WALTON. Wakefield, Yorkshire. 22nd. April, 1959.

The Walton colliery was formerly known as the Sharlston West and was near Wakefield in the West Riding of Yorkshire. It was a safety lamp mine that employed 1,285 men underground and 298 on the surface with a daily output of 2,200 tons from the Top Haigh Moor, the Low Haigh Moor, the Kent Thick and the Birkwood or Lidgett Seams. About half the output came from the Top Haigh Moor seam. The colliery was owned by the National Coal Board and was in the No.7 (Wakefield) Area of the Board's North East Division. The manager was Mr. G.S. Senior and there were two undermanagers. Mr. H.H. Gregg had responsibility for the underground working in the Top Haigh Moor where the explosion occurred. The Group Manager was Mr. T. Dodd and the Area General Manager, Mr. H. Saul.

The 10 East District lay in the Top Haigh Moor Seam on the east side of the South West Haulage Road connecting to the No. 2 shaft to the Haw Park shaft. The explosion took place in the 5's Unit. At the colliery, the Top Haigh Moor Seam was worked in the 10 East District. The two coals were separated by a band of hard fireclay about 7 feet thick and the Top Haigh Moor seam was overlain with a thick bed of strong sandstone. The accident occurred about 460 yards from the surface. Faults had been encountered in the 10 East District in 1955 and further developments had driven two roads, 22 yards apart, through the faulted area to develop a longwall face, 40 yards long which was known as the 10 East 1's. This was advanced to the boundary and stopped on the 23rd. July 1958 leaving solid coal on each side. Two faces were then worked, one to the north and one to the south. The first of these was the 10 East 2's was stopped at faults on February, 1959 and at the time of the accident the old loader gate was being continued through the faults as a stone drift which was known as the 2's Drift. This drift was intended to form part of a new return airway from the 10 East District.

Coal to the south of the 10 East Trunk Conveyor Road was intended to be worked by a double until longwall face about 280 yards long which was to advance to the south. In the general plan of operations a face, the second to be worked from 1's Development, was taken some 20 yards wide for a distance of about 40 yards to the south. The western side of the new development was then worked as a face 40 yards wide which advanced for about 100 yards to the west to connect with a heading known as 5's New Loader Gate, which was being at the same time to the south from a point further outbye on 10 East Trunk Conveyor Road. The face was then to be continued westwards so that eventually a double unit face about 280 yards long would be advanced to the south, after 2's Drift had afforded a new return airway for the district.

At the time of the explosion the 40 yards face, 5's Unit, had advanced about 97 yards. A small further advance, which would have been made in a few days but for the disaster, would have brought it to the position where it could have been stopped to await for the connection of the New Loader Gate. At the north end of the working face the roof had been ripped to form a road supported by steel arch girders 12 feet wide and 8 feet high. This road was known as the 5's Intake Gate and it was intended to become the return airway for the western until of the 280 yards face when it was finally developed. It was connected to 10 East Trunk Conveyor Road by means of 5's Intake Slit, which was a passage some 37 feet long that had originally been made about 6 feet wide and the height of the seam.

At the left end of the 40 yards face, a passageway of seam height and 12 feet wide was being left so that it could eventually become the left side of the main longwall face to the south. This passage was known as the 5's Ribside and was formed by the coal and a pack about 12 feet wide. At the outbye end of this pack, there was a gap about 9 yards long which had been left as an access to the waste. This had not been closed but in which thin slabs of stone had fallen from time to time. A bottom loading belt conveyor on 5's Belt Return Gate. This conveyor discharged on the 10 East Trunk Conveyor at the same transfer point as the stone loading conveyor from 2's Drift.

In the planned system of ventilation air entered 10 East District from the South West Haulage Road, partly along the 10 East Main Haulage Road and partly from a second source to and from the 5's Unit. This course was on conventional lines, but because of the heavy leakage losses beyond the loading point only a small proportion of the 12-16,000 cubic feet of air per minute available there reached the face of the 5's Unit. A few days before the accident, a direct connection had been made by means of a scour driven through the waste between 5's intake and 5's Return but sheets had been erected in it to prevent a short circuit of the ventilation there.

The coal on the 5's Unit was undercut by an electrically driven coal cutting machine, blasted and hand loaded on to the face conveyor. Coal was filled on the morning and afternoon shifts. The Intake gate ripping was advanced on the afternoon and night shifts and the stone pack on the Ribside was advanced on the night shift with stone from the Intake ripping. There had been difficulty in achieving the management's objective of obtaining two cuts in each 24 hours and in order to maintain work in the break of 12.30 to 1.30 p.m. between the day and the afternoon shifts, two coal cutting machine men and an overman worked a supplementary shift from 8 a.m. to 3.30 p.m.

On the afternoon shift of the 21st. April, 1959, the day before the disaster, coal had been prepared for filling and the 5's Intake Gate ripping was advanced. On the night shift some of the colliers were employed in squaring out the right hand corner of the face and the rippers for the Intake Gate, having no work to do there, spent the shift at the new connection where about 12 shots were fired in the stone to enlarge the holing.

On the day of the explosion, the morning shift filled loose coal left by the afternoon shift and from the shots fired in each corner of the face. Three men spent the whole of their shift transporting stone in a small tub from the new connection to the intake roadhead where it was put into the roadside pack. At about 10 a.m., the coal cutting machine operators of the supplementary shift, W. Hudson and W. Wardle, arrived and began to turn the machine round at the corner of the face. During this operation the machine stuck and displaced the tension end of the Ribside conveyor so that it had to be stopped. The driving head of the face conveyor was advanced into it's new track and the tension end of the Ribside conveyor moved, but the coal cutting machine could still not be worked because it's jib had then become fast in the undercut. A shot was fired over the jib between 11 and 11.30 a.m., to try to release it. This was successful and the machine was turned, jibbed in and made to cut for about 10 feet to a stump of coal which required to be filled off. The tension end of the Ribside conveyor was placed in it's proper position, both conveyors were re-started and the coal cutting machine trailing cable was disconnected and re-threaded into the new cutter track. No electrical trouble was experienced with the face equipment during the day shift.

By 12.30 p.m. the day shift had left the face with the exception of two conveyor men J. Rothery and C.E. Ray who remained to assist the men on the supplementary shift. On his way out, the day shift deputy, F. Canham saw J. Williams, a drifter employed on 2's Drift, eating his snap at 2's Transfer Point. He asked Williams to keep an eye on the two conveyors until the afternoon shift arrived. So by 12.30 p.m. five men were in the 5's Unit, L.E. Coe, the overman, W. Hudson, W. Wardle, J. Rothery and C.E. Ray. J. Williams was just outside. There were no eye witness to the say what happened during the next half hour as five of the men were killed in the explosion. Williams escaped with minor injuries but he could remember little of what happened.

At about 1. p.m., the lights went out at 10 East Loading Point, the conveyor stopped and three men working there felt a rush of air and dust from inbye. One of them T. Furlong, telephoned to the top of the 10 East Haulage Road asking for the deputies to be sent back. He also phoned the overman. H. Cunningham, telling him that he thought there had been an explosion. Furlong then opened the switch controlling the supply of the power inbye of the Loading Point and with his work mates, went inbye but returned after making an unsuccessful attempt to enter 5's Unit.

Canham and another day shift deputy, H. Towler, had reached the top of the 10 East Main Haulage Road when Furlong telephoned and they went back to the district. On their way they met Williams making his way out. All he could tell them was that he had been bowled over and he thought there had been an explosion. Tower isolated the gate-end switches near the 2's Transfer Pint and they, along with Canham, they tried to get beyond the end of that Slit because of the fouled air. Two afternoon shift deputies, J. Wilsher and J. Bedford also attempted to go up the Intake Gate but Wilsher's lamp went out after he had travelled about 15 yards.

The undermanager H.H. Gregg, had been with Cunningham when Furlong telephoned and these two men went inbye, Gregg having first informed the surface electricians that there had been power failure in 10 East District at about 1.10 p.m.. On reaching the top of the 10 East Main Haulage Road, Gregg learned that Williams had been injured and concluded that there had been an explosion in 2's Drift where Williams normally worked. He telephoned the manager at 1.25 p.m. and asked for ambulances and stretcher parties to be made available. When he reached the 5's Intake Slit, Gregg saw that the belt had been blown of the Trunk Conveyor for about 50 yards and there was every sign that an explosion had occurred in the 5's Unit. He sent a message to this effect to the surface and the Wakefield Rescue Station was called out to give assistance. The Rescue Station received the call at 2.p.m. and a team left at once for the colliery.

Gregg and others then entered the 5's Return Gate and travelled along it to the ripping lip without difficulty but when they were attempting to go under the lip, his flame safety lamp went out and he had to withdraw. Gregg started to restore the brattice sheets in 10 East Trunk Conveyor Road and in the new connection. He them made another attempt, with others, to get into the 5's Unit through the Intake gate. This attempt failed because of fouled air.

By 2.50 p.m. a fresh air base had been established at the entrance to the 5's Intake and from there Rescue men wearing breathing apparatus, explored the Unit via 5's Intake and quickly found the bodies of four men. On trying to travel down the Ribside, they met a fall and returned to the fresh air base. they inspected the 5's Return Gate and found a fifth body. All the bodies were recovered and their clothing was searched for prohibited articles by a Police officer on their arrival at the Wakefield City Mortuary and no contraband was found.

At about 7.50 p.m., a series of 'bumps' was heard and it was thought that there had been further explosions. The news was sent to the surface and after a conference it was decided to withdraw to the fresh air base near the 10 East Loading Point. at about 10.50 it was decided to seal off the 5's Unit to limit the spread of any further explosion. The construction of stoppings was started and the air was sampled in the return while the work was going on at hourly intervals. Since these samples contained a steadily decreasing quantities of explosion products, the seals were not completed. On the afternoon of 24th. April there seemed no risk of any further explosion and the area was inspected by two of H.M. Inspectors, W.M. Crumpsty and T.W. English and officials of the N.C.B. The inspection showed that there was no risk of another explosion and the stoppings were removed.

The men who lost their lives were-
Lawrence Coe aged 38 years, overman,
William Hudson aged 46 years, machine man,
Jack Rothery aged 54 years, belt maintenance man,
Charles Ray aged 53 years, belt maintenance man,
Wilfred Wardle aged 38 years, machine man and
Jack Williams aged 43 years, drifter was injured.

The inquiry into the disaster was opened by T.A. Rogers, C.B.E., H.M. Chief Inspector of Mines and Quarries at the Town Hall in Wakefield on the 29th. June, 1959 and sat until 3rd. July and then again from the 4th. to the 12th. August. All parties were represented and the report was presented to the Right Honourable Lord Mills, K.B.E., Minister of Fuel and Power and the 11th. September 1959.

A full and detailed inspection of the explosion area was made after the event and there was no indication of great violence in the 5's Unit. Charles Ray's body was found at the Return Gate Ripping and was the only one who suffered violent injuries. The other four men died from carbon monoxide poisoning and the inhalation of coal dust speeded the deaths of Wilfred Wardle and Lawrence Coe. All the dead had been burnt but in no case would this alone have been fatal.

Physical damage to the mine was confined to the roof supports and the conveyor belts in the 5's Unit. Outbye the intake Slit there were few signs of violence. Charred metal and signs of coking suggested that the flame had traversed all parts of the 5's Unit and the evidence pointed to the explosion occurring at the area of standing props at the end of the 5's face and the Ribside.

The known potential igniting agents were ruled out. No contraband was found on the men and the cap lamps were in good order. There was no shot firing going on at the time of the explosion and there was no heating at the face or of the machinery. A sample of the conveyor belting from the ribside conveyor was found to be anti-static and electrostatic sparing was ruled out as a source of ignition. Frictional sparking from the coal cutter picks was a possibility as the Top Haigh Moor seam contained streaks of pyrites but as such sparking was not produced in the undercut, this was also ruled out as a source.

The electrical equipment at in the 5's Unit was in good condition with the exception of the gate and switch and a trailing cable which supplied the coal cutting machine. This cable was examined very carefully and showed signs of arcing at a damaged point. At the inquiry it was suggested that the damage to the cable could have been caused-

"i) by an accidental blow from a hand pick
ii) by a broken wire in the coal cutter haulage rope or
iii) by a stone, possibly one projected by shot firing."

The Inspector thought that the last explanation the most plausible and concluded that the arcing from the damaged cable was the source of ignition.

As to the source of the firedamp, the Inspector concluded that the methane had not come from the sandstone floor and the only other source was the underlying Low Haigh Moor Seam and that the emission was likely to be the result for the fireclay forming suitable channels for the gas to travel upwards. Before the disaster one of the H.M. Inspectors, W.N.H. Carter, had found a break in the floor along side the ribside and it was possible that there were similar breaks in the inaccessible waste. The Inquiry concluded that the emission of gas was a heavy seepage from the floor at the fault rather than a sudden outburst. The weak ventilation current was unable to dilute the gas. Dust could have been a factor in the explosion and measures against dust were not taken in working the coal.

The Inspector summarised the conclusions of the report as follows-

"1). The accident was an explosion of firedamp, initiated at the left hand corner of 5's Face by an electric arc from a damaged trailing cable of a coal cutting machine. The explosion was propagated to some extent by coal dust.

2). The firedamp involved emanated from the Low Haigh Main Seam some 7 feet below and was emitted fairly rapidly, though not suddenly, from floor breaks mainly at a fault.

3). The ventilation of the 5's Unit id not, by standards of good practice, a low a sufficient margin for safety. as a result of defects in short term planning and in execution, there were air leakages so great that the velocity of the air at the left hand

corner of the face was not sufficient to deal with any substantial increase in the usual make of firedamp.
4). In respect of both choice and maintenance of equipment, insufficient attention was given to precautions against coal dust in 5's Unit."

The Inspector made the following recommendations at the end of his report.
"1). The appropriate development plan for a colliery should show particulars of ventilation, including the means to be adopted for ventilating new workings at each stage of their development.
2). At all levels in the industry there should be energetic efforts to overcome the difficulties which are resulting in workmen being reluctant to carry and use firedamp detectors.
3). Regulation 7 (5) of the Coal and Other Mines (Ventilation) Regulations, 1956, is technically defective and should be amended.
PRECAUTIONS AGAINST COAL DUST.
4). It should be made obligatory to provide stone dust barriers on coal conveyor roads underground.
5). Coal cut by machine should be cut 'wet'.
ELECTRICITY.
6). A further attempt should be made to devise an electrical protection system that will be capable of eliminating, or at least substantially reducing, the dangers of incendive arcing from a damaged trailing cable.
7). Local arrangements should be made between individual managements and H.M. Inspectors to ensure that notice of intention to introduce electricity is given at appropriate stages in the development of an electrical installation.
STATUTORY REPORTS.
8). Undermanagers should be given legal responsibilities similar to those imposed on the manger by section 10 of the mines and Quarries Act, 1954."

AUCHENGEICH. Chryston, Lanarkshire. 18th. September, 1959.

The colliery was situated about seven miles north east of Glasgow and was in the No.3 Central West Area of the National Coal Board. The manager was Mr. J.F. Smellie with Mr. A. Pettigrew as undermanager. The Group Manager was Mr. C.M. Inglis, the deputy Area Production Manager (Operations) Mr. J. Lawrie and the Area Production manager Mr. J. R. Cowan. The Area Manager was Mr. D. Lang. The disaster occurred in the No.2 Pit and the resulting fire cost the lives of forty seven men.

