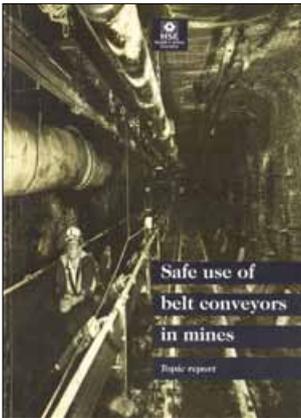


Safe use of belt conveyors in mines

Topic report



This is a free-to-download, web-friendly version of *Safe use of belt conveyors in mines* (First edition, published 1993). This version has been adapted for online use from HSE's current printed version.

You can buy the book at www.hsebooks.co.uk and most good bookshops.

ISBN 978 0 7176 0674 0

Price £12.50

Belt conveyors have been used for a long time to transport minerals below ground in mines. This report analyses data on belt conveyor accidents and dangerous occurrences for the five year period from 1986/87 to 1990/91. This report looks at how these accidents happened and makes recommendations on how to avoid them in the future. The report is aimed at mine owners, mine managers, engineers, maintenance personnel, conveyor operators and conveyor users.

© *Crown copyright 1993*
First published 1993

ISBN 978 0 7176 0674 0

You may reuse this information (not including logos) free of charge in any format or medium, under the terms of the Open Government Licence. To view the licence visit www.nationalarchives.gov.uk/doc/open-government-licence/, write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or email psi@nationalarchives.gsi.gov.uk.

Some images and illustrations may not be owned by the Crown so cannot be reproduced without permission of the copyright owner. Enquiries should be sent to copyright@hse.gsi.gov.uk.

Contents

Foreword by HM Chief Inspector of Mines	4
Introduction	5
Legislation and British Coal Corporation Standards	6
A review of accidents	7
Manriding accidents	10
Non-manriding accidents – use, installation and maintenance	12
A review of dangerous occurrences	17
Conveyor fires	17
Withdrawal of persons as a consequence of smoke etc	19
Conveyor belt breaking during manriding	21
Specific hazards	22
Manriding hazards	22
Nip-point hazards	24
Stored energy	26
Training	28
Conclusions	29
Recommendations	30
References	35
Further information	36

Foreword by HM Chief Inspector of Mines

This report on the safe use of belt conveyors in mines is the third topic report relating to haulage and transport safety to be issued in recent years by the Health and Safety Executive's HM Inspectorate of Mines. The previous topic reports covered underground locomotives¹ and the safe use of free-steered vehicles² below ground.

The report draws in particular from belt conveyor accident and dangerous occurrences history data for the five year period 1986/87 to 1990/91 during which time eight men were killed, 134 suffered serious injury and 939 suffered 'over-three-day' injuries. The death toll, the frequency of other injuries and the potential consequences of many of the dangerous occurrences represent an unacceptable catalogue of events, most of which could have been avoided.

The report is aimed at mine owners, mine managers, engineers, maintenance personnel, conveyor operators and conveyor users. Its primary objective is to make recommendations on the safe use of belt conveyors which, if adopted, in a responsible and disciplined environment, should bring about a reduction in accidents.

K L TWIST
HM Chief Inspector of Mines

Introduction

1 Belt conveyors have been used for mineral transport below ground in mines since around the time of the First World War. Their use continued to grow, aligned to the move from pillar and stall to longwall mining systems and they were initially used to replace horses and rope haulages for the more efficient transportation of mineral. As belt conveyor drive-unit power, width and tensile strength increased, conveyors gradually began to displace main line underground locomotive systems as the preferred means of mineral transportation over long distances.

2 Records show that there were 1356 km of belt conveyors installed in British coal mines in 1948 which rose to 2692 km by 1953. A typical present-day large coal mine has some 30 km of belt conveyors.

3 Individual belt conveyor installations vary widely in their design, capacity and duty. The smallest may be only 5 kW or less, 10 m long and 0.3 m wide. At Gascoigne Wood Mine a 10 000 kW, 12.2 km long conveyor with a 1.3 m wide steel cord belt conveys coal to the surface from the Selby complex of mines. It has a capacity of 2400 tonnes per hour when conveying coal the full length and up to 3400 tonnes per hour when coal is loaded on to it at a mid point. A sister conveyor of similar capacity at the same mine is of cable belt design. Conveyors are extensively used for manriding and occasionally for material transport. Developments in monitoring and control have enabled whole networks of underground conveyors to be computer operated from surface control rooms.

4 At Creswell Mine in 1950³ there was a major disaster arising from the use of an underground belt conveyor. An outbreak of fire occurred when a hold-fast due to debris at a transfer point caused the rubber conveyor belting to ignite through friction. Although detected within minutes of starting, the fire spread some 555 m downwind along an intake roadway and 80 persons on the return side lost their lives as a result of carbon monoxide poisoning. Following this disaster, fire-resistant belting was developed and adopted by the National Coal Board (NCB) as the standard in all its mines, together with the requirement for systematic patrolling of conveyors; fire proofing of certain areas of roadways; improvements in fire-fighting training and in the 1960s the introduction of filter self-rescuers.

5 The purpose of this report is to examine and review the safety of belt conveyor operations and to recommend where safety could be improved. The accident and incident analysis in this report is based on the use of belt conveyors below ground in coal mines. The majority of the recommendations, however, are applicable to the use of belt conveyors both above and below ground and some are also applicable to conveyors used in other industries.



Figure 1 Cable belt conveyor drive-head at Gascoigne Wood Mine, Selby



Figure 2 Mine surface control room

Legislation & British Coal Corporation Standards

6 It is not the intention in this report to refer to the detail of all relevant legislation but, for reference purposes, the principal mining-specific legislation relating to the operation of belt conveyors is listed below:

- (a) Mines and Quarries Act 1954 – section 36(b): prohibition on a conveyor or its load rubbing the sides or roof of a road.
- (b) Mines and Quarries Act 1954 – section 37: gives the manager of every mine the power to make transport rules.
- (c) Mines and Quarries Act 1954 – section 44: minimum age of a person operating a conveyor along a working face.
- (d) Mines and Quarries Act 1954 – section 46: signals.
- (e) The Coal and Other Mines (Shaft, Outlets and Roads) Regulations 1960 (SI 1960 No 69, as amended by SI 1968 No 1037 and SI 1978 No 1648) – regulation 46(1)(e): specification of conveyor signals which should be transmitted.
- (f) The Coal Mines (Clearances in Transport Roads) Regulations 1959 (SI 1959 No 1217) as amended by SI 1975 No 1102 and SI 1976 No 2063: Parts III and IV specify required clearances between conveyors and roadsides; between conveyors and vehicles; and between adjacent conveyors.

7 In addition to legislation, the British Coal Corporation (BCC) (formerly the National Coal Board (NCB)) has, over a number of years, introduced a number of comprehensive operating instructions, notes for guidance and codes and rules on the installation, use and maintenance of belt conveyors, for example:

- (a) NCB (Production) Codes and Rules – *Manriding by belt conveyors*.
- (b) NCB (Mining) Codes and Rules – *Protection of underground roadway belt conveyors drive units*.
- (c) Notes for Guidance NG/5 – *Minimum requirements for manless transfer points*.
- (d) Notes for Guidance NG/6 – *Belt conveyor handbook*.
- (e) BCC Operations Instruction OI/4 – *Fire prevention and control*.
- (f) NCB Codes and Rules – *Minimum standards of fencing and guarding*.

8 British Standard 7300: 1990 *Code of Practice for safeguarding of hazard points on troughed belt conveyors* states in the Scope, 'This standard does not apply to underground mine conveyors'. Nevertheless, many of the principles in this Code of Practice have been incorporated in British Coal codes and rules and notes of guidance and mine engineers may find that it provides additional guidance.

A review of accidents

9 Specified accidents are reportable to the Health and Safety Executive (HSE) as the enforcing authority under the requirements of the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1985 (RIDDOR). A breakdown of the fatal, major injury and over-three-day accidents associated with belt conveyors, for the five year period 1986/87 to 1990/91, is given in Table 1.

Table 1 Reportable accidents associated with belt conveyors for the five year period 1986/87 to 1990/91

Year	Fatal	Major injury	Over three days
1986/87	2	30	287
1987/88	-	32	226
1988/89	4	31	148
1989/90	1	24	146
1990/91	1	17	132
Total	8	134	939

