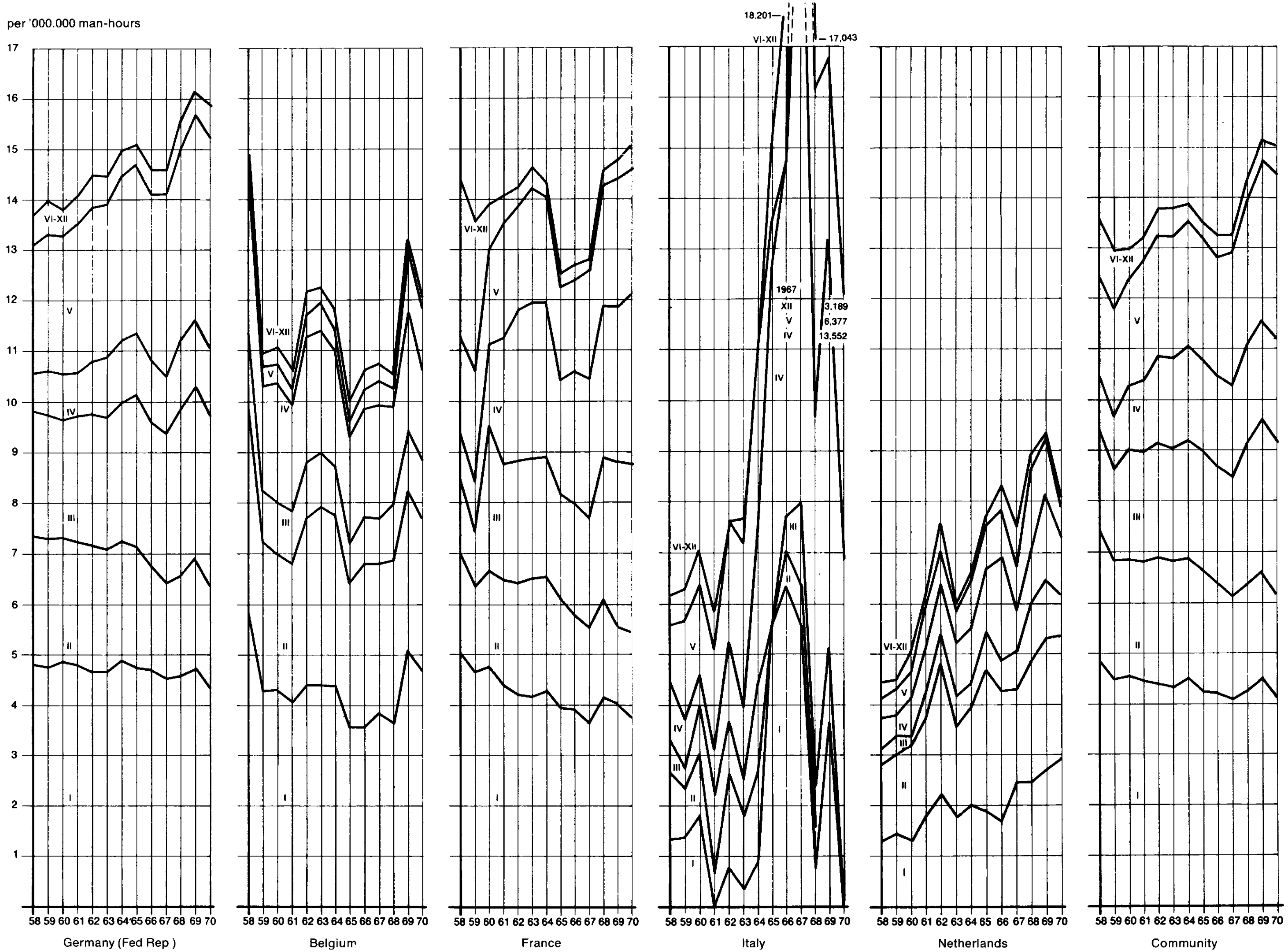
([1]) Casualties were unable to resume work for at least eight weeks.

E. FATALITIES BELOW GROUND IN THE COMMUNITY [1]) BY CAUSES OF ACCIDENT



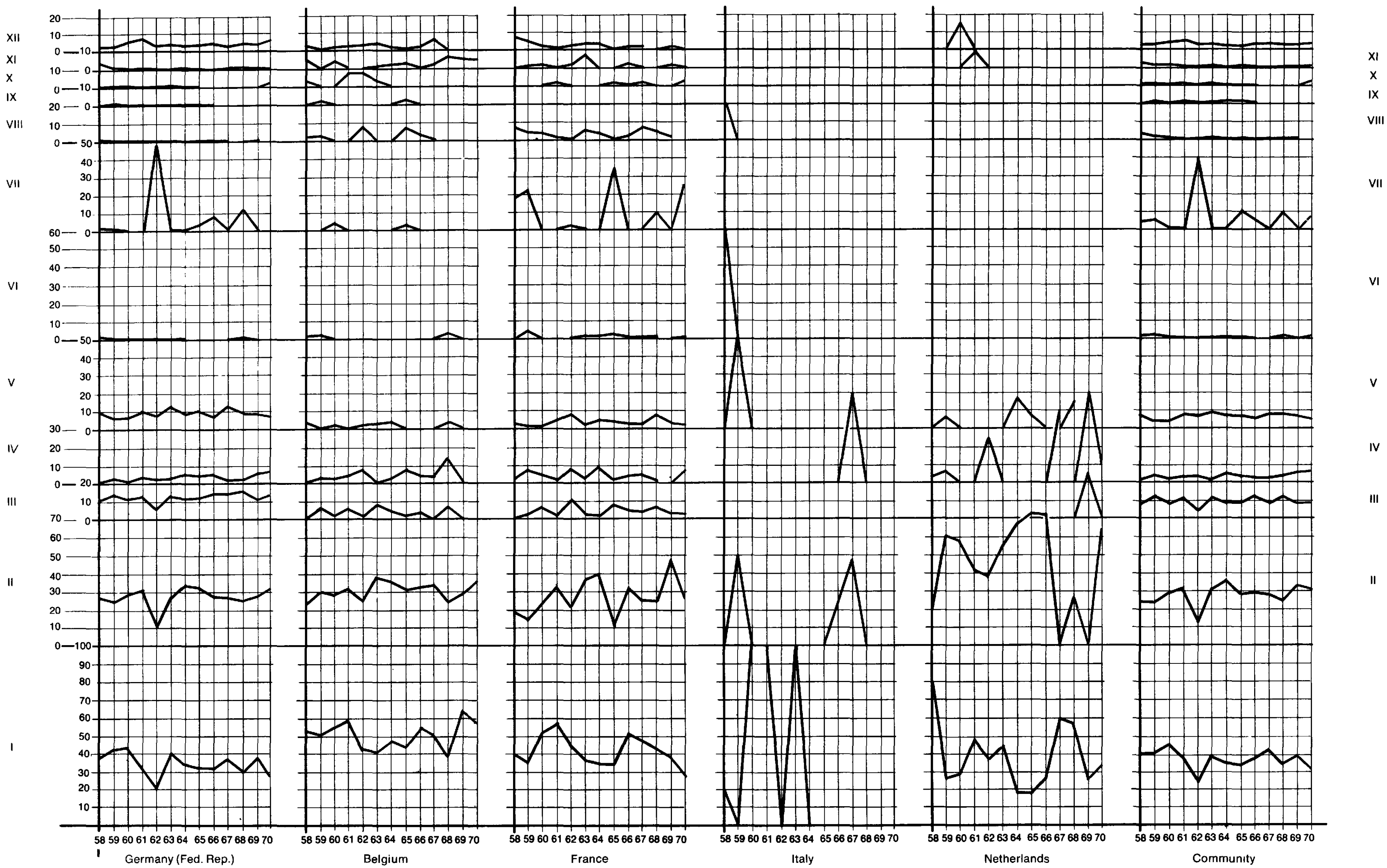
[1]) CASUALTIES DIED WITHIN EIGHT WEEKS

F. CASES OF SERIOUS INJURY BELOW GROUND [1]) IN THE COMMUNITY, BY CAUSES OF ACCIDENT



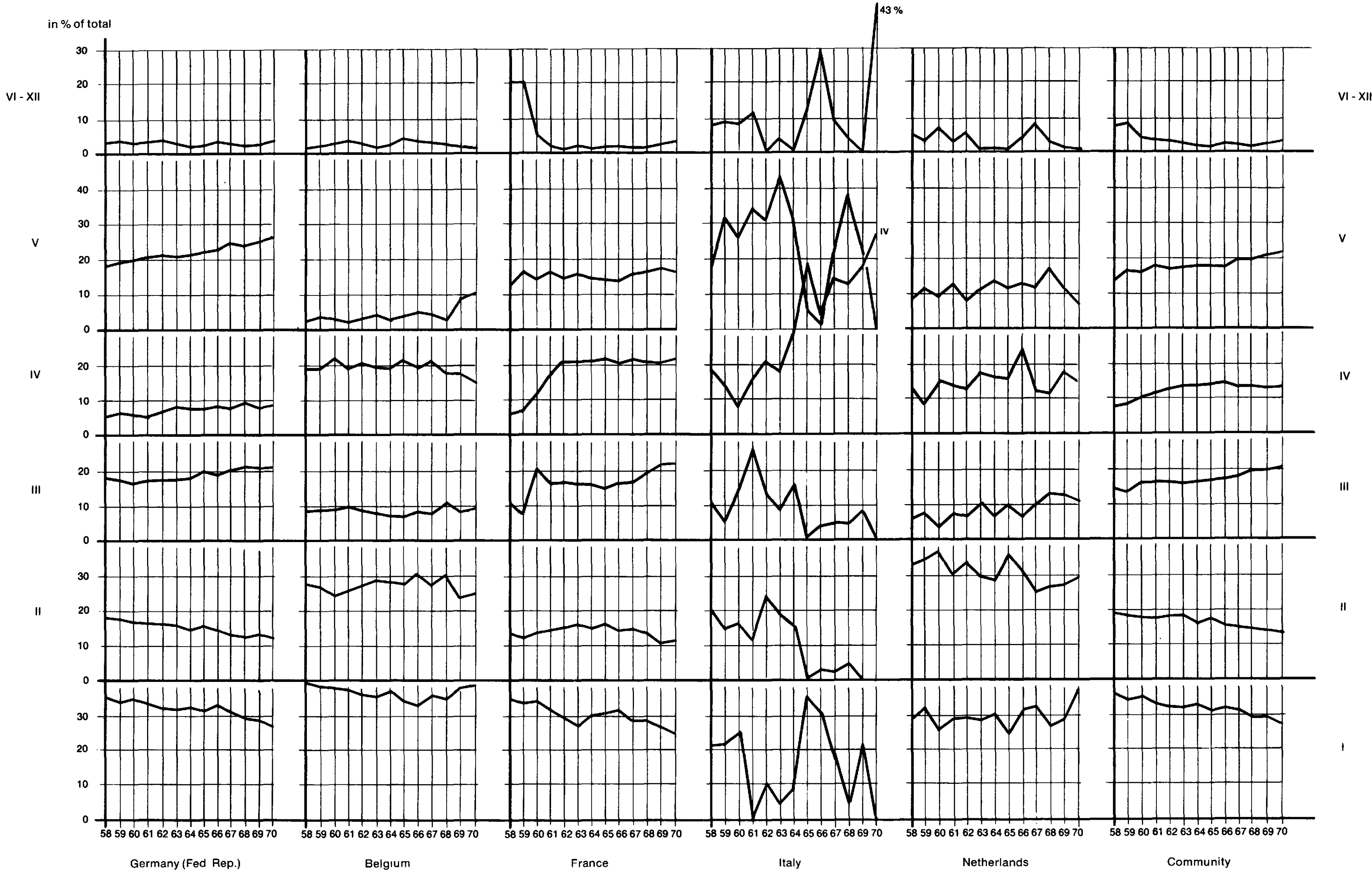
1) CASUALTIES WERE UNABLE TO RESUME WORK BELOW GROUND FOR AT LEAST EICHT WEEKS

G. FATALITIES BELOW GROUND [1]) IN THE COMMUNITY BY CAUSES OF ACCIDENT



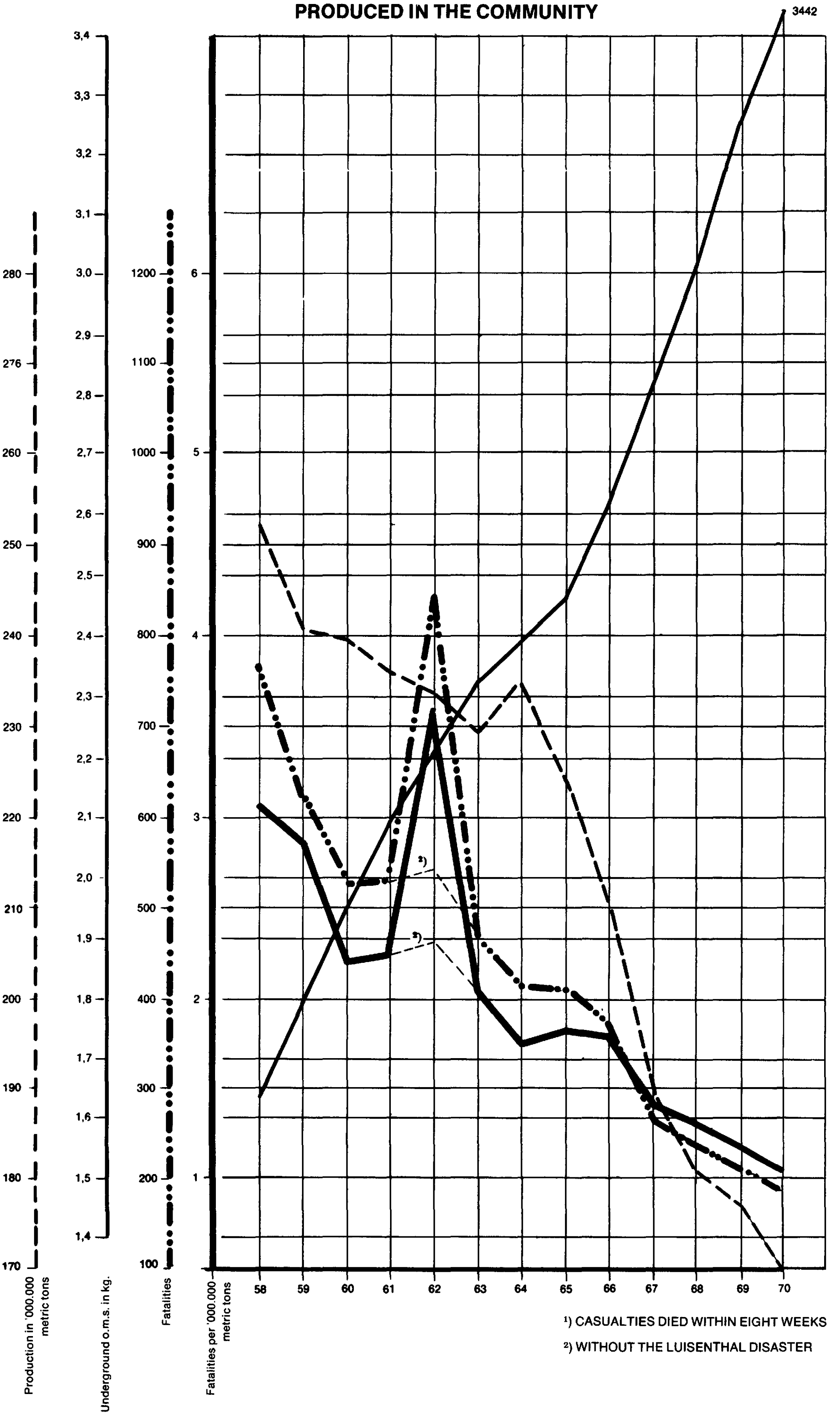
[1]) CASUALTIES DIED WITHIN EIGHT WEEKS

H. CASES OF SERIOUS INJURY BELOW GROUND [1]) IN THE COMMUNIY BY CAUSES OF ACCIDENT



[1]) CASUALTIES WERE UNABLE TO RESUME WORK BELOW FOR AT LEAST EIGHT WEEKS

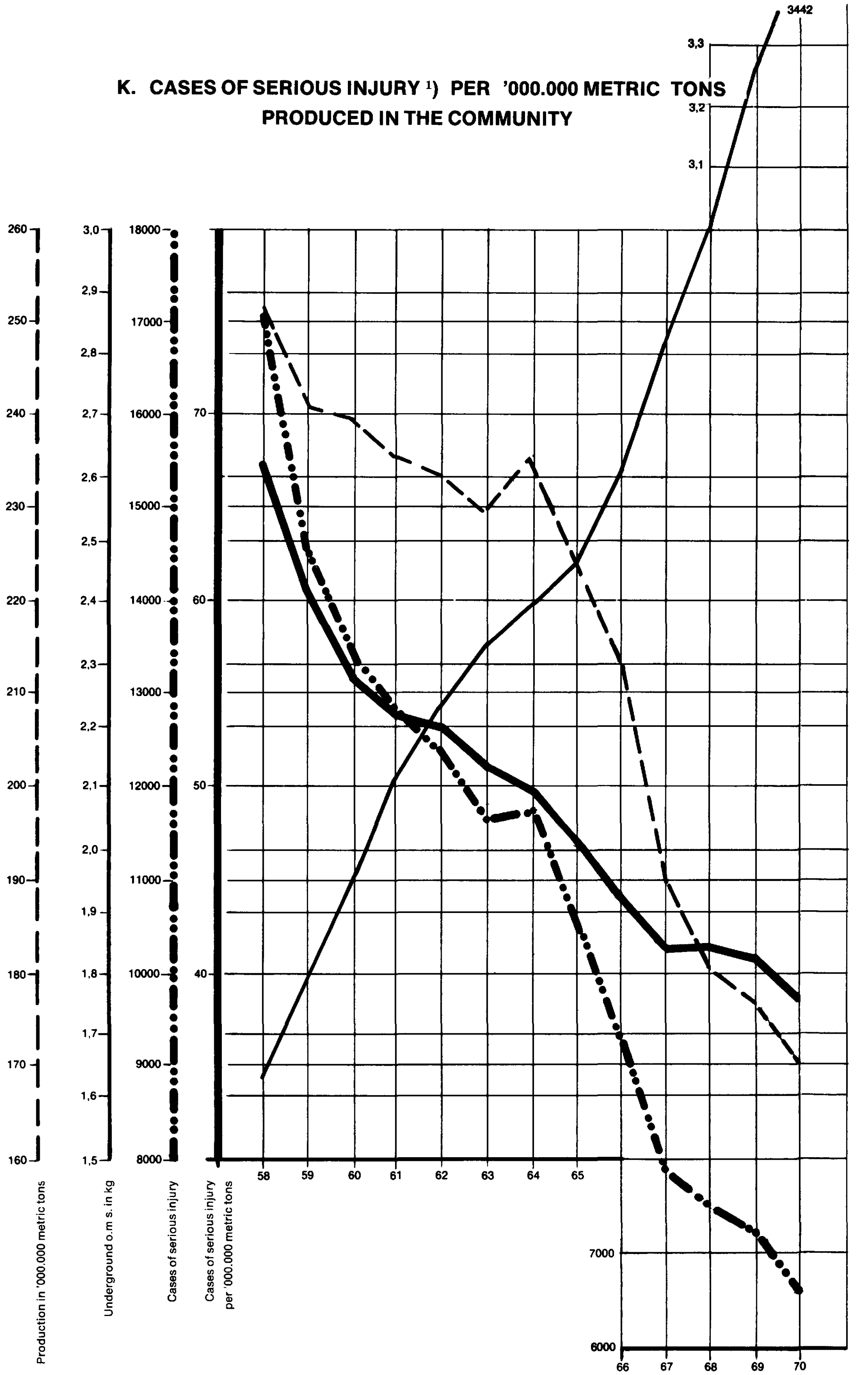
I. FATALITIES [1]) PER '000.000 METRIC TONS PRODUCED IN THE COMMUNITY



1) CASUALTIES DIED WITHIN EIGHT WEEKS

2) WITHOUT THE LUISENTHAL DISASTER

K. CASES OF SERIOUS INJURY [1]) PER '000.000 METRIC TONS PRODUCED IN THE COMMUNITY



[1]) CASUALTIES WERE UNABLE TO RESUME WORK BELOW GROUND FOR AT LEAST EIGHT WEEKS

SECTION III

OFFICIAL REGULATIONS DRAWN UP IN 1969 AND 1970

In 1969 and 1970, the various Community countries issued the following official regulations with regard to safety and health in coalmines. It should be noted that, in some countries, these regulations also apply to surface mines and quarries.

FEDERAL REPUBLIC OF GERMANY

I - Rhineland-Westphalia

1. Provisions relative to the prevention of fatal accidents caused by falling rocks and coal during operations in the face; OBA Dortmund 18.22 I 5, 23.1.1969.

2. Provisions relative to the danger of poisoning by shot-blasting fumes in workings with secondary ventilation; OBA Bonn 17. 7 I 4, 31.1.1969.

3. Provisions relative to the inspection of abandoned underground workings; OBA Dortmund 55.3 I 16, 4.2.1969.

4. Provisions relative to dust measurements and the utilisation of their results; OBA Dortmund 12.21.31. I 5, 24.2.1969.

5. Provisions relative to the material-testing conditions for brake-linings with regard to their fire-resistance; OBA Dortmund 18.43.21 I 5, 28.2.1969.

6. Regulations on the subject of filling and covering shafts opening above ground; OBA Dortmund 18.13 I 3, 7.3.1969.

7. Provisions relative to faces with suspended stowing; OBA Dortmund 18.21 2 I 1, 12.5.1969.

8. Regulations on setting up and utilising explosives stores and temporary storage sites; OBA Bonn 17.15 I 3/5, 15.5.1969.

9. Provisions relative to the principles relating to the purpose and organisation of safety services; OBA Bonn 11.4 I 11/8, 30.5.1969.

10. Provisions relative to the training of shot-firers; OBA Dortmund 17.4 I 6, 11.6.1969.

11. Provisions relative to the prevention of accidents caused by falling rocks and coal - results of an enquiry; OBA Dortmund 18.22.1 I 10, 20.6.1969.

12. Regulations on the agreement of plans relative to the conditions linked with the driving of roadways; OBA Dortmund 11.1 I 2, 28.7.1969.

13. Regulations on the treatment of rails when converting them for use as support elements and the properties required of these rails; OBA Dortmund 18.23.2 I 3, 1.8.1969.

14. Regulations on the use and inspection of portable explosimeters; LOBA NW 18.34.7 I 2, 20.3.1970.

15. Provisions relative to the danger of explosion when working in the fume condensers of steam boilers; LODA NW X8f 6-5 II 21.5.1970.

16. Provisions relative to the maintenance of the steam accumulators of armour-plated locomotives; LOBA NW 14.21 XV 41, 11.6.1970.

17. Provisions relative to the main winding and man-riding installations; LOBA NW 15.16.6 I 8, 29.6.1970.

18. Regulations relative to the representation on the ventilation plan of the underground workings of the mine and of the information required by §167, paragraph 1 of the Mining Regulations (BVOSt); LOBA NW 18.32.2 II 12, 10.7.1970.

19. Provisions relative to the ventilation of coal-winning workings during starting-up:, LOBA NW 18.3. I 3, 20.7.1970.

20. Provisions relative to the effect of shot-firing detonators; LOBA NW 17.2. I 13; 27.8.1970.

21. Provisional regulations relative to the certification of laser appliances in accordance with the working plans; LOBA NW 12.31 I 7, 15.9.1970.

22. Provisions relative to the regular transport of personnel by man-riding trains and conveyor belts; LOBA NW 16.2 I 15, 21.9.1970.

23. Provisions relative to the certification and conditions of use of synthetic resin Trihäsan A, E and B liquids for strengthening the solid rock underground; LOBA NW 18.43.22 I 17, 19.10.1970.

24. Provisions relative to the certification of trough water barriers - model 3 (suspended and laid channels); LOBA NW 18.42.5 III 3, 24.11.1970.

25. Provisions relative to the certification of troughwater barriers - model 4 (barriers with divided troughs); LOBA NW 18.42.5 III 17, 24.11.1970.

26. Provisions relative to the inspection of the mine of the work of persons exposed to dust risk; LOBA NW 12.23.23 I 12, 1.12.1970.

27. Regulations relative to the approval of working plans for the driving of roadways, development workings and faces in coal or rock in sections threatened by rock bursts; LOBA NW 18.22 I 2, 30.12.1970.

II - The Saar

Regulations for the consultation of the Works Committees in operations subject to safety inspection by the Mines Inspectorate; Saarbrücken, 30.12.1969.

BELGIUM

1. Royal decree of 5.9.1969 relative to regulations on the use of electricity in coalmines, surface-mines and underground quarries;

2. Royal decree and ministerial decree of 10.12.1970 relative to dust suppression in the underground workings in coalmines.

FRANCE

1. Circular relative to the control by electrical transmission of the position indicators of skips, cages and kibbles in mine shafts, 17.4.1969 (DMH No. 118).

2. Decree modifying Clauses 33, 37 and 38 of the decree of 20.10.1961 relative to electrical equipment, safety lamps and flameproof liquid-fuelled locomotives (accumulator batteries and portable individual electric lamps) 10.9.1969 (DMH-Z No. 85).

3. Circular modifying the commentary of Clause 33 of the decree of 30.10.1961 relative to flameproof housings for accumulator batteries (application of the decree of 10.9.1969, 6.10.1969 (DMH No. 327).

4. Supplementary Order to the general regulations of 4.5.1951 on the exploitation of solid mineral fuel mines with regard to the use of cartridged explosives and shot-firing with deep vertical shot-holes, 29.9.1969 (No. 69-899).

5. Decree regulating shot-firing with deep vertical shot-holes in open-cast operations; 7.10.1969 (DMH-Z No. 86).

6. Decree authorising bulk gravity charging of explosives in vertical shot-holes in open-cast operations; 7.10.1969 (DMH-Z No. 87).

7. Decree modifying Clauses 7 and 8 of the decree of 30.10.1969 relative to electrical equipment, safety lamps and flameproof liquid-fuelled locomotives (equipment with flameproof housing); 6.11.1969 (DMH-Z No. 89).

8. Circular relative to shot-firing in deep vertical shot-holes and gravity charging of certain non-cartridged explosives in vertical shot-holes in open-cast operations (applications of the decrees of 7.10.1969); 21.11.1969 (DMH No. 362).

9. Circular modifying the commentary of Clause 7 of the decree of 30.10.1961 (application of the decree of 6.11.1969); 28.11.1969 (DMH No. 368).

10. Circular and standard prefectoral decree regulating the use of welding and gas cutting in the underground workings on solid mineral fuel mines; 12.2.1970 (DMH No. 50).

11. Circular relative to the control by electrical transmission of the position indicator of cages, skips and kibbles in mine shafts (modifies circular DMH No. 118 of 17.4.1969); 7.9.1970 (DMH No. 316).

12. Circular supplementing the list of explosives, free-fall charging of which can be authorised in deep vertical shot-holes in open-cast operations (see circular DMH No. 362 of 21.11.1969); 12.10.1970 (DMH No. 350).

13. Decree relative to the testing of the insulation between conductors of different polarity of phase; 10.11.1970 (DMH-Z No. 92).

NETHERLANDS

On 25th May 1970, 10 ministerial decrees supplemented certain directives of the Mines Regulations of 1964, in the field of drilling installations and surface installations, and, in particular, the following directives:

- Clause 154, paragraph 4, relative to the recovery of rock piles (No. 13171/351 of 5.10.1970).

- Clauses 114, 115, 116, 175 and 181 relative to electrical installations and electric drilling gear (No. 1299/351.82 of 7.9.1970).

- Clause 43, paragraphs 1 and 44, relative to narrow-gauge transport on the surface (No. 1269/351.82 of 11.8.1970).

- Clause 176, paragraph 4, relative to a fire-fighting plan in drilling installations (No. 1272/351.82 of 11.8.1970).

- Clause 43, paragraph 1 and 44 relative to fixed transport installations on the surface (No. 1275/351.82 of 11.8.1970).

- Clause 250, paragraphs 3 and 4 relative to any overhauls in the drilling installations (No 1227/351.82 of 11.2.1970).

- Clause 97, paragraphs 1 and 5 relative to lighting in surface installations (No. 1162/351.82 of 11.2.1970).

- Clauses 257, paragraphs 2 and 5; 260, paragraph 3; 261, paragraphs 1, 4 and 5, 267, paragraph 2 and 277, paragraphs 5 and 6 on protection against ionising radiations (No. 1233/351.82 of 26.5.1970).

- Clause 43, paragraphs 1 and 44 relative to surface haulage winches (No. 1226/351.82 of 25.5.1970).

- Clause 44, relative to surface motor vehicle transport (No. 1226/351.82 of 25.5.1970).