The mine was known to be gassy and had two shafts which went to the No.2 Pit workings where the accident occurred, at a depth of 360 yards. The downcast shaft had two hinged gratings known as Needles fitted at 150 yards where there was an inset for the No.1 Pit workings in the Meiklehill Wee Seam. The cages were not normally wound below this point. At the time of the accident 830 men were working in the mine which produced about 730 tone of coal per day. In the No. 2 Pit workings there were 340 men with about 140 on each of the day and back shifts and 60 on the night shift. The daily output was about 380 tons from the Meiklehill Main Coal and the Kilsyth Coking Coal Seams. The night shift men ascended between 6 and 6.30 a.m. and the day shift men were lowered between 6.30 and 7 a.m.

In the No.2 Pit workings where the accident occurred, there were two main roads running south and parallel to each other to the workings of the Main Coal and the Coking Coal Seams. The intake airway was used for the haulage of coal by endless rope and the first 925 yards of the return airway for an man-riding haulage system. There were connections at the pit bottom and there was also a crosscut with air separation doors which was commonly known as Johnstone's Crosscut about 1,125 yards inbye near the No.6 bench which was the back of the haulage road leading to the Coking Coal Sections. The return airway from the Coking Coal Sections crossed the

main intake airway by an overcast and then joined the main return airway between these connecting crosscuts. The booster fan at which the fire occurred was in the return airway, a little further outbye. The intake and the main haulage road were supported by steel arched girders which were twelve feet wide by nine feet high from the bottom of the pit to Johnstone's Crosscut and twelve feet by eight feet from there to the No.6 Bench. The return and the man-riding road was steel arched with timber lagging which had not been fire proofed. The arches in the return where thirteen feet high for the first 350 yards from the pit bottom and ten feet by eight feet for the next 200 yards, eleven feet by nine feet for the next 500 yards to a bend of the road just beyond the inbye terminus and the man-riding haulage and finally an average of twelve feet by eight feet beyond that point.

The system of ventilation consisted of the intake air to the No.2 Pit workings being split at the No.6 Bench to provide separate intakes for the Main Coal workings and the Coking Coal sections. The return air from these sections came together at No.5 Bench and then passed through the booster fan which was about 40 yards outbye at a point 570 yards from Johnstone Crosscut and about a mile from the pit bottom. The exhausting fan at the surface was electrically driven and produced about 160, 000 cubic feet of air per minute at 5.4 to 5.5 inches water gauge. a standby fan had a similar capacity.

The booster fan was of a double inlet, forward bladed, centrifugal type with a 45-inch diameter rotor driven by a flat belt. The rotor shaft was carried on two white metal bearings, oil ring lubricated and each with an oil capacity of six pints. The cambered or 'crowned' fan pulley was 22Å inches in diameter, 12 inches wide and overhung the bearing. The fan was driven at about 540 revolutions per minute by a 100 horsepower motor, flameproof, slip-ring induction motor running at 730 revolutions per minute. The power supply was three phase, 50-cycle, alternating current at 440 volts. The motor pulley was also 'crowned' and was 16 inches in diameter and 15 inches wide. The pulley centres were 15 feet apart. The fan drive as fenced on the near side with a one inch steel aperture mesh supported from an angle iron frame secured to the side wall of the fanhouse. A timber covering or 'catwalk' was made from nine inch by two inch battens was placed over the belt to make access easier to the nearest fan bearing.

The transmission belt was seven-ply and twelve inches wide of a type known as balata belting which was made of folded high tensile cotton duck and balata gum, neither of which was fire resistant. The belt travelled at about 3,200 feet per minute if there was no slip. The fan was in the fan house in the main return airway and the outlet casing was mounted in a brick wall built across the roadway and with brick wall fairings to smooth the air flow into the inlets of the fan. The motor was mounted on three slide rails and could move about seven inches so that the belt could be tensioned. The circuit breaker and the rotor starter for the motor where in the in crosscut next to the motor.

A water gauge and an automatic indicator of the water gauge was placed near the haulage engine at the intake end of the crosscut to indicate and record the ventilation pressure between the intake and the return airways. Three wooded doors in the by-pass road were designed to open automatically by the change in the ventilation pressure in the event of a fan stoppage.

The sides of the roads inbye of the fan to the junction with the by-pass road were brickwork and the roof was supported by steel girders. Outbye from the fan the left hand wall was brick and on the right hand side there was a brick wall on which some wooden props were set to support the roof which were set to roof girders. The girders on the sides were lagged with wood but the wood had not been fire-proofed.

The man rider was an endless rope system with each car or bogie attached to the rope by an integral screw clip. The train was made up of four bogies, each seating twelve men in three compartments with seats of four, two facing each way. The electrically driven engine was housed in the return airway and provided with protection

against over running and each end of the haulage and against excessive speed. The position of the bogies was shown on an indicator and by a warning stop light.

The main telephone switchboard was in the lamp room at the surface with lines to the colliery office, the engineers surface workshop, the winding engine rooms, the pit head and down the shaft. The line from the surface to the upcast pit bottom ended in a small switchboard in the pumphouse connected to instruments in Johnstone's Crosscut, No.6 Bench and other points inbye. Conversations between any two points could be overheard on other hand sets. There was not telephone communication with the man-riding haulage system.

At about 6.25 a.m. on Friday, 18th. September, 1959 after most of the night shift had gone up and before the day shift came down, A. Paton, the night shift engineman in charge of the man-riding haulage, was waiting to be relieved by T. Campbell in his engine house near the upcast pit bottom, when he noticed a slight haze and a very slight smell of something burning. He was not worried by this and he went to meet the first cage of the day at the pit bottom containing the day shift men at just after 6.30 a.m.. One of these men was J.H. Dickson, the day shift assistant overman. Paton drew his attention to the haze and smell. Dickson was suffering from a cold and could not smell anything but he sensed what he called 'a king of heat' in the air. He decided to investigate inbye and told an oncost (day-wage) worker to inform R. Boyd, the day shift overman, when he came down the pit. Paton then went back to the engine house and ran the first train down the man-riding haulage road. Many of the men on that train gave evidence about the haze in the pit bottom and some sensed that all was not well inbye but none of the men seemed to have been alarmed. The train left at 6.40 a.m. with Dickson and about seven others. The normal journey time was about eight minutes so they must have arrived at two or three minutes after 6.45 a.m.. There was no appointed guard on the train but it was signalled back to the pit bottom. Some of the men on the train said that the haze was slightly thicker at the inbye terminus that at the pit bottom but they were still not alarmed. It was the usual practice for the en to travel along the return airway to their working places but on this occasion Dickson decided that all the men should accompany him through Johnstone's Crosscut into the intake air way. The men followed him and arrived at the fan about 7 a.m.

Dickson went alone through the doors at the back of the No.5 haulage engine house into the fan house and found flames rising from the fan belt which was burned through and lying on the floor. He saw that the belt was around the fan pulley and that the flames were being drawn into the fan casing. Others followed Dickson into the fan house and saw flames coming from the fan outlet and into the return airway at about 7.05 a.m.

Meanwhile, Boyd, the day shift overman who was down the pit about 6.50 a.m., had received Dickson's message and had gone down to the main switches near the downcast shaft with the intention of switching off all the electric current inbye. He was uncertain about the switching arrangements so he told D. Kirkpatrick, a pump maintenance man, who was conversant with the switchgear to cut off the current. To make sure that this would not affect the No.1 Pit workings, Boyd decided to telephone an electrician on the surface. While he was trying to do this, he heard Dickson on the telephone saying that the fan was on fire.

J. Thornton, an electrician, had reached the pit bottom and Boyd sent him to the main switches to check that the current to the fan was off. Thornton went to the switches and telephoned Dickson asking him to cut the supply to the fan motor. Boyd had told an oncost worker to give a message to Campbell in the engine house and this message was heard by the conveyor beltman. The message was that no one was to be let down the man-riding haulage until further notice. In evidence, Boyd said that he intended that any of the men in the haulage should be withdrawn but the message was misunderstood. He walked inbye to the intake airway and on the way met a brusher who had been sent by Dickson to Johnstone's Crosscut to stop any men going into the

return airway. Boyd felt he had stopped all the men going in, so he took the brusher with him to the fan which he reached shortly after 7.30 a.m.

Paton, on receiving the signal, started to haul the empty train outbye but was then relieved by Campbell at about 6.50 a.m. Paton walked to the cage and out of the pit. On the surface he told D. McKinnon, the chief engineer and A. Pettigrew, the undermanager that there was a haze in the return airway. Pettigrew suspected that the haze was being caused by the fan belt which, as he knew, had been giving trouble during the night. He went to the lamp room and telephoned a warning to the overman of the No.1 Pit workings that the booster fan might not be working. He had just finished the call when Dickson called the lamp room. Dickson told Pettigrew that there was fire in the fan house and that hoses and extinguishers were urgently needed. McKinnon and Pettigrew informed the manager and went down the upcast shaft about 7.10 a.m. taking with them a new fan belt which McKinnon had earlier sent for. It did not occur to then that the men in the in the no.2 Pit return airway were in immanent danger. They were anxious about the ventilation and their sole purpose was to put out the fire and restart the fan. At the bottom of the shaft they encountered dense smoke and Pettigrew saw a number of the day shift men waiting to go up and he assumed that all the men from the return airway were there. He went down the intake airway with McKinnon and D. McAuley, a mechanic.

The first train returned to the terminus about 6.55 a.m. Forty eight men then boarded the train to go inbye. According to the engineman the train left at 7 a.m. Thomas Green, the sole survivor of the men on the train, said the haze thickened very slightly during the journey to the terminus. When the train arrived , none of the men left the terminus since, just as they arrived, a thick blanket of smoke came along the return airway towards them and the men, by common consent decided to get on board the train again.

Campbell received the signal to haul outbye and started to do so but then he had signals to stop and start the train three times in quick succession but the train eventually got under way and did not stop until it was near the outbye terminus. Thomas Green remembered the train stopping once only. This was at the top of the 1 in 5 gradient when it stopped so that one of the men who had slumped off the bogie could be pulled back into his seat. Green said the smoke was very thick indeed and he covered his nose and mouth with his jacket as best he could. He was sitting at the outbye end of the train and when it stopped before reaching the terminus, he got off and stumbled along until he was overcome after passing the gate at the outbye end of the man-riding haulage road where he was rescued. None of the other forty seven men on the bogies escaped. As they were found, it was evident that forty three of them had been overcome as they sat on the bogie, one appeared to have fallen from the train about 300 yards inbye and only three seemed able to have made an attempt to escape and they had died quite close to the train.

Earlier, as the in-going train was nearing the inbye terminus, Campbell had received Boyd's message about not letting the men down the haulage. He thought the message meant that his authorised guard and any men who remained on the bogies were to be withdrawn. He was not unduly worried at this time and when he received the first signal to bring the bogies outbye, he assumed that only the guard was on board but the signal to start and stop lead him to believe that there was something wrong. The train was about half way out when the haze in the engine house turned to thick black smoke and he could not see the train position indicator. Conditions became worse and Campbell could stay no longer and was faced with the difficult decision of whether or not to stop the train. He did no know how many men were on the train and it passed his mind to leave the engine house without stopping the train which would have continued to the outbye engine house and cut out automatically. He was slowing down the engine when he heard a voice and he decided to stop the bogie for fear of running down any men who were trying to escape on foot. He brought the train to rest 100 yards from the

terminus. By this time, about 7.15 a.m. Campbell was almost overcome but was bale to make his way out through the separation doors near the Main Coal haulage engine to the intake air and from there he later rode in the downcast shaft to the surface.

A number of men were waiting near the outbye terminus for a third train to take them inbye when the haze thickened to smoke. They went into the fresh air which was leaking through the separation doors in a connection a short distance outbye but while they were waiting they heard something moving. Some of them went back into the smoke and found Green groping around in zero visibility. They took him to the upcast shaft bottom. G. Brown, the onsetter at the bottom of the upcast shaft, was also overcome and was rescued and taken into the air intake and then up the downcast shaft. Tribute was paid to the parties who rescued these two men at the inquiry.

After he discovery of the belt blaze, Dickson stopped the motor and hurried to the No.5 haulage house, about 50 yards away and picked up a fire extinguisher. He returned to the fire but found that it would not work. He instructed A. Cunningham, a deputy, and others who had followed him to the fan, to try to smother the fire with sand and stone dust while he went to the phone. He contacted the surface from the No.6 Bench, about 100 yards from the fan and asked for extinguishers to be sent down. He also told the surface that the fan was not working. He collected another extinguisher from the No.6 transformer house but this also would not work. He did not look for any more but went to the phone at the No.6 Bench and called for extinguishers and hoses. He had to wait a moment or two before the pumpman on the switch board at the bottom of the shaft connected his call to the surface.

Dickson then went to the No.5 Bench to prepare the hydrants for the hoses but found that they had been blanked off. There was a hydrant 300 yards away in the No.6 roadway but he thought this was too far away and decided to take the hydrant and fix it to the water range at the No.5 Bench. He was assisted in this task and the hydrant was ready when the hoses arrived some time later. At about 7.15 a.m., he contacted the surface and spoke to D. Gray, a general duties man, in the lamproom, and asked for the Rescue Brigades to be summoned. Up to this time, Dickson had seen only the inside of the fan house.

After the train had left, two deputies, M. Lynch and J. Roe, had walked down the return airway, through Johnstone's Crosscut and had arrived at the fan shortly after Dickson. They had seen the fan casing and the oil burning at 7.05 a.m.. Roe helped Lynch to put stone dust on the fire for a short time and then went through the three by-pass doors. Lynch had local fire service experience, tested the extinguishers that had failed when Dickson tried to use them and found them unworkable. He followed Roe through the doors and both men saw flames coming from the fan outlet and striking the roof on the right hand side of the road between the fan and the safety fence. F. McDonald, a brusher, said that at 7.15 a.m. the belt had been reduced to ashes, the fan casing was alight and when he went through the doors shortly afterwards, he saw fire in the roof outbye of the fan.

Boyd reached the fan shortly before 7.30 a.m. when the fire in the fan was still burning but when he went through the doors, he saw only smouldering in the roadway between the fan and the safety fence although the return airway was on fire outbye of the by-pass junction. When Pettigrew went through the three doors a few minutes later, he found a fire and a fall of roof at the junction.

There was some uncertainty as to the time when the hoses were taken down the pit but it was about 8 a.m. or a few minutes after. The equipment reached the scene of the fire between 8.20 and 8. 30 a.m. and it was quickly out into service by men under the supervision of Pettigrew. At first only one hose was used but later equipment was brought down by the Rescue Brigade and two more were brought into use. Fire fighting continued throughout the day and for some time they were able to control the fire but after a time they were hampered by falls of roof which occurred as the wooden lagging above the girders were burnt away.

It was much later in the morning that Pettigrew learned of the men trapped in the return airway and he instructed R. Harvey, the safety officer, to carry out a check of all men in the pit. This was done and Harvey went to the surface where a similar check was made by the manager at about 8 a.m. As a result of these checks it was found that forty seven men were missing.

At the surface, soon after Pettigrew and McKinnon went down the pit, Kirkpatrick, the pump maintenance man, who had learned of the fire from Thornton, the electrician at the bottom of the pit, reached the surface with J. White, a roadman, and began to assemble hoses and extinguishers. The manger prepared to go down the pit and he had not at this time, anticipated that lives were in danger. On his way to the lamproom at about 7.20 a.m. He saw Green being brought out of the pit unconscious and recognised that something was very seriously wrong underground. He realised that it was unsafe to use the upcast shaft and immediately gave instructions for winding in the shaft to stop. He told White to tell the engineman of the downcast shaft that the needles were to be lifted at once and then to go down the pit himself and see that the lifting operation was properly carried out and the job done quickly.