Source: HSE

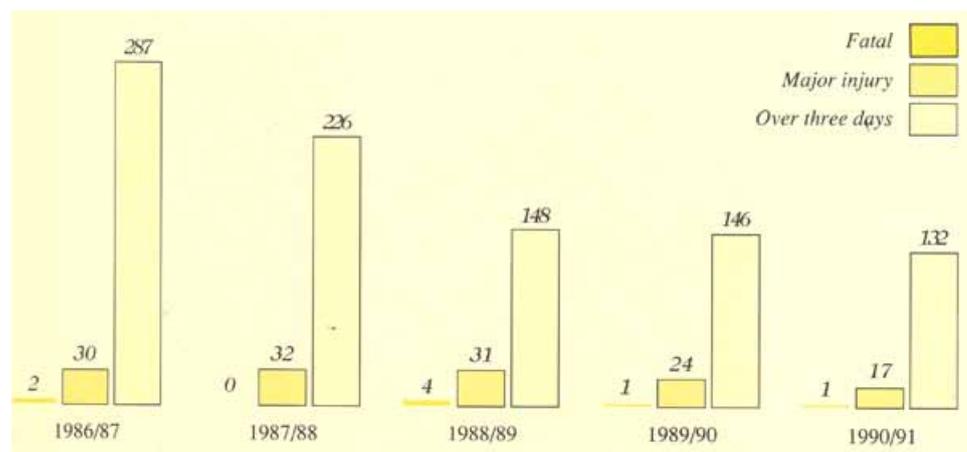


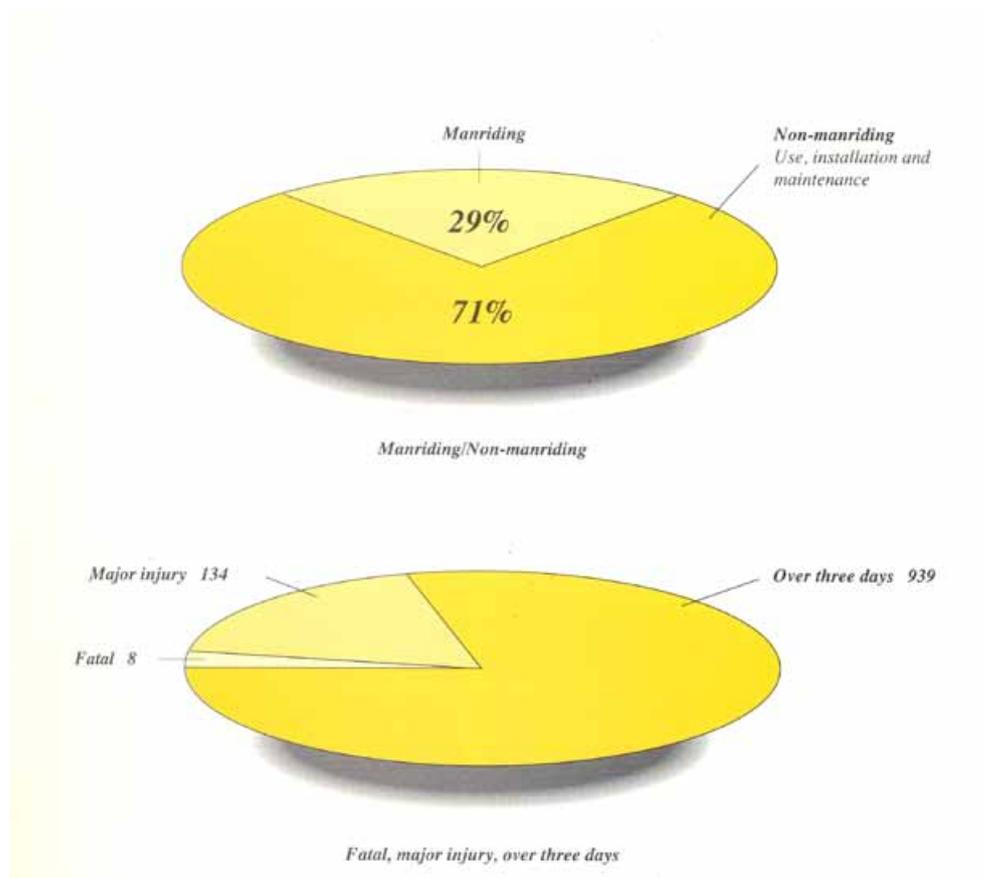
Figure 3 Table 1 represented as a histogram

10 By reference to the circumstances relating to each accident, they have been categorised in a manner which enables common causes to be evaluated and recommendations made for future prevention. Belt conveyor accidents have conventionally been classified very broadly as 'manriding' or 'other cause' but to allow a more meaningful analysis of causes, the accidents referred to have been classified into the more specific categories shown in Table 2. The first four categories relate to manriding and include illegal manriding on conveyors not designated for the purpose. The remaining eight categories relate to other causes and include, in particular, aspects relating to use, installation and maintenance.

Table 2 Conveyor accidents by category 1986/87 to 1990/91

Category	Fatal	Major injury	Over three days
Manriding accidents			
Manriding: poor installation or failure to maintain standards	-	7	52
Manriding: breach of managers' transport rules	1	19	46
Manriding: apparent lack of normal caution	-	9	154
Manriding: illegal	5	22	3
Non-manriding accidents – use, installation and maintenance			
Inadequate clearances or guards	-	11	27
Maintenance, on or around moving or stalled conveyors	-	25	118
Maintenance, on or around stationary conveyors	1	15	262
Misuse of equipment	-	12	36
Blocked chutes, falling spillage	-	8	97
Use of conveyor as working platform	-	6	55
Use of conveyor to transport materials	1	-	32
Struck or fell while crossing conveyor	-	-	57
Total accidents	8	134	939

Source: HSE



Fatal, major injury, over three days

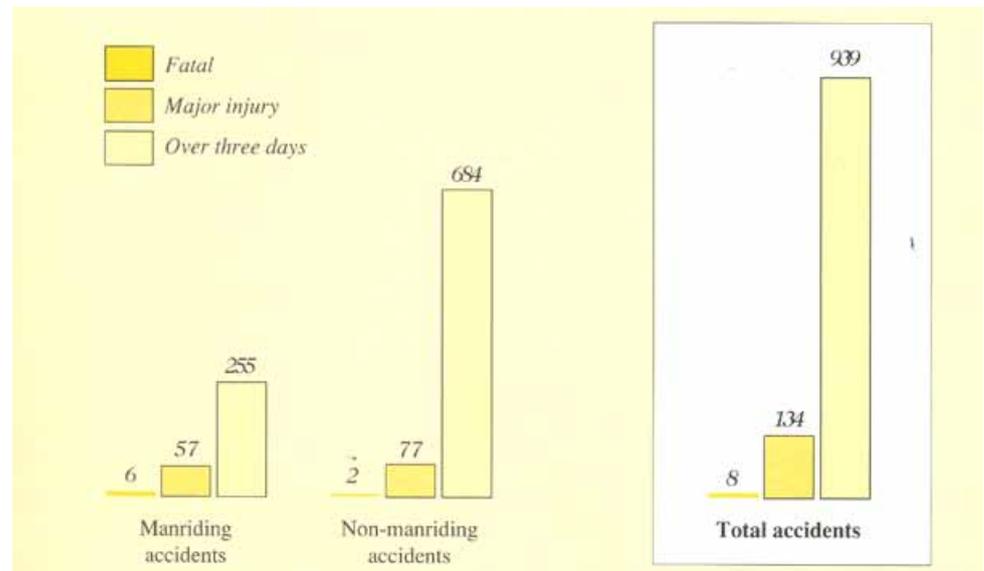


Figure 4 Table 2 represented as pie charts and histograms

Manriding accidents

11 In the manriding categories, six persons were killed, 57 received major injury and 255 received over-three-day injuries. This represents 29% of total conveyor accidents.

Manriding: poor installation or failure to maintain standards

12 In the analysis of accidents in this category it has been assumed that installations were commissioned to appropriate manriding standards, but standards had subsequently been allowed to deteriorate. Most accidents involved persons striking obstructions. In order to ensure satisfactory clearances, existing BCC codes and rules require a weekly check, but this is often only a visual check. Accurate periodic surveys are essential where clearances are marginal and ground movement is known to be a factor. Even where clearances meet specifications, any significant changes should be highlighted with reflective paint or tape.

13 Five men were injured when riding on a conveyor which surged badly and threw them off. Correct conveyor belt tension and the design of belt catenaries through swilleys are of paramount importance to ensure that the belt remains in contact with the idlers and surging during start up is minimised. Attention should also be given to the prevention and removal of trailing belt edge tears which are a hazard to riders, particularly on the lower strand of a double-deck manriding system.



Manriding: breach of managers' transport rules or illegal manriding

14 Most fatal and major injury manriding accidents resulted from breaches of managers' transport rules either while riding on designated manriding conveyors or when illegally riding other conveyors. These accounted for six fatalities and 41 major injuries in the period under review which represented three-quarters of fatalities and nearly one-third of all major injuries associated with belt conveyors underground.

15 In an unwitnessed accident a workman suffered fatal injuries when he apparently fell trying to alight from a moving manriding conveyor at a place remote from the alighting platform.



16 Five fatal and 22 major injuries resulted from illegal manriding. In one fatal accident the body of a development worker was discovered on a moving conveyor at the surface of a 1 in 3.6 drift in circumstances which suggested that he had been illegally riding and had been struck by a piece of sandstone that had slid back down the belt.

17 A double fatality occurred when two workmen were illegally manriding on a conveyor passing through an airlock 'mousetrap' arrangement. The leading rider became lodged in the airlock and the second rider was conveyed into the back of him. Coal on the still moving conveyor engulfed and asphyxiated them. There may have been some confusion at the time as to whether the conveyor had been recommissioned for manriding, after manriding had been suspended to allow the airlock to be erected. All conveyor boarding platforms should have integral lockable gates or barriers with notices to indicate when manriding has been suspended.

Figure 5 Integral lockable gate for use when manriding has been suspended



Figure 6 Conveyor manriding and crushers are not compatible

18 Two surfaces fitters, illegally manriding on an underground conveyor, passed under the safety trip wires at the infeed to a crusher and one was taken through the crusher and killed.

19 Non-manriding conveyors do not have safe means for boarding and alighting or other necessary manriding safeguards and frequently do not have adequate clearances for manriding. Conveyors should be equipped for manriding wherever practicable. The tragic accidents referred to in this category will only be eliminated if persons resist the temptation to ride on conveyors not authorised for manriding and if all mine officials rigorously enforce managers' transport rules.