ANNEXES

LIST OF ANNEXES

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2. Terms of reference of the various Working Parties of the Mines Safety and Health Commission
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3. List of specialists in drilling and drilling equipment available within the Community for rescue work: Situation on 1.1.1971
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4. Results of research into improving the physiological condition of closed-circuit breathing apparatus
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5. Instructions for the construction of plaster stoppings by the hydromechanical method
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6. Recommendation on methods of reducing dust formation in underground workings
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7. Recommendation on the organisation of special departments responsible for monitoring the dust formation in underground workings
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8. Opinion on the necessity of reducing the dust formation resulting from the use of winning and road-heading machines
   (Annex VIII)

9. Comments and recommendations following from the Report adopted by the Mines Safety and Health Commission on 20 June 1969 with respect to the characteristics and electrical protection of cables supplying mobile machines (coal-cutters, loading machines etc.) used underground in coal-mines in the various Community countries
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10. Terms of reference of the Mines Safety and Health Commission
    (Annex X)

11. Composition of the Mines Safety and Health Commission, of the Restricted Committee and of the Working Parties
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12. Bibliography of the work of the Mines Safety and Health Commission
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ANNEX I

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS AT MINES IN 1970

Year: 1970
Country: Germany
Coal-field: Ruhr, Aachen, Ibbenbüren

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS
AT MINES IN THE E.C.S.C. COUNTRIES

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	972	26		4,19	0,11	-	-	-
2) Haulage and transport	427	29		1,84	0,13	-	-	-
3) Movement of personnel	803	14		3,46	0,06	-	-	-
4) Machinery, handling of tools and supports	308	8		1,33	0,03	-	-	-
5) Falling objects	940	6		4,05	0,03	-	-	-
6) Explosives and fumes	2	-		0,01	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	3		-	0,01	-	-	-
11) Electricity	2	1		0,01	-	-	-	-
12) Other causes	137	7		0,59	0,03	1	1	4
TOTAL	3 591	94	232 044 913	15,48	0,40	1	1	4

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS

AT MINES IN THE E.C.S.C. COUNTRIES

Year: 1970
Country: Germany

Coal-field: Saar

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	141	3		5,526	0,118	-	-	-
2) Haulage and transport	90	4		3,528	0,156	-	-	-
3) Movement of personnel	65	1		2,547	0,039	-	-	-
4) Machinery, handling of tools and supports	48	-		1,881	-	-	-	-
5) Falling objects	133	3		5,212	0,118	-	-	-
6) Explosives and fumes	-	-		-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	-		-	-	-	-	-
11) Electricity	1	-		0,039	-	-	-	-
12) Other causes	-	-		-	-	-	-	-
TOTAL	478	11	25 513 559	18,733	0,431	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS

AT MINES IN THE E.C.S.C. COUNTRIES

Year: 1970
Country: Germany
Coal-field: Total

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	1 113	29		4,321	0,113	-	-	-
2) Haulage and transport	517	33		2,007	0,128	-	-	-
3) Movement of personnel	868	15		3,370	0,058	-	-	-
4) Machinery, handling of tools and supports	356	8		1,382	0,031	-	-	-
5) Falling objects	1 073	9		4,166	0,035	-	-	-
6) Explosives and fumes	2	-		0,008	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	3		-	0,012	-	-	-
11) Electricity	3	1		0,012	0,004	-	-	-
12) Other causes	137	7		0,532	0,027	1	1	4
TOTAL	4 069	105	257 558 472	15,798	0,408	1	1	4

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS

AT MINES IN THE E.C.S.C. COUNTRIES

Year: 1970
Country: Belgium

Coal-field: Borinage-Centre

CAUSE	Number of casualties: Disablements as under (a) below	Number of casualties: Fatalities as under (b) below	Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below: Number of accidents	Group accidents: Number of disablements as under (a)	Group accidents: Number of fatalities as under (b)
1) Falls of ground	45	-		11,718	-	-	-	-
2) Haulage and transport	14	2		3,646	0,521	-	-	-
3) Movement of personnel	6	-		1,563	-	-	-	-
4) Machinery, handling of tools and supports	13	-		3,385	-	-	-	-
5) Falling objects	16	-		4,166	-	-	-	-
6) Explosives and fumes	-	-		-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	-		-	-	-	-	-
11) Electricity	-	-		-	-	-	-	-
12) Other causes	-	-		-	-	-	-	-
TOTAL	94	2	3 840 200	24,478	0,521	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

Year: 1970
Country: Belgium

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS
AT MINES IN THE E.C.S.C. COUNTRIES

Coal-field: Charleroi-Namur

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	64	5		6,977	0,545	-	-	-
2) Haulage and transport	38	1		4,142	0,109	-	-	-
3) Movement of personnel	15	-		1,635	-	-	-	-
4) Machinery, handling of tools and supports	32	-		3,488	-	-	-	-
5) Falling objects	14	-		1,526	-	-	-	-
6) Explosives and fumes	-	-		-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	-		-	-	-	-	-
11) Electricity	-	-		-	-	-	-	-
12) Other causes	2	-		0,218	-	-	-	-
TOTAL	165	6	9 173 440	17,986	0,654	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

Year: 1970
Country: Belgium
Coal-field: Liège

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS
AT MINES IN THE E.C.S.C. COUNTRIES

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	29	1		4,928	0,170	-	-	-
2) Haulage and transport	29	1		4,928	0,170	-	-	-
3) Movement of personnel	11	-		1,869	-	-	-	-
4) Machinery, handling of tools and supports	11	-		1,869	-	-	-	-
5) Falling objects	6	-		1,019	-	-	-	-
6) Explosives and fumes	1	-		0,170	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	-		-	-	-	-	-
11) Electricity	-	-		-	-	-	-	-
12) Other causes	2	-		0,340	-	-	-	-
TOTAL	89	2	5 885 208	15,123	0,340	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

Year: 1970
Country: Belgium

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS
AT MINES IN THE E.C.S.C. COUNTRIES

Coal-field: Campine

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	54	5		2,434	0,225	-	-	-
2) Haulage and transport	43	3		1,939	0,135	-	-	-
3) Movement of personnel	15	-		0,676	-	-	-	-
4) Machinery, handling of tools and supports	18	-		0,812	-	-	-	-
5) Falling objects	15	-		0,676	-	-	-	-
6) Explosives and fumes	-	-		-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	-		-	-	-	-	-
11) Electricity	-	1		-	-	-	-	-
12) Other causes	4	-		0,180	-	-	-	-
TOTAL	149	9	22 182 517	6,717	0,405	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

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Year: 1970
Country: Belgium
Coal-field: Total

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS

AT MINES IN THE E.C.S.C. COUNTRIES

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	192	11		4,673	0,268	-	-	-
2) Haulage and transport	124	7		3,018	0,170	-	-	-
3) Movement of personnel	47	-		1,144	-	-	-	-
4) Machinery, handling of tools and supports	74	-		1,801	-	-	-	-
5) Falling objects	51	-		1,242	-	-	-	-
6) Explosives and fumes	1	-		-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	-		-	-	-	-	-
11) Electricity	-	1		-	0,024	-	-	-
12) Other causes	8	-		0,195	-	-	-	-
TOTAL	497	19	41 081 365	12,097	0,462	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

Year: 1970
Country: France

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS
AT MINES IN THE E.C.S.C. COUNTRIES

Coal-field: Nord/Pas-de-Calais

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	272	6		3,725	0,082	-	-	-
2) Haulage and transport	83	9		1,136	0,123	-	-	-
3) Movement of personnel	157	2		2,150	0,027	-	-	-
4) Machinery, handling of tools and supports	198	2		2,712	0,027	-	-	-
5) Falling objects	169	1		2,314	0,013	-	-	-
6) Explosives and fumes	-	-		-	-	-	-	-
7) Explosions of firedamp or coal dust	11	16		0,150	0,219	1	11	16
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	2		-	0,027	-	-	-
11) Electricity	2	-		0,273	-	-	-	-
12) Other causes	19	-		0,260	-	-	-	-
TOTAL	911	38	73 005 824	12,478	0,520	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

Year: 1970
Country: France
Coal-field: Lorraine

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS AT MINES IN THE E.C.S.C. COUNTRIES

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	128	5		4,801	0,188	-	-	-
2) Haulage and transport	59	3		2,213	0,113	-	-	-
3) Movement of personnel	161	-		6,038	-	-	-	-
4) Machinery, handling of tools and supports	36	-		1,350	-	-	-	-
5) Falling objects	90	1		3,375	0,037	-	-	-
6) Explosives and fumes	1	-		0,037	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	-		-	-	-	-	-
11) Electricity	-	-		-	-	-	-	-
12) Other causes	8	-		0,300	-	-	-	-
TOTAL	483	9	26 663 128	18,115	0,338	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS

AT MINES IN THE E.C.S.C. COUNTRIES

Year: 1970
Country: France

Coal-field: Centre-Midi (1)

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	74	7		2,807	0,266	-	-	-
2) Haulage and transport	68	4		2,579	0,152	-	-	-
3) Movement of personnel	107	-		4,059	-	-	-	-
4) Machinery, handling of tools and supports	186	2		7,055	0,076	-	-	-
5) Falling objects	58	-		2,200	-	-	-	-
6) Explosives and fumes	1	1		0,038	0,038	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	4	-		0,151	-	-	-	-
11) Electricity	1	-		0,038	-	-	-	-
12) Other causes	10	1		0,379	-	-	-	-
TOTAL	509	14	26 360 728	19,309	0,531	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).
(1) As from 1970 including Provence.

Year: 1970
Country: France

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS
AT MINES IN THE E.C.S.C. COUNTRIES

Coal-field: Total (1)

CAUSE	Number of casualties: Disablements as under (a) below	Number of casualties: Fatalities as under (b) below	Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below: Number of accidents	Group accidents: Number of disablements as under (a)	Group accidents: Number of fatalities as under (b)
1) Falls of ground	474	18		3,761	0,143	-	-	-
2) Haulage and transport	210	16		1,666	0,127	-	-	-
3) Movement of personnel	425	2		3,372	0,016	-	-	-
4) Machinery, handling of tools and supports	420	4		3,332	0,032	-	-	-
5) Falling objects	317	2		2,515	0,016	-	-	-
6) Explosives and fumes	2	1		0,016	0,008	-	-	-
7) Explosions of firedamp or coal dust	11	16		0,087	0,127	1	11	16
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	4	2		0,032	0,016	-	-	-
11) Electricity	3	-		0,024	-	-	-	-
12) Other causes	37	-		0,294	-	-	-	-
TOTAL	1 903	61	126 029 680	15,099	0,484	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).
(1) As from 1970 including Provence.

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS
AT MINES IN THE E.C.S.C. COUNTRIES

Year: 1970
Country: Italy
Coal-field: Sulcis

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place)	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	-	-		-	-	-	-	-
2) Haulage and transport	-	-		-	-	-	-	-
3) Movement of personnel	-	-		-	-	-	-	-
4) Machinery, handling of tools and supports	8	-		6,896	-	-	-	-
5) Falling objects	-	-		-	-	-	-	-
6) Explosives and fumes	-	-		-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	-		-	-	-	-	-
11) Electricity	-	-		-	-	-	-	-
12) Other causes	6	-		5,172	-	-	-	-
TOTAL	14	-	1 159 644	12,068	-	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

COMMON STATISTICAL SUMMARY OF UNDERGROUND ACCIDENTS
AT MINES IN THE E.C.S.C. COUNTRIES

Year: 1970
Country: Netherlands
Coal-field: Limburg

CAUSE	Number of casualties		Man-hours worked	Number of disablements as under (a) per million man-hours (to third decimal place)	Number of fatalities as under (b) per million man-hours (to third decimal place	Group accidents as under (c) below		
	Disablements as under (a) below	Fatalities as under (b) below				Number of accidents	Number of disablements as under (a)	Number of fatalities as under (b)
1) Falls of ground	32	1		2.634	0.082	-	-	-
2) Haulage and transport	32	2		2.634	0.165	-	-	-
3) Movement of personnel	11	-		0.905	-	-	-	-
4) Machinery, handling of tools and supports	23	-		1.894	-	-	-	-
5) Falling objects	8	-		0.659	-	-	-	-
6) Explosives and fumes	-	-		-	-	-	-	-
7) Explosions of firedamp or coal dust	-	-		-	-	-	-	-
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-		-	-	-	-	-
9) Underground combustion and fires	-	-		-	-	-	-	-
10) Inrushes of water	-	-		-	-	-	-	-
11) Electricity	-	-		-	-	-	-	-
12) Other causes	2	3		0.165	-	-	-	-
TOTAL	108	3	12 145 752	8.891	0.247	-	-	-

(a) Casualties were unable to resume work below ground for at least eight weeks.
(b) Casualties died within eight weeks.
(c) Accidents involving more than five casualties of types (a) and/or (b).

Comparative table of number of persons
incapacitated by underground accidents for eight weeks or longer

(Year 1970; per million man-hours)

CAUSE	Germany	Belgium	France (1)	Italy	Netherlands	Community
1) Falls of ground	4,321	4,673	3,761	-	2,964	4,144
2) Haulage and transport	2,007	3,018	1,666	-	2,388	2,009
3) Movement of personnel	3,370	1,144	3,372	-	0,823	3,082
4) Machinery, handling of tools and supports	1,382	1,801	3,332	6,896	1,153	1,991
5) Falling objects	4,166	1,242	2,515	-	0,576	3,306
6) Explosives and fumes	0,008	-	0,016	-	-	0,011
7) Explosions of firedamp, or coal dust	-	-	0,087	-	-	0,025
8) Sudden outbursts of firedamp suffocation by natural gases	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-
10) Inrushes of water	-	-	0,032	-	-	0,009
11) Electricity	0,012	-	0,024	-	-	0,014
12) Other causes	0,532	0,195	0,294	5,172	0,082	0,431
TOTAL	15,798	12,097	15,099	12,068	7,986	15,022

(1) As from 1970 including Provence.

Comparative table of accidents resulting in death within eight weeks

(Year 1970; per million man-hours)

C A U S E	Germany	Belgium	France (1)	Italy	Netherlands	Community
1) Falls of ground	0,113	0,268	0,143	-	0,082	0,135
2) Haulage and transport	0,128	0,170	0,127	-	0,165	0,132
3) Movement of personnel	0,058	-	0,016	-	-	0,039
4) Machinery, handling of tools and supports	0,031	-	0,032	-	-	0,027
5) Falling objects	0,035	-	0,016	-	-	0,025
6) Explosives and fumes	-	-	0,008	-	-	0,002
7) Explosions of firedamp, or coal dust	-	-	0,127	-	-	0,037
8) Sudden outbursts of firedamp, suffocation by natural gases	-	-	-	-	-	-
9) Underground combustion and fires	-	-	-	-	-	-
10) Inrushes of water	0,012	-	0,016	-	-	0,011
11) Electricity	0,004	0,024	-	-	-	0,004
12) Other causes	0,027	-	-	-	-	0,016
TOTAL	0,408	0,462	0,484	-	0,247	0,429

(1) As from 1970 including Provence.

ANNEX II

TERMS OF REFERENCE OF THE VARIOUS WORKING PARTIES OF THE MINES SAFETY AND HEALTH COMMISSION

I - Working Party on Electrification - Chairman Mr. LOGELAIN

A. Terms of reference

1. Comparing adopted safety and accident prevention provisions relating to :

   a) electric shock,

   b) fire hazard,

   c) explosion hazard.

2. Ascertaining the present position in Community countries with regard to safety regulations on underground electrical networks of low and medium voltage (up to 1 100 V) and feeder cables for movable equipment, with due regard to the specifications for the said cables.

3. Reporting on steps to be taken when work has to be carried out on electrical equipment under voltage.

4. Studying the deleterious effects on electrical equipment used underground of moisture in salt pastes and salt pastes used in dust suppression.

5. Studying the construction of high-tension cables (of op to 6 000 V) used underground, and protective equipment.

6. Comparison of safety provisions relating to underground electric locomotives, with emphasis on the possibility of reducing the frequency of trolley wire sparking.

7. Study of over-voltage caused by lightning and the problem of stray currents.

B. Preliminary work undertaken by the Secretariat

1. Periodic reports on oil-powered contactors used in gassy environments.

2. Investigations of the use of remote-control circuits in automated mining operations.

II - Working Party on Rescue Arrangements, Fires and Underground Combustion - Chairman Mr. HELLER

A. Rescue Arrangements, Fires and Underground Combustion

General Terms of reference (Section 7 of the Mines Safety and Health Commission's Terms of Reference)

Exchange of information on rescue work and fire-fighting in connection with accidents of interest to the Working Party.

B. Rescue work

I. Standing terms of reference

1. Communication of the annual reports issued by the rescue stations and regular discussion of these documents.

2. Convening meetings on special occasions (accidents from which new information can be gained, technical innovations in materials, equipment, etc.).

3. The publication every two years of a report outlining in particular the state of rescue arrangements in the Community and the United Kingdom.

II. Terms of reference

1. Improvements in CO-filter self-rescuers.

2. Drawing up a list of experts on drillings in connection with rescue work and the apparatus to be used.

3. Examination of the technique for rescuing trapped miners by means of large boreholes with a view to formulating the rules based on experience gained in different countries and submitting practical regulations to the mining authorities.

4. Studying of the Community criteria for fireproof clothing and general requirements.

5. Examination of the need to draw up, alongside traditional alarm procedures, plans for sending help in the event of disaster.

6. Drawing up a synoptic comparison of the rules and regulations relating to rescue and medical attention as drafted by the mining authorities of the Community and of the United Kingdom.

C. Underground fires

I - Standing terms of reference

Exchanging views on the reopening in the Community and the United Kingdom of fire zone stoppings and where necessary adapting regulations already drafted.

II - Terms of reference

1. Continuing the study of the problem of fire-fighting in very deep pits, if necessary with the help of small-scale model tests and full-scale experiments, should a favourable opportunity arise.

2. Continued study of specifications and test conditions applicable to fire resistant fluids (3.a)-c) by the experts on hydraulic fluids):

   a) comparing test results so as to prevent products being differently assessed;

   b) where necessary, adapting test criteria to technological progress;

   c) in addition, examining to what extent if might be possible to relax these criteria and test methods so that the said products may be more easily assessed and approved.

3. Continued study of the stabilisation of ventilation in the event of pit fires in accordance with Professor Budryk's theory (4.a)-h) by the ventilation experts):

   (i) Problems outstanding within the framework of the former terms of reference:

      a) the extent of instability in diagonal ventilation roadways,

      b) the effects of a fire on descensional ventilation systems,

      c) means of guarding against the danger of explosion during fire-fighting.

   (ii) Extension of this term of reference to general ventilation problems in view of their importance, especially to fires:

      d) assessment of the danger of explosion in a fire area during its isolation by means of stoppings,

      e) effects of auxiliary ventilators on pit ventilation in the event of fire,

f) ventilation tolerances (where the object is to study problems of stability: measurement of wind speeds, air flow and pressures),

g) possibilities of early detection and technical measurement of parasitic air currents,

h) use of fire regulators and fire doors.

4. Early detection of underground fires, especially smouldering fires, and assessment of combustible gases (remote control installations for the early detection of CO).

5. Measuring instruments enabling ventilation to be checked (oxygen deficiency warning devices): Exchange of information on the practical use of oxygen deficiency warning devices, especially those which were singled out for special mention in the competition organised by the High Authority (concluded in December 1967).

6. Sealing off abandoned underground workings by means of dams.

7. Generation of fire in means of transport and other long installations (conveyor belts, air ducts, piping, guides, etc.) and propagation of fire by means of these installations.

8. Synoptic comparison of rules and regulations on fire prevention and fire-fighting in mines, worked out by the mining authorities of member countries and of the United Kingdom.

III - Working Party on Winding Ropes and Shaft Guides: Chairman Mr. MARTENS

Terms of reference

1. Follow-up of progress made in the testing of winding ropes by means of appropriate instruments in order to obtain information concerning its application in the mines of the Community and the United Kingdom.

2. Testing of couplings for circular and flattened winding ropes.

3. Arrangements for the installation and inspection of capels.

4. Testing of guides for winding cages in drafts and guide mechanisms for cable haulage in roadways.

5. Maintenance required to ensure safe operation of winding ropes and balance ropes.

6. Use of studies on the dynamic behaviour of shaft and roadway ropes.

7. Exchange of views on the properties operating conditions and strength of winding ropes of particular interest.

8. Discussion on accidents involving winding and hauling ropes and their couplings, which could provide new information.

IV - Working Party on Mining Accident Statistics: Chairmand Mr. KOCH

Terms of reference

Examination of the methods used in Community countries for establishing mining accident statistics. Paricular examination of the criteria applied in defining the term "Mining accident" and the criteria used in classifying the accidents according to cause, duration of stoppage and, possibly, position of the injuries.

With the exact definition of these criteria as a basis, establishing differences between the statistical elements assembled in each country and ways of taking these differences into account in comparisons on a Community level.

V - Working Party on Combustible Dusts: Chairman Mr. CHERADAME

Terms of reference

Taking into account the mechanism of dust combustion and of flame propagation and the various factors which may influence this, including the fact that methane is frequently involved in this phenomenon, the working partu is instructed to carry out a study of precautions against dust combustion, in particular :

a) dust neutralisation (dust control in situ, stone dusting, spraying, dust fixation by means of spreading salts and coagulating pastes, etc.), this study to include the comparative analysis of the regulations and instructions applied in the Community countries and the United Kingdom, along with the methods of application of the different processes

b) dust barriers of various types to halt dust explosions, mixed dust-methane explosions and pure methane explosions.

The working party may make any suggestions for research work considered necessary to advance the knowledge of the phenomena studied and to promote safety in these fields.

VI - Working Party on Health in Coal Mines: Chairman Mr. VANDENHEUVEL

Studying, from the standpoint of technical prevention and industrial medicine, the prevention of environmental risks to the health of workers in coal mines.

A. Terms of reference

1. Where necessary, making recommendations on means of dust control, and general measures to reduce dustiness in underground workings, recognised as being to some extent effective (wet drilling, water infusion, spraying, special attachments to winning machines, pulsed-infusion shotfiring.

2. Where necessary, making recommendations on the organisation of specialised dust-control services.

B. Preliminary work to be undertaken by the Secretariat

The assembling of documentary material and comparison of legislation in the various Community countries with reference to:

1. General rules covering the prevention of dust in respect of the design and use of winning machines.

   Standards to be observed to ensure minimum dustiness arising from the use of these machines.

2. Dust measurement (methods, frequency, measuring points, conclusions to be drawn etc.) and where necessary establishing a scale of comparison of the various methods employed.

3. Establishment of dustiness thresholds. Definition of categories of permissible dustiness. Steps to be taken when faced with various categories of dustiness.

VII - Working Party on Effects of Working Time on Safety at Work, especially in Difficult or Unhealthy Conditions: Chairman Mr. VAN DER HOOFT

Provisional terms of reference (definitive text to be submitted to the Restricted Committee):

Number of hours worked in wet working points. Determining in what cases a working points is to be considered wet and the precautions to be taken.

VIII - Working Party on Psychological and Sociological Factors affecting Safety: Chairman Mr. SCHNASE

Terms of reference

1. Safety campaigns.

2. A draft recommendation on the employment of foreign and young workers.

ANNEX III

LIST OF SPECIALISTS FOR BOREHOLE RESCUE WORK AND EQUIPMENT AVAILABLE IN COMMUNITY COUNTRIES

Position on 1 January 1971: to be brought up to date every 2 years

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(Approved by the Mines Safety and Health Commission at its meeting of 26 March 1971)

CONTENTS

A. INTRODUCTION

The present list is intended to supply all the centres concerned in the coal industry with information on the appliances available in the countries of the Community for drilling rescue holes from underground and from the surface as well as organisations and specialists in this field.

The drilling appliances with their accessories shown in this list can in an emergency be placed at the disposal of any coalfield in the Community.

Where required, the centres in each country should be contacted. The directors are also members of the Working Party on "Rescue and mine fires" of the Mines Safety and Health Commission.

The closed-circuit breathing apparatus is also regularly included according the most recent development of technology in the biennial reports *(1)* published by the Working Party and the other appliances undergoing research and development and particularly suitable for rescue work in mines are not included in the above list of apparatus. It is therefore unnecessary to list them in the present publication.

The biennial reports can be obtained from the Secretariat of the Mines Safety and Health Commission *(2)*.

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(1) Latest (Seventh) Report for 1967 and 1968.

(2) 29, rue Aldringer, Luxembourg.

B. SPECIALISTS AND APPARATUS FOR RESCUE DRILLING FROM UNDERGROUND

I. GERMANY (FEDERAL REPUBLIC)

Ruhr

1. Note

The availability of the apparatus below together with accessories depends on the rescue centre at Essen. The apparatus is available in fairly large numbers in the Ruhr collieries or at the depot of the rescue centre at Essen and can be dispatched immediately when required.

2. Addresses of organisations and specialists

2.1. Hauptstelle für das Grubenrettungswesen, 43 Essen-Krey, Schönscheidtstr. 28, Telephone: Essen 2-18-66 (The switchboard is continuously manned)

Director of the rescue centre: Herr E. BREDENBRUCH, (member of the Rescue Working Party)

Private address: 433 Mülheim/ruhr, Am grossen Berg 18, Telephone: Mülheim (Ruhr) 5-27-15

Technical director of the rescue centre: Herr A. SCHEWE, (member of the Rescue Working Party)

Private address: 464 Wattenscheid-Höntrop, Langacker 11, Telephone: Wattenscheid 7-12-13.

The following experts are at the disposal of the rescue centre:

Mining engineers, W. BOTH, M. FUNKENMEYER and F.J. KOCK.

2.2. For drilling rescue holes from underground, the assistance of the following specialists from the drilling division of SKBV can be obtained by applying to the Essen rescue centre:

Herr K. TRÖSKEN, 43 Essen, am Wünnesberg 37,
Telephone: Essen 71-33-21 and

Mining engineers, H.J. GROSSEKEMPER, V. MERTENS, E. MOSBLECH and G. MOGWITZ.

3. Appliances and accessories available for drilling rescue holes from underground

3.1. Drilling machines

1. Turmag P 30, 1220 mm dia.
2. Turmag P VI/12-120, 610 mm dia.
3. Wirth HG 170, 1400 mm dia.

All the drilling machines for drilling large diameter holes are compressed-air driven. The Wirth drill can also operate electrically and is therefore also suitable for use at the surface.

3.2. Drill rods

1. 4½" dia. regular
   - P VI/12-120
2. 5½" dia. regular
   - P 30 -
3. 5¼" dia. regular
   special - HG 170 -

With the rods, there is a sufficient number of guide rods for oriented drill holes.

3.3. Roller bits

1. Non-removable roller bits 98 to 216 mm dia.
2. Enlarging roller bits up to 1400 mm dia.

3.4. Valves and "preventors"

4. Auxiliary apparatus (communication)

4.1. Location apparatus

4.2. Sound location apparatus for mines

4.3. Telephones for drill holes

4.4. Intrinsic safety telephones with loudspeaker

4.5. Radio apparatus for use underground

4.6. Television apparatus

5. Auxiliary apparatus (supply and rescue)

5.1. Containers

5.2. Rescue cages

1. Dahlbusch apparatus 370 mm dia.
2. Dahlbusch apparatus 430 mm dia.

5.3. Pressuried chambers

6. Auxiliary apparatus (miscellaneous)

Saar coalfield

1. Note

Requests for the apparatus below should be addressed to the following departments of Saarbergwerke A.G.:

Safety
Underground surveying and mine damage
Rescue centre at Friedrichsthal (Saar).

2. Addresses of services and experts

2.1. Safety

Director, A. VAN GEMBER (member of the Rescue Working Party),
66 Saarbrücken, Triererstr. 1,
Telephone: Saarbrücken 40-51

2.2. Underground surveying and mine damage

Director: Prof. A. JUNG, 66 Saarbrücken, Triererstr. 1,
Telephone: Saarbrücken 40-51.

2.2.1. Drilling service: Director: drilling engineer LÜTZOW,
Telephone: Saarbrücken 40-51.

2.3. Rescue centre, Friedrichsthal (Saar)

Director: Dipl. Engineer R. MÜLLER (member of the Rescue Working Party)
6605 Friedrichsthal (Saar)
Telephone: Sulzbach (Saar) 81-00 and 8-81-82 (The rescue centre is permanently manned by a full-time rescue team).

3. Apparatus and accessories available for drilling rescue holes from underground

3.1. Drills

1. Turmag P 30 up to 1220 mm dia.
2. Turmag P VI/12-120 up to 610 mm dia.
3. Wirth HG 170 up to 1400 mm dia.

All the drilling machines for large diameter holes are operated by compressed air. The Wirth drill can also be operated electrically and can therefore be used at the surface. The time required for transport is very variable. In unfavourable local conditions, it may be two or three days before the apparatus is ready to operate.

3.2. Drill rods

1. 4½" dia. regular - P VI/12-120 -
2. 5½" dia. regular - P 30 -
3. 5½" dia. regular special - HG 170 -

Each drill rod is accompanied by a sufficient number of guide rods for oriented drilling.

3.3. Roller bits

1. Non-detachable roller bits, 98 to 216 mm dia.
2. Enlarging bits up to 1400 mm dia.

3.4. Valves and "preventors"

100 mm dia.

II. BELGIUM

1. Note

The Belgian coal industry has no equipment specially designed for drilling large diameter rescue holes. Each colliery has the material for making holes for first contact. They have contracted out to Messrs. FORAKY, specialising in large diameter drilling. The necessary operations for detection and first contact, and arrangements on the spot for drilling will be carried out while awaiting the arrival of the equipment and the specialists from Messrs. Foraky, which will be prompt, in accordance with the agreements.

2. Addresses of the firm and the organisation concerned

2.1. Address of the firm:

Foraky, 13,Place des Barricades, Bruxelles 1000
Telephone: Bruxelles 18-20-53 and 17-59-40.

2.2. In order to obtain the equipment when required, contact the rescue centre: Centre de coordination et de sauvetage, Hasselt, Kempische Steenweg 555, Telephone: Hasselt 2-28-87. (The telephone exchange is continuously manned by full-time rescue teams ready for action at all times.)

- Director: Monsieur A. HAUSMAN (member of the Rescue Working Party)
  Telephone: Hasselt 2-28-87
- Secretary of the centre: Monsieur A. SIKIVIE,
  Telephone: Hasselt 2-28-87.

3. Apparatus and accessories available for drilling rescue holes from underground and from the surface.

   Drills for rescue holes from 400 to 600 mm dia. are available.

III. FRANCE

1. Note

   The availability of the apparatus below together with accessories will be authorised by the rescue centre, Belle Roche, Merlebach. The apparatus is mainly in the Lorraine and Nord and Pas-de-Calais coalfields and with the specialist firm "LONGYEAR" which will supply them on request.

2. Addresses of organisations and specialists

2.1. Belle Roche rescue centre in the Lorraine coalfield, at F 57 Merlebach, Telephone: Merlebach 04-19-95.

(The switchboard at the rescue centre is manned continuously.)

Director:
Monsieur J. CRETIN, divisional mining engineer (member of the Rescue Working Party).

2.2. Rescue centre of Nord and Pas-de-Calais coalfield, Rue Notre Dame de Lorette, F 62 Lens (Pas-de-Calais), Telephone: Lens 28-24-31.

(The switchboard at the rescue centre is continuously manned).

Director:
Monsieur G. ROGEZ, Mining engineer (member of the Rescue Working Party).

2.3. Monsieur R. GRISARD, mining engineer, head of the Safety Service of CdF (member of the Rescue Working Party)
9, Av. Percier, F 75 Paris 8e, Telephone: Paris 225-95-00.

3. Apparatus and accessories available for drilling rescue holes from underground.

3.1. Drills

1. 1 Turmag P 30 up to 610 mm dia., complete with

   1 swivelling support, flittable and telescopic
   1 Turmag prop
   1 winch

2. Equipment for 508 mm tubing with the P 30 drill, with

   1 plate for screwing and unscrewing 486 x 508 mm tubes,
   1 appliance for guiding and retaining tubes
   1 hydraulic brake for tubes of 508 mm dia
   70 m tubes of 486 x 508 mm in lengths of 0.50 m - 0.75 m - 1.00 m - 1.20 m and 1 of 3 m with the handling pulley.

3.2. Drill rods

1. 100 drill rods 1.50 m in length
2. 6 guide rods of 193 mm dia. and 1.50 m length
3. 25 guides of 600 mm dia.

3.3. Roller bits

1. 4 tricone bits of 193 mm dia.

4. Auxiliary apparatus (communication)

4.1. Detection apparatus

4.2. Sound location apparatus

1. 8 genephones consisting of HALL SEARS receivers, type HS-J, model 12
2. 8 pre-amplifiers, type VBI-Grundig, built-in battery
3. 8 amplifiers type E. OMY 3 - Hartmann and Braun, supplied from mains 200 V - 5 VA.

4.3. 1 lumiscript type 151-8, Hartmann and Braun (8 tracks).

5. Auxiliary equipment (supply and rescue)

5.1. Containers

1 container 0.30 m, 1 of 0.60 m, 1 of 0.90 m and 1 of 1.50 m for rods NQ and BQ.

5.2. Rescue cages

2 Dahlbusch appliances (370 and 430 mm dia.)

6. Auxiliary equipment (miscellaneous)

6.1. 1 friction winch for fitting the rope to the rescue device

1 return end

1 tension and control device with pull-lift and dynamometer

1 Westphalia winch, model 1033, equipped with Güldner HW 10 hydrostatic transmission.

C. SPECIALISTS AND APPARATUS FOR DRILLING RESCUE HOLES FROM THE SURFACE

I. GENERAL REMARKS *(1)*

The possibility of saving emtombed men by drilling from the surface depends essentially on the depth. For rescue purposes, the maximum depth would be in the region of 500 m. On the other hand, in certain conditions drill holes for searching and supply purposes can be successfully carried out to a depth of about 1000 m.

A distinction should be made between drill holes for searching and supply purposes on the one hand and rescue drill holes on the other.

Drill holes for search and supply purposes should be carried out at a minimum diameter of 6 inches, remembering that the smallest turbine has a diameter of 5 inches. In the looser overburdens, a sufficiently large diameter should be chosen for an intermediate tubing of 7 inches.

Rescue drilling can be carried out using normal clay flushing, at a diameter of 26 inches down to a safety zone above the objective. The extent of the safety zone should be determined according to the circumstances, taking into account the local conditions. When the safety zone is reached, the flushing liquid should be removed and drilling continued with air flushing. It is also possible to carry out preliminary drilling with a coring bit (8½ inches) and air flushing, and then to enlarge it with water flushing.

Drilling for search and rescue purposes requires a considerable time as it is shown by the following table.

1. Drilling for search and supply purposes

1.1. Depth of 500 metres.

Transport (300 km) and setting up equipment (including 12 hours to mark out, level and strengthen a drilling base of 50 x 50 metres)	24 hrs.
Drilling including direction and tubing work	
0 - 300 m (8 5/8")	48 hrs.
300 - 500 m (8")	48 hrs.
Total time	5 days

1.2. Depth of 1000 m

Transport and assenbly	24 hrs.
Drilling	
0 - 300 m	48 hrs.
300 - 1000 m (400 m carboniferous)	240 hrs.
Total time	13 days

(1) *This note has been taken from the list of specialists and equipment for drilling from the surface drawn up by the Essen Rescue centre, January 1st 1970.*

2. Drilling rescue holes

Depth up to 500 m

Drilling and sealing off with cement 0 - 300 m (drilling first hole of 17½" and enlarging to 26")	5 days
300 - 500 m (17½")	5 days
(23")	5 days
Setting tubes	1 day
Drilling in safety zone	2 days
Total time	18 days
+ search drilling	23 days

II. GERMANY (FEDERAL REPUBLIC)

Ruhr

1. Note

Coordination of specialists and use of equipment for drilling rescue holes from the surface are the responsibility of the rescue centre at Essen. This centre should be informed in case of emergency.

2. Addresses of organisations and specialists

The same institutions and specialists quoted for drilling holes from underground are also available for drilling from the surface. These are given on page 4 of this list.

3. Specialised drilling firms

3.1. C. Deilmann AG. (Oil and natural gas).
4442 Bentheim, Postfach 75.
Telephone: (05922) 7-21, Telex: 96833, Telegrams: Deilmann Bentheim

3.2. Deutsche Erdöl-AG Hamburg, Prospecting and winning.
2 Hamburg, Kreuzweg 7
Telephone: (0411) 44-19-21, Telex: 0211477 (Aufschluss und Gewinnung, Kreuzweg 7), 0211103 (Hauptverwaltung, Mittelweg 180), Telegrams: Leawerke Hamburg.

3.3. Deutsche Schachtbau- und Tiefbohrgesellschaft mbH, Drilling and oil winning.
445 Lingen (Ems), Waldstrasse 39, Postfach 142,
Telephone: (0591) 41-71, Telex: 096840, Telegrams: Tiefbohröl Lingenems.

3.4. Gewerkschaft Brigitta, Oil and natural gas.
3 Hannover, Kolbergstrasse 14, Postfach 1049
Telephone: (0511) 8-11-71.
Telex: 0922852, Telegrams: brigittaoel Hannover.

3.5. Gewerkschaft Elwerath (Oil company), Hannover, Werk Nienhagen
31 Celle, Postfach
Telephone: (051405) 2-11, Telex: 092553, Telegrams: Elwerath Celle.

3.6. ITAG Hermann von Rautenkranz, International drilling company
31 Celle, Itagstrasse 5-27, Postfach 114
Telephone: (05141) 60-81, Telex: 925174 Itagc d,
Telegrams: Itag Celle.