The fire fighting equipment collected by Kirkpatrick and White was waiting to go down the shaft when the needles were lifted. The banksman, T. Montgomgery, said White descended at 7.35 a.m. and the needles were lifted and the rope lengths adjusted by a drum clutch to allow winding down to the pit bottom. The manager telephoned C.M. Inglis the Group Manager before contacting the Rescue Brigade and the Area General Manager and B. Spencer, H.M. Senior District Inspector of Mines and Quarries and L. Cheesborough, H.M. District Inspector were informed and quickly arrived at the colliery.

The call was received at the Coatbridge Rescue Station at 7.40 a.m. and the first team left at 7.45.a.m. and arrived at the colliery seven and a half miles away at 8.a.m. The second team followed ten minutes behind. After a briefing by the manager, the first team of five men descended at 8.08 a.m. and immediately set up a fresh air base on the intake side of the pair of separation doors nearest the man-riding haulage, wearing self-contained breathing apparatus they made a preliminary inspection and reported that the atmosphere was very bad, they had been unable to see anything but had stumbled on a body. The team returned and recovered the body. Artificial was given for about half an hour but without success.

In the meantime the second team went into the return airway and remained for fifteen minutes reporting that conditions were no better and they came out with some of the team distressed by heat. The atmosphere was full of carbon monoxide which after tests, was determined at 0.4 per cent which would cause death in a minute or two. From 9.30 a.m. onwards the rescue teams made regular examinations along the return airway near the shaft and took air samples. The Superintendent looked into the return airway and decided that conditions were so bad that it was not a justified risk of life to send men in. all hope was lost for the men trapped in the airway. Signal bells were heard about 4.30 p.m. but it was discovered that the signal had been caused by a fall of roof.

The operations went on and it was realised that the fire was not being brought under control and there were indications that methane was building up in the mine and R.J. Evans, H.M. District Inspector advised that all men should be withdrawn. This was done with the agreement of all parties. Hoses that had been laid in the downcast pit bottom were brought into use to start flooding the valleys in the intake and return airways near Johnstone's Crosscut and to seal off the fire.

The men who died were-
Alexander Morrison Beatie aged 26 years, roadsman.
Thomas Bone aged 27 years, beltmen.
Francis Broadley aged 38 years, developer.

Matthey Mcliwain Cannon aged 38 years, stripper
William Brynes aged 54 years, coal cutterman.
Walter Clark aged 61 years, back brusher.
Henry Clayton aged 62 years, train guard.
Robert Conn aged 30 years, back brusher.
Andrew Crombie aged 42 years, oncost worker.
James Devine aged 39 years, shotfirer.
Andrew White Docherty aged 43 years, coal cutterman.
John Duffy aged 39 years, shotfirer.
Francis Jones Fisher aged 49 years, shotfirer.
Martin Fleming aged 51 years, stripper.
Michael Fleming aged 47 years, shotfirer.
Richard Hamilton aged 48 years, stripper.
James Harvey aged 44 years, stripper.
Patrick Harvey aged 33 years, developer.
Edward Henery aged 61 years, stripper.
George Jackson aged 21 years, spare stripper.
Francis Kiernan aged 26 years, beltmen.
Peter Kelly aged 40 years, stripper.
William Lafferty aged 39 years, stripper.
Alexander Todd Lang aged 35 years, stripper.
William Leishman aged 65 years, oncost worker.
Gerald John Martin aged 34 years, shotfirer.
John McAuley aged 42 years, back brusher.
Robert McCoid aged 55 years, stripper.
Joseph McDonald aged 53 years, stripper.
Denis McElheney aged 49 years, developer.
George Wilkie McIntosh aged 58 years, shotfirer.
Andrew McKenna aged 41 years, deputy.
Peter McMillan aged 55 years, shotfirer.
James McPhee aged 54 years, shotfirer.
William Meechan aged 22 years, oncost worker.
John Muir aged 38 years, oncost worker.
John Mulholland, Senior aged 50 years, stripper.
James Nimmo aged 32 years, oncost worker.
Aaron Price aged 50 years, stone worker.
Robert Price aged 47 years stone worker.
Alexander Sharp aged 34 years, stripper.
John Shelvin aged 46 years, oncost worker.
William Skilling aged 53 years, oncost worker.
John Mack Stark aged 23 years, stripper.
Thomas Stokes aged 32 years, oncost worker.
Donald Cameron Weir aged 30 years, roadsman.
George Thomas Thompson McEwan aged 20 years, oncost worker.

The inquiry into the causes and circumstances attending the underground fire which occurred at Auchengeich Colliery, Lanarkshire, on 18th, September 1959 was conducted by T.A. Rogers, C.B.E., H.M. Chief Inspector of Mines and Quarries at the Justicary Court, Glasgow on the 4th. January 1960 and sat for ten days until the 15th. January. The final report was presented to The Right Honourable Richard Wood, M.P., Minister of Fuel and Power in May 1960.

The inquiry heard evidence from eighty five witnesses and all interested parties were represented. The following conclusions were reached-

“1). The fire originated in the balata transmission belt of the electrically driven fan in the return airway from the No. 2 Pit workings. The fire was caused by frictional heat generated between the rotating motor pulley and the belt, which had left the fan pulley and jammed near it. Flame from the belt ignited the oil vaporised from the fan shaft bearings and oily deposits in and around the fan. The flame then spread downwind to ignite roadway timbers.
2). By tragic coincidence, forty eight men riding through the return airway were overtaken by smoke containing carbon monoxide and forty seven of these men were asphyxiated.
3). The fire would not have reached dipterous proportions had inflammable material been excluded from a substantial length of roadway immediately adjacent to and on the return side of the fan.
4). The haze which proceeded the smoke was not recognised, either by officials or by workmen, as a sign on imminent danger. By the time the fire was found the second men-riding train had already left the pit bottom.
5). Fire fighting arrangements were inadequate but the deficiencies did not contribute to the loss of life.
6). The fire would probably have been averted had the fan been under continuous supervision. It might have been averted or it’s development halted had the fan been inspected at half hourly intervals prescribed as a maximum by Regulation.
7). Closer examination of the belt performance after speeding up the fan might have indi ated the advisability of reverting to the previous speed or altering the drive.
8). The unsatisfactory performance of the belt and the damage done to it in the two days before the fire, particularly the night immediately before, received insufficient attention.
9). By calculation, a balata transmission belt made of 33.3 oz. cotton dick put on after the speed-up of the fan had an excess capacity of about 50 per cent and a 31 oz. belt caught fire about 25 per cent. But the first of these belts lasted less than tow weeks and the other only two days.
10). The belt which caught fire was not the 33.3 oz. weight ordered by the National Coal Board and failed to satisfy completely some of the tests prescribed by the British Standard 2066.”

The Inquiry made the following recommendations following the disaster-

“1) Underground booster fans driven by inflammable belts should be constantly attended by competent and properly instructed persons.
2) The bearings of underground fans should be lubricated with grease or any suitable non-inflammable lubricant that may be developed.
3). All power transmission belts used at collieries should be made of fire resistant material. Pending the introduction of fire resistant flat belting, managers should make effective arrangements to ensure that any over-heating or fire in machinery, driven by an inflammable belt, will be discovered and dealt with before serious danger can develop.
4). All managers should carry out thorough reviews of their fire fighting arrangements to ensure that sufficient appliances in proper working order will be available for prompt use in any place where fire may break out underground. These reviews should include consideration of telephone systems and means of warning men of fire.
5). All managers should have made thorough examinations made of the whole of their pits to identify any places on unusually high fire risk and determine what can be done to minimise the risk at each of these places and to deal with any fire which might occur.
6). The attention of all officials should be drawn specifically to their obligation under Regulation 11 (1) of the Coal and Other Mines (Fire and Rescue) Regulations, 1956, that men must be withdrawn as soon as there in any indication that fire has, or may have, broken out below ground.

7). The industry should reconsider it's decision to discontinue the trials of self-rescuers.
8). There should be a suitably constituted standing committee of experts, representing all sides of the Industry and the Ministry of Power, charged with the task of keeping under close and constant review the prevention of explosions and fires in mines, with particular reference to the lessons of actual fires and explosion in this country and abroad, and of anticipating any possible ignition hazards arising or likely to arise from new developments in mining practice."

BICKERSHAW. Leigh, Lancashire 10th. October, 1959.

On the 12th. November 1959, Colonel R.M. Barlow, H.M. Coroner of the County of Lancaster, Bury District resumed his inquest on the bodies of the five men. A verdict of 'Misadventure' was recorded in each case, and medical evidence showed that all five men died from carbon monoxide gas poisoning.

The Inquiry was made by Mr. R.H. Clough to the Right Honourable Richard Wood, MP., Minister of Power. In accordance with your direction given under the terms of Section 121 of the Mines and Quarries Act 1954.

Owing to the circumstances immediately following the explosion which demanded the isolation of further stoppings of the affected Plodder Seam, there had been no physical examination of the scene of the explosion after rescue operations were completed, other that a necessary brief examination made by men wearing self contained breathing apparatus,

Bickershaw Colliery was at Leigh, Lancashire and was one of the No.3 Group of the No.2 (Wigan) Area of the North Western Division of the National Coal Board. The following Area officials under Section 1 of the Mines and Quarries act 1954, for the purpose of fulfilling the responsibilities of the N.C.B. under the Act were the Area General Manager, Mr. H.E. Clegg, the Area Production Manager, Mr. E. Small, M.B.E. and the Group Manager, Mr. J. McGann.

At the time, Bickershaw Colliery was served by four shafts numbered 1, 2, 3, and 4. Numbers 1 and 2 shafts served one part of the mine and Nos. 3 and 4 the other. Both parts have separate systems of ventilation, but are accessible to each other below ground. Under the terms of Section 168 of the Mines and Quarries act 1954, the two parts are regarded as separate mines, each with it's own manager. The manager of No.1 and 2 was Mr. A. Miller, and Mr. J. M. Lawson was the manager of Nos. 3 and 4. a statutory notice of approval had been issued setting out the respective spheres of responsibility of the two managers. In particular the surface works are the responsibility of Mr. T. W. Allison, but who did not shoulder the direct responsibility under the Act.

The explosion took place on the 10th. October 1959 in the Nos. 3 and 4 workings, and in particular to the Plodder Seam. The Plodder (sometimes known as the Ravine) Seam had a worked section at Bickershaw of about 6 feet. It lies immediately over the High Yard Seam. These two seams, and their associated dirt bands, have an overall thickness of 18 feet. The Plodder Seam is well known in the coalfields as one liable to spontaneous combustion, particular in the Wigan and Leigh areas, and there is at Bickershaw a long experience of trouble from this cause. With seams as close together as the Ravine and the High Yard spontaneous heating could occur in the individual working of either, since the extraction of any one is bound to expose, in part, the other. The risk of self-heating is often associated with such thick seams in close proximity.

At Bickershaw Colliery the Plodder Seam was developed in a south easterly direction on a line of almost full dip at an average gradient of 1 in 7. By 1959 a large amount of extraction had taken place and large goaf areas formed, progress was by a developing face to the dip with wing faces advancing east and west respectively.

At the end of August 1959, only two longwall faces were working in the Plodder Seam, Nos.1 and 2 Dip Faces with a combined output of about 550 tons per day. The

only other accessible face was the No.9 east, which ceased production on 14th. August 1959. It was still being ventilated, and a small team of men were engaged in salvaging material. Of the three open faces, No.2 was ventilated by an air current separate from the others, while another split of air was conducted, first along No.1 Dip Face after which it passed into the Main Level of the No.9 East Face, where it was augmented by some intake leakage from the No.4 Brow. The quantity of air ventilation No 9 East, when last measured on 21st. August 1959, was 14,700 cubic feet per minute, and the average percentage of inflammable gas in the return airway from this face as determined at a point 10 yards from the face on No.9 East Top Level was 0.95 per cent. Of this gas some was contributed on No 2 Dip Face, the air on which normal contained about 0.3 per cent in a quantity of 12,500 cubic feet per minute. a rough estimation suggests an average emission of firedamp on No.9 Face of the order of 100 cubic feet per minute.

The No.9 Face had advanced about 800 yards alongside the goaf of the old abandoned No.8 Face to the rise side, keeping contact with this goaf as it progressed, while the No.9 right hand or dip side was forming a coal rib. Both Main and Top Levels of No.9 Face were supported by steel arches. The general dimensions of the Main Level were 13 feet wide by 10 feet high, those of the Top Level, 9 feet wide by 7 feet high at the face, but, owing to the sever crush probably associated by the nearness of the No 8 Goaf it was reduced to about 3.5 feet by 4.5 feet for about 200 yards of its total length.

The No.8 East Face, when working, was 160 yards in length. it ceased production on 9th. August 1957 and stoppings were put in some three months later. These stoppings were later expanded by stowing of waste dirt and by October 1959, the No. 8 Top Level stopping was 150 yards long, and the No. 8 Main Level stopping, 100 yards long.

During the morning of Sunday the 4th. October, a deputy Mr. F. Hodgson, accompanied by a workman as a travelling companion, was making an ordinary week-end inspection of the No.9 Face. These two men encountered the face by the Main Level (intake), travelled up the face, and then outbye the Top Level (return). Immediately on leaving the face at the Top Level, Hodgson noticed a smell of ‘heating’ when he was about 3 yards outbye of the face ripping lip. He also recognised some haze and seating on the roof at the higher side, adjoining the abandoned No.8 Face. These findings were communicated to the manager who subsequently made and examination of the place accompanied by the assistant manager, Mr. Allison, Mr Lawson decided that it would be practicable to deal with the heating by excavating or ‘digging out’ the pack, and steps were taken at once to do this.

During that Sunday afternoon, and the three following shifts, men were engaged in removing the packing, and from the evidence of those engaged on this work, it is possible that this excavation eventually penetrated for some few feet at least, into what was originally the right hand pack of the abandoned No.8 Face. About the heating there was no doubt. The packing material taken out was hot and had to be quenched with water before being cast aside, and at one time or another incandescence was observed by Mr. Allison and by one of the deputies immediately in supervision.

By the end of the morning shift of Monday, the 5th. October, it was decided that all the heated material had been removed and quenched and steps were taken to restore the roadway side by filling the excavation with sand, faced with a sand bag wall. All this was completed by the end of the morning shift on the 6th, by which time the road surfaces were observed to be sensibly cooler.

During the digging out operations, and the subsequent re-sealing of the affected part of the packing, atmospheric conditions were not unduly uncomfortable. Samples of the atmosphere from the general body of the air in No.9 Top Level on there turn side of the place where the heating was found did not, on analysis, give gaseous constituents of the character which might have been expected from heated ground on the intensity

actually observed. The carbon monoxide contained (0.0014-0.0036 per cent) was not unduly high for the Plodder Seam at Bickershaw.

Although the management were convinced that the heated material had been successfully removed, the occurrence served as a warning that it was time for the No.9 Face to be abandoned and stopped off. Salvage operations were almost completed, and Mr. Lawson therefore decided to put in final stoppings.

It was the usual practice in the Plodder Seam at Bickershaw to seal off abandoned panels by first building stoppings in the levels some 70 to 100 yards inbye of the main airway from which they were sent out. Once the sealing of the panel had been completed, the remaining space outbye the stoppings is then used for the intermittent stowing of waste dirt, with the result that the stoppings were gradually increased in thickness until they could be faced with a masonry wall alongside the main airway.