20 Recognising that there have been occasions when men have, for whatever reason, travelled below the over-travel safety-gate of a designated manriding conveyor, and also that illegal manriding must be countered by every means possible, HM Inspectorate of Mines and BCC have jointly sponsored a research project on a man-detection system. The system will incorporate the attachment of a passive transponder to the cap-lamp battery, and aerial transmitter/detectors will be sited at locations on conveyors where hazards could be present if manriding takes place. If the aerial detects persons riding in such circumstances it will automatically stop the conveyor and sound the alarm. It is hoped that this research will result in an acceptable system in the near future.

21 No conveyor which delivers into a crusher or bunker should be authorised for manriding.



Figure 7 Conveyor manriding below ground

Manriding: apparent lack of normal caution

22 There were nine major injury and 154 over-three-day injuries in this category for the period under review which included injuries sustained to persons boarding, riding or alighting from manriding conveyors, who although they reportedly adhered to managers' transport rules, suffered injury through apparent lack of normal caution. The majority occurred when boarding and alighting. Persons riding on manriding conveyors should recognise that the practice is only safe if managers' transport rules are followed, personal discipline is maintained and horseplay avoided. Managers should be aware that apparent lack of personal care may be only part of the reason for an accident and that there may be contributory defects in the system which should be addressed. Information relating to the circumstances of some over-three-day accidents is often limited. For all accidents (including over-three-day) the recording of belt speed, vertical clearances, gradient and other relevant details would enable management to assess better how these accidents can be avoided. Furthermore, where certain installations give rise to repeat accidents, the installation itself may warrant further scrutiny and modification. There should be effective crowd control when large numbers of persons are engaged in belt manriding, especially at shift change times.

23 Numerous accidents occurred when persons, in the process of alighting from manriding conveyors which had stopped, over-balanced and fell when they suddenly restarted. Managers' transport rules should specify a safe method for persons to alight from stationary conveyors. All manriding conveyors should be provided with prestart audible warning along their entire length.

24 Two accidents occurred to inexperienced visitors and one to a rescue brigadesman wearing breathing apparatus. Managers' transport rules should address the special requirements for safe manriding by inexperienced persons or those who foreseeably have to carry personal equipment. For inexperienced persons the precaution of supervising their boarding and alighting should be undertaken by competent and experienced personnel.

Non-manriding accidents: use, installation and maintenance

25 Non-manriding accidents, primarily involving conveyor use, installation and maintenance, accounted for two fatal, 77 major injury and 684 over-three-day accidents. This represented 71% of all conveyor accidents during the period under review.

Inadequate clearances or guards

26 This category of 11 major injury and 27 over-three-day accidents relates to accidents arising from persons coming into contact with the conveyor, where guarding or other arrangements were inadequate, but excludes those which occurred during maintenance operations. Examples included stumbling onto the lower strand and being carried beneath top idler sets, stepping back onto the conveyor, and dropping materials onto the conveyor which bounced back causing injury. Some were caused while attempting to cross over or under the conveyor, to gain access to roadways, substations, pump lodges or other equipment.



Figure 8 Access bridge over conveyor

27 Mine installations should where practicable be designed to eliminate the need for persons to cross over or under conveyors, but where travelling routes have to cross conveyors, suitable bridges or underpasses should be provided. Bridges equipped with handrails and kicking-boards should be constructed of steel or other suitable fire resistant materials and be firmly fixed. They should give adequate clearance over the conveyor, so as not to cause obstruction and should be convenient to use. Conveyor underpasses should be provided with effective guarding to prevent persons coming into contact with moving parts of the conveyor.



Figure 9 Guarding at a conveyor underpass at a non-coal mine

28 Where sections of a conveyor installation are located below the normal walkway, suitable guards or hand-rails should be provided to prevent persons falling or slipping onto the conveyor

Maintenance on or around moving or stalled conveyors

29 In the study period, 25 men suffered major injury and 118 suffered over-three-day accidents while working on or around moving or stalled conveyors. Almost all the accidents could have been prevented by the normal precaution of stopping and isolating the conveyor before starting work. Management should give clear instructions, although these will no doubt have been given before, that no maintenance activities which could cause a person to come into contact with the moving parts of a conveyor should be carried out while the conveyor is in motion. Worn or damaged idlers should only be changed when conveyors are stationary. Deployment of maintenance staff should ensure that full advantage is taken of non-production shifts so that maintenance and repair work can be segregated from production pressures. Injuries have sometimes been sustained when persons have been struck by protruding belt joints and these can be minimised by the correct trimming of the belting and joint pins.

30 The use of signal lockouts for preventing conveyor start-up during maintenance should be strictly confined to simple tasks of low risk where a pre-start warning would be heard and inadvertent starting would not cause personal injury. In most cases conveyors should be immobilised by isolating and locking off the main power supply. Conveyor drives and loops should be marked to show the location of the relevant switchgear, which should be properly identified and labelled and the isolating handles clearly marked.

ISOLATE 302s L/GATE
CV AT THE A.U.H.T
CONTACTOR SER. No 0609
IN 302s L/GATE

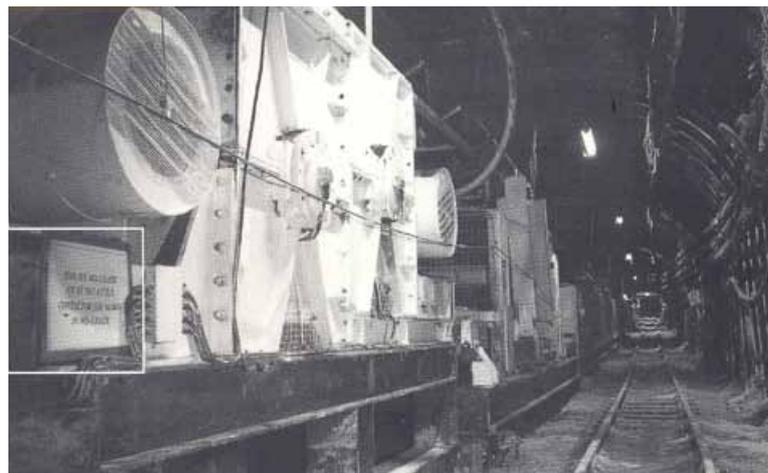


Figure 10 Notice giving location of isolating switchgear

31 To help counter some of the aforementioned dangers, it is recommended that pre-start warning facilities are provided on all conveyor installations throughout their total length and not just on manriding conveyors.

Accidents on or around stationary conveyors

32 One person was killed, 15 suffered major injury and 262 suffered over-three-day accidents while working on or around stationary conveyors. The proportion of accidents due to maintenance activity is disturbing and managers and engineers are urged to review their maintenance procedures, the equipment used and the training and competence of the personnel involved.

33 A fitter was fatally injured while tensioning a large conveyor. A wedge-type clamp fitted to secure a rope holding a 70 tonne tension weight, failed to grip the rope and allowed the weight to slide down the 1:1 inclined track. This caused the rope to whip violently, striking the fitter. The clamp failed to grip the rope because it was incorrectly fitted and the person responsible had been inadequately trained. The system of work was cumbersome and required repeated securing and

winching of the weight. Following the accident, the system of work was modified to eliminate the use of the wedge-type clamp.

34 Maintenance procedures and safe systems of work should, where practicable, be simple and avoid repetition which may induce short-cutting or complacency. Where special equipment has to be used, persons should be properly trained to use it safely.

Misuse of equipment

35 Misuse of equipment accounted for less than 5% of the total accidents but caused 12 major injuries. Conveyor belts are elastic and when under tension store considerable amounts of energy. Improvised maintenance methods and misuse of equipment, either deliberately or due to lack of training, have often caused sudden uncontrolled release of stored energy. This can result in violent movement of the belt or heavy components such as loop carriages or tension weights. Managers, engineers and supervisors should be alert to the misuse and abuse of equipment and to improvised practices because suitable equipment is not provided or maintained. The dangers associated with stored energy in conveyor belts are also described in paragraphs 86 to 94.

36 A fitter suffered traumatic amputation of both legs while tensioning a stationary and isolated 150 hp conveyor. Due to a fault on the loop winch brake, the winch would not hold tension. The workmen placed a monorail beam across the loop side frames in front of the carriage as a makeshift anchorage until they could fit bolted backstops to the carriage. The monorail was sticking out of the loop by 0.6 m on the walking side and, as one of the men stood between this and the loop side, the winch rope broke causing the carriage to be violently propelled forward, dislodging the beam at the far side. The man was trapped between the projecting end of the beam and the loop side as the beam violently rotated in line with the loop. Advice for controlling loop winch rope tension is given in paragraph 93.

Accidents due to being struck by spillage

37 There were eight major injuries and 97 over-three-day accidents of this type. A large lump of mineral does not have to fall far to cause severe injury. Men working close to transfer points are at most risk and a significant number of the accidents involved persons dealing with chute blockages. The design of roadways and transfer points should be compatible in order to achieve safe and effective mineral transfer. Transfer points should be engineered to give efficient and controlled transfer of mineral with minimum production of fines and spillage.

38 Spillage regularly occurs at transfer points where chutes, which have been overfilled by conveyor overrun, do not load out gradually on restart. This may be overcome by a small receiving hopper with an adjustable guillotine door to control the delivery on restart so as to prevent mineral flooding onto the outfeed conveyor.



Figure 11 Transfer point receiving hopper with adjustable guillotine door

39 A simple but ingenious open-bottomed chute has been designed and successfully applied at one large colliery to eliminate the problem of fines and slurry sticking and causing chute blockages. Fines and slurry are delivered straight through the open bottom onto the outgoing belt while larger material is channelled along a widening aperture (see Figure 12). The design has the added benefit of minimising damage to the surface of the belt as the small material falls through the chute before the large material and forms a protective layer for the larger lumps. The design is worthy of wider consideration.