3.7. Mobil Oil AG (Crude oil division)
31 Celle, Burggrafenstrasse 1, Postfach 110
Telephone: (05141) 1-51, Telex: 92551 (925151-925152),
Telegrams: Mobiloil Celle.

3.8. Preussag AG, (Oil and drilling)
3 Hannover 1, Leibniz-Ufer 9, Postfach 4829
Telephone: (0511) 1-93-21, Telex: 0922828,
Telegrams: Preussag Bohrverwaltung Hannover.

3.9. Rheinische Braunkohlenwerke AG, Gruppe Nord
(Drilling and drainage division)
5151 Niederaubem, Postfach 40
Telephone: (02271) 8-11

3.10. Wintershall AG (Oil company)
2847 Barnstorf Bez. Bremen, Postfach 220
Telephone: (05442) 6-11-14, Telex: 941205,
Telegrams: Wintershall Barnstorf Bez. Bremen.

4. Drilling specialists

The assistance of the specialists of the above firms can be requested directly from the firms or through the Essen rescue centre.

5. Drilling equipment

The following firms have the drilling equipment specified above:

Drilling firms	Depths		
	0-500 m	- 1000 m	- 1500 m
Deilmann		2 Failing 2500	2 Ideco H 525
Deutsche Erdöl			Ideco H 30 Ideco H 525
Deutsche Schachtbau			SMG FS 291
Elwerath		Haniel & Ineg SR 12	
Itag		SMG/Za 312	Cardwell J-450
Mobil Oil		SMG 61100/30	
Preussag		SMG ZA 292	
Rheinbraun	2 Wirth L 10		

5.2. Drilling equipment for rescue work (18 5/8")

Drilling firms	Depths	
	0-500 m	-1000 m
Deilmann	2 Ideco H 525	NSCO 80 B EMSCO 800
Deutsche Erdöl	Ideco H 30 Ideco H 525	2 NSCO 80 B
Deutsche Schachtbau	SMG FB 291	
Itag	Cardwell J-450	
Rheinbraun	2 Wirth L 10	

6. Note on drilling equipment and accessories

6.1. Drilling for search and supply purposes

Nearly all the firms listed have the required tools and tubes for drilling holes for search and supply purposes at a diameter of 6 to 8 inches.

6.2. Drilling rescue holes

6.3. Bits

Bits of all sizes can be obtained at Deutsche Schachtbau- und Tiefbohrgesellschaft. In all the other firms, the bits shown are only available at certain times.

6.4. Tubes

For tubing rescue holes, tubes up to 24" diameter are required. The stocks of tubes of this size vary according to the firm. However, it can be assumed that the total length required can be obtained from all the firms listed.

6.5. Air compressors

To carry out a search drilling with air flushing, the appropriate compressors will be found at the following firms:

Rheinische Braunkohlenwerke AG, Gruppe Nord
Abteilung Bohrbetrieb und Wasserwirtschaft
5151 Niederaussem, Postfach 40
Telephone: (02271) 8-11

Atlas Copco Deutschland GmbH
43 Essen, Kupferdreher Strasse 86
Telephone: (02141) 44-91, (02141) 44-92-00 (after office hours).

Saar

1. Preliminary note

In order to request the following equipment, the following services of Saarbergwerke AG should be contacted:

Safety

Underground surveying and mine damage

Rescue centre at Friedrichsthal (Saar).

2. Addresses of organisations and experts

The same organisations and specialists for drilling work from underground are also competent for carrying out drilling work from the surface. The addresses are shown on pages III, 10 and III, 11.

3. Drilling organisations

Saarbergwerke AG has the following equipment and accessories:

3.1. Drills including carriages

1. Salzgitter SG 750, directed drilling up to 159 mm, enlargement possible up to 270 mm dia.
2. Wirth BW H 563, directed drilling up to 159 mm, enlargement possible up to 270 mm dia.
3. Joy 275, directed drilling up to 159 mm, enlargement possible up to 270 mm dia.

All the drilling machines are operated by a diesel engine and are mobile. The machines at 1 and 2 can be transported in a few hours. The machine at 3 (which is more powerful) takes several days.

3.2. Drill rods

2 3/8 inches Regular N - Asme
can be used with the 3 types of drill listed under 3.1.

3.3. Bits

The roller bits up to 216 mm have already been mentioned in connection with machines for underground.

3.4. "Preventors"

Type Wirth 6 5/8 inches for presssures up to 140 kg/cm^2 suitable for drill rods of 2 3/8 inches.

3.5. Valves (complete locking)

Type Wirth 6 5/8 inches for pressure up to 140 kg/cm^2.

The drilling machines belonging to the service for drilling at great depths are in continuous use, except when being moved from one place ot another. Allowance should be made for the transport times required, as given above.

III. BELGIUM

1. Note

The remarks on page III, 11 of this list, on drilling from underground, also apply for drilling from the surface.

Requests for experts and for equipment, as well as for coordination of drilling work, are made by the Rescue Centre, Hasselt.

2. Addresses of organisations and experts

These addresses and those of the firm are given on page III, 11.

IV. FRANCE

1. Note

Requests for drilling equipment and experts, as well as for coordination of drilling work, are dealt with by the services in Section B of this list.

2. Addresses of organisations and experts

The addresses are on page III, 12 of this list.

3. Drilling firms

3.1. Forex Forages & Exploitations Petrolières
35, rue St. Dominique, Paris 7e
Telephone: 70595-00 (Lignes groupées)

4. Drilling experts

Requests for experts and equipment to be addressed to:

M. Maurice Lepreux
24, rue Boissières, Paris 16e
Telephone: 704.59-06.

5. Drilling equipment

5.1. Drilling equipment available at the rescue centre, Belle-Roche

1 Joy oleo-hydraulic drill - 22 HD (400 metres in NQ.U)

5.2. Drilling equipment available at Forex

5.2.1. Drilling equipment for search and supply (6 inch dia.)

For depths up to 1000 metres:
Ideco H 25

For depths up to 1500 metres:
Ideco H 40
Ideco H 525

5.2.2. Drilling equipment for rescue work (18 5/8 inch dia.)

For depths up to 500 metres
Ideco H 40
Ideco 525

6. Note on drilling equipment and accessories

The information given at II.6 is also applicable here.

ANNEX IV

RESEARCH AIMED AT IMPROVING THE PHYSIOLOGICAL CONDITIONS OF CLOSED-CIRCUIT BREATHING APPARATUS CARRIED OUT WITH THE FINANCIAL ASSISTANCE OF THE COMMISSION OF THE EUROPEAN COMMUNITIES FOLLOWING A PROPOSAL BY THE MINES SAFETY AND HEALTH COMMISSION

Summary of Results

(Approved by the Mines Safety and Health Commission on 26 June 1970)

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CONTENTS

1) SUMMARY OF RESULTS OBTAINED BY THE ERNEST MALVOZ REGIONAL INSTITUTE AT LIÈGE (BELGIUM)

Respiratory resistance and its effect on the mechanical ventilatory force has been examined on wearers for thirteen types of self-contained apparatus. The results are given in table 1 which deals with data which can be reproduced for ventilations of 10, 30 and 50 l/min. These ventilation values were chosen for the comparison; where such values were not obtained exactly from the wearers, the necessary corrections have been calculated. In this table the mechanical force represents the additional respiratory effort which the self-contained apparatus requires over a given unit of time: it defines this in an overall sense. Variations in flow pressures of zero correspond to non-dynamic resistances, which occur in the absence of flow: they mainly consist of critical pressures due to opening of valves and the elastic resistance of the bag. The average pressure characterises the effect of possible continuous low or lowered pressures during the ventilation cycle. Pressure variations at the averlage volume of inhaling and exhaling characterises the component dynamic of variations in buccal pressure and enables the dynamic resistance, which is the sum of resistances to the air flow, to be calculated. The maximum pressure values also represent the characteristics of the different types of self-contained apparatus.

Table 2 compares the results of the ventilatory mechanics most frequently met (column 3, which refers to values called 'commercial') with different physiological data.

1) inherent mechanical thorax values in the average normal person;
2) values beyond which the subject undergoes additional resistances and below which it is not advisable to go;
3) values for which the tolerance may be considered as correct, taking into account the reserves of mechanical energy which the thorax possesses;
4) values which inevitably involve a negative tolerance to the wearing of the apparatus.

Table 2 compares the results recorded in detail in table 1 with certain physiological values and shows that the mechanical ventilatory values of self-contained apparatus prove to be satisfactory. This does not mean that these satisfactory values should not be checked for consistency with the aid of an artifical lung, which has been done at Essen.

Temperature and humidity of the air breathed quickly reach high levels - 40-50° C (in a laboratory environment) - and water vapour saturation with apparatus whose oxygen supply is compressed; on the other hand, these values remain low with apparatus with liquid oxygen supply; the addition of a cooling unit in the respiratory circuit also reduces these values.

The CO_2 content of air exhaled varies to a lesser degree than that of inhaled air. For all apparatus in use there is a limiting factor, which becomes decisive once muscular effort is prolonged or becomes more intense, due to a failure to absorb CO_2 by the element. CO_2 produces excess ventilation, which leads to overload in ventilation, through stimulation of the respiratory centre; the latter effect ist even more marked with thermal stasis of the wearer. An example is that encountered in a trial involving the use of O_2 at a rate of between 1 and 1.5 l/min, where an increase in CO_2 of from 0 to 1 % in inhaled air led to an incraese in the ventilation of about 2 l/min in a normal environment, whil the incraesed reached 10 l/min with a thermal stasis which incraesed the body temperature by 1° C.

The additional ventilatory mechanical force was minimal, the consumption of O_2 by the subject did not rise appreciably due to breathing in the self-contained apparatus. On the other hand, the weight of the apparatus did affect the consumption of O_2 by the subject within the weight limits encountered (less than 20 kg), the rise in O_2 consumtpion being equal to an increase caused by an in crease in body weight of the subject: if the trial in question means an expenditure of energy of 20 ml/kg of body weight, an increase of 1 kg in the weight of the apparatus involves an additional expenditure of energy of 20 ml or 1/60 of the weight of a man weighing 60 kg; in other words, a wearer of 60 kg consuming 1200 ml O_2/min under control conditions will consume 1400 ml O_2/min if he has to carry 10 kg. Beyond 20 kg, the consumption of oxygen becomes excessive, the burden inhibiting normal movement by the subject.

For respiratory resistances normally found in self-contained apparatus, the mechanical ventilatory force of the wearer is only slightly affected: it increases simply because of the additional effort, which would otherwise be insignificant. The admissible limit values have been well established for application to CO_2 filter self-rescuers. The physiological origin of these limit values of dynamic resistance is the maximum force which the inhaling muscles can develop (60 cm H_2O as the minimum for an average subject). The maximum tolerable resistance therefore depends on the ventilation flow permitted for the wearer according to the equation: $R = 60/V$. Taking into account the relationships between the maximum air intake, the ventilation rate permissible, the consumption of O_2 (equal to ventilation of 20 l air/l O_2) and pressure measurements in mm taken for H_2O for controlling self-rescuers with a continuous flow of 95 l/min, a diagram (Fig. 1) is obtained which fixes the maximum tolerable resistance in relation to the effort allowed to the wearer. The effect of additional clearances (mouthpieces of self-contained apparatus) is negligable with the values normally encountered (less than 100 ml): necessary adaptation is always possible in view of the size of the ventilatory reserves available: during non-exhausting trials the experimental clearances of 0.5 and 1 l only made small changes in the ventilatory behaviour of the subjects. As with CO_2 in the inhaled air, such clearances become significant when the trials are more intensive and close to the maximum. For clearances below 100 ml and low metabolisms (1 to 1.5 l O_2/min), the problem is unimportant since, at worst, it means an increase in ventilation of 2 l/min.

Some effect can be ascribed to the temperature and the humidity of the inhaled air. But, while obviously present, this effect is subordinate due to the quantitavely low calorific exchanges in the inhaled air. On the other hand, the features of the "micro-climate" represented by the wearer and his self-contained apparatus (reheating by the CO_2 absorber unit or cooling by the liquid oxygen source, followed by the carbon ice pack) play a decisive part. The key differentiation in physiological efficiency of the different self-contained apparatus therefore stems from their heating or cooling function. In high-temperature environments, the thermal limitation is a paramount factor, as tests at Hasselt have shown.

An outline diagram was devised in order to weight the different possible improvements in the design of apparatus and to provide data on the comparative values of various existing apparatus. This diagram is based on a variety of physiological approximations which enable all the stresses, to which a wearer of a self-contained apparatus is exposed, to be related to a single unit of measurement, the mechanical ventilatory force, chosen in an arbitrary fashion, being expressed in Kgm/min.

Although only an outline and rather complex, this diagram did yield simple and practical information. This included the intensity of energy expenditure, possible thermal stasis, the weight carried by the subject, the volume of the additional dead weight carried, the CO_2 content in the inhaled air and the additional resistance of the self-contained apparatus. As an example, a satisfactory self-contained apparatus involves an overall stress of 6 kgm/min; an inferior one a stress of 22 kgm/min.

Tableau 1

Comparaison mécanique ventilatoire des différents appareils respiratoires autonomes

Appareil Ventilation L/min	Draeger 160			Draeger 170			Draeger 172			Draeger 174			Auer 0,6L			Auer 1,8L			Pirelli		
	10	30	50	10	30	50	10	30	50	10	30	50	10	30	50	10	30	50	10	30	50
Variation																					
I. Puissance mécanique L. en H_2O/min	10,7	103	309	8,2	1	226	13	118	320	10,7	96	287	7,4	96	287	9	81	247	14	118	392
2. Variation de pression aux débits nuls mm H_2O	22	24	19	16	19	21	27	29	22	25	26	24	21	20	21	31	32	25	15	16	18
Pression moyenne mm H_2O	+7	+9	+6	-2	-4	-6	+9	+9	+7	+14	+12	+10	+4	-2	+6	+4	+7	+4	+1	+5	+8
3. Variation de pression au volume moyen mm H_2O	14	46	87	11	35	61	16	52	89	15	41	73	11	41	75	13	33	67	19	51	93
Résistance dynamique globale mm H_2O/(L/sec)	13	14	15	10	11	11	15	16	16	13	13	14	9	13	14	11	11	12	17	16	19
4. Dépression maximum mm H_2O	7	20	39	9	19	33	6	25	44	6	19	36	6	22	37	6	16	32	9	24	43
Pression maximum mm H_2O	17	26	48	7	16	28	26	28	45	24	25	39	20	19	38	30	31	35	10	27	50
Variation maximum de pression mm H_2O	24	46	87	16	35	61	32	53	89	30	44	75	26	41	75	36	47	67	19	51	93

Appareil Ventilation L/min	Proto			Fenzy			Fenzy + S			Normalair			Aerorlox			Air-Magic		
	10	30	50	10	30	50	10	30	50	10	30	50	10	30	50	10	30	50
Variation																		
I. Puissance mécanique L. en H_2O/min	31	296	940	6,2	81	206	13	118	320	28	155	326	27	157	385	33	236	536
2. Variation de pression aux débits nuls mm H_2O	30	35	40	19	22	24	20	21	23	28	26	26	19	21	22	21	23	20
Pression moyenne mm H_2O	+4	-20	-30	+13	+15	+16	+15	+13	+11	+21	+19	+16	+17	+16	+15	-8	-9	-4
3. Variation de pression au volume moyen mm H_2O	40	130	240	12	34	53	16	52	92	32	48	78	29	55	76	36	90	140
Résistance dynamique globale mm H_2O/(L/sec)	38	40	45	10	11	10	14	16	16	27	16	14	26	18	15	40	32	26
4. Dépression maximum mm H_2O	15	80	150	4	9	18	6	24	42	2	12	27	4	21	38	24	50	80
Pression maximum mm H_2O	25	50	90	19	25	35	19	29	50	31	36	51	28	38	45	16	40	60
Variation maximum de pression mm H_2O	40	130	240	23	34	53	25	53	92	33	48	78	32	59	83	40	90	140

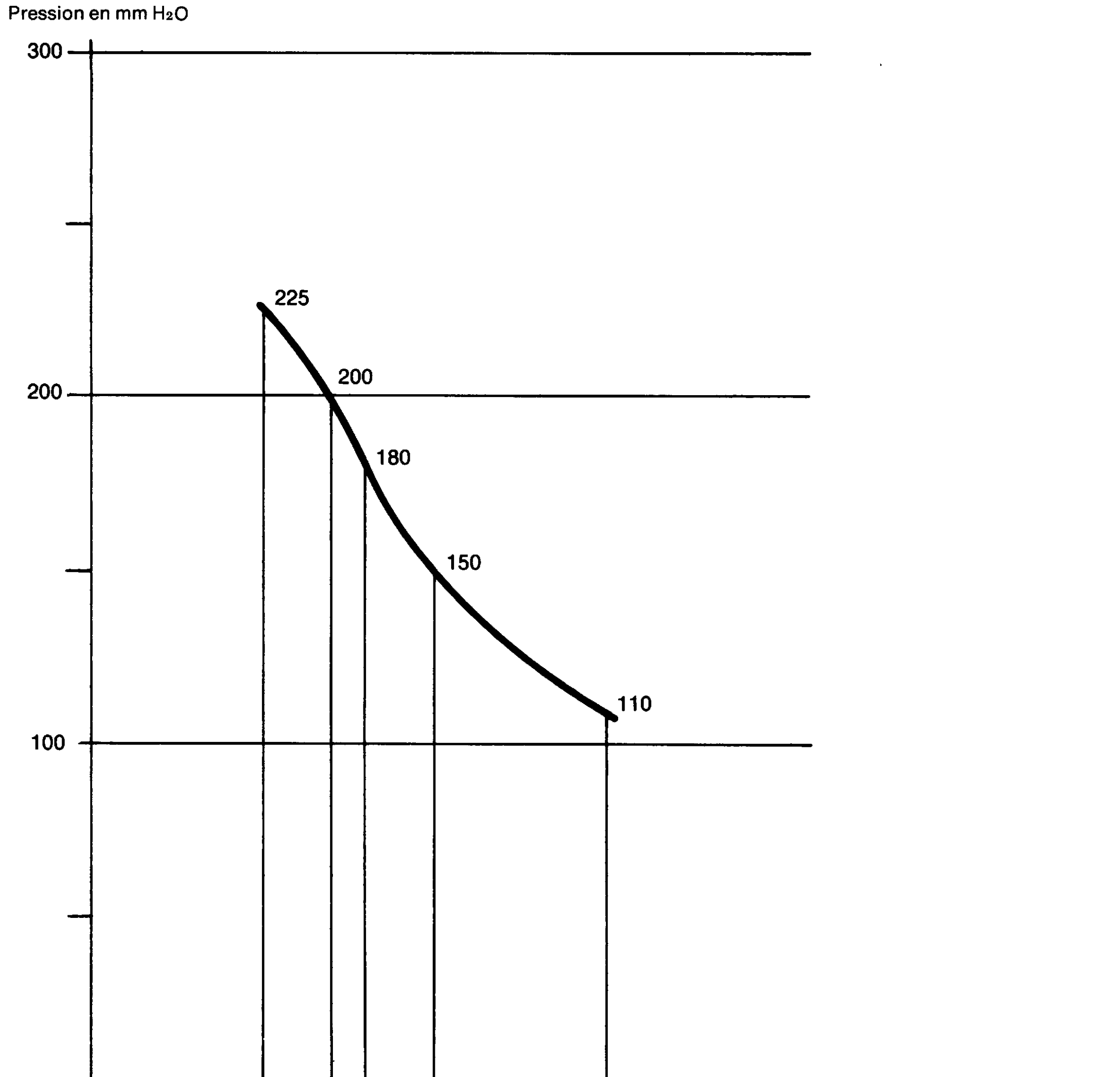
Tableau 2

Normes mécaniques ventilatoires des appareils respiratoires autonomes

Caractéristiques	1. Thorax			2. Perception			3. Commerciales			4. Tolérance			5. Intolérance		
Ventilation L/min	10	30	50	10	30	50	10	30	50	10	30	50	10	30	50
1. Puissance mécanique L cm H_2O/min	16	220	1 030	5	45	120	12	110	350	25	250	1 000	125	1 250	5 000
2. Variation de pression aux débits nuls mm H_2O	100	150	200	25	37	50	30	30	30	100	150	200	100	300	400
Pression moyenne mm H_2O	-10	-20	+10	-	-	-	±10	±10	±10	±10	±10	±10	±50	±50	±50
3. Variation de pression au volume moyen mm H_2O	21	94	260	6	19	32	15	50	80	30	100	200	150	500	1 000
Résistance dynamique globale mm H_2O(L/sec)	20	30	50	6	6	6	15	15	15	30	30	30	200	200	200
4. Dépression maximum mm H_2O	60	100	110	15	20	25	10	25	50	50	100	100	100	250	500
Pression maximum mm H_2O	40	50	150	15	20	25	30	35	50	50	50	100	100	250	500
Variation maximum de pression mm H_2O	100	150	260	25	37	50	40	60	100	100	150	200	200	500	1 000

Figure 1

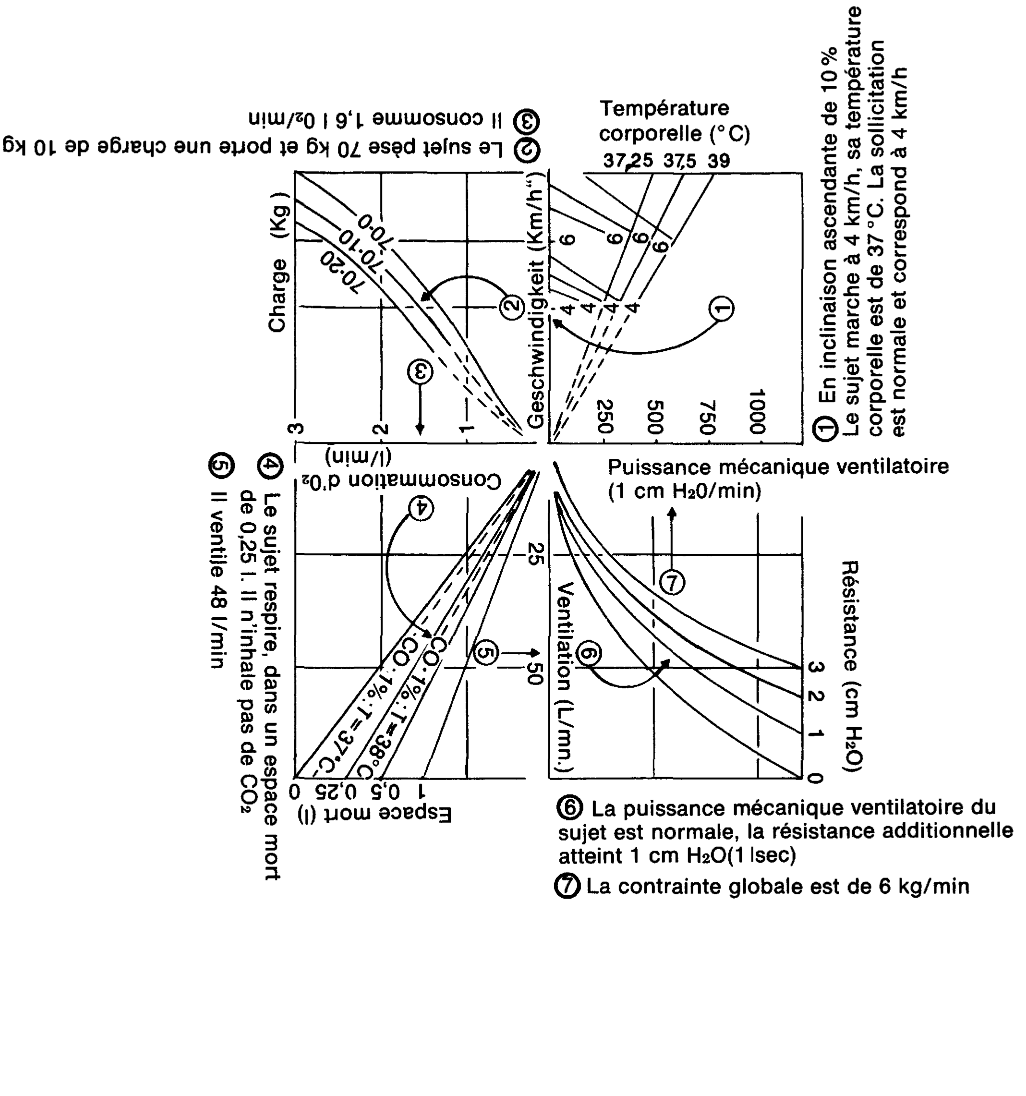
VARIATION DE LA RESISTANCE EN FONCTION DE L'EFFORT



COUT PHYSIOLOGIQUE GLOBAL DE L'UTILISATION D'UN BON APPAREIL RESPIRATOIRE AUTONOME

Exemple schématique (lire le diagramme en tournant de 1 à 7)

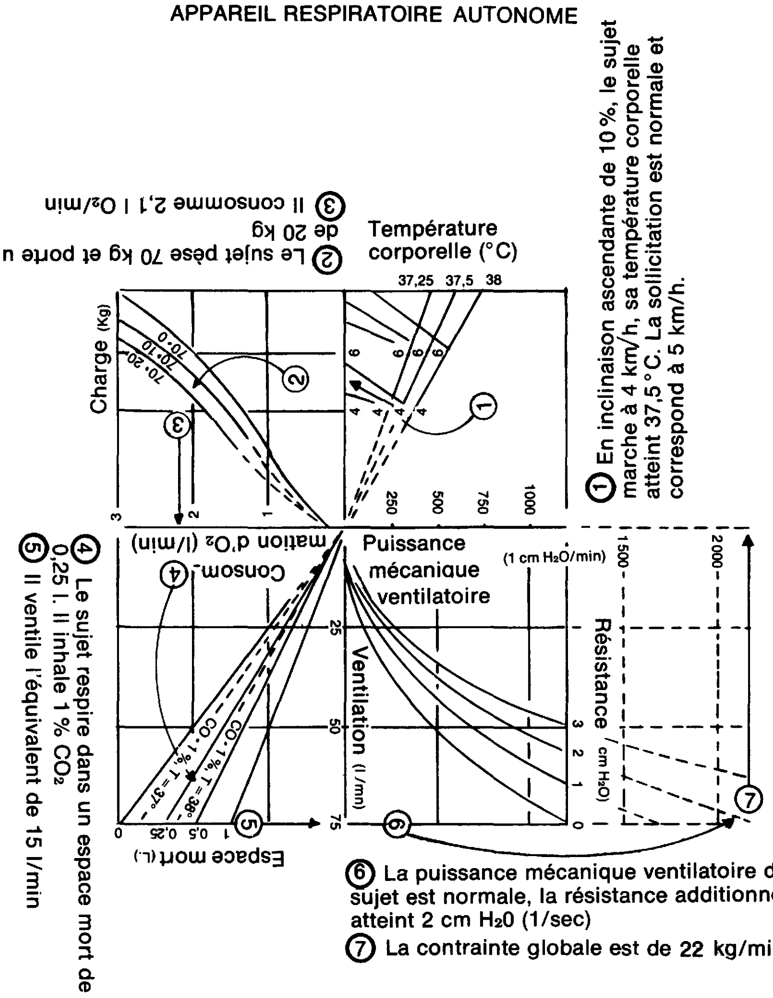
CONTRAINTE GLOBALE LIÉE AU PORT D'UN BON APPAREIL RESPIRATOIRE AUTONOME



COUT PHYSIOLOGIQUE GLOBAL DE L'UTILISATION D'UN MAUVAIS APPAREIL RESPIRATOIRE AUTONOME

Exemple schématique (lire le diagramme en tournant de 1 à 7)

CONTRAINTE GLOBALE LIÉE AU PORT D'UN MAUVAIS APPAREIL RESPIRATOIRE AUTONOME



⑥ La puissance mécanique ventilatoire du sujet est normale, la résistance additionnelle atteint 2 cm H₂0 (1/sec)

⑦ La contrainte globale est de 22 kg/min

2) SUMMARY OF RESULTS OBTAINED BY THE "HAUPTSTELLE FÜR DAS GRUBENRETTUNGSWESEN" AT ESSEN (GERMANY)

RESULTS OF THE RESEARCH PROGRAMME CARRIED OUT BY THE CENTRAL RESCUE STATION AT ESSEN-KRAY

Tests on respiratory physiology were carried out at the physiological institute at Liège University on a number of experimental subjects equipped with closed-circuit oxygen breathing apparatus as used by rescue teams in the mines of Western Europe. In order to obtain objective criteria which would enable the value of the apparatus to be assessed and improved, it was deemed necessary for these to be tried, not only longer on human subjects, but on an artificial breathing machine (artificial lung), so as to then compare the measurements obtained with the Liège test results.

With this in view, a theory was first established dealing with the physical processes noted when a closed-circuit oxygen breathing apparatus was used. This showed that the criterion of 'respiratory resistance' as used until then to monitor closed-circuit apparatus, showed only the pressure at the buccal mouthpiece of the apparatus but did not take into account flow quantity. According to this theory, a formula was devised to calculate the respiratory resistance in an overall sense, consisting of the resistance to flow and elastic resistance, a formula which even then had to be based on simplified hypotheses and did not take into account all relevant parameters. Not considered were, for example, flow turbulence, the non-constant elasticity of elastic components and the disparity in inhalting and exhaling channels. For this reason research was focussed on a better criterion of respiratory physiology, which would involve all the important factors. It was shown that the respiratory capacity, consisting of a combination of flow and elasticity capacities, met these conditions.

We have also developed a measuring device which, with the help of an artificial lung, enabled the most significant information to be obtained (annex 1). The main features of the artificial lung and the measuring device and the method of the trials have been fully described. Supervision of the trial procedure which was carried out by testing an apparatus first on a human subject, then on an artificial lung, has demonstrated that the procedure used is entirely suitable to the aim in view (annex 2).

Independently of the measurement of physical indices (annex 3), the regenerative cartridges were also checked for their chemical performance (annex 4).

The closed-circuit oxygen apparatus of the firm Fenzy, 1956 model, with values, was used as a specimen to show in detail how the measurement results obtained in trials were utilised. The results of physical indices measurements of all types of apparatus investigated are set out in separate tables. Discussion of these results centred on the distinctive features noted as between different types of apparatus. This showed how the various types could be improved. Overall, however, measurements of all the apparatus investigated were found to lie within the 'tolerance limits' worked out by the Physiology Institute at Liège.

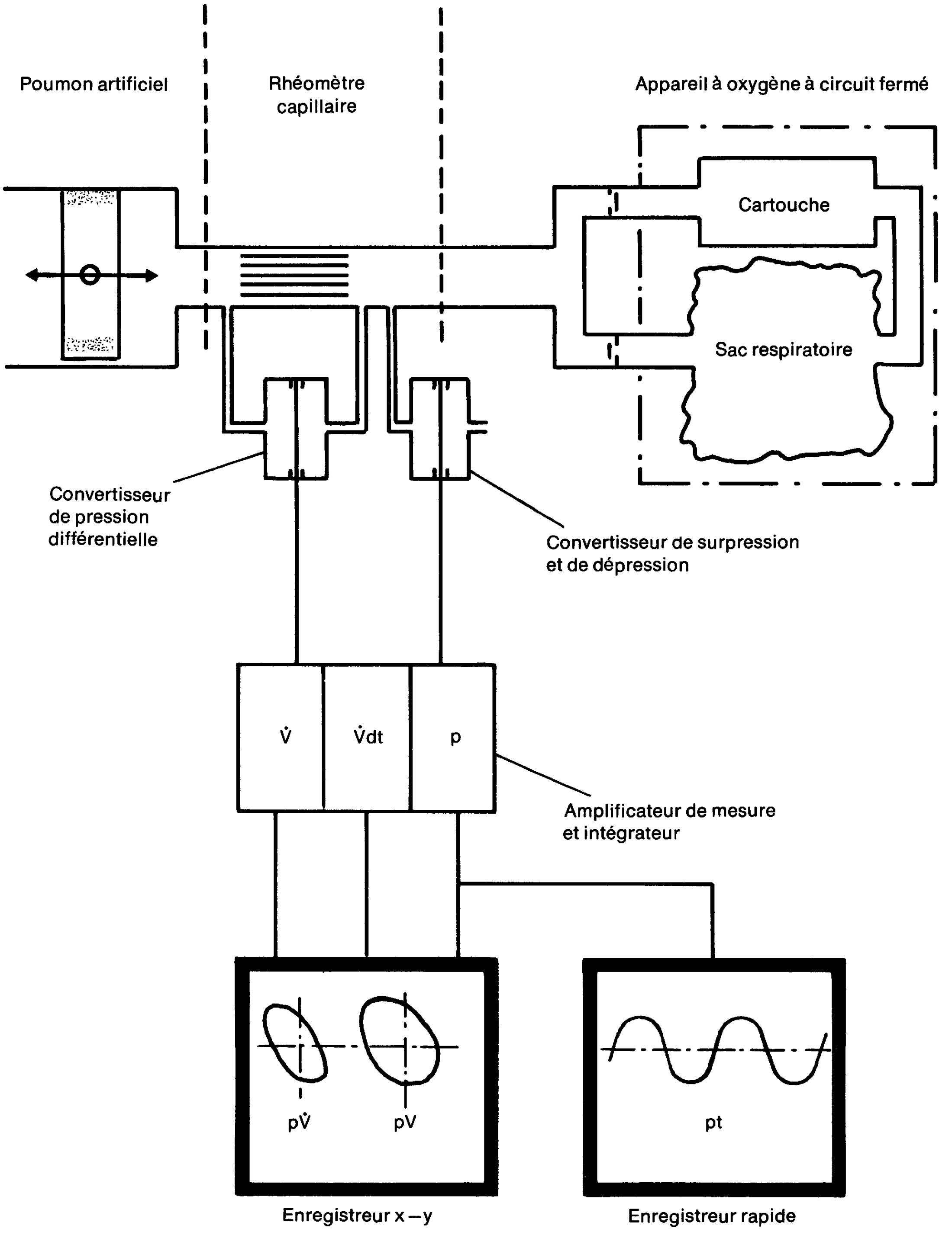
In comparing the measurements obtained with the results from the Liège investigations of apparatus, attention was particularly focussed on difficulties which are impossible to avoid when thests are made on human subjects.