It is also unusual when ordinary stoppings have to be built for members of the Central Rescue Corps to assist. This course was taken, not as an emergency measure, but because these men were trained in the building of stoppings and their help usually results in the stoppings being built more quickly. Since their training took account of fire and explosion risks, their procedure was always in accordance with these risks whether or not they are known to exist.

The building of the stoppings in the roads leading to No.9 Face was begun on the morning shift of Friday, 9th. October, and work was continuous. The Main Level, the place selected was 72 yards form the No.9 scouring at point where the steel arched roadway was about 13 feet wide and 10 feet high. The stopping in the No.9 Top Level was 64 yards from the Scouring where the roadway was 5 feet to 7 feet wide and 3 feet to 3 foot 6 inches high. The stoppings were constructed mainly of sand bags with intermingling of bags of dirt filled on the spot. There were said to be reinforced with old arches or rails or whatever else was handy, both at the inbye end and throughout their length. During the erection of the stoppings the practice was adopted of leaving narrow tunnels about 3 feet square through the base of each stopping with the object of preserving some ventilation round No.9 face until the sealing could be completed finally and quickly plugging the tunnels simultaneously with further sand bags.

Both stopping were complete except for the sealing of the tunnels by about 10 a.m. on the 10th. October at which time the Top Level (the return) stopping was 11 yards in length, and the main Level (intake) stopping 8 yards in length. The final sealing of the tunnels was completed about mid-day, the intake at 12.15 p.m. and the return half an hour later.

When both seals were completed, the separation doors in No.9 scouring between intakes and return levels were opened to provide a free flow of air from the no 1 dip Face to the main Return Brow. The immediate result of this was that for 64 yards on the No 9 Main Level, and for 53 yards on the No.9 Top Level there was no positive ventilation. This would not necessarily produce at once a poisonous or inflammable atmosphere at the face of the stoppings since all the stoppings leak a bit at first, and there would still be a small flow of air through them if only because of a small pressure difference resulting from the difference in level of the two stoppings. For the two ‘blind’ ends of the outbye the stoppings the manager had made provision for auxiliary ventilation by installing fans should the need arise. However other events supervened, and I do not think the operation of the fans would have changed the circumstances. However, as aside, I feel it my duty to say that auxiliary ventilation should have been put into operation as a prudent measure against the accumulation of dangerous amounts of inflammable or noxious gases following the arrest of the main ventilation by the stoppings.

The No.9 Face and parts of the two roads leading to it, were thus finally sealed off almost two months after coal production ceased, and four days after the heating in the Top Level had been dealt with. At about mid-day on Saturday, the 10th. October, when the stoppings against the No.9 East Face had been finally closed, the one on the intake

was some few yards short of the usual minimum length of 11 yards put on when the stoppings on old districts are first built. The manager therefore decided to continue with an afternoon shift of a small number of men to be engaged solely on the work of increasing the length of this stopping. The shift comprised two officials, two members of the Boothstown Permanent Rescue Corps and nine other workmen.

When the building of this stopping had first begun the belt of the conveyor originally in use for coal transport along No.9 Main Level had been shortened to that place, and by running it in reverse direction it could be used for conveying sand bags from the No.4 Brow Transfer Point to the stopping site.

Some of the men engaged in this afternoon shift were engaged in the actual building of the further length of the stopping. Others in the transportation of sand along the conveyor, and, farther outbye, others were preparing sand bags and taking them down the No.4 Brow from the Loading Point to the Transfer Point at the No.9 East Main Level. At about 4 p.m. there were five men near the face of the stopping, J. McLeod, the overman, F.B. Sargent the deputy, J. Dawber and R Evans, members of the Rescue Corps and H. Thomason, a haulage hand, while others were several yards away taking sand from the conveyor belt. The remainder of the men were distributed on various tasks between the Transfer Point and the No.4 Brow Loading point.

While getting on with the job, the men at the Transfer Point heard a thud coming from the direction of the stopping, and on going through the separation doors on this road they found a cloud of dust and fumes with the smell of burning. Eventually, some men emerged from the dust, and soon it was realised that five men near the stopping had been overcome in some way as the result of some kind of explosion. The men at the Transfer Point regained the air supply and the remaining group of men telephoned the surface while others reversed the conveyor belt so that the top belt travelled outbye, in the hope that someone disabled could perhaps make use of the belt to escape.

The telephone message reached the manager, Mr Lawson, at his home near the colliery. After making sure that the Permanent Rescue Corps had been summoned from the Boothstown Central Rescue Station, he left for the colliery. by this time, Mr. Allison, the assistant manager, had gone underground.

At approximately 4.25 p.m. a team of Five Rescue men from Boothstown went underground. They reached the No.9 East by 4.50 p.m. travelling by foot down the No.4 Brow (intake), meanwhile Mr. Allison was on the way and met two who had come from the affected area.

By this time some of the dust and smoke had cleared and a fresh air base was set up at the entrance to the No.9 Main Level (Transfer point). Arrangements were again made for the belt to be reversed, and the Rescue Brigade, wearing their apparatus, approached the Main Level stopping where they located the bodies of McLeod, Sargent, Dawber, Evans and Thomason, four of them together and the other a few yards distant. All appeared unconscious or dead, and they were immediately taken to fresh air base using the conveyor belt. On arrival there artificial respiration was carried out in conjunction with the administration of oxygen but these measures proved unavailing. At 6 p.m. Mr. Bond, a Group Manager from a neighbouring group, Mr. Lawson, Manager, Mr. A. Cunliffe, Rescue Station Superintendent and Dr. J. F. Erskine, the Area Medical Officer, arrived together at the fresh air base when the doctor examined the bodies of the five men and pronounced them to be dead. Arrangements were the made for the transport of the bodies to the surface and for the retreat of all persons from the seam.

However the atmosphere had cleared somewhat, the opportunity was taken by the Rescue Men to have a closer look at the stoppings. With their companions support, W. Sturgeon, the Captain, went into the main Level stopping and K. Shaw to the Top Level Stopping. Approaching the main level stopping, Sturgeon observed that flame safety lamps, although extinguished, were still hanging from roof supports, and that hanging

water bottles were understudied. There was little evidence of violence. There was no flame to be seen, but at the stopping itself a hole was observed at the top about 3 feet wide and 1 foot in height, due, possibly to the displacement of part of the top layer of sand bags. From the top level stopping, Shaw reported that no displacement had occurred, and again no sign of flame or smoke. On these occasions the opportunity was taken by these two men to collect a sample of the atmosphere at the face of each stopping. On analysis the sample from the Main Level yielded among other gases, 0.016 per cent carbon monoxide and 0.46 per cent firedamp, while that from the return stopping was much more lethal with nearly 3 per cent carbon monoxide and 5 per cent firedamp.

When all the men had been accounted for, and these conditions confirmed, M.r E. Small, Area Production Manager, who was then at the colliery, ordered a complete evacuation of the mine pending a decision on the next steps to be taken. All the men were out by about 9 p.m. after an arduous journey with the bodies of the five men through the No.4 Brow for about 2,000 yards against an average gradient of 1 in 8.

Later Mr. H. E. Clegg, Area General Manager, who was then at the colliery, having heard the principle facts of the occurrence. He decided that there should be no further exploration of the Plodder Seam because of the danger of a second explosion. It was though that permanent stoppings should be put in at the top of the three airways serving the seam. Even if the termination of some working area had been considered, it would have been impossible to build further stoppings without placing them so close to the others as to incur a grave danger from a subsequent explosion.

The sites of the final stopping-off of the Plodder Seam were carefully selected, with the advice, among others, of Dr. H.L. Willett, Deputy Director-General of the Headquarters Staff of the National Coal Board, who had been called to the colliery. It was no part of the report to recount the final work except to say that it was conducted under full emergence conditions with men underground only in sufficient numbers to secure the expeditious erection of the stoppings.

The final closing if the stopping was completed at 11 a.m. on Tuesday, the 13th. October and, after a suitably long waiting period with no men in the mine, inspections were made of the stoppings periodically with sampling of the atmosphere behind them and tests for leakage. This was followed by further measures to strengthen them.

Those who died were-
John McLeod aged 28 years, an overman,
Frederick Brian Sargent aged 27 years, a deputy,
Henry Thomason aged 48 years, a haulage hand,
Jeremiah Dawber aged 39 years, a member of the Permanent Rescue Corps and
Reginald Evans aged 38 years, also a member of the Permanent Rescue Corps.

It was at once clear that an explosion had taken place within the are contained by the stoppings on No.9 East Main Level and No.9 East Top Level. No effects of violence had been observed except the displacement of part of the Main Level stopping. The survivors had seen dust and smelled something burning, but had seen no flame. The deceased men had been overcome by carbon monoxide gas and their bodies showed signs of burning or other external injury.

When the two stopping were first begun on Friday 9th. October, there was some intermediate restriction of ventilation through No.9 Face and when they were finally plugged at about mid-day on the 10th., all ventilation would cease except for possible leakage through the stoppings. Now the estimated amount of 100 cubic feet of methane entering the air current per minute with normal ventilation might diminish with the cessation of ventilation bit it would continue to be the main cause of change in the atmosphere within the stopped-off area. With the completion of the seals the eventual production of an inflammable atmosphere was inevitable. before such areas become

sufficiently deprived of oxygen it can be assumed that the atmosphere, in its composition, passed through the inflammable range.

When Mr. Lawson, the manager, decided to seal off No.9 Face and roads, he was confident that the heated material found at the left hand side of the No.9 Top Level had been sufficiently dealt with. Samples of the atmosphere from the No.9 Top Level continued to be taken until 7 a.m. on the 10th. October, some five and a half hours before actually sealing took place. Although these samples were analysed for carbon monoxide alone the amount of this gas found was not abnormally high. In fact over the whole period of 5th. to 10th. October, the average amount of this gas found here was 0.0022 per cent, the maximum, on one occasion only, being 0.0063 per cent. The site of the heating at the left hand side of the No.9 Top Level was last seen some four hours before actual sealing took place.

There were, of course, other possibilities causes of ignition that spontaneous combustion. At the Inquest, the manager, Mr. Lawson, mentioned the possibility of frictional sparking occurring from a fall of material somewhere on the face or in the roads within the sealed area. Explosions of inflammable gas have been attributed to this cause, when in the absence of any more positive indication such falls of material have been identified with similarly positive evidence of where the ignition took place. The question of sparking from electricity but the evidence of an electrician from Bickershaw was to the effect that all electric power was cut off to the No.9 Face of the 9th. October, preparatory to the construction of the stoppings. After considering the remote possibility of frictional sparking the investigation came to the conclusion hat a much more likely source of ignition was the heating in the No.9 Top Level, and that the general confidence there was misplaced.

To support this conclusion it is necessary at this point to consider the experience with the No.8 Face, the one immediately to the rise side, and which was worked before No.9. This face had no experience of spontaneous combustion during its life. It was abandoned on 9th. August 1957 and stopped off of 11th. November 1957. Later the stopping were increased in length by the disposal of waste dirt. In July 1959, samples taken on the No.3 Brow on the return side of both No.8 and No.9 revealed an increase in the carbon monoxide content from about 0.002 to about 0.007 per cent. A closer search for the origin of the gas identified it with leakage out of the No.8 Main Level Stopping. various attempts wee made to improve the seal there. The main purpose was to reduce the amount of carbon monoxide on what was the main man-riding road, a concentration, which, although not dangerous, could not be tolerated. The measures adopted, which included the building of a brick wall as a face to the Main Level stopping, were effective in reducing the amount of carbon monoxide reaching the No.3 Brow.

When the No.8 Face was working, it was customary to leave packing about 8 yards thick on the lower side of the Main Level. Between this pack and the coal rib side being formed by the advance of the face, a small airway was left so that air could circulate round the fast end. A continuous small airway of this kind which would in time become inaccessible, could not be contemplated in a seam so liable to spontaneous combustion as the Plodder. As a result, this very small airway was cut off periodically by cross drivages through the pack about every 40 yards, the abandoned portion behind being sealed.

When No.9 Face advanced later taking out all the coal, these small spaces, and the adjoining pack would be re-exposed, with the result that within a few yards of the left hand corner of the No.9 Face there would, temporal, be only 8 yards of packing separating No.9 Top Level from what remained of the No.8 Main Level. Despite the thickness of the stoppings at the outbye end of the No.8 Top and Main Levels, it was probable that small leakages of air occurred between No.9 Face and No.8 Face. A small pressure due to the ventilation causing such leakage would be assisted by the

gradient, and by the high resistance of the outer part of the No.9 Top Level which was the proper path for the air to flow.

Small leakages of this kind are all that are needed to start spontaneous combustion the air flow is insufficient to carry away the heat being generated so the temperature of the material rises continuously. One measurement against such leakage through roadway packs is to raise the floor of the roadways by leaving down part of the face ripping until the floor level of the roadway being formed is above the roof plane of the coal extracted in working.

This had been along established practice in certain conditions, and could have been carried out in the Top Level of No.9 Face where the Plodder Seam was being worked first over the contiguous Haigh Yard seam. But in the converse case, which is sometimes adopted, of working the Haigh Yard first, the burying packs in this way would be impracticable.

While 'digging out' operations were in progress at the heating in No.9 Top Level, those engaged did not notice any movement of the air towards the abandoned No.8 Face, but it was felt that, having found distinctly hot material, and in the absence of any significant amount of carbon monoxide in the immediate atmosphere, the officials should have expected that most of the products of combustion were in fact moving through the pack away from No.9 and into No.8 Face. Such movements would also seem to explain the observed rapid cooling of road surfaces. It was possible that heated material dug out was only part of that actually raised to a high temperature, and that the remainder was still active behind the packing by which the roadway had been restored. The air leakage referred to, while feeding more oxygen to the fire, would also, because of its direction of flow, tend to conceal the real conditions from those working there. If some fire continued at this point, it is reasonable to assume that the accumulating firedamp in No.9 Face, once the main stopping were built, would first reach an inflammable or explosive concentration at the higher corner of the face to be ignited there.

Although new packing had been inserted between any continuing fire in No.8 and No.9 Top Level, it would not be 'flameproof', and it is conceivable that the ignition of an explosive mixture first occurred in No.8 Face and was propagated through the new packing into a larger accumulation of firedamp then present in No.9.

There as other, and perhaps more reliable evidence that the signs first observed by the Deputy Hodgson on the 4th. October were indicative of only a fringe of what might have been a heating of a fairly high intensity somewhere on the lower side of the No.8 Main Level. I have already referred to the detection in July last of excessive amounts of carbon monoxide from the stopping on the No.8 Main Level.

While the leakage might have been due to expansion of residual gas under falling barometric pressure, it did in fact occur during periods of very sable pressure, and therefore was more likely to have been caused by leakage coming in from No.9 Face under the influence of ventilating pressure and some buoyancy. Indeed it would seen that the progressive advance of No.9 Face was to some degree unsealing No.8 or at least aggravating the leakage of air, and I can imagine a similarly progressive tendency to self-heating along the right hand side of the No.8 Main Level. If heating did occur it would probably be stifled by the consolidation of the packing as No.9 Face advanced, and so I envisage the greatest intensity of heat, or tendency to self-heating would be just behind the No.9 Face. Once this face stopped, leakage would continue for some time at one place and the heating would grow in intensity until its effects began to be noticed within the No.9 Face and where, of course, eventually detected by Hodgson on the 4th. October.