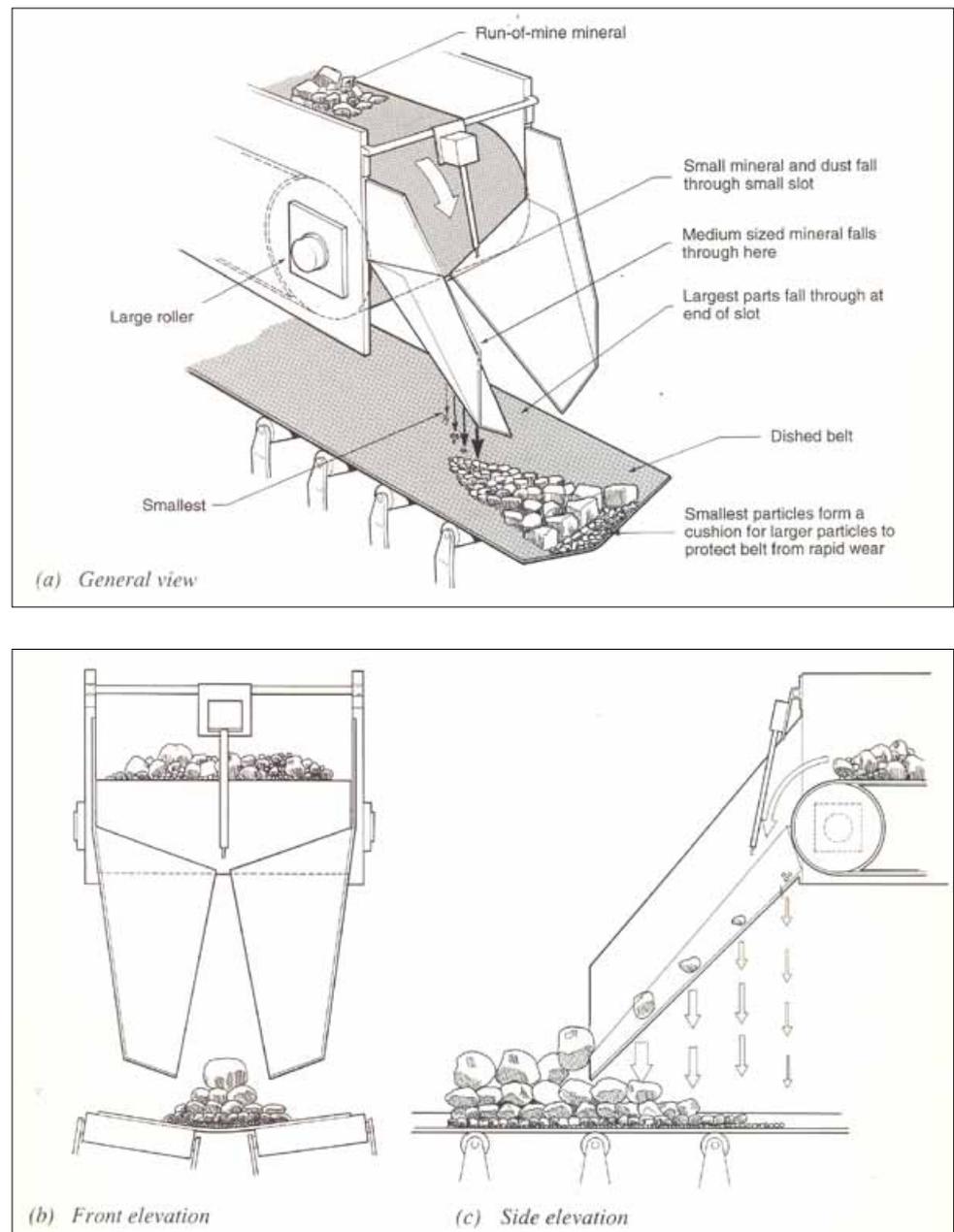


Figure 12 Chute designed to counteract blockages and belt wear

Accidents resulting from use of conveyors as working platforms

40 The majority of these accidents resulted from a failure to ensure that conveyors, which were being used as working platforms, had been properly immobilised. The use of conveyors as working platforms should be avoided wherever practicable. Where conveyors have to be so used, full electrical immobilisation is essential and signal lock-outs should not be relied on.

Use of conveyors to transport materials

41 Belt conveyors are not normally used for the routine transport of materials but when used, suitable managers' transport rules should be implemented. Such rules should specify:

- (a) suitable clearances at loading and unloading stations;
- (b) where necessary for safety that conveyors are stationary while materials, tools or equipment are loaded or unloaded;
- (c) that ploughs are fitted at bottom belt unloading stations;
- (d) that materials are positioned within the width of the belt;
- (e) that all materials loaded onto a belt conveyor are accounted for at the unloading station;
- (f) the circumstances in which pedestrians should be prohibited from the travelling road alongside the conveyor.

42 Where a conveyor loaded into a crusher, a workman was killed when he fell into the crusher after climbing up the conveyor structure, apparently to retrieve a set of chain blocks that were being transported outbye on the conveyor. In certain circumstances, where it is judged appropriate to transport equipment along conveyors, they should be stopped when the equipment is placed onto and taken off the belt.

43 Only small items that can be easily carried about the person without affecting normal movement and balance should be transported when manriding. Other equipment should be transported outside normal manriding times in accordance managers' transport rules.

A review of dangerous occurrences

44 Belt conveyor dangerous occurrences reported to HSE in accordance with RIDDOR relate to fires, withdrawal of persons due to smoke, or breakage of a belt during manriding.

Conveyor fires

45 Fires are the greatest hazard associated with underground belt conveyors as they have the potential to cause multiple fatalities. Mines can be compared to offshore oil and gas rigs in their complexity and hazard potential, both having persons and machinery in confined spaces with potentially hazardous atmospheres. At mines and offshore rigs it can be difficult to escape rapidly from fire and smoke. Additionally fire below ground creates smoke and possible lethal concentrations of carbon monoxide and other toxic gases which may be carried by the ventilating current through the mine. Paragraph 4 refers to the 80 men in the Creswell disaster who died of carbon monoxide poisoning. Even a short-lived fire can endanger persons remote from the fire as belt conveyors are predominantly in intake airways and all persons on the return side are at risk.

46 Table 3 categorises all underground fires which occurred in the study period and just over half were associated with conveyors. Table 4 categorises the causes of conveyor fires.

Conveyors	120	51
Use of electricity	38	16
Spontaneous combustion	26	11
Locomotives	15	6
Pumps	8	3
Others	31	13
Total	238	100

Source: HSE

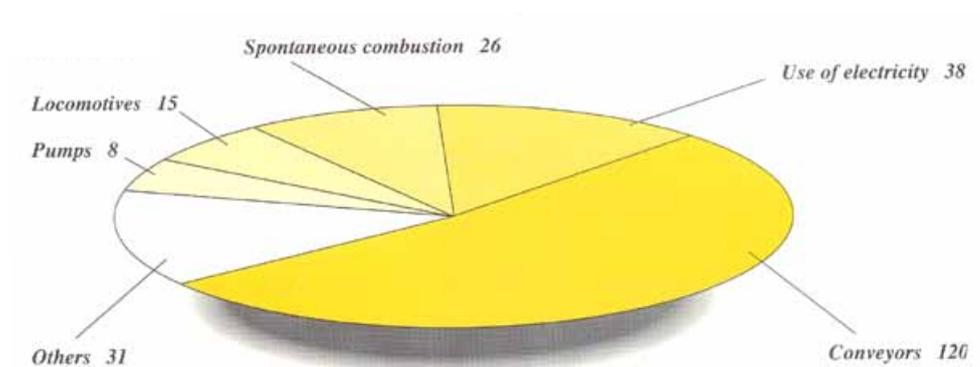


Figure 13 Table 3 represented as a pie chart

Table 4 The cause of underground conveyor fires in coal mines 1986/87 to 1990/91

Category	No of fires	Percentage of total
Collapsed idler	40	33
Defect at other bearing	23	19
Friction from belting	24	20
Mechanical friction	20	17
Brakes	13	11
Total	120	100

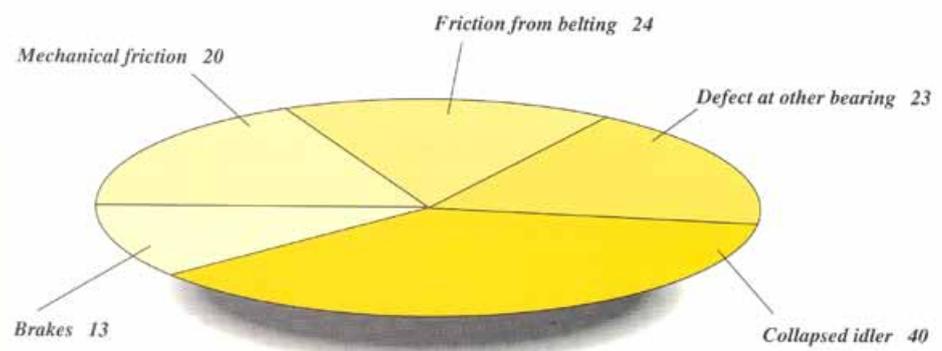


Figure 14 Table 4 represented as a pie chart

47 Twenty four of the 120 conveyor fires resulted from frictional heat due to the belt rubbing against the conveyor structure, coal spillage or other material. A further 20 were the result of idlers or rollers rotating in spillage or against structure, generating frictional heat. Conveyor alignment is an essential prerequisite to safety; idlers should be installed well clear of the floor and spillage should be removed regularly and effectively. BCC codes and rules CR/4 (which is included in Operations Instruction OI/4 – *Fire prevention and control*) at section 7 is particularly relevant to the patrolling of underground belt conveyors to ensure safety with respect to the risk of fire.