The values obtained at Essen and at Liège have been grouped together in table form; it has been found that, despite the difficulties referred to, the different values coincide to a considerable extent (annex 5).

It emerged that one can be confident that the new method of testing closed-circuit oxygen apparatus makes it possible to simulate in good conditions the use of apparatus by men and that the values obtained during these investigations provide exact indications for future improvement in closed-circuit oxygen apparatus.

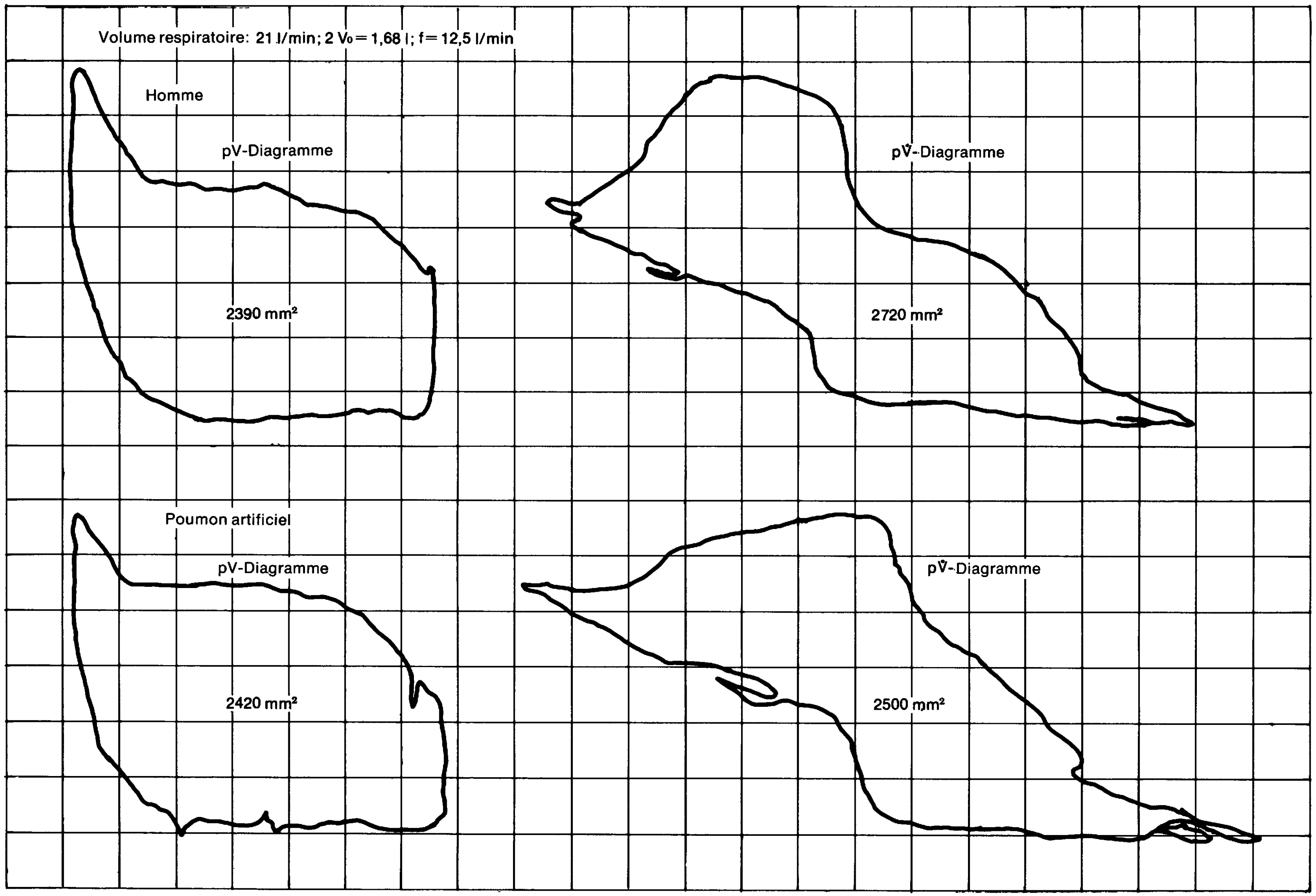
Annexe 1

SCHEMA DE L'INSTALLATION DE MESURE DE LA RESISTANCE RESPIRATOIRE



Annexe 2

pV- et pV̇- Diagramme: Homme — Poumon artificiel



Annexe 3

Récapitulation des résultats des essais

(valeurs physiques)

Modèle d'appareil		circulation d'air l/min	Aerorlox 10	25	50	Auer 54/400 10	25	50	Auer 56/400 10	25	50	Dräger 160 A 10	25	50	Dräger 170/400 10	25	50
P_u dépression max.	mm WS	I	4,8	20,5	60,0	8,0	15,5	47,0	0,0	6,8	44,0	3,9	8,7	30,2	8,1	11,1	34,4
		II	-	24,0	69,0	-	14,8	44,8	-	7,5	52,3	-	9,4	29,7	-	11,5	33,4
Pü surpression max.	mm WS	I	30,2	43,0	56,2	32,5	22,5	55,0	40,0	42,7	49,0	22,0	26,0	48,9	9,0	18,4	45,0
		II	-	44,5	54,3	-	29,2	77,0	-	49,7	75,0	-	29,1	59,0	-	28,5	79,7
P_g pression totale	mm WS	I	35,0	63,5	116,2	40,5	38,0	102,0	40,0	49,5	93,0	25,9	34,7	79,1	17,1	29,5	79,4
		II	-	68,5	123,3	-	44,0	121,8	-	57,2	127,3	-	38,5	88,7	-	40,0	113,1
Pm pression moyenne	mm WS	I	+12,1	+8,5	+1,8	+10,3	1,0	-2,1	+14,0	+13,3	-0,8	+5,0	+6,5	+3,0	+0,4	+1,3	+2,3
		II	-	+8,3	-0,7	-	+4,2	+8,3	-	+16,0	+0,8	-	+7,1	+5,7	-	+5,7	+12,8
ΔP_s $(P_1 - P_2)$ v=o	mm WS	I	33,6	53,0	111,5	21,1	36,0	101,0	12,5	28,7	91,0	10,0	25,6	72,0	14,2	28,6	73,6
		II	-	55,9	117,5	-	45,0	125,5	-	33,3	127,0	-	29,1	87,2	-	39,7	102,0
ΔP_e $(P_1 - P_2)$ $\dot{v}$=o	mm WS	I	18,9	22,9	22,3	27,7	21,0	47,1	32,1	38,0	21,6	16,6	22,6	6,4	11,9	14,3	9,2
		II	-	22,9	22,6	-	19,3	50,8	-	44,4	27,7	-	21,7	13,2	-	15,8	29,2
A_s résistance au flux	mm WS . s/l	I	32,2	20,3	21,3	20,2	13,8	19,3	12,0	11,0	17,4	9,6	9,8	13,7	13,6	11,0	14,1
		II	-	21,4	22,5	-	17,2	23,9	-	12,7	24,2	-	11,1	16,7	-	15,2	19,5
A_e résistance élastique	mm WS . s/l	I	18,1	8,8	4,3	26,6	8,1	9,0	30,7	14,6	4,1	15,9	8,7	1,2	11,4	5,5	1,8
		II	-	8,8	4,3	-	7,4	9,7	-	17,0	5,3	-	8,3	2,5	-	6,0	5,6
A résistance respiratoire	mm WS . s/l	I	37,0	22,0	21,3	34,3	16,0	21,3	33,0	18,3	17,9	18,6	13,0	13,7	17,7	12,2	14,3
		II	-	23,2	22,9	-	18,6	25,8	-	21,2	24,8	-	13,8	16,8	-	16,4	20,3
$\dot{W}_s$ capacité de flux	cm WS.l/min	I	25,2	95,5	436,0	18,8	72,8	393,0	12,3	57,2	351,0	10,45	59,2	272,0	12,8	57,1	268,0
		II	-	110,0	455,0	-	89,6	447,0	-	68,5	478,0	-	61,2	308,0	-	76,9	412,0
$\dot{W}_e$ capacité élastique	cm WS.l/min	I	10,5	44,4	86,7	14,4	36,2	113,0	24,4	64,6	75,4	12,3	27,8	28,0	4,5	5,0	8,8
		II	-	44,6	73,5	-	57,1	123,8	-	75,2	88,1	-	26,8	41,0	-	13,0	73,5
$\dot{W}$ capacité respiratoire	cm WS.l/min	I	27,3	105,5	445,0	23,7	82,0	410,0	27,3	86,5	359,0	16,1	65,5	274,0	13,3	57,5	268,5
		II	-	119,0	461,0	-	106,0	464,5	-	102,0	486,0	-	67,0	310,5	-	78,0	419,0

Modèle d'appareil		circulation d'air l/min	Dräger 172 10	25	50	Dräger 174 10	25	50	Fenzy 56 10	25	50	Pirelli 205 10	25	50	Simbal 10	25	50
P_u dépression max.	mm WS	I	4,0	9,6	41,5	4,1	10,7	41,5	0,0	1,0	8,0	4,0	16,5	67,0	2,0	10,7	35,4
		II	-	9,6	41,0	-	10,3	39,2	-	1,1	8,4	-	15,0	70,5	-	14,1	47,1
Pü surpression max.	mm WS	I	38,0	44,2	52,6	37,0	38,0	49,0	59,0	62,5	60,0	39,0	52,0	193,0	34,5	43,3	54,5
		II	-	43,4	80,2	-	40,0	74,5	-	63,5	67,9	-	60,5	208,0	-	42,4	50,7
P_g pression totale	mm WS	I	42,0	53,8	94,1	41,1	48,7	90,5	59,0	63,5	68,0	43,0	68,5	260,0	36,5	54,0	89,9
		II	-	53,0	121,2	-	50,3	113,7	-	64,6	76,3	-	75,5	278,5	-	56,5	97,8
Pm pression moyenne	mm WS	I	+9,2	+10,9	-1,6	+11,2	8,9	-3,2	+18,5	+16,0	+14,0	+10,5	+14,8	+29,8	+14,7	+8,5	+8,5
		II	-	+12,0	+4,3	-	+11,9	+3,0	-	+18,0	+16,2	-	+14,8	+29,1	-	8,7	+3,2
ΔP_s $(P_1 - P_2)$ v=o	mm WS	I	16,2	33,8	86,0	20,0	30,4	86,0	22,0	16,0	27,0	21,2	60,6	251,0	33,2	39,3	72,7
		II	-	40,6	117,0	-	40,3	112,0	-	20,3	29,7	-	70,3	268,0	-	30,1	89,0
ΔP_e $(P_1 - P_2)$ $\dot{v}$=o	mm WS	I	29,0	38,6	32,8	34,3	37,4	40,4	34,5	43,0	46,0	31,5	41,0	11,2	25,8	27,7	29,8
		II	-	40,0	22,6	-	36,2	33,3	-	45,1	51,6	-	29,2	16,2	-	29,0	32,5
A_s résistance au flux	mm WS . s/l	I	15,5	12,9	16,4	19,2	11,6	16,4	21,0	6,2	5,2	20,3	23,2	47,9	31,8	11,3	13,9
		II	-	15,6	22,3	-	15,4	21,4	-	7,8	5,7	-	26,9	52,2	-	11,5	17,0
A_e résistance élastique	mm WS . s/l	I	27,7	14,8	6,3	32,8	14,3	7,7	33,0	16,1	8,8	30,1	15,7	2,1	24,7	10,6	5,7
		II	-	15,3	4,3	-	13,9	6,4	-	17,3	9,8	-	11,2	3,1	-	11,1	6,2
A résistance respiratoire	mm WS . s/l	I	31,8	19,6	17,5	38,0	18,4	18,0	39,0	17,2	10,2	36,2	28,1	47,9	40,4	15,5	15,0
		II	-	21,9	22,7	-	20,8	22,4	-	19,0	11,4	-	29,2	52,2	-	16,0	18,1
$\dot{W}_s$ capacité de flux	cm WS.l/min	I	16,3	67,4	324,0	18,3	63,2	338,0	22,4	52,5	129,0	18,8	114,0	862,0	23,0	78,0	295,0
		II	-	83,6	424,0	-	80,0	409,0	-	54,0	143,0	-	127,5	925,0	-	83,0	362,0
$\dot{W}_e$ capacité élastique	cm WS.l/min	I	18,5	43,2	108,5	14,3	47,5	103,5	32,0	84,5	132,0	23,4	58,6	75,6	18,5	56,6	119,1
		II	-	51,7	95,4	-	48,5	91,0	-	83,5	154,0	-	28,4	101,0	-	58,9	116,9
$\dot{W}$ capacité respiratoire	cm WS.l/min	I	24,6	80,5	342,0	23,2	79,0	355,0	39,0	99,5	184,0	29,5	128,5	866,0	29,4	96,5	318,5
		II	-	98,0	435,0	-	94,0	418,0	-	99,0	210,0	-	130,5	930,0	-	102,0	381,0

A la 1re ligne figurent les mesures des essais effectués avec une nouvelle cartouche de régénération,

à la 2e ligne figurent celles effectuées avec une cartouche usagée.

Récapitulation

Examen du rendement chimique des cartouches de régénération

Appareil	produit chimique	durée de l'essai	absorption de CO_2	teneur en CO_2 de l'air inspiré, vol. % (1re ligne) / température de l'air inspiré en C° (2e ligne) / volume respiratoire 25 l/min — après le temps d'essai (min)								50 l/min (min)	
		min	l	0	10	60	120	180	240	300	fin	60	120
Auer MR 54/400	A	310	330	-	0,10	0,08	0,06	0,04	0,06	0,30	0,68		0,10
				18,5	18,5	23,5	30,5	34,5	37,0	38,5	39,0		38,5
Dräger BG 170/400	A	306	316	-	0,10	0,06	0,04	0,04	0,04	0,30	0,38		0,04
				21,0	19,5	26,0	32,0	36,0	38,0	39,5	39,5		39,5
Dräger BG 172	A	284	294	-	0,08	0,05	0,02	0,03	0,03		0,08		0,03
				22,0	19,0	24,5	31,0	35,0	38,0		38,0		39,0
Dräger BG 174	A	267	277	-	0,09	0,05	0,03	0,04	0,09		0,19		0,03
				19,0	17,0	23,5	29,5	33,0	34,5		35,5		37,5
Auer MR 56/400	A	254	264	-	0,09	0,07	0,05	0,04	0,04		0,04		0,09
				19,0	17,5	23,0	29,5	34,0	36,5		36,5		39,0
Dräger BG 160 A	A	207	217	-	0,18	0,12	0,06	0,15			0,30	0,29	
				21,0	23,0	28,5	35,5	38,0			39,0	37,25	
Aerorlox	K	200	210	-	0,35	0,40	0,38	0,42			0,42	0,35	
				25,0	1,0	4,5	7,0	10,0			11,5	2,5	
Fenzy Modell 1956	K	185	192	-	0,00	0,00	0,02	0,20			0,25	0,45	
				22,5	22,0	33,5	35,5	36,5			36,3	38,2	
Simbal	K	167	177	-	0,06	0,30	0,48				0,50	1,20	
				23,0	12,5	12,0	14,0				14,0	8,5	
Pirelli 205	A	135	145	-	0,15	0,14	0,62				0,90	0,50	
				25,0	20,5	29,5	37,2				36,0	39,5	

A = alcali; K = chaux

R é c a p i t u l a t i o n

Comparaison des résultats significatifs des essais de physiologie respiratoire pour des volumes respiratoires de 10 et 50 l/min

Appareil	capacité de flux W_s cm WS l/min		pression moyenne p_m mm WS		résistance au flux A_s mm WS s/l		dépression p_u mm WS		surpression p_u mm WS	
	10	50	10	50	10	50	10	50	10	50
Aerorlox	27,0	385,0	17,0	15,0	26,0	15,0	4,0	38,0	28,0	45,0
	25,2	436,0	12,1	1,8	32,2	21,3	4,8	60,0	30,2	56,2
Auer MR 54/400	7,4	287,0	4,0	6,0	9,0	14,0	6,0	37,0	20,0	38,0
	18,8	393,0	10,3	-2,1	20,2	19,3	8,0	47,0	32,5	55,0
Auer MR 56/400	9,0	247,0	4,0	4,0	11,0	12,0	6,0	32,0	30,0	35,0
	12,3	351,0	14,0	-0,8	12,0	17,4	0	44,0	40,0	49,0
Dräger BG 160 A	10,7	309,0	7,0	6,0	13,0	15,0	7,0	39,0	17,0	48,0
	10,45	272,0	5,0	3,0	9,6	13,7	3,9	30,2	22,0	48,9
Dräger BG 170/400	8,2	226,0	-2,0	-6,0	10,0	11,0	9,0	33,0	7,0	28,0
	12,8	268,0	0,4	2,3	13,6	14,1	8,1	34,4	9,0	45,0
Dräger BG 172	13,0	320,0	9,0	7,0	15,0	16,0	6,0	44,0	26,0	45,0
	16,3	324,0	9,2	-1,6	15,5	16,4	4,0	41,5	38,0	52,6
Dräger EG 174	10,7	287,0	14,0	10,0	13,0	14,0	6,0	36,0	24,0	39,0
	18,3	338,0	11,2	-3,2	19,2	16,4	4,1	41,5	37,0	49,0
Fenzy Modell 1956	13,0	320,0	15,0	11,0	14,0	16,0	6,0	42,0	19,0	50,0
	22,4	129,0	18,5	14,0	21,0	5,2	0	8,0	59,0	60,0
Pirelli 205	14,0	392,0	1,0	8,0	17,0	19,0	9,0	43,0	10,0	50,0
	18,8	862,0	10,5	29,8	20,3	47,9	4,0	67,0	39,0	193,0
Simbal	28,0	326,0	21,0	16,0	27,0	14,0	2,0	27,0	31,0	51,0
	23,0	295,0	14,7	8,5	31,8	13,9	2,0	35,4	34,5	54,5

A la 1re ligne figurent les résultats des mesures obtenus à Liège, et à la 2e ligne ceux obtenus à Essen.

3) SUMMARY OF RESULTS OBTAINED BY THE "COÖRDINATIECENTRUM REDDINGSWEZEN VAN HET KEMPISCHE STEENKOLENBEKKEN" AT HASSELT (BELGIUM)

RESULTS OF RESEARCH CARRIED OUT AT THE "COÖRDINATIECENTRUM REDDINGSWEZEN"

I - Object of research

It was thought expedient to compare breathing apparatus from the viewpoint of the physiological condition of rescuers in operations carried out in environments with high temperatures, and this for two reasons:

1) Work is being carried out at progressively greater depths with consequent increases in temperature in the surrounding strata.

2) The cost of equipment installed in workings which may have to be cut off by stoppings in the event of fire is so high that it will be necessary to retrieve it provided conditions and facilities permit this. At this point the problem of the close positioning of stoppings to the site of the fire arises and it will be necessary to go beyond the stoppings where the temperature is always very high.

II - Training of rescuers at high temperatures in the Campine coalfield

300 rescuers are trained 5 times a year in a working in which the difficulties of a mine are reproduced and which has been especially designed from the point of view of climate and medical supervision. A medical specialist is present at all training courses. The expenditure in energy of each test is calculated in litres of oxygen consumed per minute.

III - Research following on this training

a) comparison of different closed-circuit breathing apparatus as part of tests carried out in intensified climatic conditions.

b) establishment of the permitted length of operations in intensified climatic conditions.

c) study of the effect of the onset of the thermal stasis on the physical and mental capacity of the rescuer.

1) Comparision of different closed-circuit breathing apparatus (used in the countries of the European Community and the United Kingdom) as part of tests carried out in intensified climatic conditions

During each test the 300 rescuers had the following breathing apparatus distributed among them:

a) liquid-oxygen apparatus witn regenerative cartridge with lime soda:
Aerorlux
Dräger Normalair

b) compressed oxygen apparatus with caustic soda regenerative cartridge:
Pirelli 205
Dräger 174 BG
Dräger 172 BG
Dräger BG 170/400

c) compressed oxygen apparatus with lime soda regenerative cartridge:
Fenzi 56
Proto MK V

Tableau Figure 1

Tableau récapitulatif des cycles d'exercice effectués pour: a) la comparaison des appareils respiratoires;
b) la détermination de la durée d'intervention permise en fonction de la température humide et de l'effort;
c) la vérification de certaines données.

P. = Phase C. = Cycle

Consommation moyenne d'oxygène	ts = 33 °C th = 28 °C	ts = 34 °C th = 29 °C	ts = 35 °C th = 30 °C	ts = 37 °C th = 32 °C	Ts = 39 °C		Th = 34 °C	ts = 40 °C th = 35 °C	ts = 41 °C th = 36 °C	ts = 42 °C th = 37 °C
0,9 l/min	P.3-C.7		P.3-C.9	P.4-C.3 P.4-C.4	P.4-C.1					
1,0 l/min	P.4-C.8		P.3-C.4	P.4-C.5 P.S-C.6	P.3-C.6	P.4-C.7	P.4-C.9	P.5-C.2	P.5-C.3	P.5-C.7
1,1 l/min		P.4-C.10bis								
1,2 l/min	P.4-C.6	P.4-C.10	P.4-C.2	P.3-C.8						

A remarquer que la recherche ne prévoyait pas de dépasser la température humide de 34°C.
Nous nous sommes limités à cette température pour la comparaison des appareils respiratoires, mais pour toutes, les courbes de durée d'utilisation nous avons effectué :

- des exercices de contrôle : P.4 - C.8 et P.5 - C.6
- des exercices à température humide plus élevée, mais uniquement avec des appareils respiratoires du type "Dräger" et pour un effort de 1 litre O_2/min : P.5 - C.2, P.5 - C.3 et P.5 - C.7

The table in Figure 1 recapitulates the programme of tests carried out.

To enable a comparison among the apparatus to be made, a common measurement was needed and this had to be the physical condition of the wearer of the apparatus after a specified test.

With this in view, each rescuer at the end of the test is given a 'fatigue coefficient', which takes into account:

a) rectal temperature at the end of the test;

b) heart-beat at the end of the test;

c) weight-loss as a percentage of the body weight of the person concerned;

d) heart-rate recovery after 10 minutes of rest when seated, the recovery being calculated as a percentage of the heart-beat increase due to the test;

e) the opinion of the person concerned.

Each of the above values is allotted an index figure to be found in the diagram in Figure 2. 5 index figures are added together and divided by 5. The result provided the fatigue coefficient. The formula of the index curve is as follows:

$$y = 100 \frac{1}{\log\left(\frac{B - X}{C} + 1\right)}$$

x being the value measured.

A and B are the physiological limits which we accept in the specific case of a test in high temperatures with closed-circuit breathing apparatus. The values for each facture are shown on the y axis of the diagram in Figure 2.

$$C = \frac{B - A}{G}$$

This fatigue index or overall index, has been calculated for each rescuer for each test; for each type of test we have calculated the average fatigue index for all wearers of the same type of apparatus. This has enabled us to classify them and, after statistical analysis of the results, the following conclusions could be drawn:

a) Comparison of breathing apparatus

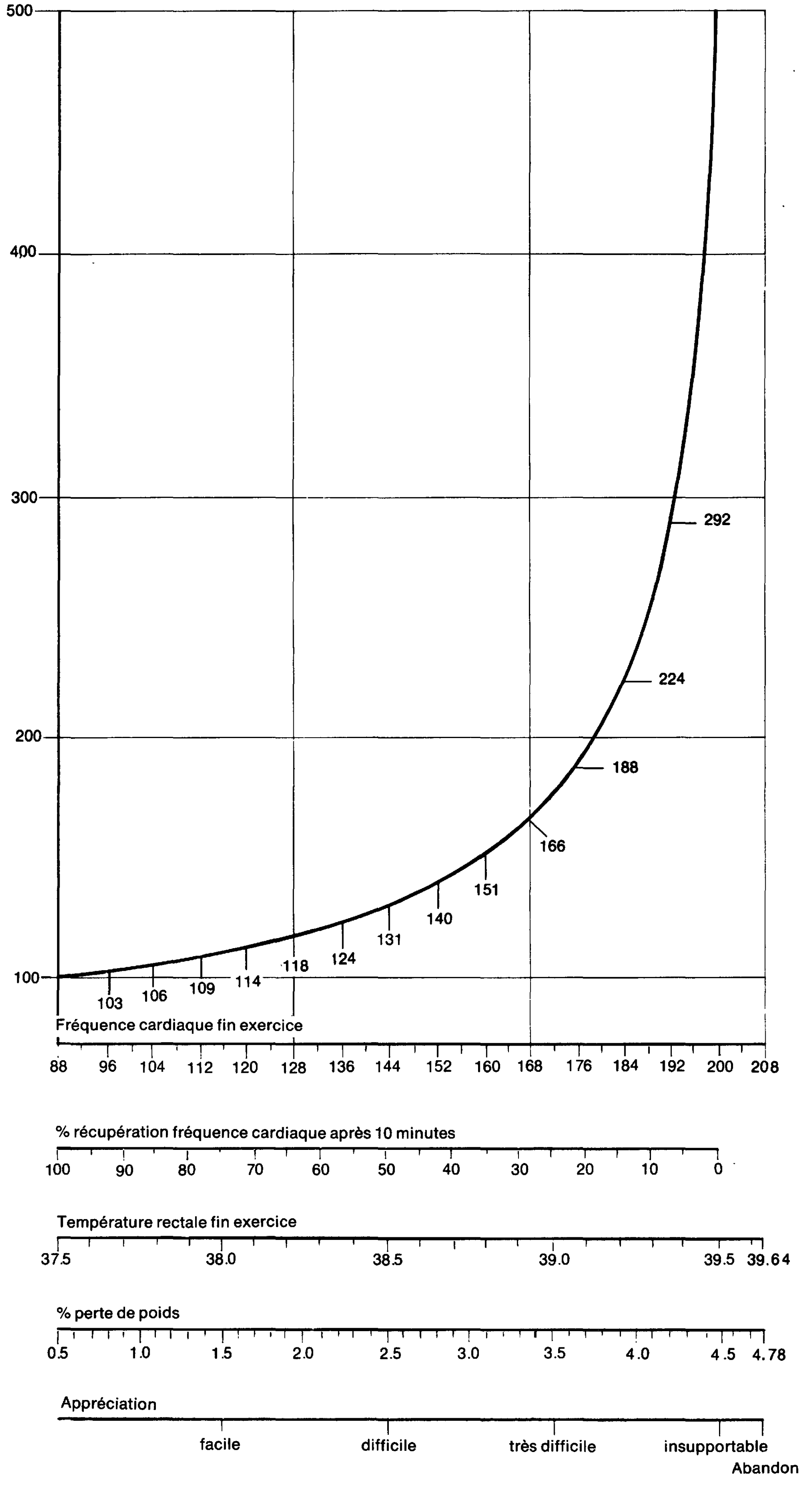
The results are shown in the table below in which the apparatus are classified in ascending order according to the average fatigue index obtained, the statistically derived difference being indicated by a solid line where the difference is not significant, by a broken line whose significant at 95 %, and by no line where the difference is very considerable.

The table should be read from top to bottom.

Dräger-Normalair	123.5
Aerolox	124.645
Dräger 174 BG	128.865
Dräger 172 BG	134.988
Pirelli 205	135.392
Dräger BC 170/400	137.440
Fenzi 56	140.020
Proto MK V	151.094

These results are calculated for 5 cycles because, after a certain point in time, the Fenzy 56 and the Proto MK V were not used.

Figure 2 – Diagramme permettant l'évaluation du coefficient de fatigue



If we calculate all the cycles, leaving out the Fenzy 56 and the Proto MK V, we obtain the following results which have a sounder statistical value:

Dräger-Normalair	122.37
Aerolox	124.38
Dräger 174 BG	127.76
Dräger 172 BG	133.65
Pirelli 205	135.49
Dräger BG 170/400	136.30

b) Difference between cooled and non-cooled breathing apparatus

Following previous results we have sought to find the determinant feature of this classification.

The best-supported apparatus are the Dräger-Normalair and the Aerolox, fed by liquid oxygen. The inhaled air is not only cooler but the entire apparatus stays cool.

Next in order came the compressed oxygen apparatus with soda regenerative cartridges. These were topped by the Dräger 174 BG, much lighter than the others.

Lastly came the compressed oxygen apparatus with lime soda regenerative cartridges.

After very detailed examination of possible reasons for these differences - weight, temperature of inhaled air, respiratory effort, etc. - the conclusion was reached that the key factor was likely to be the cooling of the apparatus and wearer due to liquid oxygen.

Using liquid oxygen does, however, present practical difficulties (preservation and transport) and we have tried to achieve the same result with solid CO_2. CO_2 in solid form was placed between the back of the rescuer and the compressed oxygen breathing apparatus. A thickness of perforated plastic foam 2 cm thick and latex straps 4 cm thick at 10 cm intervals protect the back of the rescuer against too intense cooling and allow an adequate degree of ventilation to the back.

Certain apparatus had cooling systems and others not.

We have compared the results obtained in the same tests with three groups of apparatus:

- liquid oxygen apparatus:
  Dräger Normalair
  Aerolox

- compressed oxygen apparatus, non-cooled:
  Dräger BG 170/400
  Dräger 172 BG
  Dräger 174 BG
  Pirelli 205

- compressed oxygen apparatus, cooled by solid CO_2, placed between the rescuers' back and his breathing apparatus:
  Dräger BG 170/400
  Dräger 172 BG
  Dräger 174 BG
  Pirelli 205

Without a doubt the cooling of compressed oxygen apparatus by inserting CO_2 in solid form between the back of the rescuer and the breathing apparatus markedly improves the latter in all conditions. Virtually the same result was obtained with the Dräger 174 BG cooled by a cushion of solid CO_2 with liquid oxygen apparatus.

During a test 26 Fenzy 56 apparatus were cooled with CO_2 in solid form and 19 were not cooled. The average overall index for the cooled apparatus was 137.8 and for the non-cooled 150.4. Not enough measurements exist to establish valid statistics, but the difference is of an order that it can already be stated that cooling is also very advantageous.

It is important to note that the cooling cushion can only be used in instances of high temperatures and where the rescuers work with naked torsos.

2) Permissable operating periods for rescuers wearing closed-circuit, non-cooled breathing apparatus in adverse climatic conditions

These periods are a function of:

- the dry and humid temperatures of the site of operations;
- the intensity of effort;
- the breathing apparatus used;
- the rescuer himself.

We have established curves of the periods of operation shown in Fig. 3.

These curves are valid:

1) for a pit or any site where humidity is 75 % or over;
2) for rescuers not specifically trained for work in high temperatures and for wearers of compressed oxygen, non-cooled breathing apparatus with absorbent soda cartridges, weighing approximately 17 kg.