There was further support for this view, but for this purpose from the work that had been done on the analysis of the constituent gases in mine atmospheres, which has been long established as a reliable indication of the rate of oxidation (and self heating) of coal substance.

With the oxidation of coal, a variable amount of carbon dioxide and carbon monoxide is produced. With oxidation of coal at normal temperatures a very small quantity of these gases is produced in relation to the amount of oxygen absorbed. However Mr. T.F. Winmill and Mr. J. I. Graham working together as long age as 1915 found that the proportion of carbon monoxide varies more particularly with the temperature and this gas is readily and conveniently determinate with modern apparatus in very small proportions, down to a few parts per million. Accordingly, spontaneous heating in the coal substance is always associated with a rise in the ratio of carbon monoxide produced to oxygen absorbed usually expressed as a percentage, in the formula:- Carbon monoxide produced/Oxygen absorbed x 100, and Graham suggested this ratio as an indicator to be used in the early detection of heating. It's value is maintained even when the temperature continues to rise and actual fire results, though in open workings, with constant examination, other than the obvious signs will then have become evident. Since there is some very small amount of carbon monoxide produced with normal oxidation, the ratio is calculated will have a normal value for every seam, or group of workings, or for a mine depending upon where the carbon monoxide present and the oxygen loss, respectively, are assessed. The indication of spontaneous heating lies in the rise of this ratio above what is known to be the normal value. From the experience of sampling over several years I am advised that the normal value of this ratio for the Plodder Seam at Bickershaw was 0.4 to 0.5 per cent.

There was increased levels of CO in the No.3 Brow which was later identified with an increase in the expulsion of this gas from behind the stoppings on the No.8 face. Sampling of the atmosphere from inside these stoppings was also continued and the samples collected during the period 5th. to 10th. October 1959 which were typical of those collected earlier in August and September.

At first glance, the air content of these respective groups of samples might be accepted as not being abnormal from a sealed area presuming some in leakage of air through the Main Level stopping which was the original intake. However, the general consumption of the samples does not support this. Theses from the Top Level show a low carbon monoxide/oxygen ratio and a high carbon dioxide content and therefore no evidence of heating but rather vitiation from ordinary oxidation.

However the samples form behind the Main Level stopping give a high carbon monoxide content (air free) and a high carbon monoxide/oxygen ratio and thus are typical of an atmosphere on the return side of a serious heating. In the absence of any known heating near the No.8 Main Level stopping itself (a possibility which cannot be ruled out) the atmosphere behind this stopping must be related to the known heating where No.8 and No.9 Faces joined. The continence of an abnormally high carbon monoxide/oxygen ratio from the samples collected from behind No.8 Main Level stopping after the heating in the left side of the No.9 Top Level had been dug out should have awakened some doubt of the complete efficacy of the measures there taken

There appeared to be some little doubt of the reliability of the carbon monoxide/oxygen ratio when applied to stopped off areas, and this feature offers application is worthy of further investigation. It reasonable to expect that the manger's advisers, and in particularly the Area Scientific Service, who were responsible for providing him with the analyses of the samples of atmosphere, might have shown more concern, and made a wider investigation of the series of results from No.8.

In justice to the management of Bickershaw, the investigation recorded that members of my staff, Mr. J. Lane, H.M. Senior District Inspector and Mr. R. N. Foster H.M. District Inspector, were in touch with the developments during the few days preceding the explosion. In fact, Mr. Foster visited the No.9 stoppings during the morning of the day of the explosion.

These two Inspectors from their own knowledge and observation, shared the confidence of the management that no active fire was being sealed off, but at that time

they were not aware of the character of the range of samples taken from behind No.8 stopping which was significant evidence of fire more deep seated in No.8 Face than was suspected. However, in the light of subsequent and closer examination of the nature of these analyses from No.8 Stoppings it was concluded that fire existed in No.8 Main Level, or near it. The fire might not have been of a large extent, but was probably of a high intensity. Whether this was part of the fire found in No.9 Left Hand, or another was conjectural.

In sealing off active fire there is a code of General Regulations first made in 1933 and now re-enacted under the Mines and Quarries Act 1954 as Coal and Other Mines (Fire Rescue) Regulations, 1956. Among other things, these Regulations require the withdrawl of all persons from a mine during the process of sealing off or damming off except those necessary to the work of building stoppings. In addition to these Regulations there is an accepted code of safe practice within the coal mining industry based on a large amount of experience.

In 1944 this experience was embodied in a memorandum prepared by a Committee appointed by the Council of the Institution of the mining engineers on ‘Sealing off Fires Underground. This memorandum, among other matters, dealt with the position leading up to the final sealing of stoppings already erected in part and on sealing being completed, advised the withdrawl of all persons during a period of twenty four hours.

This time interval could only be an arbitrary one, but from accumulated experience of the Committee it was felt that if in any circumstances an explosion inside the stoppings was to occur, it would come about well within that period. If Mr. Lawson, or the other members of the executive management at Bickershaw, had a remote possibility of fire continuing in the region of the No.9 Left Hand side of No.8 Right Hand side, the final sealing of the stoppings on the 10th. October would have been conducted in accordance with the recommendations of the memorandum, in which case on one would have been at risk when the explosion occurred.

Another factor which must have contributed to the rate at which firedamp collected behind the stoppings on the No.9 roadways was the fall in barometric pressure which began about 1 p.m. on Friday the 9th. October after an unusually long period of stable pressure which accompanied the summer and autumn months in 1959. The fall of pressure continued into the 10th. October, the day of the explosion. The maximum rate of fall was one of 2 millibars per hour during the four hours 12 noon to 4 p.m. This rate of fall though not abnormal, is quite appreciable, and would have a significant effect in producing an inflammable mixture in the sealed area at an earlier stage after the stoppings had been finally plugged.

Bickershaw Colliery, amongst others in the North West Division, receives warnings from the Meteorological Office of approaching severe barometric depressions, a service initiated by the National Coal Board as a measure of assistance to these in charge of gassy seams. t was confirmed that a signal was sent out by the Met Officer of an expected rate of depression and was received at the Colliery about 3 p.m. on the 10th. October. Before the sealing of No.9 and afterwards this knowledge by the officials of a sharp fall of barometric pressure would not be expected, under the circumstances to create any great anxiety in their minds about the conditions in the No.9 area, unless they knew, or were suspicious, that material at high temperature was being sealed off.

Without this knowledge, or suspicion, the precautions to be taken would consist simply of the vigilance towards the appearance of inflammable of noxious gases near the stoppings at which men were working. The evidence I have heard is to the effect that the deceased officials and the trained rescue men who were with them, had been constantly on the watch for such gases.

In the circumstances of an explosion behind the stoppings which were largely left intact, and outside of which there were no flame was seen to pass by those who survived It was not certain what part was played by coal dust in carrying the explosion towards the stoppings on No.9 roadways. The No.9 Main Level had been a coal

transport road during the working period which ended on 14th. August 1959 and the manager, Mr. Lawson, stated that until that date a stone dust barrier erected in accordance with the National Coal Board internal directive was in position about 200 yards from the face.

However, Mr. Lawson recollects that after production ceased this barrier was removed so that the fittings could be used elsewhere in a productive unit. The volatile content of the Plodder Seam is 38.1 per cent which to comply with the Coal Mines (Precautions against Inflammable Dust) Regulations 1956, required the maintenance of at least 75 per cent incombustible matter in a mixture with the roadway dust when sampled in the prescribed maker. Samples of roadway dust were collected from No.9 Main Level and No.9 top Level in July 1959.

The records at the colliery show that the lowest portion of incombustible matter found in the Main Level was 91.5 per cent and in the Top Level 89 per cent. These samples were collected some four weeks before coal production and transport ceased and therefore do not necessarily represent the conditions at the time of the explosion. It was stated by the manger that it was unlikely that any further inert dust treatment had been given to these roads after coal winning stopped on the 14th. August since the main production of coal dust would then cease.

It was concluded that the explosion that occurred on the 10th. October was mainly one of firedamp which inevitably collected on the No.9 Face and in the Main and Top Levels when the stoppings on these latter two roads were finally plugged and sealed. The firedamp would probably reach inflammable proportion first in the top corner on No.9 Face adjacent to where spontaneous combustion persisted. Firedamp was ignited there by some heating material lying possibly within the old right hand packing of No.8 Face just beyond the reach of the excavation carried out at that point on 4th. and 6th. October.

The danger of explosion following sealing was accentuated by the rapid fall in barometric pressure experienced before and during sealing. Having in mind the character of the No.9 Main Level as a coal transport road, it was possible that coal dust played some part in propagating the explosion towards in the Main Level stopping.

The exemplary behaviour of all persons in the neighbourhood of the stoppings when the explosion occurred. Everyone acted with immediate concern for the safety of the five men near the Main Level stopping and in particular The act of putting the roadway conveyor into its normal running direction (top belt moving outbye) was a resourceful move made in the hope that some survivor would not be too disabled to use this means of getting to safety. Than it was unavailing does not detach from the inspiration which prompted it.

Two members of the Permanent Rescue Corps, Mr. W. Sturgeon and Mr. K. Shaw were commented on. With the support of their Brigade companions, they made the necessarily brief but observant examinations of the two stoppings after the explosion. They, above all, from their tracing and experience would be aware of the danger of a second explosion, and their subsequent reports of the condition of the stoppings and the information that no fire existed in the open roads outside provided a valuable and comforting reassurance to all concerned with the remaining operation of the sealing off the Plodder Seam.

The following recommendations were made-

“1). I understand that the Council for the Institution of Mining Engineers have adopted a small Committee to revise the Memorandum ‘Sealing Off Fires Underground’ originally published in 1944 and referred to in Paragraph 46 of this report. Although the point may not strictly be within the terms of reference of this Committee, I think it should consider, concurrently with other related matters, the value to be attached to the relationship between carbon monoxide produced and oxygen absorbed, and indeed a any other relationship between constituent gases found in samples of atmosphere

taken fro behind stoppings as indication of continuing fire or of the progress of spontaneous combustion.
2). Where longwall working in seams liable to spontaneous combustion it is the practice for successively worked faces to strip the goaf edges of previous workings already stopped off, further measures should be considered with a view to minimising leakage between a working area and sealed off one. In this connection the already common practice of burying packs should be extended. in addition, sand packing should be inserted alongside coal ribs, especially where these will be subsequently taken out by a succeeding working.
3). In all cases the time which elapses between a working face ceasing production and its final isolation with explosion proof stoppings should be as short as possible compatible with the recovery of valuable machinery and tools.
4). Since the danger of an inflammable atmosphere can arise in any area or workings to be sealed as soon as the ventilation is reduced in amount by the beginning ion the stoppings, their completion to an explosion proof condition should be effected as quickly as possible whether fire is present or not. Consequently in seams liable to spontaneous combustion I recommend that sites for stoppings should be selected and some preparatory work done while the unit is still in production. In fact in some seams where spontaneous heating if frequent such preparatory work has been traditional practice."

SIX BELLS. Newport, Monmouthshire. 28th. June, 1960.

The colliery was formerly known as the Arrael Griffin Nos. 4 and 5 and was in the No. 6 Area of the National Coal Board's South West Division and was at the village of Six Bells some twelve miles north of Newport. There were three shafts at the colliery. One of these was the manriding and downcast shaft known as the Vivian Pit. This was half a mile north and was formerly part of another mine. The two other shafts were at Six Bells and were used for winding both men, coal and materials. The No.4 upcast was equipped with a electrically driven exhausting fan with a capacity of 280,000 cubic feet per minute at 4.6 inches water gauge. The No.5 shaft was the downcast. There were 1,213 men employed below ground and 239 at the surface. The colliery produced 1,800 tons of saleable coal per day with about 830 tons coming from the Old Coal Seam. The colliery always had been a safety lamp mine. There were 1,450 electric cap lamps, 85 flame safety lamps for the use of workmen as firedamp detectors and 79 internal relighter type flame lamps for the use of officials. The undermanager of the No.5 Pit, which included the W District, was F. White, who was killed in the explosion and the Colliery Manager was V. Luther. The Group Manager, R. Williams, the Area Production Manager A.E. Hiscox and the Area General Manager L. Walker.

The Old Coal Seam, which was the lowest that was worked, was at a depth of 352 yards at the Six Bells shaft but the average depth of the W District was 550 yards which was due to dip and surface rise. The seam averaged in thickness from four feet nine inches with a middle dirt band a few inches thick. The Meadow Vein Coal was about 22 yards above and had not been worked in this area. The strata between these seams were mainly strong clift or shale, but it included two features which called for special mention. Some five feet above the Old Coal Seam there was often a bed of quartzitic sandstone which was about on foot three inches thick. This was found in the shaft sinking and observed in parts of the district after the explosion. There was also a 'rider' coal some one foot six inches thick about 25 feet above the Old Coal Seam.

The W District was near the old, disused workings in the Old Coal Seam of the Marine Colliery where a disastrous explosion occurred in the Black Vein in 1927. The workings faces in the W District we identified by the letter 'O' followed by a number. There was a single-unit longwall conveyor faces situated between a mile and a mile and a quarter from the shafts. All three were advancing northwards towards the

disused workings of the Marine Colliery. The O.10 unit had on it's right side, the gob of a series of previously worked faces, the O.12 unit was beginning to skirt the left side of the O.10 unit. The O.18 unit had solid coal on both sides. The roadways slightly towards the faces which, in turn, rose slightly from west to seat. O.10 and O.18 were normal production units and O.12 a standby face. Coal was filled for two weeks out of three on the morning shift and in the third week on the afternoon shift.

The O.10 face was 103 yards long and had been advanced at the rate of about 12 yards a month to within about 55 yards of the Marine Colliery old workings. The coal was cut near the floor to a depth of three and a quarter feet by a machine mounted on an armoured conveyor and both machines were driven by compressed air. Hydraulic props and linked bars a meter long were used in a 'prop-free front' system of support. The roadside packs were eight yards wide and the waste between was completely caved. The intake loading gate was supported by steel arches backed with wood lagging and the height was gained by ripping the roof to six feet. The arches were 12 feet wide and ten feet high and were known as the 'twelve feet arches'. The road that had formerly been the intake for O.9 face had become the supply road for O.10 and was being reconditioned as the face advance. Shots were fired in coal and in the stone of the intake face ripping.

The O.18 face was 96 yards long and had been advanced at the rate of 27 yards a month. The coal was cut near the floor to a depth of four feet six inches and filled by hand to a belt conveyor, both machines were driven by compressed air. The roof was supported by adjustable friction-type props and linked bars four feet six inches long. The waste had been completely caved until difficult roof conditions prompted a change in May 1960, to strip packing. The packs were four yards wide and the wastes nine yards. The intake road was supported with twelve feet arches for the first 200 yards and with eight feet arches eight feet wide and seven feet high for the last 40 yards. The return was supported by ten arches. The height was made by ripping the roof and shots were fired in the coal and in stone except in the intake.

The O.12 standby face was 118 yards long. The coal was worked and filled by hand onto an electrically driven scraper chain conveyor. The face had advanced a total distance of 20 yards and only ten yards in the six months prior to the explosion. It was last worked for one shift on the 8th. June 1960.

The coal from the face conveyors was transported by way of stage loaders and semi-troughed belt gate conveyors to two 30-inch belt trunk conveyors in tandem on the main intake which were all electrically driven. The tram-loading point was on the double parting near the old O.1 intake. Supplies for the O.18 unit were distributed by trams driven by a system of compressed air from the double parting through O.7 Crosscut to the main return and then to the face of the supply gate . Those from O.10 and O.12 units were taken in trams through O.7 Crosscut to the main return and then back through O.2 Crosscut to the main intake and there they were off loaded and man handled. They were then drawn to O.10 supply gate on a single tram hauled by a compressed air driven engine situated near the face.