48 Investigation often found the fuel for conveyor fires to have been accumulations of coal spillage, dust, paper or timber. The development of fire-resistant (FR) conveyor belting has contributed to the prevention of another Creswell catastrophe, but even FR belting can burn in the presence of another fuel. Fibres or polymers torn or scrubbed from a misaligned belt or from belt retarders can be ignited and will burn readily. These potential fire hazards can only be eliminated by high standards of conveyor installation, maintenance and cleanliness. The use in one coalfield of belt alignment switches on the return ends of conveyors which are frequently extended or retracted has reduced belt damage, downtime and fire-risk, and their wider use is recommended.

49 Failed bearings are by far the most common source of conveyor fire ignition, particularly those on bottom idlers where there is more likelihood of contamination and contact with flammable material. Bearings in conveyor idlers manufactured since 1986 have been lubricated with FR grease which has reduced the likelihood of bearing fires.

50 Most idlers are changed when a bearing is running noisily with failure imminent, or after a bearing has completely collapsed. Bearing failure can develop quickly, often within the period between routine inspections, making preventative maintenance difficult. For current designs of idler, bearing failure, which is hazardous and often sudden, usually occurs before shell wear out, which is significantly less hazardous and more amenable to planned maintenance. Where imminent bearing failure is detected, idlers should be changed as a matter of priority.

51 Designed life of idlers will only be achieved if the design loads are not exceeded and correct spacing and grading of idlers is important for this reason. The improvised use of standard belt support idlers to deflect the belt at changes of gradient seriously overloads the bearings causing early failure and presents a fire hazard.

52 Defective brakes cause two or three fires each year. Most conveyor brakes are fitted to the high speed motor shaft and are sometimes dated in design. All mechanical brakes generate frictional heat when applied and dangerously high temperatures can quickly occur at the brake linings if brakes are used excessively or if there is inadequate cooling by the ambient ventilation. Most brake fires occur when brakes are inadvertently applied or not fully released due to maladjustment, inadequate maintenance or dirt. It is standard practice to monitor brake position, lining wear and temperature. Nevertheless high standards of installation and maintenance of brakes and their protection are essential if fires are to be prevented. An automatic fire extinguisher should be provided at all brakes, together with a suitably sited fire detection system for the drive-head.

53 Mechanical brakes should only be fitted where absolutely necessary and where other means of retarding or control are not practicable. When mechanical brakes are fitted they should have adequate thermal capacity to avoid excessive temperatures if the conveyor is stopped repeatedly in addition to the standard protection referred to in the preceding paragraph. The debris produced by wear of fire-resistant conveyor belting is combustible. Where retarder belts are used they should be cleaned regularly to prevent this flammable debris accumulating.

54 Routine inspection and maintenance is essential throughout the complete length of a conveyor. There is evidence that this is sometimes neglected at elevated conveyor deliveries and other similar places where safe or easy access is not provided. Suitable access should be available to all parts of a conveyor.

Withdrawal of persons as a consequence of smoke etc

55 RIDDOR requires the reporting to HSE of any incident where a person has been caused to leave any place because of smoke or other indication that a fire might have broken out below ground. A total of 59 such dangerous occurrences were reported in the review period and these are shown in Table 5. Table 6 gives a breakdown of the causes.

Table 5 Causes of all underground withdrawals due to smoke etc 1986/87 to 1990/91

Source	No reported	Percentage of total
Conveyors	32	54
Spontaneous combustion	6	10
Use of electricity	5	8
Pumps	5	8
Other	11	20
Total	59	100

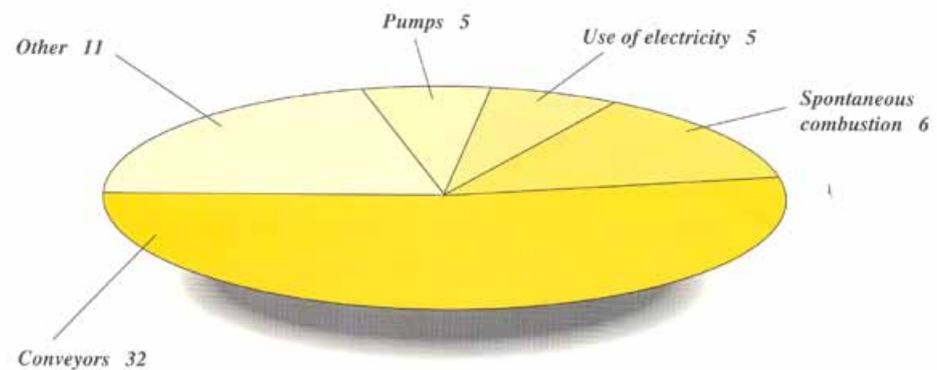


Figure 15 Table 5 represented as a pie chart

56 Table 5 shows that problems with conveyors are by far the main cause of persons having to withdraw due to smoke or other indication of fire.

Table 6 Cause of withdrawals associated with underground belt conveyors 1986/87 to 1990/91

Cause	No reported	Percentage of total
Belt slip at drive drums	22	69
Belt fouling loop or structure	6	19
Collapsed idlers	4	12
Total	32	100

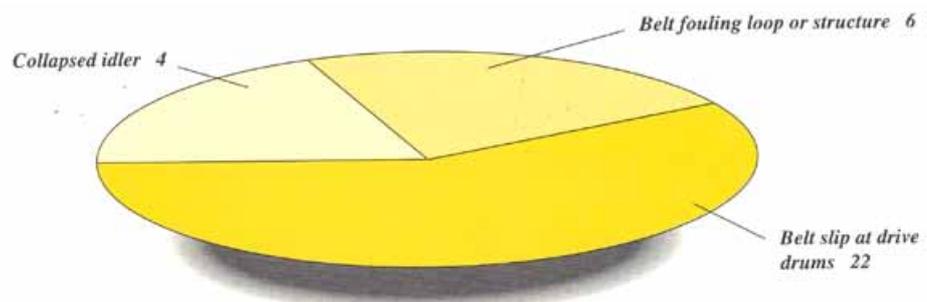


Figure 16 Table 6 represented as a pie chart

57 Conveyor drives continuing to run while a belt is in a stalled condition is the most common cause of smoke emission. Frictional heat can be developed quickly and large volumes of acrid smoke and toxic gases given off from the heated belt.

Drive drums lagged with a fire-resistant polymeric material give better adhesion than steel drums but when slip occurs, smoke emission is made worse. With adequate design, installation and maintenance the need for lagged drums is unnecessary and they should not be fitted.

58 It is vital that belt slip monitoring is provided and maintained on all conveyors, not just those with manless transfer points. On manned conveyors the control point is not always adjacent to the drive and the stopping of the belt is no indication that the drive has stopped. No more than three attempts to restart the conveyor should be made without an on-site investigation of the cause of the slip. There have been occasions when surface control room operators have exceeded this limit and smoke resulted. In one incident 12 restart attempts were made, causing a fire.

59 The use of conveyor drive power to pull lengths of belting together has resulted in slip and smoke emissions. Accidents can also be caused by this malpractice since the drive power cannot be safely controlled. This hazardous practice should be prohibited and ancillary equipment installed to enable conveyor belting to be connected safely.

Conveyor belt breakage during manriding

60 RIDDOR requires the reporting of: 'The breakage, while men are being carried, of any belt, rope or other gear used for or in connection with a belt conveyor designated by the mine manager as a manriding conveyor'. There were 12 occasions when belts broke during manriding and fortunately only one or two men were riding on each occasion and only minor injuries were sustained. If a breakage occurred on an inclined conveyor during shift manriding, multiple serious injuries may well result.

61 One belt failed after excessive tension had been applied by an untrained person and another resulted from an incorrectly fitted joint. The remaining ten breakages occurred at deteriorated joints or were due to belts fouling the structure or obstructions under the conveyor, sometimes causing holdfasts.

62 There is no evidence to suggest that conveyors are not designed with a satisfactory factor of safety when new, and normally belt strength is ten times the force which can be developed by the drive. Regular examination must be made to ensure belt strength is not significantly reduced by wear or other deterioration. If there is any doubt as to its condition, samples of the belt should be subjected to tensile tests in a laboratory to determine its remaining strength.

63 The weakest part of a conveyor belt is normally at a joint. New mechanical joints have typical strengths of 50 to 60% of the belt design strength, but may be as low as 30% or over 70%. Vulcanised joint strength is approximately 70% of that of the belt.

64 Mechanical joints can deteriorate quickly in service, due to wear, corrosion and physical damage. For manriding conveyors, daily visual inspection for obvious damage, supplemented by weekly detailed examination for joint wear, corrosion and signs of pull-out or distress in the fabric adjacent to the joint should be carried out. Joints should be given a definitive life depending on belt and joint type and service conditions. The chosen service life should be validated by tensile testing of sample joints removed from service.

65 To aid maintenance control and recording, belt joints should be numbered for ease of identification.

Specific hazards

66 Previous sections of this report analysed and commented on belt conveyor accidents and dangerous occurrences and made general recommendations to reduce them. A number of specific hazards associated with the use of belt conveyors warrant special emphasis and, as in the previous sections, these are treated as manriding and non-manriding hazards.