3) Study of the effects of the onset of thermal stasis on the physical and mental performance of rescuers

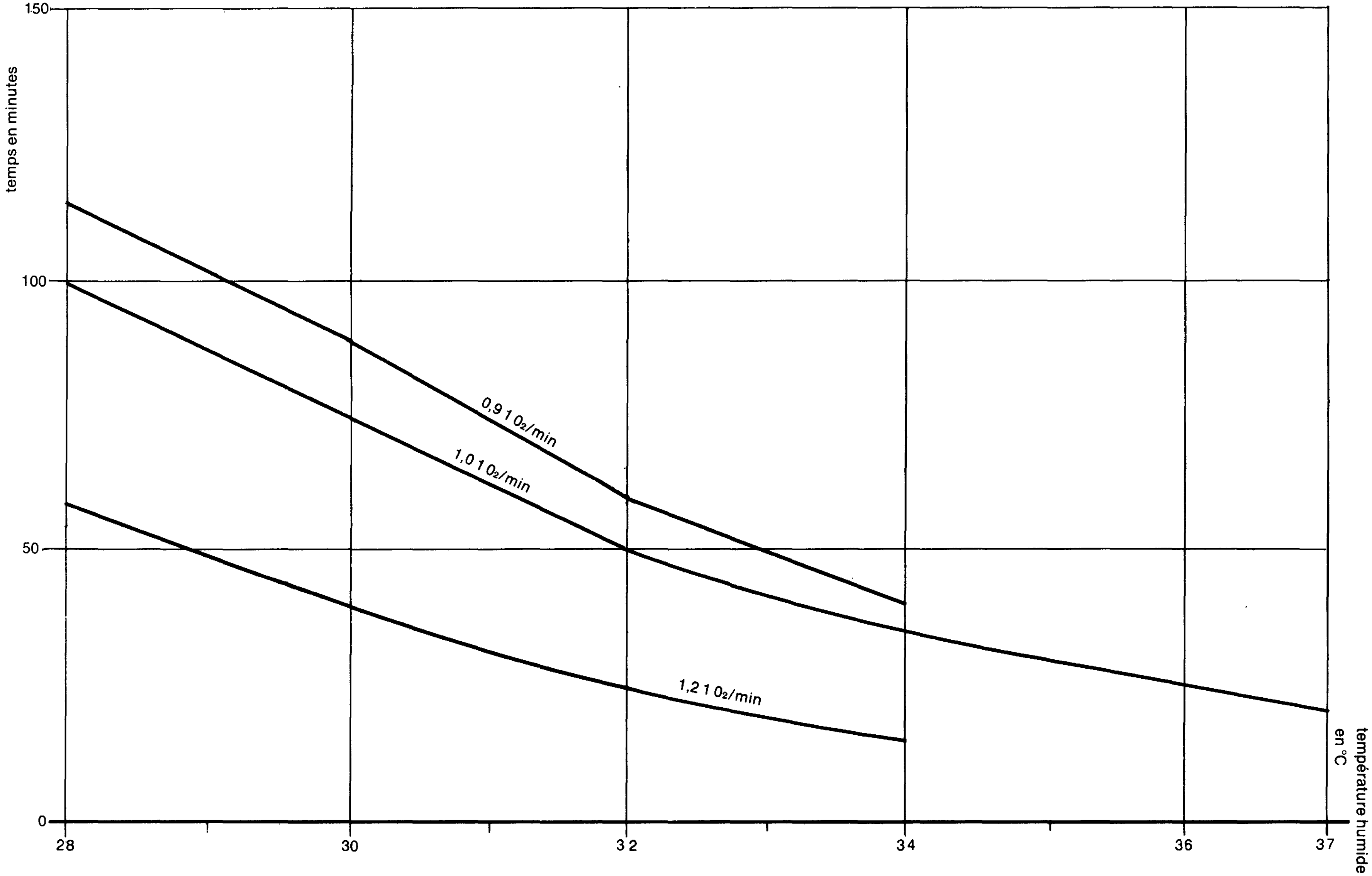
a) purpose of research

The staff of the "Coördinatiecentrum Reddingswezen van het Kempische Steenkolenbekken" had the impression that some of the rescuers at the end of a test or immediately after it were in condition of diminished psychic competence for several minutes. For example, their attention seemed reduced and they appeared to have difficulty in noticing and avoiding any obstacles in their path.

b) Tests applied

1) the Coetsier obstacle test given to everyone before and after the trial;
2) The Thurstone equivalent shape test;
3) The Coetsier obstacle test, given to half the group before and to half the group after the test;
4) The Gruenbaum test;
5) Length measurement of different sections of straight lines;
6) Interview to ascertain subjective impressions;
7) The "Amsterdamse Biografische Vragenlijst" (ABV);
8) Determination of CFF;
9) Reaction time;
10) The RT attention test.

Figure 3 — Temps d'intervention admissibles avec appareil Draeger en fonction de la température et de l'effort



c) Conclusion

In general terms it can be said that the rescue tests as carried out do not enable the psychic deterioration to be established except by tests of short duration.

Yet it would appear that:

- for the majority of rescuers the normal acclimatisation process did not exist in relation ot the obstacle test. It only appeared in a small group of persons, as shown by a minimal loss of weight;
- the degree of activation (value CFF) rises markedly during a short test. It is not known what this is for a test of long duration;
- persons having a high cardiac rate at the end of a test have a longer reaction time.

These points should be confirmed by new experiments. Attempts should also be made to apply more searching tests before drawing definitive conclusions.

In addition to these above-mentioned studies complementary research has been carried out in connection with the tests:

1) Should the above-mentioned five physiological factors be taken into account when calculating the fatigue index?

We have examined how many tests per subject provided very significant, significant and non-significant differences for each factor and its related index.

After statistical analysis we found that:

a) The overall index gave a high degree of accuracy. But the values we gave to the subjective assessment will have to be revised since it affected the overall index too greatly. This has been done and certain limits have been amended on the basis of the experience gained. Below will be found the amended diagram in Fig. 4 for calculating the indices.

b) If the test makes it impossible, or if all measurements cannot be carried out, the average value of any one of these factors or indices does provide a good comparison of the physical condition of a group of persons.

But to assess the condition of an individual we always measure the cardiac rate, the internal temperature and the recovery rate in % of the cardiac rate after 10 minutes.

2) Determining some selection criteria for rescuers called upon to work in high-temperature environments

The rescuers most suitable for work in high temperatures are:

a) those who normally engage in heavy muscular work;
b) those who generally work in a hot environment (27 °C humidity or above);
c) those not exceeding their standard weight by more than 5 kg, which is derived from the formula: (weight in kg + 100) - height in cm.
d) those whose oxygen consumption is over 35 cm^3/min per kg of body weight with a cardiac rate of 170/min.

This applies, and the proviso is very important, given that, in their first test at high temperature, their fatigue coefficient remains within acceptable limits. For example: 150 with a Dräger apparatus for a test of 1.0 litres O_2/min for a period of 100 minutes and in an environment of 28 °C (humid) and 38 °C (dry).

3) <u>Maximum permissable resistance for self-rescuer filters (in collaboration with the Ernest Malvoz regional institute at Liege)</u>.

The acceptable resistance limit for a self-rescuer filter depends on:

a) the depression a wearer can expert by breathing on an infinite resistance. This depression has been physiologically fixed at 600 mm H_2O (this value can be considered as a minimum. It is very much higher for most persons);

b) the ventilation of the wearer, hence of the effort exerted.

As an experiment we have drawn curves (Fig. 5) showing us the requisite pressure for the continuous throughput for self-rescuer filters of different resistances.

It seems reasonable to allow for a maximum effort of approximately 2.8 l O_2/min. This involves a loss in speed which is lower as the difficulty increases. For this, however, frequent training is required so that the worker realises he must on no account get out of breath but must spread out his effort.

This means going up to a maximum resistance of 180 mm H_2O for a continuous throughput of 94.5 l/min and utilising the test filters possessing this resistance.

Figure 4 – Diagramme modifié permettant l'évaluation du coefficient de fatigue

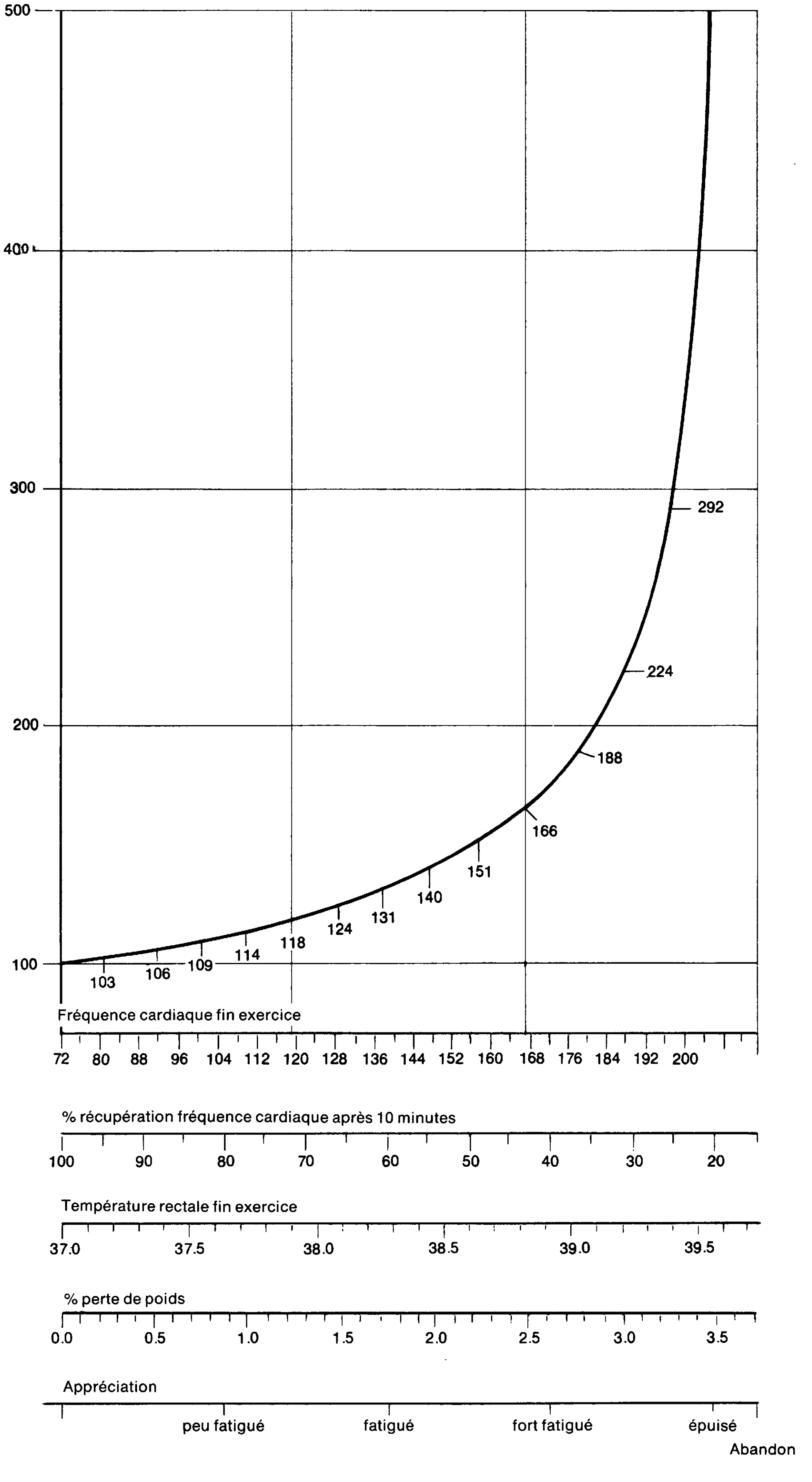
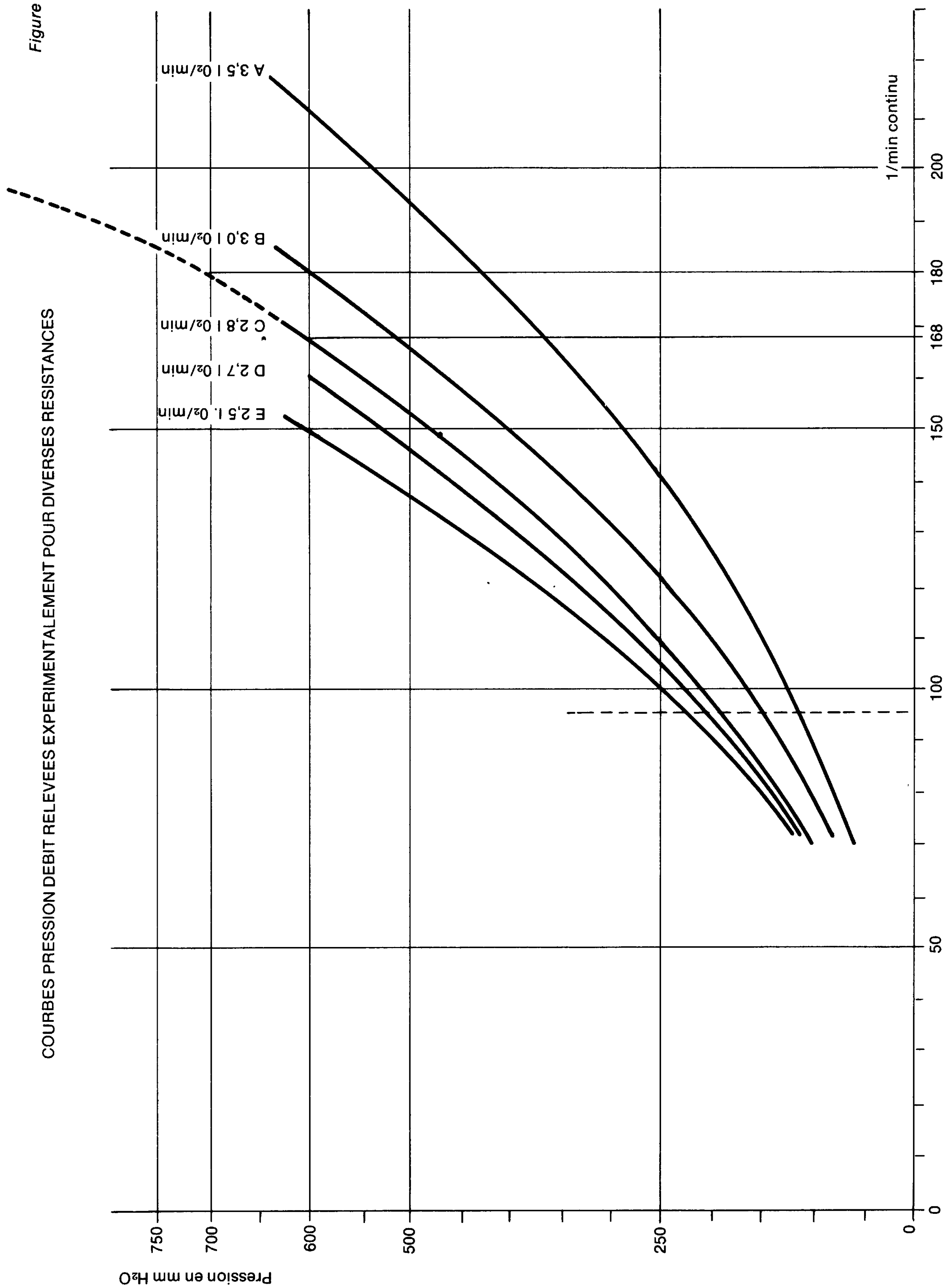


Figure 5

COURBES PRESSION DEBIT RELEVEES EXPERIMENTALEMENT POUR DIVERSES RESISTANCES



ANNEX V

INSTRUCTIONS FOR THE HYDRO-MECHANICAL METHOD OF CONSTRUCTING PLASTER STOPPINGS

(approved by the Mines Safety and Health Commission at its meeting on 26 June 1970)

C O N T E N T S

1. General

For some years attention has been focussed on evolving rapidly constructable stoppings with resistance to explosion. In the testing of various stopping designs by exposing them to explosion, plaster stoppings have shown the best results from the viewpoint of speed of erection and resistance to explosion.

Two separate ways of injecting plaster into a stopping casing were pursued in the Saar and the Ruhr. In the method developed at the Central Mine Rescue Station at Essen and widely applied throughout the Ruhr, a standard plaster in its dry state is fed pneumatically through hose systems by means of pressure vessels and only moistened with water at the stopping point. The Central Rescue Station of the Saarbergwerke AG developed the hydro-mechanical method of constructing plaster stoppings which is described below. In this method a special plaster - SAARALIT - mining plaster 'D' - is rendered pumpable by a specially designed continuous mixer of the Central Rescue Station - Sapromine mixer, Saarberg system - by the addition of water and then pumped to the site by a suitable pump via hose systems.

The advantages of this stopping construction method are:

1. Reduction of time and labour in the erection of a roadway stopping. Experience gained to date in large-scale tests have shown that a well-trained team of 8, including supervisory staff, take about one shift for erecting one plaster stopping of 1.5 m thickness and 13 m^2 roadway cross-section.

2. Increased safety for the team engaged. The use of hose systems for the hydro-mechanical transport of plaster enable large distances to be covered. The injection of plaster at the stopping point requires only 2-3 men. The remainder of the team works at the pump and continuous mixer installation point, which may often be located away from the direct danger zone.

3. Reduction of bulk transport and its easement. The installation point of pump and mixer should be so chosen as to facilitate the supply of special plaster. Since the material requirement is considerably less than for a sandbag stopping or a pneumatically-injected plaster stopping, the problem of feed is also more rapidly managable.

4. Improvement of impermeability of stoppings. The liquid plaster is still fluid when introduced into the stopping casing. Consequently, cavities cannot form in the space to be filled. In addition, the liquid plaster penetrates into cracks and crevisses of the adjoining rock so that a tight seal to the rock is achieved, even in the roadway crown.

5. Improvement of the resistance of stoppings. In a series of tests carried out in collaboration between the mining company of the test pit and the Central Rescue Station of the SAARBERGWERKE AG underground at the test pit Tremonia at Dortmund, a hydro-mechanically injected plaster stopping of 1.5 m thickness with an excavated cross-section of 10 m^2 was exposed to an explosive pressure of 1 kp/cm^2 barely 2 hours after completion. The results showed that no gas got through the stopping; nor was there any damage to the stopping itself. Even when the explosive pressure was increased to 15 kp/cm^2 the stopping held without evidencing noteworthy traces of damage. And when the maximum explosive pressure experienced since the inauguration of the test pit, well over 18 kp/cm^2, was imposed on the plaster stopping, the stopping was only minimally displaced in the roadway axis without losing its coherence.

6. Applications in mine workings with existing stoppings. The hydro-mechanical plaster stopping method is eminently suitable for advancing stoppings in mine workings already equipped with stoppings and filled with firedamp. The use of hose systems for transporting the plaster limits the work to erecting casings and supervision in the danger zone. All the other Work, including heavy work, can thus be carried out in fresh-air zones.

Moreover, this method, in contrast to the pneumatic one, prevents a transitional zone with potentially explosive gas/air mixtures being formed at the stopping construction point. Thus new opportunities are offered in advancing stoppings, when containing fire zones, by the introduction of hydro-mechanical plaster stopping methods, which are advantageous to the safety of mine fire teams, the operational time and therefore also to the costs.

7. Other applications. With the hydro-mechanical method of plaster stopping construction, which has been evolved especially for the erection of explosion-resistant rapid stoppings, the stopping operations in fire fighting are considerably facilitated. Above all, stopping is effected quicker than before.

   Beyond the applications already noted, this plaster stopping will be used as a temporary roadway seal or as an abutment for permanent roadway seals. This will make extensive mechanisation of stopping operations possible. In addition, the hydro-mechanically transported plaster is suitable for sealing roadway walls, which is frequently necessary in combatting concealed mine fires. Further, the shot-firing stoppings widely used at Saarberg can be constructed of plaster "in one casting".

   The above-listed advantages of SAARALIT plaster stoppings are so obvious that all previously used methods of stopping construction in Saar mining will be replaced by the hydro-mechanical method.

2. Materials required to construct a stopping

2.1. Plaster

For the hydro-mechanical method a special plaster is used called SAARALIT mining plaster 'D'. This plaster was developed, at the suggestion of the Central Rescue Station of Saarbergwerke AG, by the firm Gebr. Knauf, Saargipswerke GmbH, Siersburg-Saar. It consists of standard plaster with inorganic and organic powder additives which slow down the setting process. The liquid plaster is adjusted in such a way that the setting process is completed 12-17 minutes after it leaves the pump.

SAARALIT mining plaster 'D' is supplied in PVC-coated paper bags holding 40 kg. The plastic coating is to give it the best insulation. Nevertheless, when loading, transporting and stocking plaster, care must always be taken that it does not become damp. Only dry mine cars may be used for underground transport. In wet workings the plaster should be protected from dripping water.

In ordering plaster, note that: SAARALIT mining plaster 'D' can be obtained from the Knauf, Saargipswerke GmbH Siersburg which is in a position to supply special plaster in large quantities at short notice. This means that special stocking of plaster at pits is not necessary. Unused residues can, however, be stocked for at least 9 months without materially altering their physical and chemical properties. Ordering of plaster should be done via the Central Rescue Station. The required quantity is 1.0 tonne per m^3 of the space to be filled. To allow for losses which might arise in transport or due to poorly sealed stoppings, this guide figure should be increased by 20%.

2.2. Scaffolding

Normally, injecting plaster is carried out between two plank scaffoldings (see annex 1). Supplies for 2 such scaffoldings, given a roadway cross-section of 10 m^2, are listed in annex 2. It should also be said that:

The special wooden stopping props (cf. annex 3) consist of 2 squared timbers of 70 x 90 mm (fir or pine). Both timbers are connected by guide forks in such a way that they can be slid one against the other. In doing this, an arrestor device can be introduced at 10 cm intervals. Fine adjustment is then effected by means of a tensioning screw which also ensures proper holding against the rock.

Special stopping props are manufactured in 2 lengths and may be obtained from the Central Rescue Station. Effective lengths of these props are from 2.00 - 3.10 metres, in the case of the short prop, and 2.50 - 4.10 metres, with the large.

Sliding props are primarily introduced when time is of the essence, i.e. in firefighting and other rescue team operations. Each main depot should therefore have 20 such props (10 long and 10 short) in stock. A larger stock of these props should be kept at the Central Rescue Station. When constructing stoppings, squared timber, slabbed timber or logs may, of course, be used instead of stopping props.

In tests to date, boards with the following dimensions have proved the most useful:

Length : 2.00 m and 1.50 m

Width : 15 cm

Thickness: 2.5 cm

The calking for sealing roadway walls, through-pipes, etc., is made of oilcloth or stowing brattice. A section 2 x 3 m of the material is rolled up and tied at 4-5 points with shot-firing cable.

It should be pointed out that all the material required to construct scaffolding, as described in Annex 2, as calculated on the ratio of 2 stoppings = 4 scaffoldings, must be kept in stock at the main fire depot.

2.3. Machines and installations

A suitable pump is required for injecting plaster into the stopping casing. Wide use of this method in Saar mining has proved the MOHNO-pump (positive-displacement pump), type 2 NE 50, of the NETZSCH firm, Waldkraiburg Obb., to be very reliable (cf. Annex 4). Reciprocating pumps, such as the Simplex-pump of KLEIN, SCHANZLIN & BECKER AG, Frankenthal, and the PLEIGER-pump type PD3W5, have also proved workable with this method. These pumps have not only a 25-50% smaller throughput than the MOHNO-pump, but require more frequent cleaning. Finally, the dimensions and weight of the MOHNO-pump, type 2 NE 50, are smaller and more effective than those of reciprocating pumps. For more difficult pumping work (long pipelines and/or greater level differences) the MOHNO-pump, type 4 NE 40, is suitable, which can overcome a counter-pressure of up to 20 kp/cm with a throughput comparable to type NE 50.

Plaster and water are mixed in the Sapromine continuous mixer, Saarberg system (Annex 5). The plaster sacks are cut open by a knife fitted in the filling funnel of the continuous mixer. Gravity ensures that the plaster flows into the vertically arranged blending chamber, which has a circular cross-section, whose overall volume is only 8 litres. Inset into the blending chamber is a central pipe attachable at its upper end to the water mains, which has a large number of holes. Water is forced out of these radially at high velocity, so that the downward flowing plaster is rapidly and thoroughly moistened. A spiral agitator, driven by a motor under the chamber, further ensures that a consistent liquid plaster medium is produced. This agitator also prevents plaster setting on the walls of the chamber. The prepared plaster medium, which has a water/plaster ratio (litre water/kg plaster) of approximately 0.6 controlled by appropriate water dosage, is extracted by the MOHNO-pump (cf. Annex 5) through a screen-like aperture placed on one side of the blending chamber floor via a suction hose NW 50 attached at that point.

The plaster throughput of this blender and pump installation, of course, depends on the distance between the pump and the stopping site and amounts to about 10 m^3 per hour with hose systems of up to 400 m in length. The liquid plaster is pumped to the stopping site through a hose system of "C" fire service hoses. The "C" hoses of the firm PARSCH, Ibbenbüren, Westphalis, have so far proved the best. The outlet in the stopping is the compressed air hose, diameter 50 mm and 1.50 m long. It is advisable to provide a reserve hose capacity in addition to the hose lengths strictly required for the distance so as to be able to change any hoses damaged during pumping. The reserve capacity should correspond to the distance pump-stopping, i.e. there should be a reserve hose for each hose in operation.

The required machines and installations, including air and water hoses and cleaning equipment discussed in the following section, are listed in Annex 2.

Between the pump installation point and mixer, and the stopping site, there should be a telephonic link using light-weight mine rescue telephones.

2.4. Air and Water Connections

The following connections are required for the operation of the pump and continuous mixer:

MOHNO-pump:	1 compressed air connection	50 mm
MIXER :	1 compressed air connection	19 mm
	1 water connection	19 mm

At least one other 19 mm water connection should be provided for cleaning operations and breakdowns. Depending on the number of connections, there should be made available 1 section compressed air hose of 50 mm and 19 mm diameter and 2 19 mm water hoses. In order to keep pressure falls and frictional losses in the hoses to a minimum, each hose length should not be longer than 5 metres.

The compressed air system should be under a pressure of at least 4 kp/cm^2. The requisite amount of water is assured if the minimum requirements laid down in the fire protection regulations for water systems of the Saarbrücken Chief Mining Inspectorate of 6.5.64.(400 litres/minute at a hydraulic pressure of 1.5 kp/cm^2) are complied with. If the water is contaminated, a cleaning filter should be interposed before the agitator, to avoid blockage of the nozzle.

3. Construction of a stopping

3.1. Choice of stopping site

The choiche of fire stoppings should always be made according to the "Regulations and Guide Lines of the Saarbrücken Chief Mining Inspectorate for combating fires underground in pits, of 4.11.1965", paras. 2.3.1 and 2.3.2.

To achieve a tight seal with the rock, no undercutting is required. Only the lagging and loose lumps need be removed. The removal of iron lagging mats requires an adequately strong wire cutter or a compressed air puller.

3.2. Determining thickness of stopping

The stopping thickness in the direction of the roadway axis must be at least 1.5 m with roadway cross-sections of up to 16 m^2. With cross-sections above this the stopping thickness must be at least 2 m.

3.3. Erection of scaffolding

For the construction of a plaster stopping 2 scaffoldings are usually required, the distance between these giving the desired stopping thickness. Since the plaster injected between the scaffoldings has a relatively short setting time, the casing of the stopping is only exposed to a small hydro-static pressure.

For this reason a light scaffolding may be chosen, which is of advantage for the time needed for erection. A photograph of such rapidly-erectable scaffolding is shown in Annex 2. It consists of the special wooden stopping prop described under 2.2., on to which planks are nailed. The roadway wall is sealed with a prefabricated calking of stowing brattice (see Annex 6). Oilcloth is affixed to the inner side of the casing. Both scaffoldings should be as near perpendicular to the roadway axis as possible.

The number of special wooden stopping props required for one scaffolding depends on the roadway cross-section. With a cross-section of 10 - 13 m^2, 4 props are needed. They should be set at an adequate distance (at least 15 cm) from the roadway supports, so that any further sealing can be effected at the outside edges of the stopping. The prop should on no account lean up against the roadway supports.

To avoid seepage of the liquid plaster into the roadway which is to be stopped, the stopping casing must be sealed thoroughly. To do this the inner sides of the scaffoldings should be lagged with oilcloth, stowing brattice, etc. In doing this care should be taken that the strips of the sealing material overlap by at least 40 cm, to ensure proper sealing even when bulging. Above all, at the connections to the rock and at any points where a stopping pipe, pipelines, cables, etc. are being inserted, seepage of plaster must be prevented by the use of oilcloth, rock wool or even empty plaster bags.

In the upper third of the scaffolding on the protection side an adequate observation opening should be left (See Annex 7). This opening makes the stopping negotiable for as long as possible, and work can continue in the stopping area while the plaster is injected. Since the plaster sets relatively quickly, it is possible to move about on the surface of the plaster without sinking in more than 15 cm, given that the thickness of the stopping is 1.5 m. It is therefore possible to work on the scaffolding from the inside even when injection of plaster is going on. Closing this opening with single, prepared planks is done when the liquid plaster rises. In order to seal the stopping well to the rock up to its crown, an artifical dome cavity, if no natural one exists, should be hollowed out in the roof on the protection side of the scaffolding. The highest point of the stopping should be at this point of the scaffolding. Here the outlet point for the sealing of the stopping should be located (Annex 7). In any event, one NW 50 pipe for ventilation sampling and one de-gassing pipe NW 150 should be laid through the scaffolding. Should the stopping be constructed in conditions of explosive danger, or if there is a future need to go through or ventilate the sealed-off zone, a stopping pipe should also be introduced. If water seepage is anticipated, a water outlet pipe with a siphon should be provided.

The hydro-mechanical injection of SAARALIT mining plaster 'D' has also proved itself in the re-surfacing of roadways and in the sealing of roadway walls, as is frequently necessary when combating mine fires. In such cases also, no more than a light plank casing is required, suitably sealed with oil cloth.

3.4. <u>Setting up pump and continuous mixer</u>

In selecting the site for pump and continuous mixer the following points should be considered:

1. Hydro-mechanical transport of SAARALIT mining plaster 'D' has so far been effectively tested in hosepipe systems of up to 400 m in length. Even though the maximum distance has probably not yet been achieved, the hosepipe length between pump and stopping site should be kept as short as possible for the sake of effective operation.

2. In stopping work with danger of explosion, the site should be chosen in such a way that the work team is protected as far as possible from the effects of an explosion.

3. At the site the air should be respirable, so that the work may be carried on without using respirators as far as possible.

4. The compressed air and water connections, required as per para. 2.4., can if necessary also be made over longer distances with the aid of fire service "C" hoses.

5. The required area for setting up the MOHNO-pump 2 NE 50 is 2.40 x 0.45 m^2, and 0.9 x 0.6 m^2 for the continuous mixer. The distance between the two machines is determined by the length of the suction hose and should be no more than 1.0 m. In addition, sufficient space should be available at the site for the smooth feeding of plaster to the continuous mixer.

6. A rapid supply of plaster in sufficient quantity should be ensured.

7. The fire service "C" hoses should be laid on the roadway floor in such a way that no sharp kinks occur.

3.5. Pumping

To avoid blockages, and to maintain the required liquid plaster consistency, the following instructions should be noted:

1. Fully open the conical cock for the water supply on the continuous mixer. Regulate water feed and pump action in such a way that the amount of water in the blending chamber remains constant during normal pump working.

   Pump only water until it is clear that the mechanical equipment is working properly and the hoses are correctly laid and water-tight.

2. Switch on compressed air motor on the continuous mixer. The compressed air feed can be regulated by means of control levers.

3. Start filling plaster into the filling funnel, slowly to begin with, and then so that the funnel is always full of dry plaster. Care must be taken that no scraps of packages or other impurities get into the mixer.

4. Always start with some excess water. The consistency of the liquid is visually judged at the end of the hose system. The optimum mix ratio can only be achieved by reducing the water supply. The correct liquid consistency is achieved when it resembles thin cream. Pump action and plaster feed are not altered. It must be noted that any change in the mix ratio only becomes noticeable at the output end after some time, which depends on the length of the pipeline and the action of the pump. Cutting back the water supply should therefore be carried out slowly and cautiously.

5. Once the stopping is completed, the plaster supply should be halted first. The mechanical equipment and the hoses should be flushed through with water until clear water emerges at the end of the pipeline. Adhering plaster in the pipeline can be removed by making a sharp bend at the outlet end of the hose. The resulting increased pressure causes the hose material to expand so that the deposited plaster is detached from the walls and can then be flushed out. The suction chamber of the MOHNO-pump should be inspected for any plaster residues. Any solids should be removed from the mixer's agitator and the screen in the pump nozzle checked.

6. After 12-15 t of plaster have been processed, the pump should be stopped and the installation cleaned as described under point 5. This takes about 10 minutes.

   According to the above instructions it is necessary, at the beginning and end of pumping operations, to work only with water or with excess water. Care should be taken that no liquid with an incorrect mix ratio reaches the stopping cavity, as this would delay the setting of the plaster, or even prevent it altogether. The output end of the injection hose should therefore be readily movable, so that it can be laid in fromt of or into the stopping area as required.

A hydro-mechanically injected plaster stopping can be injected in one operation, apart from brief interruptions for cleaning. Additional sealing is not necessary, since the plaster increases in volume by 0.04 % when setting.

For actual pumping operations an average throughput of 4 bags per minute can be expected, which corresponds to an hourly rate of 9-10 t plaster.

For a stopping of 1.5 m in a 13 m^2 cross-section roadway, a pumping time of 2.5 - 3 hours should be allowed. Smooth supply of plaster feed involves the cleaning of all mechanical parts.

3.6. Closing the stopping pipe

In the case of isolating pit fires in the presence of explosion danger, the stopping pipes on the completion of all stoppings on the aire intake and air return sides are closed on instruction of those in charge of the rescue operation (para. 2.3.2. of the Regulations and Guide Lines of the Saarbrücken Chief Mining Inspectorate for combatting underground pit fires of 4.11.1965). It is sufficient if the stopping pipes are sealed with blank flanges.

3.7. Elimination of breakdowns

With faults in the pump, hose bursts, etc. there is a danger that plaster will set in the hose system. Therefore, at least one separate water connection with C-coupling should be provided, so that in such cases the hose systems filled with plaster can be immediately disconnected and flushed with water.