About 5.000 cubic feet of air per minute entered the O.10 face from the loading gate and about another 1,500 cubic feet per minute from a controlled leakage passing along the supply gate. There was no provision made to deflect air into the O.12 face but some air naturally took this course. The ventilation of the O.18 face was in series with the of the O.12.

The only major difficulty that had been encountered in working the O.10 unit arose from a large roof cavity which developed in the intake near two parallel faults about 170 yards from the main intake. The cavity began at the roadhead and extended as the face advanced until it was at least 30 feet long and about 20 to 30 feet high from the roof to the seam. The arches set beneath it were originally covered with lagging timber and some debris but this was altered by later repair work. At the time of the explosion there was a considerable thickness of fallen stone above the lagging. Firedamp

accumulated above the debris and was sometimes found at the face ripping up to, but not after, 9th. May 1960. At the time of the disaster it was not considered necessary to maintain a brattice sheet at the face ripping.

The most serious problem from the point of view of the ventilation was encountered in O.18 unit. Firedamp was frequently found at the intake roadhead face ripping and from time to time shots could not be fired there. The ventilation engineer, R.W. Simpson, investigated the problem in December 1959 and on his recommendation a 'Venturi' type air blower was installed at the ripping. this did not overcome the problem and in May 1960 the thickness of the roof ripping was reduced from about six feet to three feet by taking up some of the floor and reducing the size of the roadway by using eight feet arches. The manager prohibited shotfiring in the ripping and arranged for methanometer surveys with daily reports of the results. Another 'Venturi' was installed in the face ripping of the return roadhead.

On the afternoon shift of 27th. June coal filling proceeded normally on the O.10 unit under the supervision of W. Doel, an overman, and J. McDonald, a deputy. R. Hall, a deputy acting as shotfirer, assisted by K. Baker, a collier, fired about 30 shots in the coal. Neither Hall nor the overman, who had tested the waste at the return end of the face before any shots were fired, found any indication of firedamp. McDonald, on his mid-shift inspection, found small feeders of firedamp in O.10 and O.9 returns and in the O.12 loader gate. during his pre-night shift inspection, he found the same small amounts of gas. T.G. Morgan, the overman in charge of O.18 stated at the inquiry that because of trouble with the conveyors, coal filling stated late i the shift and the 'cut' was not cleared. The deputy for the O.18 unit D.E. Price found firedamp a the face ripping in the return and intake and at two place on the face in both his mid-shift and pre-night inspections. It was reported to him later in the shift that a coupling on the face conveyor motor had been sparking, but when he reached this place the trouble had been attended to by a fitter and Price was satisfied with his work.

Only ripping and repair work was done on the night shift of 27th-28th. June in O.10 unit where deputy R.H. Law was in charge. He had found small quantities of firedamp in the returns of O.9 and O.10 during his mid-shift inspection. During his pre-day shift inspection, he found slight indications of gas in the return end of the waste and in the return of O.10 unit, in O.9 return rippings and in a cavity farther outbye. He did not find any firedamp in O.10 intake rippings during either of his inspections. At about 3. a.m., E. Boots, a shotfirer, assisted by J.H. Evans, fired a round of shots on the O.10 intake face rippings. Boots tested for firedamp, examined the holes with a break detector and used a charge of two, four-ounce cartridges of Unigex explosion in each. He fired the round and examined the rippings for firedamp and pulled down the loose stone. Law was not present at the firing of the shots but on his inspection later noticed some bed separation at the face of the ripping. The supports had not been advanced but he considered that this could safely left for the day shift as nothing was likely to fall.

On O.18 unit, the deputy W.C. Mash, detected some firedamp in the intake ripping and replaced the brattice sheet. W.V. Jenkins and A. Mathews, underground fitters, were putting in a two inch compressed air line through an existing hole in the brickwork of the O.9 Undercast and they noticed that a girder on the face side of the undercast had shifted slightly and a small quantity of debris had fallen but they considered that there was no danger from further falls. The compressed air supply was twice cut off for the whole of the district as Jenkins repaired a tapping gland. The first period was from about 11.30 p.m. to 12.15 p.m. and the second from 5.30 a.m. to 6.15 a.m. During there periods the 'Venturi' appliances in O.18 unit could not function.

The day shift descended between 6 and 6.30 ,m, on the 28th. June. No one can say what the men were doing on that shift but the manger would have expected five men, including the deputy on O.10 face, three or four men working on the face rippings of O.18 intake, a maximum of six supply men in O.18 return and a borer and his assistant in the return outbye of the crosscut near O.18 unit. The rest of the men would normally

have been advancing packs, withdrawing supports and advancing the face conveyor and should have been along the main loader belts since the manger had had a report that the conveyors were getting very dirty and had arranged that they should be thoroughly cleaned.

At about 10.45 a.m. on Monday 28th June, M. Purnell, a linesman, was working with D. Lang putting up a signal line near the electric haulage engine about 25 yards inbye of the entrance to the old T intake. Lane was about ten yards inbye of Purnell when there was a noise and a lot of dust. Purnell fell on the engine and Lane was blown past him. Purnell had no idea what had happened but when he picked himself up he found Lane apparently dead. He began to make his way to the pit bottom, feeling along pipes because the air was so thick with dust.

Two fitters H.J. Legge and C.J. Lewis, were eating by the transformers in the mouth of the old T intake when they heard a sound like compressed air pipe bursting. There was great deal of dust in the air and they lost contact with each other but made for the pot bottom as best they could. Legge thought that a transformer had blown up and on his way to outbye, he telephoned to the pit bottom. Shortly afterwards he met S, Holland, a deputy, and W. Coleman, an underground engineer, who were coming to investigate and told them of his experience..

S. Holland was the deputy responsible for the inspection of the airways and had a good overall knowledge of the pit. He and Coleman had been coming outbye from an old district when they met a cloud of dust. They thought a compressed air pipe had broke and hurried to the bottom of the downcast pit. The dust cloud had been seen at both shafts and someone had telephoned the surface. The manager told Holland to investigate and he and Coleman went along the main intake towards W District. They met a number of men going about their normal work and were told that a man nearby was feeling ill. Holland gave instructions to take the man out of the pit. He did not speak to the man but later realised it was Lewis..

Holland and Coleman later met Legge who told them of his experience at the old T transformers. They went to the transformers and finding them undamaged, returned to the main intake and continued inbye. A few yards past the junction with the old T intake, they saw a body, which must have been Lane. At the double parting they found the air so thick with dust that they concluded that an explosion must have occurred. They were unable to make contact with the pit bottom by telephone so Holland sent Coleman out to report to the manager and went on alone. Just inbye of the air bridge at O.7 he found a fall almost blocking the main intake and he decided to retreat. On the way back he noticed that one of the separation doors in the mouth of the old T return was damaged. The other was open. He close it and observed then a considerable increase in the quantity of air passing down the main intake.

Holland continued inbye and met the manager and the area general manger who happened to be making a visit to the colliery. He reported his findings and the manager issued instructions that all the men were to be withdrawn from the pit and the emergency procedure was to be put into operational, All three went to the surface to study the plans of the mine and to decide what action to take. The manager and Holland returned below shortly afterwards with a canary. On their way inbye they met H. Silverthorne, an overman and these three went over the fall where the met P.J. McLaughlin, the captain of the colliery rescue team. They also found other men among whom was B. Rees, a collier in No.4 Pit, who was chairman of the colliery lodge of the National Union of Mineworkers. Some of these men had found two doors in O.7 Crosscut destroyed and fixed a temporary door to try to restore the ventilation.

The manager instructed everyone to leave the pit except Holland, Silverthorne and McLaughlin. These men accompanied him through O.7 Crosscut into the main return. There they tested for firedamp and found up to two per cent. About 15 yards inbye Mclaughlin saw that the canary had died so the party had to go back. They went to the

fall in the main intake and started to make a hole over it. They had just succeeded in doing this when the rescue teams arrived.

The rescue brigade from Porth Central Rescue Station and Six bells Colliery went down the pit soon after 1 p.m. under the supervision of Superintendent of the Crumlin Rescue Station. After setting up a fresh air base, these teams started exploratory work and were later supported by two other teams.

The hole over the fall was not large enough to allow a man to pass wearing breathing apparatus and the first explorations were made by way of the O.7 Crosscut and the main return. One team got as far as half way along the O.18 face before they had to retire since the air in their breathing apparatus was used up. They found a number of bodies and saw that the doors on the crosscut near O.18 unit had been blown towards the return. Another team went into the O.9 return but found the way blocked by a fall of roof inbye of O.9 Undercast. By the time these two teams had returned and reported, the hole over the fall had been sufficiently enlarged for the men to get in wearing apparatus. The teams returned to say that the air was stagnant and there were no survivors.

The men who lost their lives were-
Ivor James Bainton aged 48 years, cutterman.
Daniel James Bancroft aged 46 years, collier on Panzer.
Robert Charles Brown aged 35 years, roof control officer.
Frank Cooper aged 44 years, supplies man.
Joseph Corbett aged 50 years, haulier.
Thomas George Crandon aged 46 years, repairer.
Walter Thomas Davies aged 34 years, borer.
Royden James Edwards aged 27 years, repairer.
Percy Gordon Elsey aged 52 years, repairer.
Albert John Evans aged 34 years, packer.
Leonard Keith Frampton aged 29 years, collier.
Albert Gardner aged 59 years, assistant cutterman.
George Goldspink aged 37 years, repairer.
Clive Alan Griffiths aged 18 years, prop checker.
Vernon Alexander Griffiths aged 33 years Deputy Grade I.
Ernest Victor Harding aged 51 years, Deputy Grade I.
Idris Jones aged 57 years, packer.
John Percival Jones aged 56 years, repairer.
Joseph John King aged 56 years, packer.
Dennis Edmund Lane aged 19 years, wireman.
George Henry Luffman aged 55 years, general worker.
Telford Cecil Mapp aged 42 years, general worker.
Herbert Amos Mayberry aged 55 years, dumper.
William John Morden aged 52 years, engine driver.
Sidney Moore aged 54 years, repairer.
Colin Malcolm Donald Morgan aged 26 years, repairers.
Colin Reginald Morgan aged 22 years, assistant repairer.
Ray Martin Morgan aged 44 years, repairer.
Islwyn Morris aged 44 years, deputy grade II.
Anthony Verdun Partridge aged 20 years, assistant borer.
William Henry Partridge aged 45 years, borer.
Trevor Paul aged 25 years, assistant repairer.
Wilfred Alfred Charles Phipps aged 60 years, cutterman.
Albert George Pinkett aged 45 years, collier.
Frederick Rees aged 37 years, fitter grade II.
Mansel Reynolds aged 21 years, measurer.

William Glyn Reynolds aged 21 years, assistant repairer.
Wilfred Hughes Thomas aged 57 Years, repairer.
Arthur Waters aged 37 years, general worker.
Phillip John Watkins aged 53 years, engine driver.
Wilfred Weston aged 47 years, water infuser on Panzer.
Frederick White aged 58 years underground manager.
William Burdon Whittingham aged 55 years, assistant repairer.
Richard John Williams aged 51years, general worker.
John Woosnam aged 24 years fitter Grade I.

The inquiry into the causes and circumstances of the disaster took place in the No.2 Court of the Civic Centre, Newport on the 19th. September 1960 and sat for eight days until the 28th. September. All the interested parties were represented and the inquiry was made by T.A. Rogers, C.B.E. M.I.Min.E., H.M. Chief Inspector of Mines and Quarries. The final report was presented to The Right Honourable Richard Wood, M.P., Minister of Power on the 15th. December, 1960.

The preliminary investigation of the explosions area failed to disclose any obvious cause of ignition and it was realised that it would be difficult to determine the point of origin of the explosion. Microscopic examination of a large number of samples showed that the flame had swept through about 3,000 yards of roadway and each of the faces with the exception of the O.10. The explosion as not violent and there were few signs of blast. Specimens of coked dust gave clear signs that the flame had entered both ends of the O.12 face and coked deposits were found in O.10 supple road which indicated that the flame had travelled from the main intake to the old O.9 face and along it to the O.9 return where it died out about 200 yards from the face.

Tests were made on the ventilation and a careful watch was maintained, especially when the barometer was falling, but there was not any time any indication that firedamp was given off. The safety lamps, forty eight electric cap lamps, from the explosion area were examined at the S.M.R.E. Twenty nine were found to be undamaged and the damage to the others could not have caused the disaster. The flame safety lamps were also examined with the same results. An examination of the colliery records showed that the dust had been sampled before the explosion and was in order except for December 1959 and April 1960. No explanation was given for the December omission but the man who had to take the samples, said that he was prevented from doing so in April because of his daily work in the ventilation of the O.18 unit.

K.S. Worthington, H.M. Inspector of Mechanical Engineering, made a critical examination of all the mechanical machinery in the W District and of the compressed air machinery on the surface. He found some minor defects but none that could have been the source of the explosion. The electrical apparatus was examined by A.L. Alexander, H.M. Electrical Inspector of Mines and Quarries. The apparatus was found to comply with the certified designs and, apart from minor defects, was well maintained.

F.J. Hartwell, a Senior Principle Scientific Officer at the S.M.R.E. said that the indications of the directions of the blast and flame suggested that the explosion started in the vicinity of the O.10 intake roadhead and the inquiry accepted this. It was thought that the firedamp accumulated from small feeders close to the roadhead and although the evidence was not complete, the inquiry took the view that the firedamp came from a fall of roof and was ignited by a stone falling and sparking on a steel girder. As to the means of ignition, contraband, shotfiring and frictional heating could be dismissed. A. Davies, a National Union of Mineworkers' Inspector, took a minority view that the gas was ignited by a shot fired in the ripping but the direction of the flames did not support this theory.

The inquiry came to the following conclusions-

"No one can say with certainty where or by what means the explosion at the Six Bells Colliery started. But after careful consideration I think that-

1) The explosion started as an ignition of firedamp in the roadhead roof ripping of O.10 intake.
2) The accumulation of the firedamp might have been prevented had there been a hurdle sheet near the face ripping.
3). The cause of ignition was frictional heat produced by the impact of a piece of quartzitic rock falling for a distance of about six feet, from the roof cavity exposed by shot firing, onto a steel girder forming part of a conveyor canopy.
4). The fall of this rock might have been prevented had the roof between the last-set steel arch and the new ripping face been supported immediately after the firing of a round of shots there about seven hours before.
5). An explosion of firedamp alone might not have caused any casualties as there was nobody in the vicinity at the time.
6). The explosion which spread throughout most of the district was mainly of coal dust raised on the conveyor roads.
7). The coal dust explosion might have possibly have been confined to O.10 unit had there been sufficient stone dust barriers suitably placed."

Mr. T.A. Rogers, made some recommendations as a result of the inquiry. He said-
"Implementation of some of these suggestions might well necessitate an increase in specialised staff, but I am convinced that in some fields much more specialised work should be done to help the manager in the discharge of his very onerous responsibility for safety.