Manriding hazards

Discipline

67 A high proportion of manriding accidents are caused by personal carelessness and indiscipline. Familiarity is no excuse for non-compliance with any transport rule, for persons failing to remain alert, or for horseplay. Managers and supervisors must enforce discipline within a sound safety culture and all persons should recognise that any shortcoming on their part can result, not only in injuries to themselves, but also to others.



Figure 17 Illegal manriding kills

68 Whenever any person is tempted to ride illegally on a conveyor, he should remember the four deaths reported in paragraphs 16 to 18 and the 22 major injuries listed in Table 2, all of which resulted from illegal manriding. Further, it is a matter of conjecture as to how many unrecorded near misses have occurred. No matter how tired a person may be, illegal riding on a non designated conveyor is not worth the risk. Illegal manriding kills and maims.

Hazards from mineral being conveyed

69 Manriding on mineral carrying conveyors may give rise to particular hazards and managers' transport rules and the system design should ensure that:

- (a) the bed of mineral does not result in unacceptable clearances;
- (b) boarding, lying on and alighting off mineral can be done safely;
- (c) mineral does not roll down inclined conveyors;
- (d) airborne dust does not affect visibility;
- (e) clearances are such as to obviate the possibility of a blockage occurring.

Hazards associated with manriding on inclines

Thurcroft conveyor manriding incident

70 An unusual but serious incident occurred at Thurcroft Mine in 1991 which resulted in 42 men being taken to hospital. Fortunately there were no major injuries but the consequences could have been far worse and the shock and injuries sustained caused 41 men to be absent from work for more than three days.

71 Men had been delayed at the start of their shift by inbye haulage activities and they congregated at the top of a drift with a maximum gradient of 1 in 4.5 in which a 2.13 m/s (450 ft/min) top and bottom manriding belt conveyor was installed. They were eventually given permission to board the bottom belt to ride down the drift. When an estimated 104 men were riding down the steepest part of the drift, the conveyor accelerated. Men pulled the stop wire and an emergency stop was also applied at the conveyor drive, but this made the situation worse, since it isolated power to the conveyor motor, and the speed of the conveyor, which was not fitted with a brake, increased. Many men jumped from the belt and were injured. The conveyor subsequently slowed and stopped as the reduced man load reached a shallower gradient.

72 Tests using a simulated man load demonstrated that a conveyor runaway could occur when motor power was switched off at a load well below that at the time of the incident. This runaway potential was eliminated by the installation of conveyor

retarder belts. Attention should always be paid in conveyor design to the potential out-of-balance load which might arise and cause a runaway.

General

73 Where conveyors (manriding or non-manriding) operate on inclines they should, where necessary, be designed and provided with suitable devices to prevent run-back of the belt when conveying uphill and to safely stop the belt and prevent excessive overrun when conveying downhill. Fire-resistant retarder belts sited under the carrying conveyor may be used for both purposes, but they must be firmly anchored, properly sited and regularly inspected and cleaned if they are to remain effective and safe. Sprag clutches may also be used to prevent runback, but mechanical brakes should only be fitted when they comply with the recommendations in paragraph 52 and 53 and where retarder belts and other devices are not practicable.

74 Where safety critical mechanical components (such as brakes, sprag clutches and anchorages) can fail suddenly and cause danger they should be duplicated.

75 During commissioning, following significant alterations and at regular service intervals, all retarding devices should be tested under the most adverse loading conditions. Test procedures should be specified and retardation rates or stopping distances should be recorded. Sprag clutches should be subjected to regular inspection for internal wear.

76 Movement of mineral relative to the belt can be a hazard with manriding and non-manriding conveyors. Existing BCC codes and rules allow the simultaneous conveying of persons and mineral or material on gradients not steeper than 1 in 5 provided all practical measures are taken to prevent mineral or material from moving relative to the belt. However, the codes and rules do not specify any practical measures that might be appropriate. The evaluation of any potential risk of mineral moving relative to the belt should take into account:

- (a) the rate of acceleration or retardation of the belt;
- (b) any surge at start-up which can lift the belt off idlers;
- (c) the smoothness and the coefficient of friction of the belt surface;
- (d) the existence of raised or worn idlers which can cause belt bounce;
- (e) the size and shape of mineral lumps.

77 Managers should only allow simultaneous conveying of persons with mineral on gradients not exceeding 1 in 5 if competent engineers have studied the conveying conditions and concluded that under the most unfavourable operating conditions mineral will not move relative to the belt.

78 Some conveyors operate over varying gradients, some sections being suitable for manriding while others may be too steep. Some mines make effective use of anti run-back devices (often referred to as lump warwicks) to prevent mineral running back from a steep non-manriding section of a conveyor to a manriding section below.



Figure 18 Potential danger of manriding with mineral on steep gradients

Hazards arising from boarding stationary conveyors

79 It is possible for a stationary conveyor to start in reverse, or be grossly overloaded if boarded while stationary. For these reasons the boarding of stationary conveyors should normally be prohibited, except where special arrangements are being followed for the transportation of persons on stretchers or inexperienced persons not familiar with belt manriding. Means should be provided to prevent handles of electrical control panels being inadvertently positioned to cause conveyors to start in reverse.

Hazards arising from high speed manriding

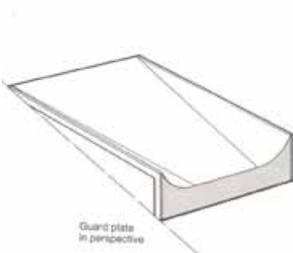
80 Manriding speeds do not usually exceed the 2.67 m/s stated in British Coal codes and rules. For conveyor speeds in excess of this, special consideration should be given to the width of the conveyor to aid safe boarding and to the vertical clearances throughout the manriding length, especially at boarding and alighting platforms. It is recommended that the nominal width of such conveyors should not be less than 1.05 m and vertical clearances at boarding and alighting stations should not be less than 1.8 m. Suitable notices should be posted at boarding stations warning of the higher conveyor speeds. The industry should evaluate manriding accident experience at the faster speeds (above 2.67 m/s) and take whatever action is necessary to prevent any increased risk. Manriding should not be allowed at speeds in excess of 3 m/s unless a safe method can be provided for boarding and alighting from the conveyor. The conventional practice of stepping onto and off a conveyor belt is not considered safe at speeds faster than 3 m/s.

Emergency signals for safe manriding

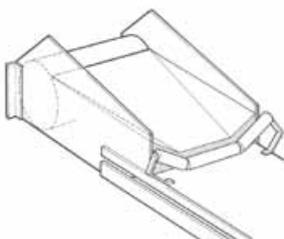
81 It is essential that pull wires are provided and positioned so that all riders can easily and safely operate them. The system should be arranged so that the operation of the pull wire latches out the adjacent lock-out switch in the opposite direction to travel. This is assured if double sided pull keys are used.

Nip-point hazards

82 There have been numerous fatal and major injury accidents resulting from a failure to guard nip points adequately. This type of accident is also common in other industries. In 1968 the NCB issued instructions that all conveyor delivery rollers used both on the surface and underground must be guarded by an anti-nip guard to prevent persons being trapped between the belt and roller. These guards virtually eliminate the in-running nip point and do not merely guard against it. In 1976 the Coal Industry National Consultative Council (CINCC) Safety and Health Committee produced *A prescription for the reduction of underground accidents* which recommended that conveyor return ends be similarly guarded. There have been no known serious accidents where this type of guard has been fitted.



(a) Delivery head guard plate



(b) Guard in position

Figure 19 Discharge head nip guard

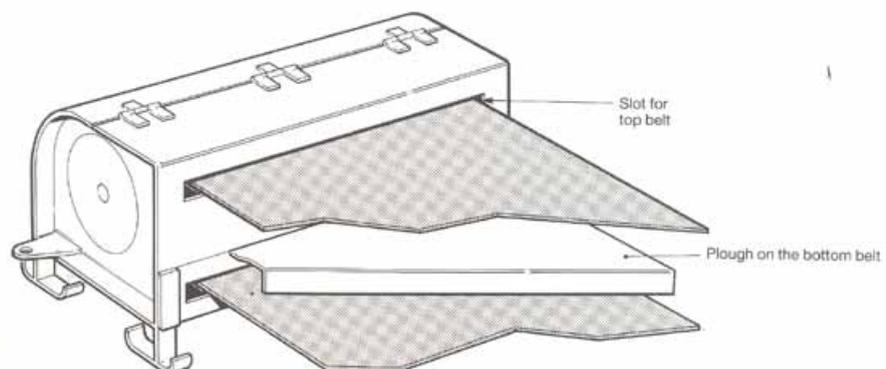


Figure 20 Belt conveyor return end nip guard



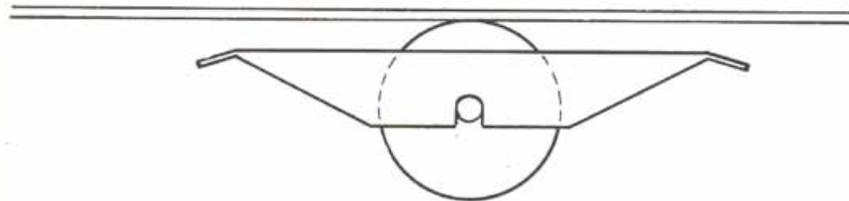
Figure 21 Working on moving conveyors with guards removed can kill.