4. Staff requirements

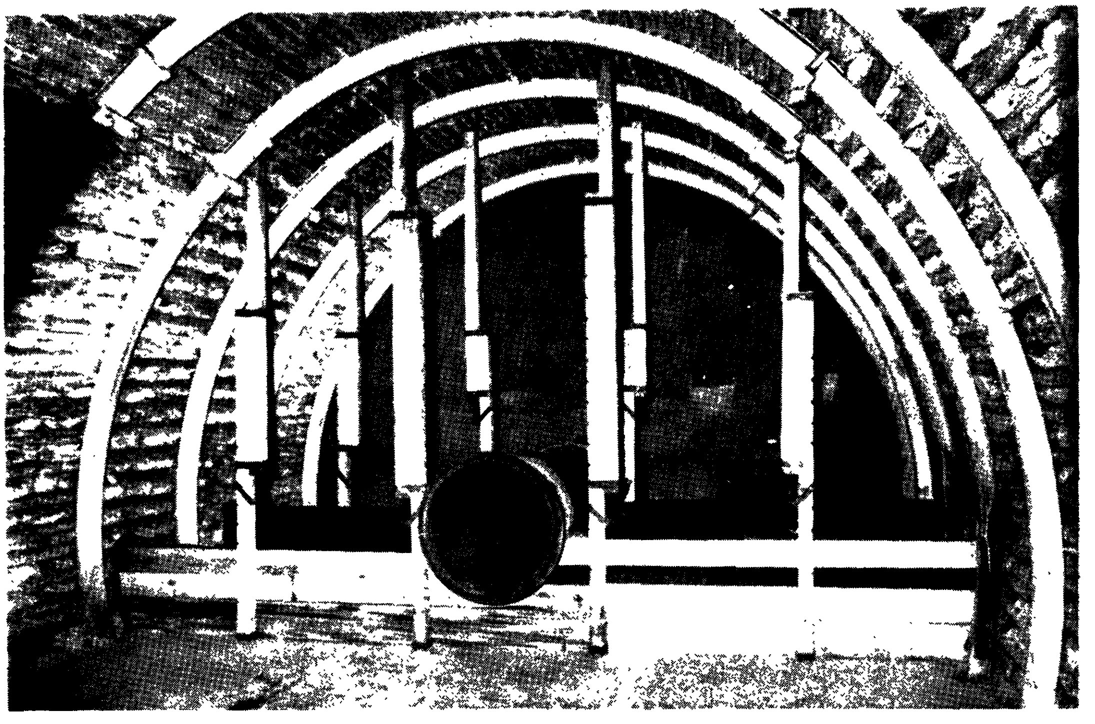
Pumping plaster requires:

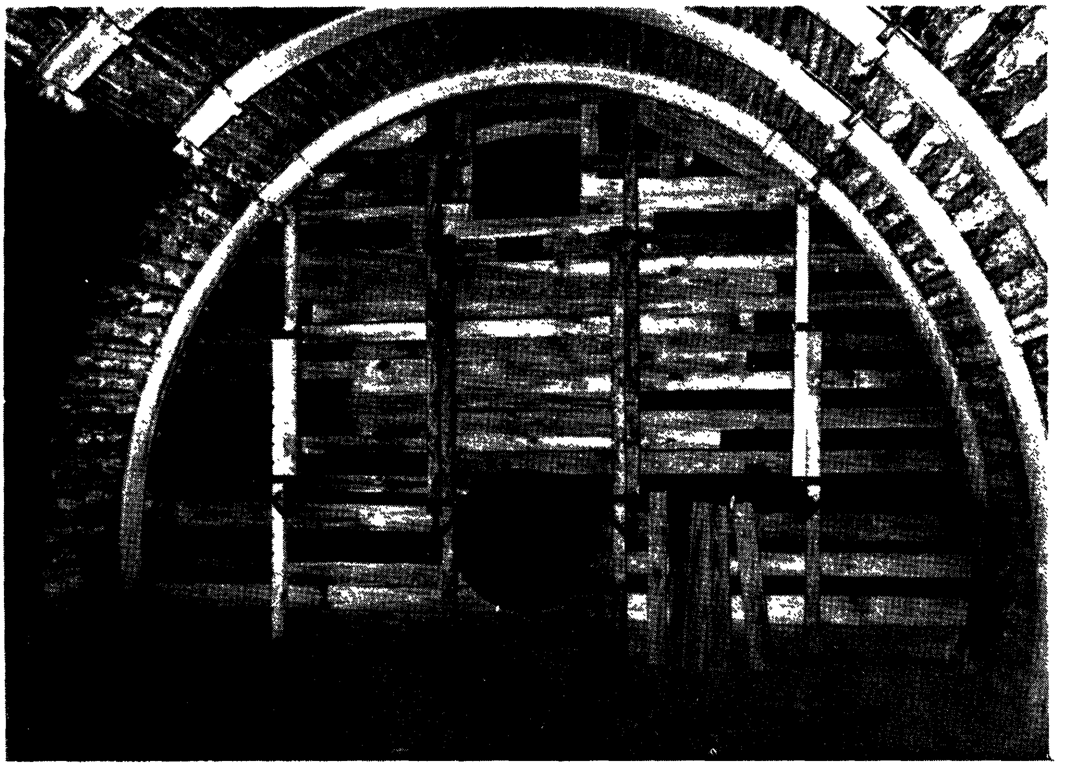
1 supervisor,

3-4 men to operate the machines and feed plaster to the continuous mixer,

3 men for sealing operations on the stopping, preparation of the casing, checking the hose system, necessary repair work, etc.

Annex 1





Scaffolding for a hydro-mechanically injected plaster stopping

Annex 2

Required material, tools, machines and equipment to construct a plaster stopping for a roadway cross-section of 10 m^2

1. Material for 2 scaffoldings:

special stopping or other wooden props, minimum thickness 10 cm, 4 m long	8
planks 2 to 2.5 m long	40
planks 1 to 1.5 m long	40
oil cloth	40 m^2
stowing brattice for calking	60 m^2
3" wire pins	1 pack
roof felting pins	1 pack
fire barrier pads	3-5

For insertion in the stopping:

sampling pipe, NW 50, 5 m long with blank flange	1
de-gassing pipe, NW 150, 2 m long with blank flange	1

If required:

stopping pipe 700 mm Ø	1
blank flange 700 mm Ø	1
sealer 700 mm Ø	1
screws	as required

For stoppings where water seepage is expected water outlet pipes with siphon should be provided.

2. Machines and equipment

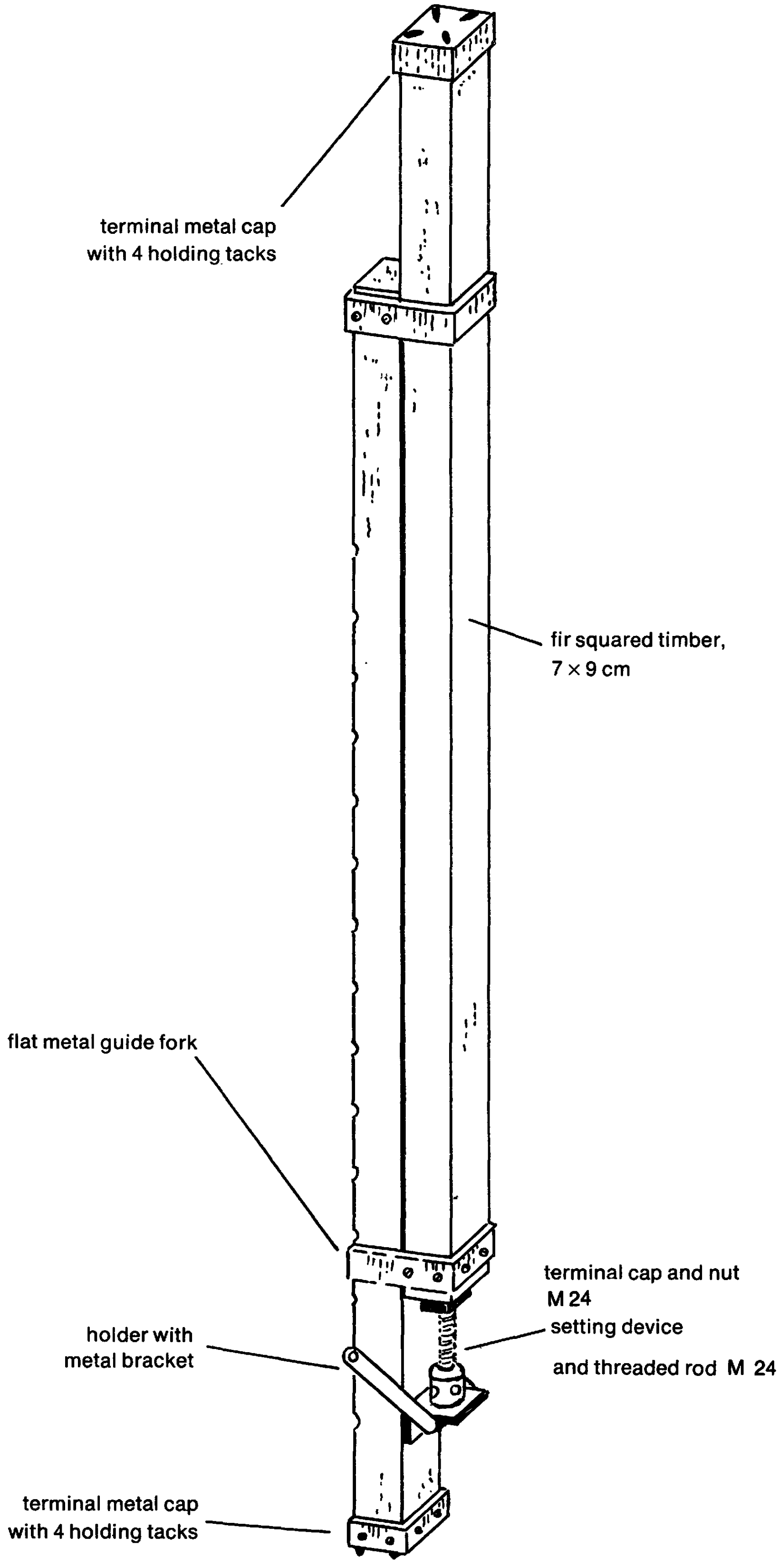
injector pump (for example Mohno pump 2 NE 50 continuous mixer for plaster	1
(Sapromine mixer, Saarberg system)	1
fire service C hoses	as required
compressed air hose Ø 50 mm, 5 m long	1
compressed air hoses Ø 19 mm, 5 m long	3
water hoses Ø 19 mm, 5 m long	3
suction hose 0.6 - 10 m long (compressed air hose 50 mm Ø)	1
outlet hose 1.5 m long (compressed air hose 50 mm Ø with fire service C coupling)	1
19 mm connector with roll thread on fire service C coupling (for cleaning)	at least 1
hose brackets for fire service C hoses	as required
mine rescue telephone	1 set
water filter	1

3. Tools

miners axes	2
hack saws	2
shovels	2
pickaxes	2
spikes for wooden stopping props	2
hand hammers	2
coupling wrenches for fire service hoses	2
tape measure	1
fitters tool bag, with tools for pump and mixer, also pipes and flanges	1
cleansing tools for pump and mixer (long chisel, scraper, etc.)	as required
wire cutter Ø 12 mm	2

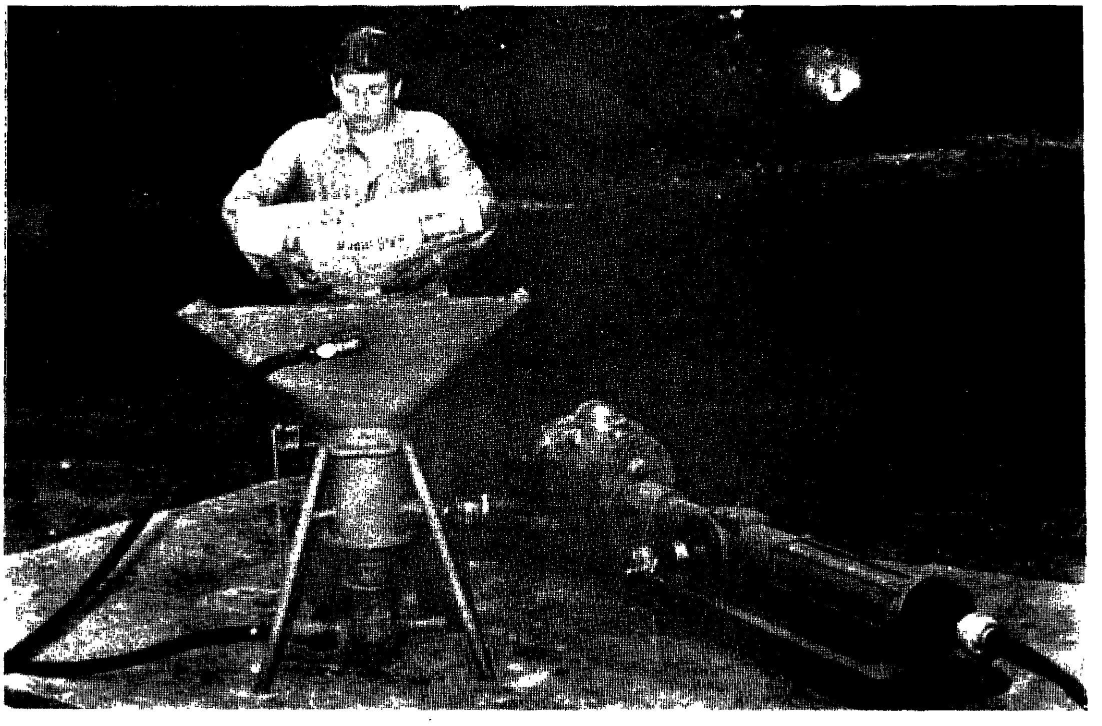
Annex 3

ADJUSTABLE SPECIAL WOODEN PROP FOR STOPPING



Reddingscentrale
SAARBERG

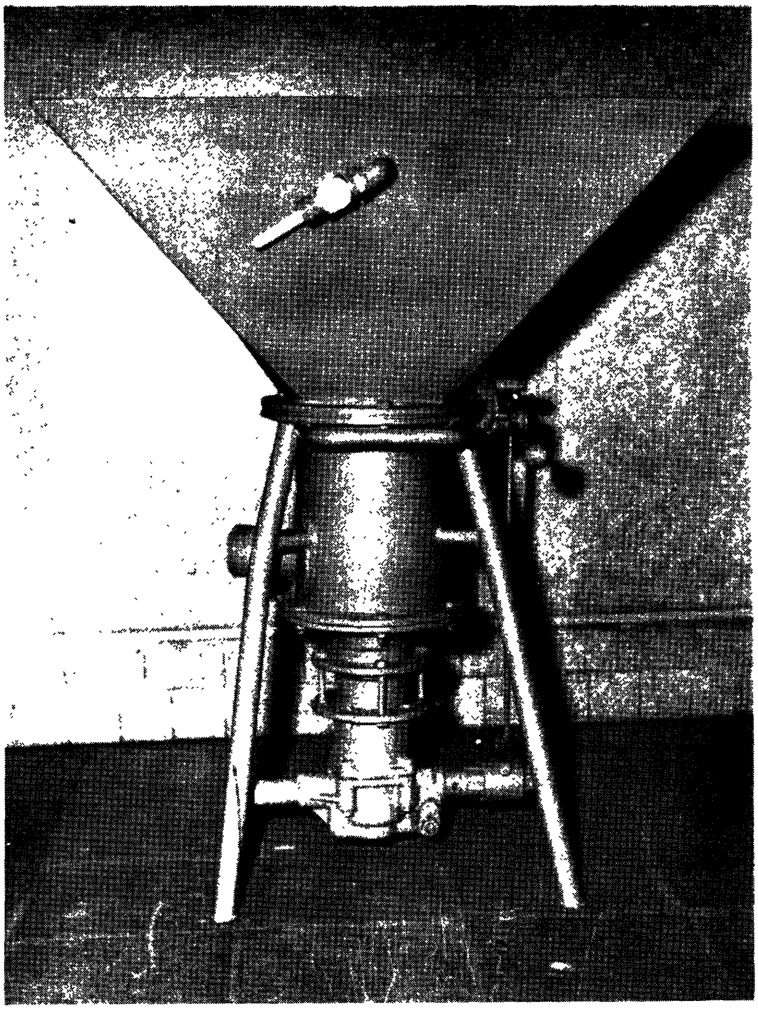
Annex 4

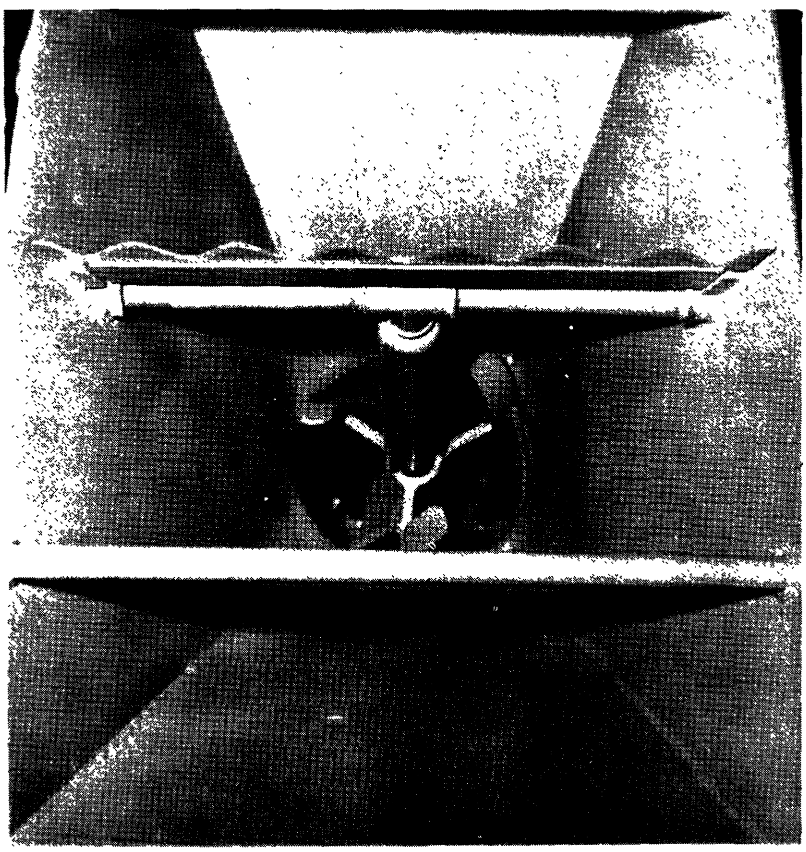


Mohno pump 2 NE 50 (Netzsch)

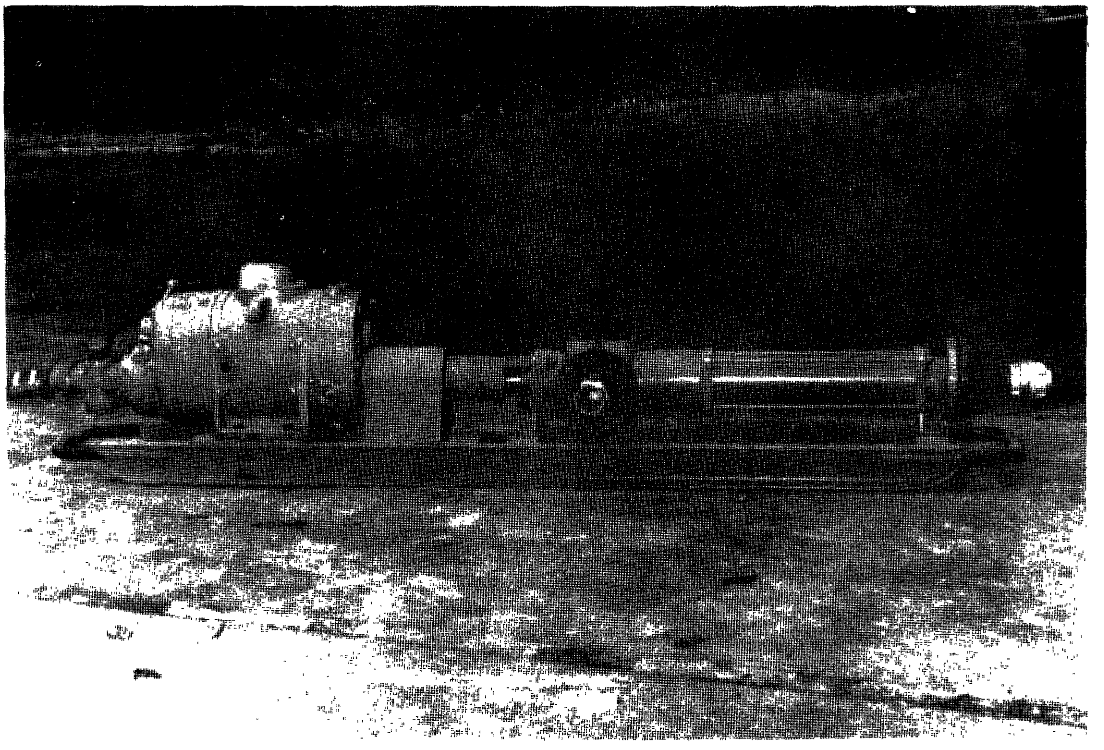
Sapromine-mixer, Saarberg system ; side view & view from above

Annex 5





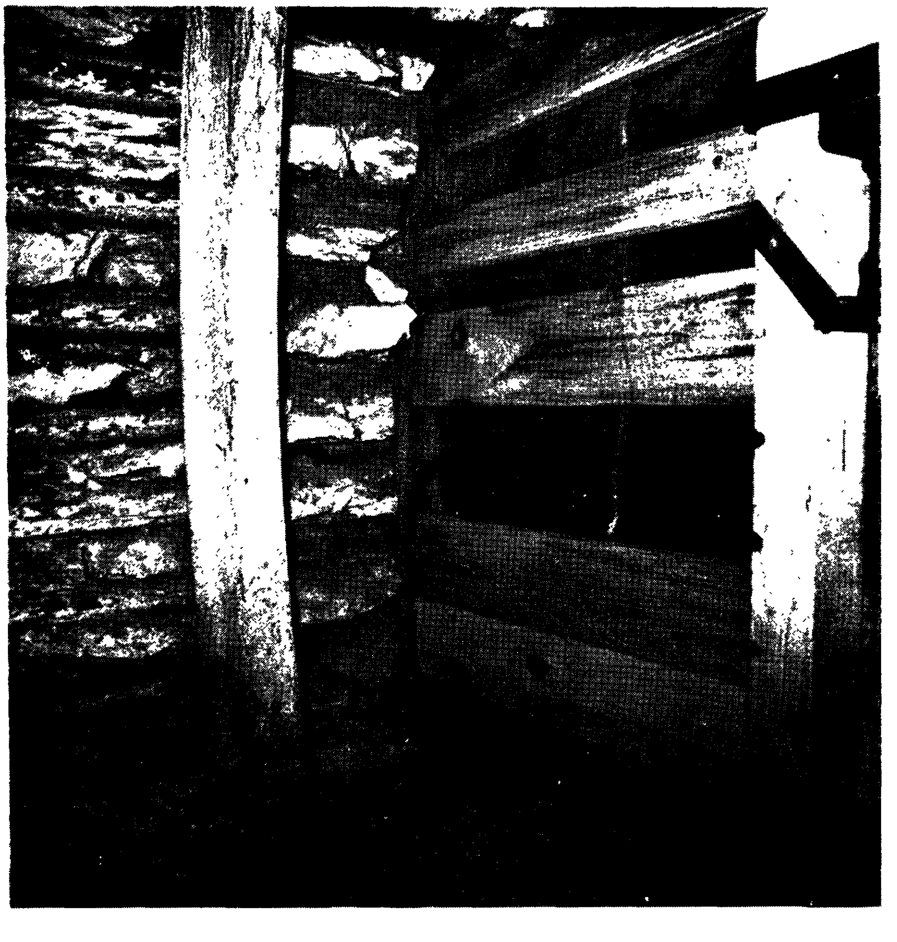
Annex 6



General view of mixer and pump installation

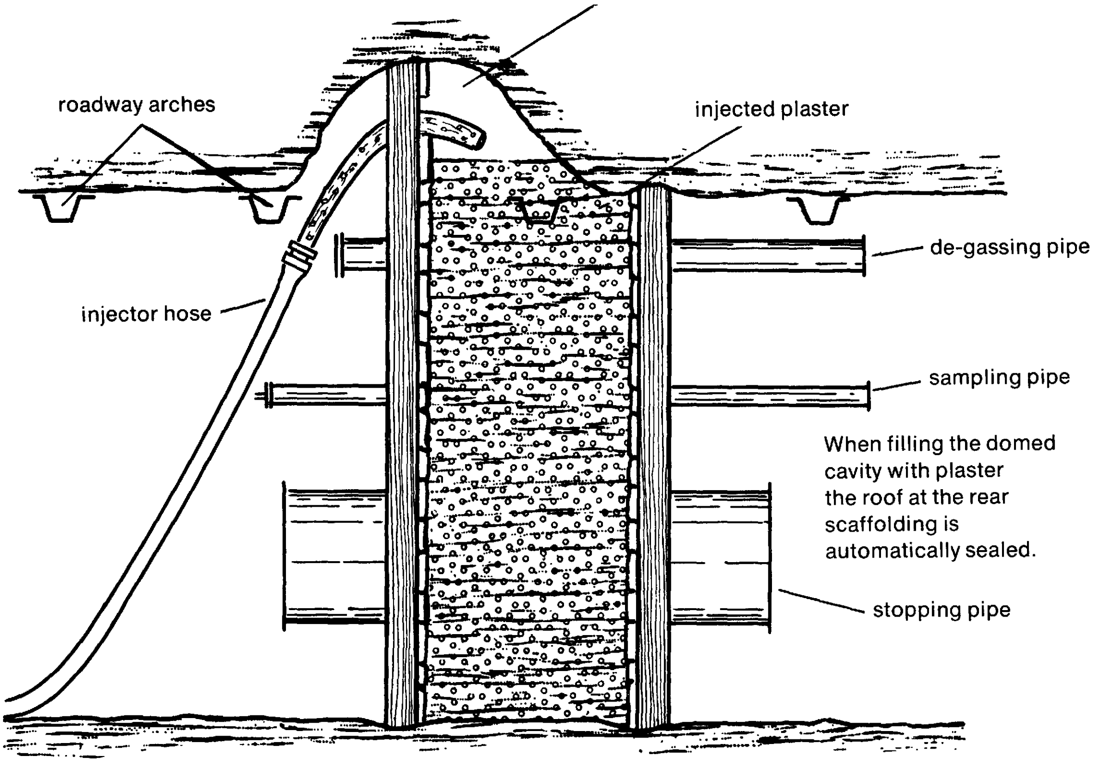
Annex 7

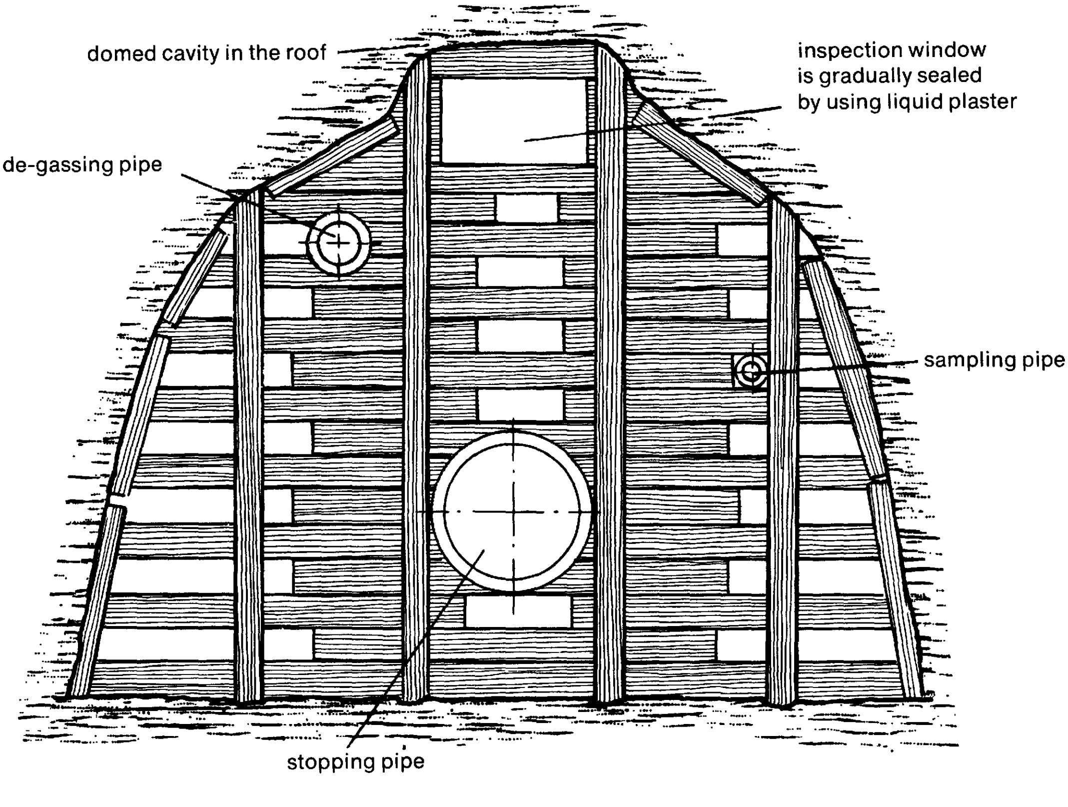
Sealing the roadway walls



Annex 8

SEALING THE ROADWAY CROWN





ANNEX VI

RECOMMENDATION EMBODYING DIRECTIVES ON MEANS OF SUPPRESSING DUST CONCENTRATIONS IN UNDERGROUND WORKINGS

(Approved by the Mines Safety Commission at its Plenary Session of 26 June 1970)

I - Basic principles

Before examining dust control methods, and with a view to their selection, the Mines Safety and Health Commission considers it necessary to lay down the following basic principles:

1) The efficiency of the dust suppression practice, to be examined as soon as an operating schedule has been drawn up, does not depend on the use of a single method, but on the simultaneous or successive use of a number of methods.

2) Control methods which counter actual dust production are preferable to those which suppress dust already made.

3) The control methods recommended should take into account their possibility of application, which itself depends on the coal measure conditions and the techniques used.

Having stated these principles, the Mines Safety and Health Commission considers that, despite the diversity of geological conditions and the dust measuring methods used in the various coalfields, it would be advisable to classify to some extent the control methods in relation to the operating conditions, conditions in the workings, and the type of operations carried out.

This classification, which presupposes the simultaneous or successive use of a number of methods, depending on their possible use, is above all based on the principle that it is better to prevent dust formation than to suppress dust already made.

Dust suppression proper consists in wetting the rock in situ; in a working face this means injecting water into the workings, and wet drilling in drivages.

The suppression of dust produced but not discharged to the atmosphere includes such methods as spraying in situ during coal production and drilling, and the aspiration and precipitation of dust both during drilling and the mechanical development of drivages and as a supplementary measure in the mechanical working of the face.

Lastly, the following factors have a more or less important bearing on the suppression of dust emitted, in suspension, or already deposited:

- Ventilation. An inadequate air flow results in an insufficient dilution of suspended dust, and on the other hand a too rapid air flow resuspends dust emitted and already deposited on the ground. Experience has shown that a suitable air velocity is about 2 metres per sec.

- The use of salt pastes and powders for settling dust.

- Equipment for purifying dusty atmospheres.

- Individual protective means, e.g. masks. These may be useful where other methods are either inefficient or non-existent, but their drawbacks (skin irritation and respiratory difficulties) should not be lost sight of. It should be noted that these drawbacks can be considerably reduced by using small ventilators provided with a small turbine for air circulation.

II - Evaluation of methods according to place and operation

The operations have been classified according to place, as follows:

1. Faces

   a. Coal winning

   b. Stowing

   c. Caving

2. Roadways
   a. Drilling blast-holes
   b. Shotfiring
   c. Loading excavated material
   d. Machine heading
   e. Miscellaneous stonedrift operations
3. Various product-handling operations

1. Faces

   a. Coal winning

   Seam injection

Among the various possible techniques, the most suitable would appear to be seam injection since it suppresses dust formation in situ and proper injection has a beneficial effect on all subsequent causes of dust production, e.g. dissociation of coal, falls of rock, handling operations, transferring material, etc.

Seam injection, where feasible, is the most effective method, whatever others are used later, since from the point of view of dust suppression it is always advantageous to treat a pre-injected coal, notwithstanding any improvements made or to be made to the coal-winning machinery.

Seam injection may be carried out in the following ways:

Injection from the working place by means of perpendicular holes in the coalface

Shallow injection, corresponding to the daily advance in the working, gives fairly poor results since the cracks enable the water to run back again quickly, with increased consumption of water, without the internal texture of the coal being necessarily wettened; moreover this injection method may have harmful effects on the roof and wall.

Medium-deep or deep injection gives considerably better results for the same or even a smaller amount of water, the coal being more uniformly wettened. The coal should be injected in the microcrack zone preceding the coalface; this zone, which should be determined empirically is usually situated 8 to 30 metres from the face.

Injection from the roadways by means of holes parallel to the coalface

Having regard to the advance in the coalface the best site is selected for obtaining an optimum circulation with the lowest possible pressure, the water penetrating more readily and uniformly under these conditions.