I recommend that-
1). The Working Party of the Safety and Health Committee of the Coal Industry National Consultative Council which is to review the general problem of coal dust explosion hazards should consider, as a matter of urgency, what additional precautionary measures could be taken on lengths of conveyor roadways nearest the face and most likely to be affected by a firedamp explosion.
2). The potential danger of firedamp ignition associated with the fall of certain kinds of rock should be recognised by management as an additional reason for perfecting measures designed to prevent falls at roadheads and for the maintenance at all time of effective ventilation of roof rippings, cavities and waste edges.
3). The ventilation engineering service of the National Coal Board should provide managers with the greatest possible specialist advice and assistance on firedamp drainage by boreholes and on all aspects of ventilation.
4). The National Coal Board's efforts designed to provide deputies with the best means of examining for firedamp in places out of easy reach should, if possible, be intensified.
5). All persons engaged in shot firing should bear in mind that the safe performance of their duties demands meticulous care and management should lose no opportunity of satisfying themselves that it is being exercised. The nature and form of stemming material best suited to general use and least likely to lead to malpractice should be investigated. Trails of foam injection into ripping shotholes should be encouraged. a wider use of explosives specialists could have many advantages.
6). Mining engineers of the National Coal Board and other interested parties in South Wales should give fresh consideration to ways and means of reducing the incidence of large cavities on roadheads and of dealing safely with any which occur.
7). The Ministry of Fuel and Power should review with interested parties the use below ground of air ejectors."

HAPTON VALLEY. Burnley, Lancashire. 22nd. March, 1962.

Happton Valley Colliery was in the N.C.B. North West Division on the boundary of the County Borough of Burnley. The structure of management was Mr. R. Lowe, Area General Manager, Mr. J. Whittaker, Area Production Manager, Mr. W.E. Rawstron, Group Manager, Mr. A.L. Wier Manager, and Mr. R. O'Hara Undermanager.

On the day of the explosion, Mr. B. Kennedy, a certificated colliery manager was in charge of the colliery in the absence of Mr. Weir. The colliery, which employed three hundred and eighty six men below ground and sixty seven on the surface, had a daily output of about 700 tons of saleable coal all got from two faces Nos.2 and 5 in the Union Seam.

The colliery had three shafts. No.3 was the downcast shaft used for winding men coal and materials, No.4 was the upcast shaft used for winding men only and the No.2 shaft was used for pumping water. The No.4 shaft was equipped with an electrically driven exhausting fan producing 112,000 cubic feet of air per minute and 4.3 inches of water gauge.

Following the completion in January 1962 a surface drift, 1,260 yards long and dipping at a gradient of 1 in 4.16 was brought into use as a second intake. Before this drift connected with the mine workings the ventilation of the mine had been assisted by a booster fan situated in the main return airway about half a mile from the bottom of the upcast shaft. Because it no longer made a significant contribution to the ventilation of the mine, the booster fan was taken out of commission and put on care and maintenance basis in March 1962.

The colliery had always been a safety lamp mine and in addition to electric cap lamps in general use flame safety lamps were issued to officials and elected workmen as firedamp detectors. These lamps were of the internal relighter type.

The Union Seam was 171 yards deep at the shafts and the only one that was worked at the colliery and was from 3 feet 4 inches to 3 feet 9 inches thick with a hard fireclay floor and a roof of medium strong shale. As a result of faulting, the cover at the face of No.2 District was 242 yards. The seam was gassy and in before this explosion there had been three ignitions of firedamp at the colliery.

On the No.1 face, which was discontinued, there was an ignition during shotfiring on 23rd. June 1960 and another in the undercut attributed to frictional sparking on 28th. July 1960. The third ignition also ascribed to fictional sparking in the undercut occurred, in No.2 return gate stable on 4th. April 1961.

To reduce the risk of ignition in the undercut, the management had installed cutting jibs with an internal water feed. The cutting machine on the main face line was also fitted with a compressed air/water ejector for ventilating the undercut, but this additional safeguard could not be applied to the machines that were undercutting in the stables.

The No.2 face was 155 yards long was nearly 1Å miles from the pit bottom and was advancing southwards in the solid on a rising gradient of 1 in 6.25 with a very slight rise from the intake gate to the return gate. It was started in September 1960 and the face had advanced 765 yards at a rate of about 10 yards per week. The No.5 face was advancing in the same direction and was 400 yards behind and 33 yards to the east of the No.2 face.

At the face, the coal was cut about 1 foot above the floor level by an electrically driven machine mounted on a armoured flexible conveyor. Until the 3rd. February 1962, the depth of the cut was 6 feet 6 inches but on that day the jib was changed and the depth of the cut increased to 7 foot 6 inches.

Coal in the stables was cut at the floor level by shortwall machines. After cutting all the coal was won by explosives and compressed air picks. The same type of explosive was used in taking down the ripping gate which were kept well up to the face. The normal cycle of face operations was as follows:.-

The afternoon shift advanced the face conveyor, drilled shotholes in the face, withdrew supports from the waste, drilled and cut the stables and ripped the intake gate. The night shift ripped the return gate, cut the face line and commenced filling. The day shift completed the filling.

The roof at the face was supported by friction type props set to corrugated steel bars 8 feet long. Additional frictional props were set as breakers at the edge of the waste which was completely caved between the six yards wide intake gate pack and the 8

yards wide return gate pack. The intake gate was 14 feet wide and 10 feet high and the return gate, 10 feet wide and 8 feet high. These were supported by arched steel girders which were tilted and backed with by fire resistant wood boards.

The coal from the conveyor face was transferred to a belt conveyor in the intake gate. This was the first stage of a trunk conveyor belt system to the bottom of the shaft. Some supplies reached the face from the surface drift and the intake gate, using the tub pack provided in that gate. Other supplies came down No.3 shaft and along the main intake airway in the tube to the cut-back. There the tubs passed through separation doors into the return airway where they were taken by and endless rope haulage to a point in the return some 300 yards outbye of the face ripping. The tubs were then hauled inbye by and electrical engine direct rope engine situated near the face ripping.

The ventilation records show that for some months before the explosion, the quantity of air as measured at a point in the intake gate 10 yards outbye from the face was slightly in excess of 20,000 cubic feet per minute. The records also show that during the thirteen months before the explosion, the firedamp content of these samples collected at a point in the return gate, 10 yards from the face varied between 0.4 and 0.7 per cent but occasionally it was outside these limits.

Firedamp was drained by holes 120 feet long bored from the return gate into the shale above the waste at intervals of 35 yards. The holes were connected to a pipe 6 inches in diameter which was increased to 8 inches in the main return to the bottom of No.2 shaft and to 12 inches in the shaft. The firedamp was drawn from boreholes and discharged to the atmosphere by an exhauster on the surface. The quantity of gas drained averaged over 100 cubic feet per minute which represented about 55 per cent of the make firedamp on the face.

The practice was to fire shots in the intake gate stable and also in some of the top coal on the face during the night shift to facilitate the start of filling operations, The return gate stable was fired either at the end of the night shift or at the start of the day shift according to how work had progressed. The remainder of the top coal followed by the bottom coal was fired during the day shift. The intake gate ripping was fired on the afternoon shift and the return gate ripping on the night shift.

In addition to the deputies who were not authorised to fire more than 10 shots per shift there were shotfirers available on the day and night shifts and they each carried 40 detonators. In order to ensure that all demands for shotfiring were met, some of the shotfirers shifts were ‘staggered’ with the main working shifts. As a result there were frequently three shotfirers available at the beginning of the day shift.

The volatile content of the coal was 32 per cent but the management had not formally declared this figure to His Majesty’s Inspectors and were thus required by law to ensure that a minimum of 75 percent incombustible materials was always present on the roof, side and floor of the roadways. At the last statutory sampling before the explosion the incombustible content of most of the road dust samples was well in excess of the minimum required.

A stone dust barrier consisting of seventeen heavy shelves and eight light shelves covering about fifty yards of roadway were in the intake gate, about three hundred yards from the ripping. One hundred yards further, inbye there was a similar barrier of twelve light shelves. Automatic firedamp alarms were not used at the time of the explosion.

The general impression created by witness was that the ventilation of the district had always been good and that men working on the face were obliged to wear coats or woollen garments to keep warm. There were no reports of firedamp having been detected other than occasionally in the return gate stable.

The day before the explosion, on the afternoon shift of the 21st. March, the face conveyor was moved over, the waste drawn off, the face and stables drilled, the coal in both stables cut and the intake gate ripped. Mr. J. McKillop, the deputy in charge of the

district, fired the ripping. In his report for the shift he noted that there was broken roof in the intake gate stable and his recollection was that the waste behaved quite normally in that as the supports were drawn it hung first for ten yards and then stared to cave progressively throughout it's full length.

On the following night shift, the district was in a charge of Mr. R. Jackson, a deputy, and the main operations in progress were the cutting of the coal on the main face line and the ripping of the return gate. Work proceeding normally and in spite of a late start, cutting was completed before the end of the shift.

The jib of the machine drawn out of the cut and the electric cable detached and taken into the return gate. Jackson, who examined the district twice during the night shift observed nothing unusual but did notice a slight roof break of about 2 to 3 inches throughout most of the face.

His last visit to the return gate stable was soon after 6.30 a.m. and although the stable had been cut on the previous shift he found no firedamp there. In his opinion the ventilation was very strong. He travelled the return gate twice and on both occasions observed three empty tubs and two bogies near to the direct rope hauler and attached to the rope. There were a few small roof cavities in this gate, apparently caused by the deterioration of the backing boards, which had allowed roof dirt to fall through.

Two shotfirers, Mr. R. Latham and Mr. R. Hutchinson started at normal shift time and a third shotfirer Mr. R. Ridge came on an intermediate shift starting after midnight. Each fired forty shots distributed between the intake gate stable and the main face line. No shots were fired in the return gate stable although nine holes had already been drilled there. None of the shotfirers found any firedamp during the shift. In addition to the shots in the coal the deputy himself fired a few in the return gate ripping.

To facilitate packing the natural from the return gate ripping Mr. G. Rimaldi, who was in charge of the rippers took down brattice sheet which had been erected to deflect the air into the return gate stable. This sheet was not re-erected because Rimaldi and his team failed to complete the building of the pack. The unpacked ripping debris was retained in the highly inclined gate behind a wooden barrier about three feet high. It is worthy of note that Rimaldi confirmed the deputy's statement that there were three or four tubs at the head of the return gate.

At about 10.15 p.m. Mr. J. Feltell, an attendant, started up the booster fan and ran it ran about and hour. This had no significance in relation to the ventilation for the district, it was part of the care and maintenance routine of the fan.

Mr. Jackson left the return end of the face just after 7 a.m. and at about 7.30 a.m. he met Mr. J. Halstead, one of the incoming day shotfirers, at the junction of the No.2 return with the No.1 return. He told Mr. Halstead about the holes which were drilled and ready for firing in the return gate stable. At the deputies' Meeting Station at the cut-back, Mr. Jackson discussed the condition of the district with Mr. S. Bullen the coming day shift deputy.

The workmen of the day shift reached the face about 8 a.m. on the 22nd, March, some by the return and others by the intake gate. With one exception, none of those who went on to the face from the return gate recalled seeing a brattice sheet in the position near the return gate stable. In addition to the deputy in charge of the district there were two shotfirers on the face, Mr. J. Halstead at the return end and Mr. K. Clarkson at the intake end, nineteen fillers with Mr. J. Murray as captain, two conveyor attendants Mr. T. Isherwood at the return end and Mr. P. Ince at the intake end, a conveyor maintenance man, Mr. J. Allen and a mechanic Mr. G. Hartley. In the intake gate were Mr. J. Pollard, Mr. W. Bradshaw and Mr. T. Chapman who were working at a floor dinting about five hundred yards from the face ripping.

Two men, Mr. D. Rushton and Mr. R. Dunston were completing the building of the return gate waste side pack with ripping debris left by the previous shift. In the return gate was Mr. D. McGoogan, a mechanic who had been instructed to make an extension piece of the rope on the direct electric hauler. His machine had recently been

moved nearer to the face and the existing rope was not long enough to reach the return wheels of the endless haulage. Also in the gate were four electricians Mr. G. Pickles, Mr. R. Howarth and Mr. P. Tinsley who were engaged in hanging a new length of armoured cable and extending the signalling system for the newly positioned electric hauler. Mr. J. Barritt was responsible for supervising for this work and for the routine maintenance of the electrical equipment in the district. According to Mr. J. Holden, the driver of the endless rope haulage engine, three lads, R. Taylor, J Connings and J. Forrest left that cut-back early in the shift to collect tubs which had been left up the No.2 return gate.

The evidence suggested that the conditions on the face in the early part of the shift were quite normal. There was no evidence of roof weighting, of floor movement or of broken coal other that that constant with the firing of shots on the previous shift. The fillers who gave evidence said that on the face line the ventilation was normal and indeed many were wearing jackets and pullovers. With the exception of J. Madden and A. Fisk, none of the fillers heard any shots fired that morning.

The colliery records showed that flame safety lamps of the re-lighter type had been issued to the deputy and two shotfirers and on the non-lighter type to Murray and Fisk. Automatic firedamp detectors had been provided and used at the colliery but were not available on the day of the explosion because some had become defective and all had been sent from the colliery for repair or overhaul.

When the day shift overman, Mr. H. Lister, reached the intake end of the face at about 9 a.m., he found that there had been difficulties with the running of the face conveyor. Apart from a visit to the return gate ripping where he tested for firedamp, he appeared to have been entirely preoccupied with these difficulties. While at the return end of the face, Mr. Lister spoke to Halstead, the shotfirer, who, in the course of some jocular conversation said that he had already made a start by firing three shots. Lister did not go over the conveyor to the face of the stable but he gained the impression that some of the coal was down because he saw it being turned back into the stable by men who were working down there. He left the return end just before 9.45 a.m. to travel down the face.

Madden who was the last filler at the return end of the face line said that he was told by Rushton and Dunston as they were passing props to him over the conveyor, that shots were about to be fired and that they were going down the return gate to take shelter. Madden assumed that he was expected to act as sentry and regarding himself as being in a safe position continued to pull down some coal. Fisk who was working with J. Robinson in the return gate stable said that he did not find firedamp when he tested there at the beginning of the shift. He helped Halstead to stem ‘nine out ten shot holes’ in the stable and thought that the shotfirer coupled up the leads from the shotholes in series to the shot firing cable. Fisk went about 50 yards down the return gate to what he regarded as a safe place and he believed Halstead stopped some 10 yards short of this point.

When the explosion occurred, Murray was filling coal at a point on the face about thirty yards along from the intake gate stable. He thought it was about 9.40 a.m. when he heard a sound like the bursting of a compressed air line. The air reversed but the normal direction of the current was quickly restored, and although there was a considerable amount of dust in the air he did not see any flame.

The fillers along the face described in their own ways their experiences of the blast and the reversal of ventilation. Madden said he was flung over the conveyor and enveloped in ‘swirling soot’ which came rushing on to the face from the return end. He felt certain that the noise he heard was that of a shot being fired. Although he had never before experienced a firedamp explosion, he thought that it would produce a far large ‘Bang’. Fisk sheltering in the return gate also thought the sound he heard was that of a shot being fired. He said he heard the shotfirer turning the key in the exploder immediately before and he naturally associated this with the event. So far as he could

be expected to remember what happened in such circumstances. Fisk seems to have retained an impression that the blast came towards him from the face.

Pollard working on the floor dinting in the intake gate had just looked at his watch at 9.45 a.m. when he heard what he described as a thud and he and his mates Bradshaw and Chapman were enveloped in dust. The air reversed but it's normal direction was resumed very quickly. Pollard, whose evidence about the time of the explosion was confirmed by the recordings on the methane drainage chart, realised that something serious had occurred.