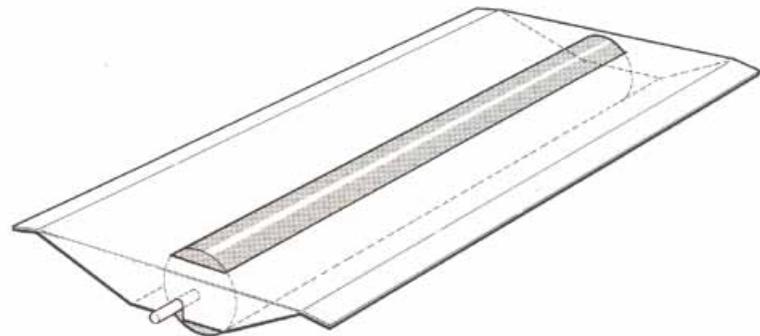
Figure 22 A split second from potential death or serious injury.

83 Fatal and major injury accidents involving traumatic amputation have occurred at other roller nip points in conveyor loops, tension arrangements and at deflection rollers. Often simple mesh guards had either been removed, usually to gain access for adjustment or cleaning, or were inadequate. Some mines have successfully fitted nip-point guards to loop tension rollers. It is strongly recommended that, in order to eliminate this type of accident, loop tension and deflection rollers should be fitted with nip-point guards in addition to good external box guarding.

84 Occasional accidents have occurred at the nip points of unguarded bottom belt idlers, either beneath conveyor jibs or where the structure has been raised. A flat-plate guard of the type shown in Figure 23 which was developed from a Mines Inspectorate original design, eliminates the nip-point danger and its use is recommended. The guard also has the advantage of preventing spillage accumulating – many accidents have resulted from guards being removed from spillage cleaning while conveyors were in motion.



(a) End elevation



(b) General view

Figure 23 Flat-plate bottom idler guard

85 All guards should be fitted so that they can only be removed by the use of a tool. Simple lift off guards are not acceptable.

Stored energy

86 Belt conveyors inherently have a considerable amount of stored or elastic energy in their design and mode of operation. Serious accidents have occurred due to the uncontrolled and unintentional release of stored energy. Four particular work activities are worthy of special comment.

Design of anchorage and methods of conveyor extension

87 Conveyor drives, delivery ends, return ends and tension arrangements must be firmly fixed in order to sustain the maximum force transmitted by a stalled drive with a reasonable factor of safety. In addition, when conveyor systems comprise components or units from various manufacturers, care must be taken to ensure that all are rated for the forces which may result from a stalled drive. Manufacturers should specify the maximum design loads for main roller assemblies and their anchorages.

88 A workman, when advancing a conveyor return end assembly using a properly designed hydraulic chain pulling arrangement, suffered serious head injuries when part of the return end anchorage broke off violently and struck him on the head. Many accidents have occurred due to the failure of improvised or incompatible pulling arrangements for advancing conveyors.

89 Safe systems of work should be provided for all pulling operations and the equipment used should be properly engineered. All pulling equipment should have a safe working load (SWL) marked on it and systems should be designed so that the SWL cannot be exceeded.

Methods of belt jointing

90 The jointing of belts can be hazardous if suitable equipment is not used. For small conveyors, hand operated tiffors or pull-lifts with properly rated chains and belt clamps may be used safely. With larger conveyors this method may not be adequate and drives have often been misused to throw slack belt. This is fraught with danger since the forces developed by the drive cannot be properly controlled and may exceed the safe working loads of the clamps, chains etc. Where hand operated equipment is not sufficient, purpose-designed powered equipment is necessary. The drive should always be isolated before jointing work commences and remain so until the work has been completed and the clamps removed.

91 A method statement describing how belt jointing is to be carried out should be written into the conveyor specification at the initial design and conceptual stage and any special equipment or joint station anchorages should be provided as part of the installation.

Working in loops and tensions

92 Even when a conveyor is stationary, large forces are held within the belt and its tensioning arrangements. Sudden failure of the belt or any load bearing component in the tensioning arrangement will result in a violent release of energy, sufficient to cause severe damage and possible fatal injury. Under no circumstances should persons be allowed to work within loops when either the conveyor belt or the tensioning ropes are under tension or until the power supply to the conveyor and any auxiliary equipment (such as winches) has been properly isolated. Provision should be made to enable spillage to be removed safely without the need to enter the loop.

93 The powered winches provided with many loops and tension arrangements are capable of generating sufficient force to break the winch ropes (see accident reported in paragraph 36). All powered winches should be equipped with load measuring instruments and their controls suitably positioned. Automatic load

limiting devices should be provided to ensure that the safe working load of winch ropes is not exceeded.

Holdfast dangers relating to the use of sprag clutches and brakes

94 Fatal accidents have occurred in the past when cleaning spillage from rollers of stalled conveyors fitted with anti-runback sprag clutches. Belt between the drive drums and the seized rollers can become highly tensioned before the drive power is switched off and remains in tension. As spillage is removed it will allow the belt to move violently to equalise belt tension and unsuspecting persons can be drawn into the underside nip points. Managers should specify safe systems of work for dealing with holdfasts, where sprag clutches and brakes are installed, including a means for allowing belt tension to be equalised safely. Such arrangements should be coupled with the use of nip-point guards to further reduce any risk.

Training

95 Persons expected to work on or otherwise be involved with belt conveyors should be properly trained. It is considered that some of this training in the past has not been sufficiently structured and comprehensive and persons have been expected to pick up knowledge and experience in their day to day work rather than through dedicated training.

96 Owners, managers and engineers should be alert to the different training needs of personnel whose conveyor duties may be extremely varied.

97 It is considered essential that more formalised and structured training courses are developed. These should be graded incrementally to cover simple tasks like spillage cleaning and belt manriding through to conveyor extension, coupling and tensioning activities and on to conveyor belt installation and maintenance. Mine officials and supervisory engineering personnel should be sufficiently well trained to be aware of all the relevant dangers associated with belt conveyors. Training should be given to control room operators with respect to the dangers associated with conveyors and the purpose of protection transducers fitted to detect and give an alarm at an early stage in the development of such dangers. They should be trained to respond correctly to alarms and emergency situations.

Conclusions

98 Few of the recommendations contained in this report provide new information to persons experienced in underground belt conveyor operations and maintenance and it is acknowledged that many of the recommendations are a statement of recognised good practice. For an industry with such a wealth of experience of underground conveyors, supported by extensive specifications and codes and rules for their safe design and use, the accident toll and incidence of dangerous occurrences has been disproportionately high.

99 The eight fatal, 134 major injuries and 939 over-three-day accidents in the five year period 1986/7 to 1990/91 indicate only too well that there is considerable scope for improvement in conveyor accident prevention. Most of the fatal accidents and many of the seriously disabling ones could have been avoided by:

- (a) the elimination of illegal manriding;
- (b) a more planned and disciplined approach to maintenance procedures and activities;
- (c) the fitting and maintenance of effective guards, particularly anti-nip guards at drives, loops, deflection rollers and exposed bottom idlers.

100 Accidents will be reduced if management and supervisory staff take every opportunity to demonstrate their commitment to the safe use of conveyors. They will also be reduced where clear instructions are given as to the permissibility of manriding and when it is essential to stop and isolate conveyors before commencing maintenance work. Regular safety audits of conveyor manriding and maintenance procedures will assist this aim.

101 There is a lack of detailed information relating to over-three-day accidents and improved reporting procedures would better aid the evaluation of accident causes.

102 The conveyor runaway accident at Thurcroft Mine in 1991 highlighted a potential danger which had not been identified and properly addressed. Hazard identification and risk assessment techniques applied in a simple manner will assist management to recognise hazards and hazardous scenarios and ensure that appropriate safeguards are provided to minimise the risks arising from them.

Recommendations

- 1 Accurate periodic clearance surveys should be made where clearances are close to the minimum specified and ground movement is known to be a factor. Any significant changes in clearances should be highlighted with reflective paint or tape (paragraph 12).
- 2 Trailing belt edge tears should be prevented and should be removed when they do occur (paragraph 13).
- 3 All boarding platforms should have integral lockable gates or barriers with notices to indicate when manriding had been suspended (paragraph 17).
- 4 Conveyors should be equipped for manriding wherever practicable (paragraph 19).
- 5 Persons should not ride on conveyors not authorised for manriding and mine officials should rigorously enforce managers' transport rules (paragraph 19).
- 6 No conveyor which delivers into a crusher or bunker should be authorised for manriding (paragraph 21).
- 7 For all accidents (including over-three-day) the recording of belt speeds, vertical clearances and other relevant details will assist management in evaluating their causes (paragraphs 22 and 80).
- 8 Conveyors having repeat manriding accidents caused by apparent lack of personal care should be studied for possible contributory defects which should be remedied (paragraph 22).
- 9 Effective crowd control should be provided when large numbers of persons are manriding, especially at shift change times (paragraph 22).
- 10 Managers' transport rules should specify a safe method for persons to alight from stationary conveyors (paragraph 23).
- 11 All manriding conveyors should be provided with prestart audible warning along their entire length (paragraph 23).
- 12 Managers' transport rules should address the special requirements for safe manriding by inexperienced people or those who foreseeably have to carry personal equipment (paragraph 24).
- 13 Mine installations should, where practicable, be designed to eliminate the need for persons to cross over or under conveyors, but where it is necessary suitable bridges or underpasses should be provided. Bridges should be firmly fixed and constructed of steel or other FR material and equipped with handrails and kicking boards. They should give adequate clearance over the conveyor. Conveyor underpasses should have guarding to prevent persons contacting conveyor moving parts (paragraph 27).
- 14 Guards or handrails should be provided to prevent persons falling or slipping onto any section of a conveyor located below the normal walkway (paragraph 28).
- 15 Management should give clear instructions, even if they have been given before, that no maintenance activity is carried out on a running conveyor if this could cause a person to contact a moving part (paragraph 29).