But if the road drivage is far in advance of the coalface, or if use can be made of retreating working, it is advisable to drill the holes parallel to the coalface some time beforehand, the period being increased when the water pressure is low; the water will circulate effectively even when only 1 or 2 l/min. are injected. This method, which has been tested in panels previously loosened by adjacent working, is one of the most economic and efficient when permitted by the working.

But these methods of injection into the actual seam are subject to certain difficulties when impermeable intercalations are encountered; in this case it may be necessary to drill and wetten each consecutive layer of the seam, or the actual intercalation, or to employ the following method.

Advanced remote injection, or injection from a point outside the seam to be treated

One or more boreholes are drilled from a roadway outside an already partly or wholly loosened panel, these holes being injected at minimum pressure and a low flow-rate.

The advantage of this method is that seam can be subdivided and all the included dirt bands van be treated. It is particularly suitable when excess water is troublesome,especially in deep workings with ventilation problems; it has, in fact, been found that from the point of view of dust production, 1 % of water injected via a point outside the working or injection into the seam at a great distance from the face is as effective as 2 % injected into the microcrack zone at 2 medium depth and 3 % - 5 % injected into the microcrack zone at a slight depth. *(1)*

Evaluation of the various injection methods

Analysis of the various methods shows that the aim shoud be to wetten the layers with the minimum amount of water, at a minimum pressure and for a maximum injection time; the best results have been obtained by injecting water at the greatest possible distance from the face.

The Mines Safety and Health Commission is of the opinion that the following graded list of injection methods, which has also been found te be the best as regards operating costs, is the most efficient from the point of view of dust suppression:

- advance remote injection;
- injection via long holes parallel to the coalface, at a great distance from the face (remote injection);
- injection via long holes parallel to the coalface in the microcrack zone (remote injection);
- injection via long holes at right-angles to the coalface in the microcrack zone;
- injection via shallow holes at right-angles to the coalface.

When coal is extracted from very thick seams the various methods referred to above are inadequate and the operations should employ supplementary methods adapted to deposit and working in question.

Spraying

Sprays have now been so perfected that spraying may be regarded as a useful supplement to injection and as the most effective method where the coalface could not been injected.

The Mines Safety and Health Commission recommends spraying, especially in non-injected coalfaces, provided the spraying techniques employed are the result of tested methods and are capable of laying dust with the minimum amount of water; in addition certain technical conditions should be observed on which the method's effectiveness is based.

The use of this method presupposes the existence of a network capable of supplying clean water. This network should be designed to supply sufficient water to the sprays of the coal-winning machinery; when coal ploughs are used water sprays should operate along the coalface.

These machines and ploughs should also be studied at the construction stage so as to minimise dust production when the seam is fissured; this point is also dealt with in another recommendation aimed at reducing the amount of dust created by the use of coal-winning and drivage machinery.

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(1) These percentages are quoted for comparison in order to characterise the various methods in a given deposit.

Water should be used in conjunction with mechanical picks when there are no other effective means of dust suppression.

b. Stowing

There are obviously no dust problems when hydraulic stowing is employed.

When, however, dry soil is being stowed, the workmen are exposed to fine dusts released when the stowing materials are placed in position or fragmented, and to the sedimented dusts re-suspended by stowing.

For the suppression of dust caused by stowage of dry soil, the Mines Safety and Health Commission recommends previous sprinkling of this soil and of the site to be stowed.

For the suppression of dust due to pneumatic stowage, it recommends, in addition to wettening the stowage area :

- the lowest possible specific consumption of ventilated air;
- with a view to preventing subsequent fissuring both during transport and before using forced ventilation, the use of soil of fine mechanical composition and sufficiently humid (as wash dirt usually is).
- taking into account the anti-aerodynamic force caused by tipping the goaf, and preventing stagnation of air in the stowage zone.

c. Caving

For suppressing dust resulting from caving, the Mines Safety and Health Commission particularly recommends the measures taken previously, consisting in subjecting the actual seam to a thorough treatment, since dust resulting from caving operations is caused by the fall of roof strata on coal dust deposited on the floor and by fissuring of the actual rock.

Sprinkling is advisable in flat seams, and provided floor conditions are suitable, but it only leads to a considerable improvement in the case of coarse-grained dust, not toxic dust. Moreover, excessive sprinkling makes the working climate difficult for personnel who therefore tend to turn it off.

2. Roadways

a. Drilling mine chambers

The Mines Safety and Health Commission recommends (1) systematic wet drilling in the stonedrifts, and (2) dry dust extraction where the first method is inapplicable.

b. Shotfiring

It is recommended to use wet tamps or gelatine pastes for tamping mine chambers, so as to suppress the dust caused by the cracking of the rock when the shot is fired; this method should be supplemented by previous sprinkling of the floor and the sides of roadways, as well as the dirt resulting from previous shots.

When such tamps cannot be used it is advisable to employ a water-screen which is turned on a few seconds before the shot is fired.

c. Loading of excavated material

The Mines Safety and Health Commission recommends abundant and systematic sprinkling of excavated material.

d. Machine drivage

In this case a suitable distribution of the dust-extraction and ventilation flow rates may form the basis of dust suppression so as to keep the dust against the drivage front at the maximum distance away from the machine-operators.

Dusty air should be purified by seams of dry or humid dedusting equipment before being diluted in the general ventilation system.

e. Various rock-working operations

It is recommended to use wet mechanical picks.

Lastly, the Mines Safety and Health Commission would point out that the air flow in preparatory operations and advancing working in the seam should also be adapted both to the firedamp detection and dust conditions, and that the air flow rates should meet the requirements specified in the introductory section of the recommendation.

3. Various material handling operations

The handling of products, whether coal or stone, inevitably gives rise to fine-dust suspensions; it is therefore useful to draw attention to the specific methods relating to the suppression of dust due to these operations.

Independently of the methods already recommended for coal-getting, e.g. seam injection, atomisation of water on the coalface, the steps required for stowing and caving, the Mines Safety and Health Commission also recommends a series of precautions relating to various operations, viz:

- determining the minimum height of fall during withdrawal and transfer operations;
- ensuring materials are completely tipped out at the loading and unloading points;
- using addition products ensuring or maintaining surface wettening of which the effect continues during successive tipping operations.

As regards the direction of ventilation in workings to be recommended in order to reduce dust suspension, it is advisable to conduct the air in the same direction as the materials, either by using a downcast air current when the materials are withdrawn via the lower bottom road, or to hoist the products into the top road when there is an upcast air current. In gassy workings, downcast air currents may only be used provided the safety regulations permit.

The Mines Safety and Health Commission believes however, that this method of ventilation has advantages in certain cases, both from the point of view of mine climate and dustiness.

ANNEX VII

RECOMMENDATION ON THE ORGANISATION OF SPECIAL SERVICES RESPONSIBLE FOR THE INSPECTION OF DUST CONDITIONS IN UNDERGROUND WORKINGS

(Approved by the Mines Safety Commission at its Plenary Session of 26 June 1970)

Modern production methods show a clear trend towards the concentration of working places and pits. The increase in the daily rate of advance in working faces, resulting from the mechanisation and increased number of production shifts, automatically leads to an increase in instantaneous dust production.

Moreover, when coal is being produced in several shifts a day this involves a number of simultaneous operations such as pneumatic stowing, caving and coal winning.

This technological progress has meant an increase in dust sources and its production.

The Mines Safety and Health Commission notes that special sources responsible for the general organisation of dust control and the inspection of dust conditions are already in existence in the Community countries and the United Kingdom, and it believes that it might be useful for these services to be streamlined to some extent.

At this early stage it would not be possible to impose a uniform classification of workings, considering the present disparity in the instructions at present in force in the various countries, the measuring methods used for dust sampling and the frequency of measurement.

The Commission accordingly recommends the following methods of operating:

- The management of each pit shall appoint from among its staff a person who shall be responsible for dust control and is not directly concerned with production and output.
- The said person, and any assistants, shall be responsible for dust control operations, any improvements required, and dust sampling.
- Dust is to be sampled in all working places. The frequency and location of sampling or measurement will depend on the hazards to which the men are exposed. The results of measurements are to be recorded in accordance with the standards laid down in the various countries and made available to the appropriate administrations and the mine's medical department.
- A department belonging to the mining organisation or coalfield shall assemble the results of measurements, be responsible for training persons in charge of dust control operations in each mine, and work out and co-ordinate instructions for use in the latter.
- The special services belonging to the mining organisation or coalfield shall keep in touch with the relevant technical and medical departments so as to take any precautions needed for reducing inadmissible dust concentrations or moving staff following the results obtained during the periodical medical examinations.

ANNEX VIII

STATEMENT ON THE NEED TO REDUCE THE DUST CONCENTRATION RESULTING FROM THE USE OF COAL-CUTTING AND GETTING MACHINERY AND ROADWAY DRIVAGE

(Approved by the Mines Safety Commission
at its Plenary Session of 26 June 1970)

Modern coal production methods necessarily involve a concentration of workings, collieries and coal faces and ever-increasing mechanisation.

When mechanisation is applied to coal faces the coal cutting and getting machinery employed produces a greater instantaneous volume of coal, the direct result being a simultaneous increase in dust in the workings; likewise, the development of roadway drivage techniques calls for special measures for dust capture and precipitation.

Although considerable progress has been made on the economic and output side, designers have so far failed to overcome the parallel technical problem of dust suppression.

At the present date the machinery is not designed for reducing the dust they produce; improvements have had to be introduced by the operators themselves, and in some cases, despite such improvements, machinery which from the viewpoint of economic efficiency was technically well-designed, could only be used after many alterations, some of which were basic, in order to ensure acceptable conditions in the workings.

In the opinion of the Mines Safety and Health Commission steps should be taken as soon as possible to ensure that no machinery is used in underground workings which does not ensure the dust conditions as approved by regulation or statute.

In order to meet this requirement it recommends, in the initial stage, close co-operation between designers, operators and research bodies or centres when the coal-getting and drivage machinery is being designed or constructed; il would draw the designers' attention to the need to reduce the dust concentration resulting from the use of their machines, so as to prevent further failures or preliminary difficulties.

In order to assist designers and to mark the operators desire for close co-operation, it recommends that the Commission of the European Communities should make available to them a bibliography on research work carried out in the Community countries and the United Kingdom and which has already produced good results in the suppression of dust.

Having regard to the lack of regulations governing the design of coal-getting and drivage machinery, the Mines Safety and Health Commission proposes at a later stage to draw up a set of technical specifications for the use of operators so as to help them to explain to designers what is needed in the field of dust suppression.

ANNEX IX

COMMENTS AND RECOMMENDATIONS ARISING OUT OF THE REPORT ADOPTED BY THE MINES HEALTH AND SAFETY COMMISSION ON 20 JUNE 1969 ON THE CHARACTERISTICS AND ELECTRICAL PROTECTION OF CABLES SUPPLYING MOBILE MACHINES (COAL CUTTERS, LOADING MACHINES, ETC.) USED UNDERGROUND IN COALMINES IN THE VARIOUS COMMUNITY COUNTRIES.

(Approved by the Mines Safety and Health Commission
at its Plenary Session of the 26 june 1970).

CONTENTS

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(1) Report on the characteristics and electrical protection of cables supplying mobile machines (coal-cutters, loading machines, etc.) used underground in coalmines in the various Community countries. Available without charge from the Secretariat of the Mines Safety and Health Commission, Luxembourg.

I. Introduction

The Mines Safety and Health Commission approved on 28 April 1960 and 27-28 April 1964 the two Recommendations set out below:

a) "Protection of underground electrical systems against the risk of electrocution" *(1)*,

b) "Protection of underground electrical systems against fire and firedamp explosion risks" *(2)*.

In order to arrive at a more precise formulation of these recommendations and to complete them, the Mines Safety and Health Commission empowered the Working Party on Electrification to investigate the practical measures adopted in the Community to ensure the safety of systems and to prevent electrocution accidents and accidents due to fire or firedamp explosion. (See Third Report of the Mines Safety and Health Commission, p. 38, point 2.)

In the framework of this investigation, the first task imposed on the Working Party was defined as follows: "To determine the present state in the various Community countries of devices used to ensure the safety of underground systems carrying low- or medium-tension current (up to 1,100 volts) and of cables supplying power to mobile machines, taking into account the characteristics of such cables". *(3)*

The Working Party has accomplished that part of its task relating to the areas of greatest risk, namely the supply cables to machines which are moved - in the face or during roadway drivage - while they are live. The Working Party drafted a Report on this subject which was adopted by the Mines Safety and Health Commission at its session on 20 June 1969. *(4)*

The Working Party was invited at this meeting to add to its Report some brief comments and, if possible, a set of conclusions which might serve as a basis for special recommendations to be published concerning the supply of current to mobile machines underground. These comments and recommendations are the subject of the present document.

II. Recapitulation of the recommendations of the Mines Safety and Health Commission concerning networks

We review below the essential provisions of the recommendations of the Mines Safety and Health Commission mentioned above an extract of which is given in the annex.

The Mines Safety and Health Commission recommends:

A. Preventive measures

Prevention of direct contact.

B. Protective measures

Connecting together of metallic coverings and earthing conductors and connection to the main earth electrode.

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(1) See Second Report of the Mines Safety and Health Commission, page 11.
(2) See Third Report of the Mines Safety and Health Commission, page 379.
(3) Classification of movable machines see Annex I of the present document.
(4) See footnote, page IX, 3.

C. Intervention measures

1. Permanent insulation monitoring by:
   a) cutting off the power supply at the first fault in systems with the neutral point connected to earth through an impedance.
   b) signalling of 1st fault and cut-off at 2nd fault in networks with insulated neutral point.
2. Automatic cutting-off of power from supply cables to mobile machines following damage to sheathing which causes leakage to earth.
3. Protection against overloading.
4. Protection against short circuits.
5. Electrical protection of cables supplying power to mobile machines in gassy pits.

III. Information to be drawn from the report

The Report *(1)* describes in detail the various practices adopted and the protective devices used in Community countries in response to the Mines Safety and Health Commission's Recommendations; the characteristics of the different processes are summarised in the survey table (annex V of the report).*(2)*

It may be seen from this table that the solutions adopted by the various Community countries closely resemble each other. The Safety Commission's Recommendations on the supply of power to mobile machines are for the most part satisfied in the following manner:

1. Permanent insulation monitoring is provided:
   a) in insulated neutral point systems, by a so-called insulation monitoring device (CI), operating generally by direct current injection;
   b) in systems where the neutral point is connected to earth through an impedance, by means of a core-balance (CB) relay.
2. Electrical protection for cables is generally speaking satisfactory, consisting usually of devices known as safety blocks (SB), of which several variations are described in the Report *(1)*, which are specially adapted to the different types of cables with which they are used.

IV. Preliminary remarks

Faults likely, because of their characteristics, to affect the cables supplying mobile machines with current have been studied in the order in which they are listed in annex V to the Report.*(1)* The absolute minimum requirements with regard to measures which should in any case be taken to guard against faults are listed under annex V of the report.*(2)*

The means at present used to apply these measures are set out under "Comments". The techniques described are those most generally used. They are only considered in so far as they provide the protection required, although different and more sophisticated processes may give similar if not better results. Thus no details are given

(1) See footnote page IX, 3.
(2) See annex III of the present document.

"impedance fault detectors" (DDI) *(1)* or double fault detectors *(2)*, which are certainly highly effective but which have not come into general use.

V. Recommendations

The Mines Safety and Health Commission therefore recommends that electrical equipment supplying current to mobile machines should meet the following minimum requirements:

Recommendation A

Power should automatically be cut off cables supplying mobile machines *(3)* in the following cases:

a) phase to phase faults;
b) faults between phase and earth;
c) faults between phase and polarised screen; *(2)*
d) faults between conductor or polarised screen and earth;
e) breaking of the monitoring circuit.

Comments

a) Phase to phase faults

Faults between two phases should in principle be dealt with by current operated protection at the gate-end box.

It is not be noted that when the cable has individual screens, a fault between two phases is always preceded by a fault between phase and screen of lower energy.

b) Faults between phase and earth

Protection against faults between phase and earth is in principle provided by insulation monitoring (core balance (CB) relays in networks with neutrals earthed through impedances; insulation monitoring devices (CI) in systems with insulated neutral points).

It should be noted that when the cable has individual polarised screens, the phase to earth fault is preceded by a fault between phase and polarised screen.

c) Fault between phase and polarised screen

When the fault arises between a phase and a polarised element, conductor or monitoring screen, the fault current flows to earth across the supply to the monitoring circuit.

The current is cut off by both BS and CI or CB.

In a network with an insulated neutral point protection by BS is only possible if the phase to earth capacity of the network is sufficient. Generally speaking, this capacity must be in the region of 1 μF for each phase and, in short networks, it can be obtained by a capacitor.

d) Fault between conductor of polarised screen and earth

Protection against this fault is provided by safety blocks (BS).

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(1) Pages 23 and 39 of the Report referred to in the footnote of page IX,3.
(2) Pages 21/22 and 33/35 of the Report referred to in the footnote of page IX,3.
(3) Classification of cables for mobile machines see annex IV of the present document.
(4) Explanatory notes concerning the notion "screen" see annex V of the present document.

e) Break in the monitoring circuit

Protection is provided by safety blocks.

Protection in the event of cables being pulled out of connectors requires that the monitoring conductors or polarised screen should be connected in such a way that it breaks before the main conductors and the earth conductor.

Recommendation B

The electrical installations defined above should be designed in such a way that any fault arising in the cable cannot result in unintentional starting of machines connected to the supply.

Recommendation C

Ci or CB insulation monitors and BS safety blocks not automatically monitored should incorporate a device which monitors their operation and integrity. They should also have a fault-indicating device.

Recommendation D

The BS safety block should be arranged so that the supply cable cannot become live again after power has been cut off due to a fault.

Recommendation E

The monitoring circuits should not give rise to any risk of igniting firedamp.

Recommendation F

The earth conductors should be symmetrically arranged.

Finally, the Mines Safety and Health Commission recommends that the power to a cable supplying a mobile machine should be cut off when the first fault between phase and screen (polarised screen or earth conductor) appears and, in view of the present state state of the art it recommends the use of cables provided with screens (polarised screens or earth conductors) of one of the types described in annex II *(1)* of the Report *(2)* except types A_2, B_2, D_2 together with:

a) protection by means of current intensity appropriate to the length and cross-section of the cables;

b) a permanent insulation monitor (CI or CB);

c) a safety block incorporated in the gate-end box.

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(1) See annex IV of the present document.
(2) See footnote page IX, 3.

Classification of Movable Machines (1)

A. Machine group	B. Category	C. Definition	D. Examples	E. Essential features demanded of supply cables
I	portable	held or guided by hand during operation	hand drills	flexibility and light weight
II	mobile	moved during operation (while cables are live)	coal-cutters (with integral winch (with separate winch continuous miners shuttle cars loading machines drilling jumbos heading machines	flexibility and robustness
III	machines which can be advanced or flitted	advanced at irregular intervals during operation (while cables are still live)	afc driveheads monorail-suspended transformers and gate-end boxes (relays etc.)	mechanical strength is of the first importance
IV	semi-stationary	advanced with current switched off, but cable connected	roadway transformers, gate-end boxes (relays etc.)	mechanical strength is of the first importance

(1) Annex I of the report referred to in the footnote of page IX, 3.

Annex II

Recommendations of the Mines Safety and Health Commission on electrical systems underground (extract)

1. Electric shock hazard

A. Regarding networks *(1)*:

1. With all types of network direct contact with a live conductor must be rendered impossible

2. All low-tension networks must have the best possible equipotential connection between metallic enclosures, earth conductors and the general body of earth. This is a most important precautionary measure.

3. To attain the same degree of safety with allmedium-tension systems it is necessary:

a) automatically to cut off the power from the system (or parts of the system) whether the neutral point is earthed through an impedance or without any impedance (in which case the fault current is not restricted), as soon as possible after the fault current reaches a value of a few amperes;

b) to check continuously the insulation of systems with insulated neutral points or to cut them off automatically (either partially or completely) as soon as a double fault occurs.

It is obvious that automatic cutting-off on the occurrence of a single fault would make the networks even safer but a regulation to this effect is not essential.

It is obvious that the protection must come into action automatically and as rapidly as possible, as soon as a double fault occurs in networks with insulated neutral point and a single fault in networks with earthed neutral point.

If a single fault occurs in a medium-tension system with insulated neutral point the tripping of the protective device is desirable, but not essential except perhaps in very extensive networks; an absolute prerequisite for this is however that there should be an effective automatic protection against double faults, acting as quickly as possible. If this is so, it is sufficient if the interruption takes place before the total insulation resistance of the system drops to too low a value. It can on occasion also be accepted, purely and simply with regard to the danger of electric shocks, that working of the shift should be completed with an earthed phase.

B. Special note on cables supplying current to mobile machines *(2)*

If not automatic cut-off device is installed *(3)*, the switchgear controlling cables supplying mobile machines must be fitted with an automatic device to cut off power as soon as a fault occurs following damage to the external insulation or by damage of the insulation to an individual phase.

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(1) See 2nd Report of the Mines Safety Commission, p. 20 etc.
(2) See 2nd Report of the Mines Safety Commission, p. 14.
(3) i.e. if there is no insulation monitor with automatic cut-off in accordance with point A 3b) above for the system or part of a system concerned.

2. Fire Risk *(1)*

1. The systems should be automatically protected against overloads by suitably selected, adjusted, inspected and maintained relays, switches or other equivalent devices.

2. The systems should be automatically protected against short-circuits by means of protective devices - e.g. fuse units, circuit-breakers, etc. - or by the combined use of these devices. All these devices to be capable of breaking safely the maximum possible short-circuit current which can occur at the point where they are installed.

   These devices should be chosen and ajusted according to the lowest short-circuit current which can occur at the end of the section of the system which they protect.

   Switches, relays, protective devices against short-circuits, etc. should, on switching on, be able to cope with the maximum short-circuit current which can occur at a point where they are installed.

   Should the power involved in the short-circuit on switching off require it, the speed of movement of the switch contacts should not depend on the amount of physical energy exerted by the operator in the case of hand-operated switch-gear.

3. Measures must be taken to ensure that as far as possible there is effective protection against faults with low current intensity which would fail to trip the protective devices named above and could cause dangerous heating.

3. Firedamp explosion risk *(2)*

1. The systems should be laid out in such a way that any possible fault current between phase and earth is reduced to a low value or rapidly cut off.

2. Preference should be given to the use of automatic protective devices - either collective or selective - against faults between phases and against earth faults.

3. Precautions should be taken to exclude the risk of accidents to men when detecting faults or when locating them and when the sections of the systems in question are switched on again.

4. Cables without metal armouring, and especially cables supplying power to mobile machines in the workings, must be electrically protected against internal or external earth faults by individual or collective screens which are capable of carrying sufficient current to operate protection devices in the event of a fault, or alternatively by the use of equivalent methods of protection.

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(1) See 3rd Report of the Mines Safety Commission, pp. 375-376.
(2) See 3rd Report of the Mines Safety Commission, p. 379.

Annex III

Table showing the main electrical protection equipment for cables supplying mobile machines *(1)*

(1) Annex V of the report referred to in the footnote of page IX, 3.

Legend to the table showing the main devices for electrical protection of cables supplying mobile machines

The classification and the terms described in the cables and given in the first line of the table correspond to the concepts defined in Annex IV.

The protective devices indicated by symbols in the third line of the table are described in Annex IV of the report *(1)*.

The symbols used in the table have the following meanings:

a) CI = insulation-monitoring device (see Annex IV, page V, 20)*(1)*

b) BS = safety-blocks (see Annex IV, page V, 21)*(1)*

c) amp. = amperometric relay

d) R_1 = relay for insulation-monitoring device

e) R_2 = relay for control current

f) R_3 = relay for fault current

g) R_{2+3} = combination of the two relays $R_2 + R_3$

h) R_4 = double-fault relay *(2)*

i) CB = core-balance relay (see Annex IV, page V, 19)*(1)*

j) BU = Back-up relay: amperometric relay with time-lag, which cuts off the supply transformer on the primary side when the core-balance relay on the secondary side does not operate (see Annex IV, page V, 20)*(1)*

k) DBT = deviced based on amperometric and directional detection of homopolar current (see Annex IV, page V, 20)*(1)*

l) DDI = impedance-fault detectors (see Annex IV, page V, 23)*(1)*

If the detection of a fault is simultaneously provided by two relays, the symbols are connected by a + sign. The dash indicates if this point is not applicable, the symbol 0 indicates that the device does not operate.

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(1) This reference relates to the report referred to in the footnote of page IX, 3.

(2) In Germany this double-fault relay is used because up to 1 October 1971 work can go on for 8 hours when there is a fault. This relay R_4 then eliminates the danger of occurrence of a double fault (fault between phase and earth accompanied by a fault between phase and monitoring conductor).

Table showing the main devices for electrical protection of cables supplying mobile machines

		A.1	A.2	A.3	B.1	B.2, D.2	B.3, D.3	C.1b	C.1a, D.1	C.1a, D.1	C.1a, D.1
	Cable type	A.1	A.2	A.3	B.1	B.2, D.2	B.3, D.3	C.1b	C.1a, D.1	C.1a, D.1	C.1a, D.1
	Screen(s)	Collective mass conductor	Collective screen to mass	Collective polarised screen (3)	Individual mass conductors	Individual polarised screens (3)	Individual polarised screens (3)	Individual mass conductor & collective polarised screens (3)	Collective mass conductor and individual polarised screens (3)		
	Protective device	CI + BS	CI + BS	CI + BS	CI + BS	CI + BS	CI + BS	CB + BS + BU	CI + BS	CI + BS	CI + BS
	Diagram (1)	(IV or V) + VI	(IV or V) + VI	(IV or V) + VI	(IV or V) + VI	(IV or V) + VI	(IV or V) + VI	II + XI	VII	VIII	IX
Type of fault	1) Phase to phase	amp.	amp.	amp.	R_1 + amp.	$R_1 + R_3$ + amp.	$R_1 + R_3$ + amp.	CB + amp.	$R_1 + R_{2+3}$ + amp.	$R_1 + R_{2+3}$ + amp.	$R_1 + R_{2+3}$ + amp.
	2) Phase to mass (2)	R_1	R_1	R_1	R_1	$R_1 + R_3$	$R_1 + R_3$	CB + BU	$R_1 + R_{2+3}$	$R_1 + R_{2+3}$	$R_1 + R_{2+3}$
	3) Phase to polarised screen(s) or to concentric mass conductor	R_1	R_1	$R_1 + R_3$	R_1	$R_1 + R_3$	$R_1 + R_3$	CB + BU	$R_1 + R_{2+3}$	$R_1 + R_{2+3}$	$R_1 + R_{2+3}$
	4) Phase to polarised conductor (3)	$R_1 + R_3$	$R_1 + R_3$	-	$R_1 + R_3$	-	-	CB + BU + R_3	-	$R_1 + R_{2+3}$	-
	5) Double fault (4) a) Phase to mass conductor or earthed screen b) Another phase to polarised screen (3)	-	-	-	-	-	-	-	R_4	R_4	-
	6) Polarised screen (3) to mass conductor	-	-	R_3	-	R_3	R_3	R_3	R_{2+3}	R_{2+3}	R_{2+3}
	7) Polarised conductor (3) to mass conductor	R_3	R_3	-	R_3	-	-	R_3	-	R_{2+3}	-
	8) Breakage of polarised conductor (3) or of polarised screen (3) or of mass conductor (breakage of interlocking circuit)	R_2	R_2	R_2	R_2	R_2	R_2	R_2	R_{2+3}	R_{2+3}	R_{2+3}
	9) Penetration into the cable of a metallic object connected to mass and touching only the screens	O	O	R_3	O	R_3	R_3	R_3	R_{2+3}	R_{2+3}	R_{2+3}
	10) Penetration into the cable of a metallic object insulated from mass and touching only the screens, or possibly also the concentric conductor	O	O	O	O	O	O	R_3	R_{2+3}	R_{2+3}	R_{2+3}
	Symmetry of mass conductor	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
	Application in (name of country)	Belgium	Belgium	France	Germany Belgium	Belgium France	France	Netherlands	Germany	Germany	Italy

(1) See Annex IV of the report referred to in the footnote of page IX, 3.
(2) In France, certain installations are also equipped with CBT and DDI devices (see Annex IV, pages V, 20 and V, 23 respectively of the report referred to in the footnote of page IX, 3).
In Germany and Belgium, efforts are made to fit the installations with CBT type devices.
(3) Polarised screen or polarised conductor = screen or conductor under monitoring voltage.
(4) Only for delayed switching-off by CI (see Annex IV, page V, 20 of the report referred to in the footnote of page IX, 3) with respect to BS or if the CI device is switched off).

Annex IV

Classification of the Cables for Mobile Machines *(1)*

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(1) Annex II of the report referred to in the footnote of page IX, 3.

Explanation of the symbols used *(1)*

Capital letters:

A : cables with a single collective screen (A.2 and A.3) or a mass conductor which serves at the same time as a single collective screen (A.1).

B : cables with individual metallic screens for each core (B.2 and B.3) or a divided mass conductor serving at the same time as individual screens (B.1).

C : cables with the combined characteristics of groups A and B.

D : cables with individual semi-conducting screens in which good lontigudinal conductivity is guaranteed (D.1, D.2 and D.3).

Indices:

1 : cables with a mass conductor serving at the same time as a collective screen or as individual core screens (A.1, B.1, C.1 and D.1).

2 : cables with a single mass conductor set asymmetrically with respect to the phase cores (A.2, B.2 and D.2).

3 : cables with a mass conductor divided into three cores set symmetrically with respect to the phase cores (A.3, B.3 and D.3).

Description of the cables:

A.1 : cable with 3 phase cores and 1 concentric mass conductor which serves at the same time as collective screen.

A.2 : cable with 4 cores, one serving as a mass conductor, with a collective screen.

A.3 : cable with 3 phase cores, a mass conductor divided into 3 cores set symmetrically, and a collective screen.

B.1 : cable with 3 phase cores, with a mass conductor divided into 3 parts serving at the same time as individual core screens.

B.2 : cable with 4 cores, one serving as a mass conductor, and with individual core screens.

B.3 : cable with 3 phase cores, a mass conductor divided into 3 cores set symmetrically, individual core screens.

C.1a : cable with 3 phase cores, a concentric mass conductor serving at the same time as a collective screen and individual screens.

C.1b : cable with 3 phase cores, a mass conductor divided into 3 parts serving at the same time as individual core screens, and a collective screen. *(2)*

D.1 : cable with 3 phase cores, a concentric mass conductor serving at the same time as a collective screen, and individual core screens of semi-conducting material.

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(1) See note at the end of page IX,19 and the illustrations of cable types on page IX,21 of this annex.

(2) In the Netherlands, to ensure better continuity of the masses, use is made of the 4th core which is electrically connected over its whole length with the 3 individual mass screens. In cable C.1b, it is central.

D.2 : cable with 4 cores one of which serves as a mass conductor, with individual screens of semi-conducting material.

D.3 : cable with 3 cores, a mass conductor divided into 3 parts set symmetrically, with individual core screens of semi-conducting material.

NOTE:

All the cables may have a certain number of cores or pairs of auxiliary cores which are insulated and can be used as pilot cores or monitoring cores.

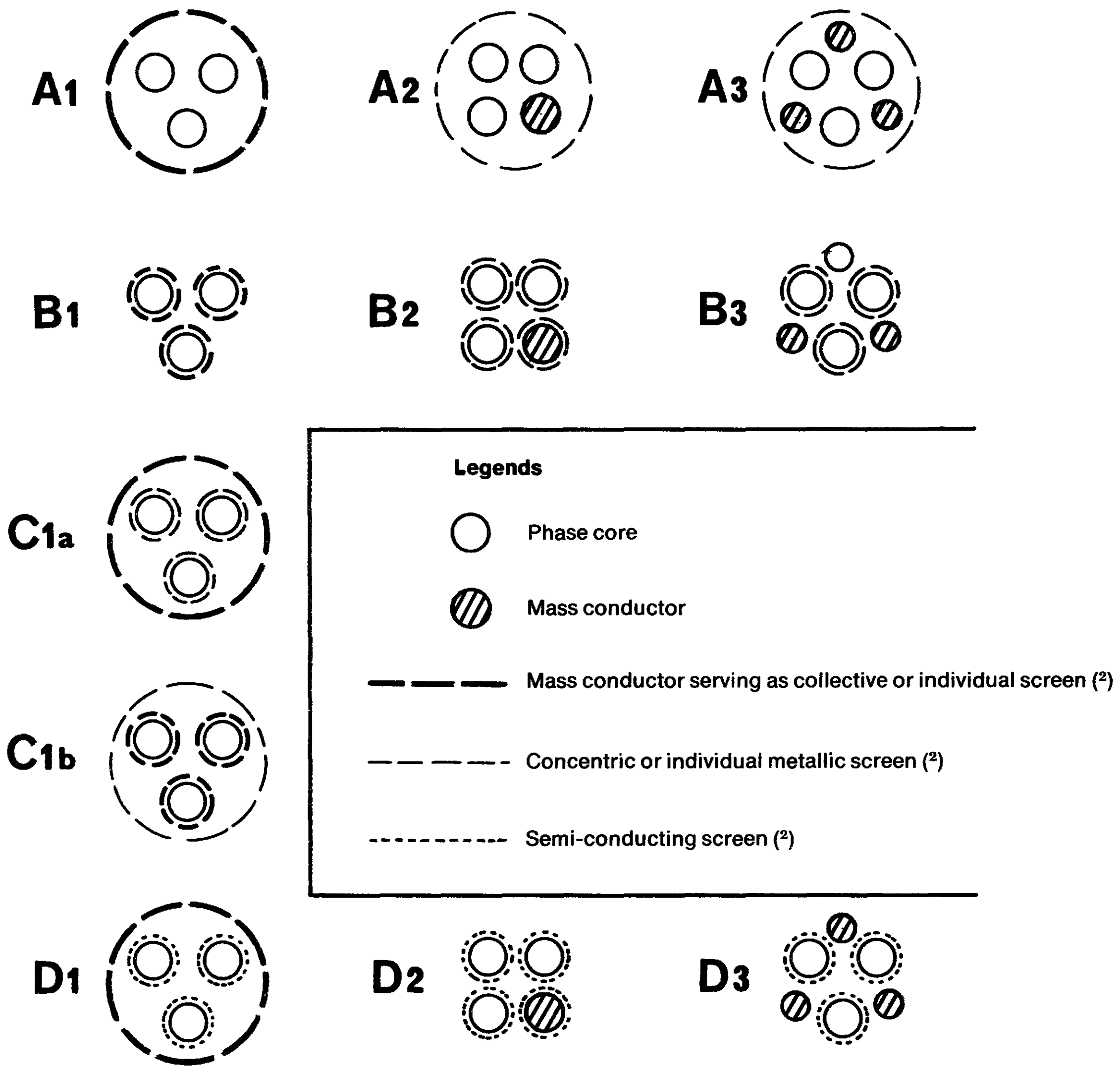
The collective screen or the mass conductor which also serves as a collective screen may in some cases also act as armouring.