- 16 Belt idlers should only be changed when the conveyor is stationary (paragraph 29).
- 17 Maintenance staff should be deployed to take advantage of non-production shifts when conveyors can more conveniently be immobilised for maintenance or repair (paragraph 29).
- 18 Belting and joint pins should be trimmed to eliminate protruding belt joints (paragraph 29).
- 19 The use of signal lockouts to prevent conveyor start-up during maintenance should be strictly confined to simple tasks of low risk where a pre-start warning would be heard and inadvertent start-up would not cause injury. Conveyors should otherwise be immobilised by isolating and locking off the power supply (paragraph 30).
- 20 Conveyor drives and loops should be marked to show the location of the isolating switchgear, which should be properly identified and labelled and isolating handles clearly marked (paragraph 30).
- 21 All conveyors should have pre-start warning throughout their total length, not just manriding conveyors (paragraph 31).
- 22 Managers and engineers should review their maintenance procedures, the equipment used and the training and competence of the persons involved (paragraph 32).
- 23 Maintenance systems should, where practicable, be simple and avoid repetition which may induce short-cutting or complacency. Persons should be trained to use any special equipment provided (paragraph 34).
- 24 Managers, engineers and supervisors should be alert to the misuse and abuse of equipment and for improvised practices as a result of suitable equipment not being provided or maintained (paragraph 35).
- 25 Roadways and transfer point designs should be compatible to ensure controlled transfer of mineral with minimum production of fines and spillage (paragraph 37).
- 26 A colliery designed open-bottomed chute, which allows fines and slurry to be delivered on to the outgoing conveyor before larger lumps, can eliminate chute blockages due to fines and slurry sticking. This design should be more widely considered (paragraph 39).
- 27 The use of conveyors as platforms should be avoided wherever practicable and they should never be used without full electrical immobilisation. Signal lock-outs should not be relied on (paragraph 40).
- 28 When belt conveyors are used for transporting materials, suitable managers' transport rules should be implemented (paragraphs 41 and 42).
- 29 Only small items that can be easily carried about the person should be transported when manriding. Other equipment should be transported outside normal manriding times in accordance with managers' transport rules (paragraph 43).
- 30 Conveyors should be aligned, idlers installed well clear of the floor and spillage cleaning carried out regularly and effectively (paragraph 47).

- 31 Belt alignment switches should be fitted on the return ends of conveyors which are frequently extended or retracted (paragraph 48).
- 32 Idlers should be changed as a matter of priority when imminent bearing failure is detected (paragraph 50).
- 33 Standard belt support idlers should not be used to deflect belts at change of gradient (paragraph 51).
- 34 Conveyor brakes and their protection should be installed and maintained to a high standard. They should be equipped with an automatic fire extinguisher and a suitable and effectively sited fire detection system provided at the drive-head (paragraph 52).
- 35 Mechanical brakes should only be used where other means of retarding or control are not practicable. They should have adequate thermal capacity to avoid excessive temperatures if the conveyor is stopped repeatedly (paragraphs 53 and 73).
- 36 All retarder belts should be cleaned regularly to prevent the accumulation of flammable debris, produced by surface wear of FR belts (paragraph 53).
- 37 Suitable access should be available to all parts of a conveyor, including elevated deliveries (paragraph 54).
- 38 Lagged drive drums should not be fitted on underground conveyors (paragraph 57).
- 39 Belt slip monitoring should be provided and maintained on all conveyors. No more than three attempts to restart the conveyor should be made without on-site investigation of the cause of the slip (paragraph 58).
- 40 Conveyor drive power should not be used to pull lengths of belting together. Ancillary equipment should be installed to enable conveyor belting to be connected safely (paragraph 59).
- 41 Regular examination should be made to ensure belt strength is not significantly reduced by wear or other deterioration. If there is any doubt as to its condition, belt samples should be subjected to laboratory tensile tests (paragraph 62).
- 42 Manriding conveyors should be inspected daily for obvious damage and examined in detail weekly for wear, corrosion and signs of pull-out or distress in the fabric adjacent to the joint (paragraph 64).
- 43 Belt joints should be given definitive lives which are validated by tensile testing of sample joints removed from service (paragraph 64).
- 44 Belt joints should be numbered for ease of identification (paragraph 65).
- 45 Managers and supervisors should enforce discipline within a sound safety culture (paragraph 67).
- 46 Manriding on mineral carrying conveyors should be in accordance with managers' transport rules which address the particular hazards (paragraph 69).
- 47 Conveyors operating on inclines should where necessary be fitted with suitable devices to prevent runback of the belt when conveying uphill and excessive overrun when conveying downhill (paragraph 73).

48 Safety critical mechanical components, eg brakes, sprag clutches and anchorages, which can fail suddenly and cause danger, should be duplicated (paragraph 74).

49 All retarding devices should be tested under the most adverse loading conditions at commissioning, after significant alterations and at regular service intervals. Test procedures should be specified and belt retardation or stopping distances recorded (paragraph 75).

50 Managers should only allow simultaneous conveying of persons with mineral on gradients not exceeding 1 in 5 if competent engineers have studied the conveyor conditions and concluded that there will be no mineral movement (paragraphs 76 and 77).

51 The boarding of stationary conveyors should be prohibited except in special circumstances where persons on stretchers or inexperienced persons are to be conveyed (paragraph 79).

52 Manriding conveyors running at speeds in excess of 2.67 m/s should:

- (a) have a nominal width not less than 1.05 m;
- (b) have vertical clearances at boarding and alighting stations not less than 1.8 m;
- (c) have notices posted at boarding stations warning of the high speed

(paragraph 80).

53 The industry should evaluate manriding accident experience at the faster speeds and take whatever action is necessary to prevent any increased risk (paragraph 80).

54 Manriding should not be allowed at speeds in excess of 3 m/s unless a safe method can be provided for boarding onto and alighting from the conveyor. The conventional practice of stepping on and off a moving conveyor belt is not considered safe at speeds greater than 3 m/s (paragraph 80).

55 Signal pull wires should be provided and positioned so that all riders can easily and safely operate them. The pull wire should latch out the adjacent lock-out switch in the opposite direction of travel (paragraph 81).

56 All loop tension and deflection rollers should be guarded by anti-nip guards in addition to good external box guarding (paragraph 83).

57 Flat plate guards which eliminate the nip-point danger of bottom belt idlers should be considered for use at conveyor jibs or where the structure has been raised (paragraph 84).

58 All guards should be fitted so that they can only be removed by the use of a tool (paragraph 85).

59 All conveyor components and units should be rated for the forces which may result from a stalled drive (paragraph 87).

60 Manufacturers should specify the maximum design loads for main roller assemblies and their anchorages (paragraph 87).

61 All conveyor pulling equipment should have an SWL marked on it and systems should be designed so that this cannot be exceeded (paragraph 89).

62 The use of the conveyor drive power to throw slack belt when uncoupling or rejoining belts should be prohibited. If hand operated equipment is insufficient,

purpose designed powered equipment is necessary. The drive should be isolated before jointing work commences and remain isolated until completed (paragraph 90).

63 A belt jointing method statement should be written into the conveyor specification at the initial design stage and any special equipment or joint station anchorages provided as part of the installation (paragraph 91).

64 No person should be allowed to work within loops when either the belt or tensioning ropes are under tension. The power to the conveyor and any auxiliary equipment should be isolated (paragraph 92).

65 Provision should be made for the safe removal of spillage without the need for persons to enter the conveyor loop (paragraph 92).

66 Powered winches provided for conveyor loop tensioning should have load measuring instruments. Automatic load limiting devices should be fitted if the available winch force can exceed the SWL of the winch rope (paragraph 93).

67 Managers should specify safe systems of work for dealing with conveyor belt holdfasts where sprag clutches and brakes are installed, including a means to equalise belt tension safely (paragraph 94).

68 Persons expected to work or be involved with belt conveyors should be properly trained for their duties. It is considered essential that formalised and structured training courses are developed (paragraphs 95 to 97).

69 All mine officials and supervisory engineering personnel should be made aware of potential belt conveyor dangers (paragraph 97).

70 Training should be given to control room operators with respect to the dangers associated with conveyors and the purpose of protection transducers. They should be trained to respond correctly to alarms and emergency situations (paragraph 97).

References

- 1 *Underground locomotive haulage* Mines Topic Report 1991. Available free from HM Inspectorate of Mines, St Anne's House, Stanley Precinct, Bootle L20 3RA.
- 2 *The safety of free steered vehicle operations below ground in British coal mines* Mines Topic Report 1992 ISBN 0 11 885996 X.
- 3 *Accident at Cresswell Colliery, Derbyshire* Mines Report 152 Cmd 8574.

Further information

For information about health and safety or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. Hse priced publications are also available from bookshops.

The Stationery Office publications are available from The Stationery Office, PO Box 29, Norwich NR3 1GN Tel: 0870 600 5522 Fax: 0870 600 5533 email: customer.services@tso.gov.uk Website: www.tsoshop.co.uk/ (They are also available from bookshops.) Statutory Instruments can be viewed free of charge at www.legislation.gov.uk/.

The TSO website www.tso.co.uk is a corporate site address aimed at business customers - to purchase TSO products you have to go to www.tsoshop.co.uk