The various possible ways of using these screens are set out clearly in Annex V of the present document.

In Great Britain the mass conductor is usually referred to as the earthing conductor.

Annex IV

Cables for mobile machines
Types in service or to be introduced (1)



(1) This diagram does not take into account the possible use of auxiliary conductors (polarised conductors and pilote conductors)

(2) See Annex V of the present document

Annex V

Explanatory notes on the concept of "screening of electrical cables"(1)

The "screen" on a cable is understood to mean a conducting envelope surrounding one or several insulated main conductors.

The screens are made either of metal or of semi-conducting elastomer or plastomer material, in which one or several copper conductors are embedded to ensure good longitudinal conductivity.

The screen is collective when it is set concentrically around all the conducting cores.

The screen is individual when it is set separately round an individual conducting core.

The main function of a screen is to allow for the detection of an insulation fault on main conductors, this detection being based on the production on the screen of a fault current to earth. For this reason the screen is generally electrically connected to the mass, which is in turn earthed.

In certain cases, the screen is not directly connected to the mass but is polarised. In this instance, it still serves the same main purpose but also makes it possible to have constant electrical monitoring of the cable in respect of damage caused by the penetration of any conducting object which may be connected to the mass or to earth.

When a collective screen has a sufficient degree of conductivity, it can also serve as a mass conductor. The same is true of the individual screens, when the totality of these screens has sufficient conductivity. In Germany the terms screen ("Schirm") is then replaced by two different terms, respectively "concentric protective lead" ("konzentrischer Schutzleiter") or "protective lead in the form of an individual core sheath" ("Schutzleiter als Einzeladerhülle").

When a collective screen has a high degree of mechanical strength, it can also serve as an armouring which protects the cable against mechanical damage.

In the Netherlands, use is made of cables fitted with individual screens of high conductivity which also play a part in the structure, serving as "safety armouring" ("veiligheidsscherm").

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(1) Annex III of the report referred to in the footnote of page IX, 3.

ANNEX X

DECISION *(1)*

OF 9 JULY, 1957

CONCERNING THE TERMS OF REFERENCE AND RULES OF PROCEDURE OF THE MINES SAFETY COMMISSION

(1) See "Journal officiel de la Communauté européenne du charbon et de l'acier" no. 28 of the 31st August 1957.

COUNCIL OF MINISTERS

DECISION

of 9 July 1957

concerning the terms of reference and rules of procedure of the Mines Safety Commission

Having taken note of the Recommendations adopted by the Conference on Safety in Coalmines and of the proposals submitted by the High Authority in connection with the Conference's final Report, which afford a working basis for the improvement of safety in coalmines, and

having regard to their Decisions at the Council's 36th and 42th sessions on September 6, 1956 and on May 9 and 10, 1957, setting up the Mines Safety Commission,

THE REPRESENTATIVES OF THE GOVERNMENTS OF THE MEMBER STATES MEETING AT THE SPECIAL COUNCIL OF MINISTERS,

- hereby lay down that the terms of reference of the aforesaid Commission shall be as follows:

1. The Commission shall follow developments regarding safety in coalmines, including those regarding the safety regulations instituted by the public authorities, and assemble the necessary information concerning progress and practical results obtained, more especially in the matter of accident prevention.

   To secure the necessary information, the Commission shall apply to the Governments concerned.

   The Commission shall evaluate the information in its possession and submit to the Governments proposals for the improvement of safety in coalmines.

2. The Commission shall help the High Authority to work out a method of compiling intercomparable accident statistics.

3. The Commission shall ensure the prompt forwarding to the quarters directly concerned (including in particular mines inspectorates and employers' and workers' associations) of relevant information assembled by it.

4. The Commission shall ascertain, by regular contact with the Governments, what action is being taken to implement the proposals of the Conference on Safety in Coalmines, and such proposals as it may itself draw up.

5. The Commission shall propose such study and research as it deems most indicated for the improvement of safety, with notes as to the way in which these can best be effected.

6. The Commission shall facilitate the exchange of information and experience among persons responsible for safety matters, and propose appropriate measures for this purpose (e.g. organization of study sessions, establishment of documentation services).

7. The Commission shall propose appropriate measures for ensuring the necessary liaison among the rescue services of the Community countries.

8. The Commission shall submit annually to the Council of Ministers and the High Authority a Report on its activities and on developments regarding safety in coalmines in the different member States. In this connection, il shall in particular examine the statistics compiled on accidents and incidents in coalmines.

- The Representatives of the Governments further lay down that the rules of procedure of the Commission shall be those set forth in the Annex to the present Decision.

- The Representatives of the Governments trust that the High Authority will arrange for the Commission to start work at the earliest possible moment.

This Decision was adopted by the Council at its forty-fourth session, on July 9, 1957.

For the Council,

(sgd.) J. REY

President.

ANNEX

RULES OF PROCEDURE
of the Mines Safety Commission

CHAIRMAN

Article 1

The Chairman of the Mines Safety Commission shall be a Member of the High Authority of the European Coal and Steel Community.

Article 2

The Chairman shall conduct the work of the Commission in accordance with these Rules of Procedure.

MEMBERS

Article 3

The Commission shall consist of 24 members appointed by the Governments; each country shall have four members, of whom two shall be representatives of that country's Governments, one of the employers and one of the workers.

Each Government shall send in writing to the Chairman a nominal roll of the members appointed by it. It shall notify the Chairman of all changes in this.

Each Government may appoint for any particular meeting of the Commission one or two advisers, whose names it shall send to the Chairman.

I.L.O. PARTICIPATION

Article 4

Representatives of the International Labour Organization shall be invited to attend the proceedings of the Commission in a consultative capacity.

U.K. PARTICIPATION

Article 5

Delegates appointed by the Government of the United Kingdom may attend the proceedings of the Commission as observers.

ORGANIZATION

(a) Restricted Committee

Article 6

A Restricted Committee shall be set up, to consist of Governments representatives on the Commission.

Article. 7

The Chairman of the Commission shall act as Chairman of the Restricted Committee.

Article 8

The function of the Restricted Committee shall be to ensure permanent liaison among the Governments of the member States and between them and the Commission, more especially for the purpose of exchanging relevant information. The Restricted Committee shall see to the preparation of the Commission's activities.

Article 9

The Restricted Committee shall be convened by the Chairman.

The Chairman shall be required to convene it when asked to do so by the representatives of three or more Governments.

(b) Working Parties

Article 10

The Commission of the Restricted Committee may set up Working Parties of experts to consider specific technical matters.

Article 11

The Working Parties shall decide their own modus operandi.

Article 12

The Restricted Committee shall be given reports by the Working Parties on the results of their proceedings, which it shall submit to the Commission with the comments of its members.

In the event of differences of opinion within the Working Parties, the views expressed shall be given, together with the names of those expressing them.

SECRETARIAT

Article 13

The High Authority shall be responsible for the secretarial arrangements in connection with the work of the Commission, the Restricted Committee and the Working Parties.

These arrangements shall be under the charge of a High Authority staff member appointed to act as Secretary.

All documents shall be in the four official languages of the Community.

WORKING PROCEDURE

Article 14

The Chairman shall fix the agenda and the dates of meetings after consultation with the members of the Restricted Committee.

Article 15

The Chairman shall allow to speak any member of the Commission, representative of the International Labour Organization or United Kingdom observer asking to do so.

The Chairman may allow advisers to speak.

Article 16

The members of the High Authority shall have the right to attend meetings of the Commission and of the Restricted Committee, and to speak there.

The Chairman may bring with him advisers, whom he may allow to speak.

Article 17

Where the Commission or the Restricted Committee deems it desirable to obtain information concerning the various aspects of safety in coalmines, it shall request this from the Governments of the member States.

Article 18

Sixteen members shall constitute a quorum. Conclusions shall be adopted by majority of the members present.

Proposals by the Commission under 1,3 of its terms of reference shall, however, require a vote in favour by two-thirds of the members present, and by not less than thirteen members in all.

Any dissenting opinions shall be brought to the attention of the Governments should the members expressing them so request.

THE COUNCIL

DECISION *(1)*

of March 11, 1965

of the Representatives of the Governments of the Member States assembled in the Special Council of Ministers to modify the decision of July 9, 1957

concerning the terms of reference and rules of procedure of the Mines Safety Commission

THE REPRESENTATIVES OF THE GOVERNMENTS OF THE MEMBER STATES ASSEMBLED IN THE SPECIAL COUNCIL OF MINISTERS -

having regard to the decision of July 9, 1957 regarding the terms of reference and rules of procedure of the Mines Safety Commission, and

having regard to the High Authority's proposal of January 7, 1964, and

seeing that this decision in no way affects Article 118 of the Treaty setting up the European Economic Commununity,

DECIDE:

Article 1

The terms of reference of the Mines Safety Commission laid down by the decision of July 9, 1957 are replaced by the provisions in the annex.

Article 2

The provisions of Article 17 of the rules of procedure annexed to the Decision of July 9, 1957 are replaced by the following provisions:

"Should the Mines Safety Commission or the Restricted Committee consider it desirable to receive information regarding the various fields for which it is responsible, it shall apply to the Governments of the member States."

This decision was adopted by the Council at its one-hundredth session, on March 11, 1965.

For the Council

(sgd.) M. MAURICE-BOKANOWSKI

President

(1) See "Journal officiel de la Communauté européenne du charbon et de l'acier" no. 46 of 22nd March 1965.

ANNEX

TERMS OF REFERENCE FOR THE MINES SAFETY COMMISSION

1. The Commission shall follow developments regarding safety and measures to avoid at working-points conditions which represent a danger to health in coalmines, including to this end the safety regulations instituted by the public authorities and assemble the necessary information concerning progress and practical results obtained.

   To secure the necessary information, the Commission shall apply to the Governments concerned.

   The Commission shall evaluate the information in its possession and submit to the Governments proposals for the improvement of safety and healthy conditions in coalmines.

2. The Commission shall help the High Authority to work out a method of compiling intercomparable statistics on accidents and damage to health attributable to vocational activities in coalmines.

3. The Commission shall ensure the prompt forwarding to the quarters directly concerned (including in particular mines inspectorates and employers' and workers' associations) of relevant information assembled by it.

4. The Commission shall ascertain, by regular contact with the Governments, what action is being taken to implement the proposals of the Conference on Safety in Coalmines, and such proposals as it may itself draw up.

5. The Commission shall propose such study and research as it deems most indicated for the improvement of safety, and of healthy working conditions in coalmines, with notes as to the way in which these can be effected.

6. The Commission shall facilitate the exchange of information and experience among persons responsible for safety matters and the maintenance of healthy working conditions, and propose appropriate measures for this purpose (e.g. organization of study sessions, establishment of documentation services).

7. The Commission shall propose appropriate measures for ensuring the necessary liaison among the rescue services of the Community countries.

8. The Commission shall submit annually to the Council of Ministers and the High Autority a Report on its activities and on developments regarding safety and protection of health in coalmines in the different member States. In this connection, it shall in particular examine the statistics compiled in these fields.

COMPOSITION OF THE MINES SAFETY AND HEALTH COMMISSION AND ITS WORKING PARTIES (AS AT 31.12.1970)

A.- MINES SAFETY AND HEALTH COMMISSION

FEDERAL REPUBLIC OF GERMANY

Government Representatives

Ministerialrat W. SCHNASE, Referat III A 1, Bundesministerium für Wirtschaft, 53 Bonn

Ministerialdirigent Dr.-Ing. K. HELLER, Ministerium für Wirtschaft, Mittelstand und Verkehr des Landes Nordrhein-Westfalen, 4 Düsseldorf, Haroldstr. 4

Employers' Representative

Bergrat a.D. H. ERNST, Geschäftsführer des Steinkohlenbergbauvereins, 43 Essen, Frillendorfer Strasse 351

Workers' Representative

E. STEBEL, Leiter des Sachgebietes Arbeitsschutz, IG-Bergbau und Energie, 4630 Bochum, Alte Hattingerstr. 19

Technical Advisers

H. BERG, Bergdirektor, Ministerium für Wirtschaft, Mittelstand und Verkehr des Landes Nordrhein-Westfalen, 4 Düsseldorf, Haroldstr. 4

Ministerialrat K. HÜBNER, Leiter der Unterabteilung Montanwirtschaft, Ministerium für Wirtschaft, Verkehr und Landwirtschaft, 66 Saarbrücken, Hardenbergstr. 8

BELGIUM

Government Representatives

A. VANDENHEUVEL, Directeur-generaal van het Mijnwezen, Ministerie van Economische Zaken en Energie, 24-26, rue J.A. Demot, Bruxelles 4

G. LOGELAIN, Inspecteur général des mines, Ministère des affaires économiques, 24-26, rue J.A. Demot, Bruxelles 4

Employers' Representative

A. HAUSMAN, Directeur du Centre de coordination de sauvetage du bassin de Campine, 555, Kempische Steenweg, Kiewit-Hasselt

Workers' Representative

J. OLYSIAEGERS, Secrétaire national de la Centrale syndicale des travailleurs des mines de Belgique, F.G.T.B., Koolmijnlaan 1, Houthalen

Technical Advisers

L. BOULET, Directeur général du Fonds national de retraite des ouvriers mineurs, Ministère du travail et de la prévoyance sociale, 6, place Stéphanie, Bruxelles

E. VANDENDRIESSCHE, Secrétaire général de la Centrale des francs-mineurs, 26-32, avenue d'Auderghem, Bruxelles 4

FRANCE

Government Representatives

L. KOCH, Ingénieur en chef des mines, Direction des mines, Ministère de l'industrie, 99, rue de Grenelle, 75-Paris 7e

D. PETIT, Ingénieur des mines, Direction des mines, Arrondissement de Metz, 1, rue Eugène Schneider, 57-Metz

Employers' Representative

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Workers' Representative

L. CHAUVEAU, Fédération nationale des syndicats chrétiens des mineurs, 8, rue de Navarre, 75-Paris 5e

Technical Adviser

St. NOWAK, 4, rue Charcot, 62-Lens, Pas-de-Calais, France

ITALY

Government Representatives

Dott. Consigliere B. COLUCCI, Direzione generale dell'emigrazione, Ministero degli affari esteri, Roma

Dott. Ing. M. MARRA, Ispettore generale delle miniere, Ministero dell'industria e commercio, via Veneto 33, Roma

Employers' Representative

Prof. M. CARTA, Istituto Arte Mineraria della facoltà d'Ingegneria, Piazza d'Armi, Cagliari (Sardegna)

Workers' Representative

Dott. G. CRAVIOTTO, Segretario generale della Federestrattive, via Isonzo 42, Roma

Technical Advisers

Dott. C. MICHELAZZI, Ispettore generale del Ministero del lavoro e della previdenza sociale, via Flavia 6, Roma

Dott. R. PURPURA, Direttore generale al Ministero del lavoro, via Flavia 6, Roma

LUXEMBOURG

Government Representative

A. SCHUSTER, Ingénieur-directeur du travail et des mines, inspection du travail et des mines, 19, av. Gaston Diderich, Luxembourg

Employers' Representative

R. MAYER, Ingénieur de sécurité à l'ARBED, 78, rue du Fossé, Esch/Alzette

Workers' Representative

N. PASCOLINI, Président de la délégation ouvrière d'Arbed-Mines, 90, rue des Fleurs, Schifflange

NETHERLANDS

Government Representatives

Ir. A.H.W. MARTENS, Inspecteur-generaal der mijnen, Staatstoezicht op de mijnen, Apollolaan 9, Heerlen (L.)

Ir. D.J. KNUTTEL, Plaatsvervangend Inspecteur-generaal der mijnen, Staatstoezicht op de mijnen, Apollolaan 9, Heerlen (L.)

Employers' Representative

Ir. G.B. DEBETS, Directeur, Oranje-Nassau Mijnen, Heerlen (L.)

Workers' Representative

J.M. WEIJERS, Vice-Voorzitter van de Nederlandse Katholieke Mijnwerkersbond, Seringenstraat 9, Passart-Zuid

Technical Adviser

H.L. GROND, Chef van de Veiligheidsdienst, p/a Oranje-Nassau Mijnen, Heerlen (L.)

UNITED KINGDOM

Government Representatives

J.W. CALDER O.B.E., H.M., Chief Inspector of Mines and Quarries, Department of Trade and Industry, Thames House South, Millbank, London S.W. 1

J.R. WILSON, Assistant Secretary, Separtment of Trade and Industry, Thames House South, Millbank, London S.W. 1

Employers' Representative

Dr. H.L. WILLET, Deputy Director-Generaal of Production, National Coal Board, Hobart House, Grosvenor Place, London S.W. 1

Workers' Representative

S. SCHOFIEDD, Vice-President of the National Union of Mineworkers, c/o Miner's Offices Barnsley / Yorkshire

INTERNATIONAL LABOUR ORGANISATION, GENEVA

A representative of the International Labour Office sitting as an observer.

B.- RESTRICTED COMMITTEE

The Restricted Committee consists of the Government members of the Mines Safety and Health Commission.

C.- WORKING PARTIES ON TECHNICAL QUESTIONS

I. Working Party on Electrification

- Members of the Working Party

GERMANY

Bergdirektor W. SCHÖTTELNDREIER, Landesoberbergamt Nordrhein-Westfalen, 46 Dortmund, Goebenstr. 25

Dipl.-Ing. L. GEBHARDT, Steinkohlenbergbauverein, 43 Essen, Frillendorfer Strasse 351

BELGIUM

G. LOGELAIN *(1)*, Inspecteur général des mines, Ministère des affaires économiques, 24-26, rue J.A. Demot, Bruxelles 4

R. STENUIT, Directeur divisionnaire à l'Administration des mines, 24-26, rue J.A. Demot, Bruxelles 4

G.J.A. COOLS, Inspecteur général des mines honoraire, Eug. Plasky Laan 75, B-1040 Brussel

FRANCE

N. TRETIAKOW, Ingénieur en chef au service exploitation des charbonnages de France, 9, avenue Percier, 75-Paris 8e

F. VIN, Ministère de l'industrie, service de l'hygiène et de la sécurité minière, 97, rue de Grenelle, 75-Paris 7e

P. FLINOIS, Houillère du bassin du Nord et du Pas-de-Calais, service technique du fond, 20, rue des Minimes, Douai (Nord)

ITALY

Dott. Ing. C. MACCIONI, ENEL, Compartimento Cagliari, Sett. tecnico, Piazza Deffenu 2, Cagliari

LUXEMBOURG

R. MAYER, Ingénieur civil des mines à l'ARBED, 78, rue du Fossé, Esch-sur-Alzette

NETHERLANDS

Ir. E.A.R. HOEFNAGELS, Inspecteur der mijnen, Staatstoezicht op de mijnen, Apollolaan 9, Heerlen (L.)

Ir. P.H. GIESBERTZ, p/a Staatsmijn Emma/Hendrik te Hoensbroek, Hoensbroek/Heerlen(L.)

UNITED KINGDOM

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R. HARTILL, Chief Electrical Engineer, National Coal Board, The Lodge, South Parade, Doucaster (Yorkshire)

- Experts on cables and leads

Dr. J. UELPENICH, Land- und Seekabelwerke, Niehler Strasse 100, 50 Köln-Nippes

H. GOBBE, Directeur à la division câblerie des A.C.E.C., Charleroi

---

(1) Chairman of the Working Party as representative of the Restricted Committee

M. OSTY, Directeur technique à la société industrielle de liaisons électriques, 64bis, rue de Monceau, Paris 8e

M. PAINDAVOINE, Ingénieur au CERCHAR, Verneuil-en-Halatte (Oise)

Y. EYRAUD, Chef du laboratoire d'études générales des câbles de Lyon, 170, avenue Jean-Jaurès, Lyon (Rhône)

Ir. F. GOEDBLOED, Nederlandse Kabelfabriek, Delft

Ir. W.L. BAER, N.V. Hollandse Draad- en Kabelfabriek, Amsterdam

II. Working Party on Rescue Arrangements and on Fires and Underground Combustion

- Members of the Working Party

GERMANY

Ministerialdirigent Dr.-Ing. K. HELLER *(1)*, Ministerium für Wirtschaft, Mittelstand und Verkehr, Land Nordrhein-Westfalen, 4 Düsseldorf, Haroldstr. 4

Dipl.-Berging. E. BREDENBRUCH, Leiter der Hauptstelle für das Grubenrettungswesen des Steinkohlenbergbauvereins, 43 Essen-Kray, Schönscheidtstr. 28

Dipl.-Ing. A. SCHEWE, Technischer Leiter der Hauptstelle für das Grubenrettungswesen des Steinkohlenbergbauvereins, 43 Essen-Kray, Schönscheidtstr. 28

A. VAN GEMBER, Erster Bergrat a.D., Direktor der Grubensicherheitsabteilung der Saarbergwerke AG, 66, Saarbrücken, Trierer Strasse 1

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L. DE CONINCK, Directeur du centre national belge de coordination des centrales de sauvetage, 17, rue Puissant, Charleroi

A. HAUSMAN, Directeur du centre de coordination de sauvetage du bassin de Campine, Kempische Steenweg 555, Kiewitt-Hasselt

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J. CRETIN, Ingénieur divisionnaire, poste central de secours, Belle-Roche, 57-Merlebach

H. BONARDOT, Ingénieur en chef, houillères du bassin de la Loire, 9, rue Benoit Charvet, 42-Saint-Etienne

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(1) Chairman of the Working Party as representative of the Restricted Committee.

LUXEMBOURG

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Dott. Ing. G. FORTE, Distretto minerario, via C. Battisti 10, Trieste

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Prof. Dr. W. MAAS, Chef van de Veiligheidsdienst, N.V. Nederlandse Staatsmijnen, Postbus 65, Heerlen (L.)

H.L. GROND, Chef van de Veiligheidsdienst, p/a Oranje-Nassau Mijnen, Heerlen (L.)

UNITED KINGDOM

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G. MILLER, Deputy Chief Inspector of Mines and Quarries, Department of Trade and Industry, Thames House South, Millbank, London S.W. 1

1. Experts on Aspects of Fires in Deep Shafts

GERMANY

Dipl.-Ing. K. GRUMBRECHT, Abteilungsleiter, Versuchsgrubengesellschaft mbH, 46 Dortmund, Tremoniastr. 13

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Dr.-Ing. K. RENNER, Forschungsstelle der Grubenbewetterung des Steinkohlenbergbauvereins, 43 Essen-Kray, Frillendorfer Strasse 351

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FRANCE

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R. LOISON, Directeur des groupes de recherches, Cerchar, 35, rue Saint-Dominique, 75-Paris 7e

M. FROGER, Ingénieur au Cerchar, 35, rue Saint-Dominique, 75-Paris 7e

NETHERLANDS

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Prof. Dr. W. MAAS, Chef van de Veiligheidsdienst, N.V. Nederlandse Staatsmijnen, Postbus 65, Heerlen (L.)

UNITED KINGDOM

Dr. H.S. EISNER, Ministry of Power, Safety in Mines Research Establishment, Harpur Hill, Buxton (Derbyshire)

2. Experts on Fire-Resistant Fluids

GERMANY

Dipl.-Ing. E. BREDENBRUCH, Leiter der Hauptstelle für das Grubenrettungswesen des Steinkohlenbergbauvereins, 43 Essen-Kray, Schönscheidtstr. 28

Dr. rer. nat. H.W. THOENES, Direktor, Technischer Überwachungsverein e.V., 43 Essen, Steubenstr. 53

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Prof. Dr. med. MALORNY, Direktor des Pharmakologischen Instituts der Universität Hamburg, 2 Hamburg, Martinistr. 52

Prof. Dr. med. C.A. PRIMAVESI, Hygiene-Institut des Ruhrgebietes, 4650 Gelsenkirchen, Rotthauserstr. 19

Prof. Dr. med. BENTHE, Pharmakologisches Institut der Universität Hamburg, 2 Hamburg, Martinistr. 52

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Dr. J. CRISPOUX, 2, rue Potresse, 7200-Wasmes

FRANCE

G. BLANPAIN, Ingénieur, Centre d'études et de recherches des Charbonnages de France, Verneuil-en-Halatte (Oise), BP 27, F-60 Creil

R. PLOUCHARD, Ingénieur des mines, chef du laboratoire lubrifiant, 59-Sin-le-Noble/Nord

Dr. AMOUDRU, Médecin-chef des Charbonnages de France, 9, avenue Percier, Paris 8e

E. QUINOT, Chef de la section physique et recherches mathématiques, Centre d'études médicales minières du Nord/Pas-de-Calais, 129-133, avenue Salengro, 59-Sin-le-Noble/Nord

NETHERLANDS

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3. Experts on Ventilation

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E. SIMODE, Ingénieur divisionnaire, houillères du bassin de Lorraine, direction des études et des travaux neufs, Petite-Rosselle (Moselle)

NETHERLANDS

Prof. Dr. W. MAAS, Chef van de Veiligheidsdienst, N.V. Nederlandse Staatsmijnen, Postbus 65, Heerlen (L.)

III. Working Party on Winding Ropes and Shaft Guides

- Members of the Working Party

GERMANY

Dr.-Ing. H. ARNOLD, Leiter der Seilprüfstelle der Westfälischen Berggewerkschaftskasse, 4630 Bochum, Dinnendahlstr. 9

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R. STENUIT, Directeur divisionnaire à l'Administration des mines, 24-26, rue J.A. Demot, Bruxelles 4

J. STREBELLE, Directeur, association des industriels de Belgique (A.I.B.), 29, avenue A. Drouart, Auderghem

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LUXEMBOURG

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NETHERLANDS

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Ir. F.H. SMULDERS, Laura en Vereeniging, Eygelshoven (L.)

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ANNEX XII

BIBLIOGRAPHY OF THE WORK OF THE MINES SAFETY AND HEALTH COMMISSION

I - TECHNICAL PROBLEMS

A - Mine rescue

1. Organisation of mine rescue arrangements

- Report on tour of central rescue stations in the Community countries and Great Britain (First Report on the organisation of mine rescue services 1958/59) (2nd Report of the Mines Safety and Health Commission, Annex B, June 1961);

- Second Report on the organisation of mine rescue services 1960 (3rd Report of the MSHC, Annex V a, November 1966);

- Third Report on the organisation of mine rescue services 1961 (3rd Report of the MSHC, Annex VI a, November 1966);

- Fourth Report on the organisation of mine rescue services 1962 (3rd Report of the MSHC, Annex VII a, November 1966);

- Fifth Report on the organisation of mine rescue services 1963 and 1964 (3rd Report of the MSHC, Annex VIII a, November 1966);

- Sixth Report on the organisation of mine rescue services, 1965/66 (5th Report of the MSHC, Annex V, October 1968);

- Seventh Report on the organisation of mine rescue services, 1967/68, (7th Report of the MSHC, Annex IV, September 1970).

- Recommendations regarding the provision of advice from foreign experts in the case of major accidents (3rd Report of the MSHC, Annex III, November 1966);

- Communication links between the rescue base and the rescue team (3rd Report of the MSHC, Annex IV, November 1966);

- List of regulations and directives concerning the organisation of mine rescue services in the countries of the Community and the United Kingdom (Doc. 3845/1/70; to be published in the 9th Report of the MSHC).

2. Rescue equipment

- Interim report on the continued development of the CO-filter self-rescuer (Doc. 1872/68/1, 10th October 1968);

- Results of the research carried out with financial assistance from the Commission of the European Communities into the improvement of the physiological conditions for the wearing of breathing apparatus (8th Report of the MSHC, Annex IV, June 1971);

3. Research work at high temperatures

- Final report on research into the establishment of simple criteria for the selection of rescue team personnel for heavy work in high temperatures (3rd Report of the MSHC, Annex IXa, November 1966).

4. Rescue with borehole

- List of specialists for borehole rescue work and equipment available in Community countries (8th Report of the MSHC, Annex III, June 1971)

B - Fires and underground combustion

1. Shaft fires at great depth

- Recommendations on the equipment having regard to the prevention of open fires (1st Report of the MSHC, April 1959);

- Fighting of fires in shafts by bringing in water (2nd Report of the MSHC, page 24, June 1961);

- Final report on experiments with shaft fires carried out by the Experimental Roadway Association in Dortmund, with the financial aid of the High Authority, at Dorstfeld Colliery, Dortmund (3rd Report of the MSHC, Annex III a, November 1966);

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2. Ventilation

- Study of the Group of Experts on Ventilation: Stabilisation of Ventilation in Pit Fires - investigation in the light of Prof. Budryk's theory (this study consists of two separate parts: the Report itself and Annex III to the 6th Report of the MSHC, September 1966);

- Practical conclusions of the application of the theory of stabilisation of ventilation (6th Report of the MSHC, Annex III, September 1969);

3. Fire stoppings (dams)

- Sealing-off of mine fires and underground combustion by dams (2nd Report of the MSHC, page 51, June 1961);

- Report on trials with explosion-proof dams carried out by the Experimental Roadway Association in Dortmund at the request of the Safety Commission and with financial aid of the High Authority - Statement of policy regarding the erection of advance dams of plaster as a fire fighting measure (3rd Report of the MSHC, Annex I, November 1966);

- Final Report on trials with explosion-proof dams, carried out by the Experimental Roadway Association in Dortmund with the financial aid of the High Authority (3rd Report of the MSHC, Annex I a, November 1966);

- Instructions for the construction of plaster stoppings by the method developed by the Essen-Kray Main Rescue Station (3rd Report of the MSHC, Annex X a, November 1966);

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- Fourth Report on specifications and testing conditions relating to fire-resistant fluids for power transmission (pamphlet 26th March 1971).

5. The reopening of fire areas

- Report on the opening of sealed-off fire areas and the rules applicable thereto (3rd Report of the MSHC, Annex II, November 1966);

- Study on the reopening of sealed-off fire areas by Bergassessor a.D.G. Lehmann (3rd Report of the MSHC, Annex II a, November 1966).

6. Use of urethane foam for sealing

- Opinion on the use underground of polyurethane foam in the coal mining industry (7th Report of the MSHC, Annex VI, September 1970).

C - Electricity

- Decision on the removal of oil from resistors, condensers, transformers, switches and relays used underground (1st Report of the MSHC, April 1959);

- The use of non-flammable materials for the manufacture of electric cables and leads for underground use (2nd Report of the MSHC, page 5, June 1961);

- Requirements which must be met by electrical shotfiring leads (2nd Report of the MSHC, page 8, June 1961);

- Protection of the underground electrical network against the danger of electric shocks (2nd Report of the MSHC, page 11, June 1961);

- Report on investigations into the protection of underground electrical network against dangers arising from fires or from firedamp explosions (3rd Report MSHC, Annex VII, November 1966);

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- Report on the electro-magnetic examination of winding ropes (3rd Report of the MSHC, Annex VI, November 1966);
- Final report on electro-magnetic tests carried out with the financial aid of the High Authority in the Bochum Rope-testing Station (3rd Report of the MSHC, Annex XI a, November 1966);
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- Report on measurement and testing procedures for shaft- and roadway winding ropes and for guides for shaft- and roadway haulage installations (7th Report of the MSHC, Annex VII, September 1970).

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- Report on work done on the neutralization of combustible dusts and dust barriers (7th Report of the MSHC, Annex VIII, September 1970).

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- Recommendations concerning the equipment of locomotives (1st Report of the MSHC, April 1959);
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III. HUMAN FACTORS

A - Medical problems

- Report on pre-entry and routine medical examinations and recommendations (2nd Report of the MSHC, page 74, June 1961);
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- Report on the psychological and sociological factors affecting safety (3rd Report of the MSHC, Annex XII, November 1966);

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- Report on the implications of payment at piece rates for mine safety (4th Report of the MSHC, Annex III, December 1967);

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