Bradshaw telephoned the surface the three men went into the intake gate on to the face. After going sixty yards along the face, Pollard realised that there had been an explosion immediately went back to a telephone and informed someone on the surface probably B. Kennedy the acting manager. He rejoined his mates and together they made their way along the face and into the return gate doing all they could to comfort the survivors, while stretchers and first aid equipment were being bought. Although in the course of his search for survivors, Pollard was obliged to move some bodies, he distinctly recollects it was not necessary to move that of Halstead the shotfirer who was found face downwards with his head outbye, lying on debris in the vicinity of the ripping.

Mr. J. Holden, the engine driver at the cut-back, said at about 9.40 a.m. he attempted to 'inch' the haulage rope but after moving it very slightly it held fast. Some five minutes afterwards he was enveloped in dust and both doors in the cut-back were blown open. Mr. R. McKenna, who was working in the cut-back at the time was sure Mr. D. Whitehead, who had been a deputy for many years and was now engaged on the supervision of fire-fighting equipment and stone dust barriers, was at the point in the main intake some two hundred yards outbye of James Bradley's junction when he felt the reversal of the air. He went to the cut-back where he was told on the telephone that something had happened in No.2 District. On going through the separation doors into the return, he tested for firedamp and estimated four per cent in the general body of the air. He then went up the intake along No.2 face and into the return gate giving what assistance he could.

The Boothstown Rescue Station's No.1 Team was practising at the nearby Huncoat Colliery and were summoned at 10.15 a.m. They arrived at the colliery 10 minutes later. The Station's No.2 Team arrived from the Rescue Station some 25 miles away at 11.10 a.m.

The No.1 Rescue Team was captained by Mr. L. Wheeldin and accompanied by Mr. W. Rawstron, the Group Manager. They went into the pit by the surface adit at 10.35 a.m. They entered the main return airway at James Bradley's Junction where they found .006 carbon monoxide but no firedamp in the general body of the air. The ventilation was good and although there was no smoke or haze, there was a slight smell resembling that found after a fire. The team proceeded towards No.2 face by the return gate.

The No.2 Team captained by Mr. W. Sturgeon and accompanied by Mr. L. Hampson, the Rescue Station Instructor and Mr. E. Whatmore the manager of Bank Hall Colliery, went underground by the surface adit at 11.15 a.m. They travelled the main intake airway where they passed a number of stretcher parties, along the face and a short distance down the return gate, Sturgeon reported among, other matters that he seen a shotfiring exploder on top of the retained debris near the return gate stable but he was not clear whether or not it was connected to the terminals.

Because of the relatively slight disturbance by violence and the absence of fire and the rapid dispersal of the afterdamp the affected area was re-entered very soon after the explosion. True to the traditions of the industry many willing helpers were immediately available to give first aid treatment including the administration of morphia to the injured. Very soon afterwards all the survivors were examined underground and further treatment given where necessary by the nursing sister and the Group Medical

officer. The positions of those who died in the pit were determined by the rescue teams.

Those killed-
Christopher William Brown, aged 55 years, driller,
Sampson Henry Bulle, aged 44 years, deputy,
James Cumming, aged 19 years supply man,
Robert Dunston, aged 26 years, ripper,
Stanley Faulkes, aged 41 years, filler,
John William Halstead, aged 53 years deputy and shotfirer,
George Hartley, aged 32 years, mechanic,
Raymond Earnest Howarth, aged 20 years, electrician,
Tom Isherwood, aged 49 years, face supervisor,
Donald Stewart McGoogan, aged 28 years, mechanic
Garry Pickle, aged 22 years, electrician,
John Robinson, aged 24 years, filler,
Donald Rushton, aged 33 years, ripper,
Robert Shuttleworth, aged 33 years, filler,
Ronnie Anthony Taylor, aged 16 years, supply man and
Benjamin Walsh, aged 25 years, filler.

Died from injuries.
John Grieg Barritt, aged 23 year electrician,
Joseph Forrest, aged 17 years,
supplies man and
Peter Tinsley, aged 16 years, apprentice electrician.

Immediately the recovery operations had been completed H.M.Inspector of Mines, accompanied by representatives of the management and the workmen carried out a preliminary inspection of the greater part of the mine including the explosion area. Shortly afterwards the Inspector and scientists from the Safety in Mines Research Establishment made other inspections of the explosion area. Neither inspection revealed any obvious point of ignition, ignition agent of the presence of firedamp. The Inspector and the scientists commenced and extremely detailed investigation which lasted two months

A detailed picture of the explosion area emerged from these investigations. Specimines of fibrous material collected in the intake gate were examined microscopically and did not show signs of having been subjected to heat. Although there was a thin layer of explosion dust on the conveyor gate, the dry stone dust on the barriers had not been disturbed.

specimens collected at points along the face indicated that the flame had travelled down the face to within about thirty yards of that stable. Much of that part of the face affected by flame and there were unmistakable signs of coking on the intake sides of the props, an indication that flame had come from the return side. Detonator leads coming from charged shotholes in the return gate stable showed obvious signs of charring on the first twenty yards of the face from the intake but further along the face where signs of some violence, although roof supports had not been affected.

Microscopic examination of fibrous specimens collected from an area between the face ripping and a point 550 yards outbye, showed signs of exposure to flame. Beyond this point to the junction of the No.5 District return, specimines had been subject to some heat but had not been carbonised. There were signs of blast near the ripping but the evidence as to the direction in this area was not positive. In the length of gate between points 28 yards and 180 yards outbye of the ripping, there were unmistakable

signs of blast in the direction of the face. Outbye of this area although there were a small number of small roof cavities and the floor was strewn with fallen stone, backing boards and other debris there were no indications of blast up to a point 280 yards from the ripping.

There was an electric section switch had been moved outbye presumably by blast. In the next 40 yards of roadway the damage from blast was the most sever in the whole of the affected area. In this length a number of badly damaged tubs and bogies were found derailed and smashed near the return wheel of the endless rope haulage. The wheel the carrying frame and the arch girder supporting it had all been displaced in an outbye direction but there was no sign of abrasion on the return wheel or its framework. For a further 200 yards outbye signs of damage were much less in evidence but there had evidently been strong blast some 650 yards from the ripping where a tank had been displaced. From there to the junction with No.5 District return there were signs of only slight blast.

Nowhere in the area was there any indication of a slow burning of rich firedamp/air mixture. The results of the examination suggest that the blast had affected in varying degree nearly 1000 yards of face and roadway of which 680 yards had been exposed to flame.

Ventilation measurements made shortly after the explosion indicated that the quantity of air leaving the district varied from 14,200 to 15,000 cubic feet per minute. The firedamp content of this air as ,easured by a methaneometer was between .6 and .8 per cent. The colliery records show that before the explosion in the quantity of air passing was higher and the percentage of firedamp lower but the actual make of firedamp was about the same. Excluding that being drawn off by the drainage system, this was about 100 cubic feet per minute.

Discarded firedamp drainage holes were sometimes sealed by the insertion of wooden plugs but some had been left unsealed. Six of the unsealed holes in a length of from 321 to 709 yards from the face ripping were examined for firedamp issuing from them. By using a methaneometer and probe firedamp was found in five holes but only one at 472 yards from the ripping gave any indication of continuing flow. This was small in quantity but up to 30 per cent was detected at the mouth of the hole. Relatively high concentrations of firedamp were found in a number os small cavities in the roof of the return gate but it was estimated that the total volume of pure firedamp in these cavities could not have been more than 50 cubic feet.

On the 24th. March one of HM. Inspectors made a ventilation survey in the return gate stable without a brattice sheet in position. By using artificially produced vapour clouds as a tracer he found that only a small proportion of the air leaving the face entered the stable. Here there was very marked recirculation. Using a methaneometer with a probe attachment the inspector found high concentrations of firedamp at a number of points between the roof and the top of the fallen coal but the total quantity involved was very small. On the same occasion the inspector using the same equipment made determinations of the firedamp content in the waste some of them from points 7 to 8 feet above the seam roof level. In no case was the concentration higher than that in the general body of the air at the face.

Although the quantity of air leaving the district immediately after the explosion was found to be substantially less than that record from the last statuary measurements made before the explosion later measurements showed that the quantity had increased to between 16.000 to 17,000 cubic feet per minute with a firedamp content of .4 per cent.

Because of the frequency with which the men and materials were known to pass through doors at the Cut-back and men through the doors at James Bradleys Junction it was decided to measure the effect of opening these doors on the ventilation district. Two tests were carried out one with the doors at James Bradleys Junction fully open and the other with the doors at the Cut-back partially open. In the first test the normal

quantity of air reaching the face was reduced to 6,000 cubic feet per minute and in the second by 5,000 cubic feet per minute.

In the course of the investigation two hessian sacks were found each containing the same type of Eq.S explosive in the cartridge form. One near the intake gate ripping contained 12 pounds on the other near the return gate ripping 56 pounds.

Although the first 14 yards of the face from the intake gate stable 10 shotholes had been drilled in the bottom of the coal, Nine of these had been charged and stemmed and a single shot exploder with connected cable was lying between the ninth and tenth holes.

In the return gate stable seven shotholes had been drilled and six of them charged and stemmed. The charged shotholes were disposed in two groups, two near the ribside and four to the left side of the stable. In the short length between the two groups there was a heap of broken coal lying against the face. It was clear from the evidence in the roof and face that at least two shots had been fired in the vicinity. Of the group of four shotholes the one immediately next to the broken coal and about 12 feet from the face buttock invited particular attention.

It was observed that the coal on the loose side of this hole was fractured by innumerable fine cracks. When this coal was removed by hand a plug or stemming at the front of the hole and three cartridges of Eq.S explosive were revealed. The latter were impacted together as through they had been subjected to pressure from the back of the hole, and the inner end of the last cartridge was covered by a coating of coal dust 1/8 " thick. The shothole was subsequently found to extend 12 inches beyond the last cartridge but this section was empty. A primer cartridge was not found and there was no evidence to suggest that the shot had blown out laterally. Two detonator wires were found in the hole one reached only as far as the stemming but the other extended to the inner end of the recovered part of the charge.. Nothing unusual was observed in the condition of the remaining five charged holes and they were subsequently fired without incident under the supervision of H.M. Inspectors.

A shotfiring cable without detonator leads attached extended from the face side of the conveyer over a roof bar under the return gate ripping on to the ripping debris where the remainder was tied in a hank with one of the leads connected to a single shot exploder. A shotfiring exploder key was later found in the clothing of Halstead, the shotfirer whose body was recovered from nearby.

A case subsequently found to contain 31 detonators was also found in Halsted’s clothing. Some of these with others were taken from the colliery magazine 25 in all were sent to the Armament Research and Development Establishment, Woolwich for X-ray examination and test. They were found to be in normal in all respects.

Explosive from the pit and from the colliery magazine when tested for behaviour and composition proved to be normal. Tests for sensitivity to initiation of detonation on some of the explosive referred to in paragraph 51 showed that it had not deteriorated.

The five safety lamps and 53 electric cap lamps (some incomplete) recovered from the district were sent for test. The flame lamps and 28 of the cap lamps were found to be in approved condition securely locked and in working order. The remainder of the electric cap lamps had sustained some damage but this was considered to have been caused by the explosion.

Smoking materials were not found either during the underground investigation or when the effects of the victims were examined on the surface. No combustible material was found. No electrical defect was found. All signalling and exploders were found to be in good condition. The apparatus was examined to look for frictional heat and all was found functional. The seams included pyrites nodules known locally as ‘bobbers’ and ignitions of firedamp had been known at the colliery attributed to cutter picks striking them. Because of smears left by aluminium alloys left with rusty steel a thermite reaction could arise. A fire hose nozzle was tested and found that it could leave aluminium smears but there was no indication that it had done so. In the length of the

return gate ripping there were 18 metal foils from the wrappings used for confectionery and chewing tobacco. When pieces of the specimines were submitted to glancing blows with rusty steel in a firedamp atmosphere ignition was obtained in all but two specimines. These foil wrappings which are generally of aluminium usually have paper backing sometimes waxed where this backing was retained ignition could not be obtained.

The two specimines which had signs of fusion when picked up 300 yards from the return gate ripping. The signs of fusion were very similar to the signs on the pieces of aluminium foil which had given incendive flashes when tested.

The state of the roof was the same before and after the explosion. The roof breaks observed at the face by the afternoon and night deputies were not accompanied by marked displacement and were not unusual. the deputies described the wastes a behaving normally. The small cavities in the gates were attributed to the force of the explosion.

Mr. F.J. Hartwell, the Senior Principle Scientific Officer in charge of the S.M.R.E. examination summarised the point of ignition and the spread of the explosion. These were based on three facts. First, none of the fibrous material had been exposed to flame for more than a very short time. Second, at no point in the explosion area was there evidence of slow burning by rich firedamp and third there had been a rapid moving of flame accompanied by considerable violence although not so great as would have been expected from the most explosive mixture of firedamp and air with a relatively ‘quiet zone’ between 180 yards and 280 yards outbye of the return gate ripping.

These three facts led to he belief that the explosion originated in the ‘quiet zone’. The signs were, that the flame had travelled outbye from this area with some violence to a point about 550 yards from the face ripping and possibly less violence inbye to the return gate stable. Here it was probable that there had been added firedamp which would have added to the violence sufficiently to raise some coal dust along the face contributing to the spread of the flame and blast in that direction.

Mr. Hartwell added that there might have been firedamp in the return gate stable and that flame from such an ignition could have blown out onto the face causing a minor coal dust explosion there. If this did occur, flame from the stable could have been propagated down the he return gate in a ‘trail’ of firedamp along the roof to a body of firedamp which would have exploded with flame and blast in both directions.

Either possibility would have required a presence in the return gate of a reasonably well mixed volume of firedamp and air. The violence of the explosion was of 8 per cent mixture of gas and air. He estimated that about 2,00 cubic feet of firedamp would have had to be present to have remained undispersed it would have appeared rather quickly.

There was no scientific evidence to show where the firedamp came from but he thought that the most probable place was along the face or the return gate stable. Dr. Willett for the N.C.B. thought that it came from ‘either the sold coal in the vicinity of the stable or the waste’. Mr. Clough, H.M. Divisional Inspector of Mines was firmly of the opinion that it came from waste because neither the face nor in the return gate stable were there strata breaks or displaced coal which were the more common signs of a rapid emission.

All were of the opinion that only frictional heat and explosives need be considered as the means of ignition. Mr. Crawford of N.A.C.O.D.S. suggested that the firedamp had been ignited by a frictional spark or thermite reaction as a result of vehicles running uncontrolled down the return gate. No other form of frictional heat was considered as a possible source of ignition.

Mr. J. Gormley for N.U.M. and Mr. Clough were both of the opinion that the shot fired in the return stable was responsible for ignition. Shotfiring operations were in progress when the explosion occurred. Some of the men that died were grouped some little way down the return gate as if sheltering from shotfiring and Madden and Fisk thought that

the explosion followed a shot. However if the explosion occurred after a shot the shotfirer must have had time to return the firing key to his pocket and this was found not to be the case.

Mr. Clough thought the ignition was in the stable would have been from the gas from broken coal and that this flame in turn ignited gas passing from the face into the return gate after being emitted from the waste. In these circumstances it was concluded that Halstead would have had time to return the firing key into his pocket and to begin returning to the shotholes before he realised that gas was burning in the stable.

In conclusion the commissioner was not able to give an entirely satisfactory explanation either of the source of the firedamp or of the means of ignition.

It was accepted that the explosion was caused by firedamp present in the return gate. The possibility that this was caused by an interruption of the ventilating current would mean that the ventilation would have to be stopped for two minutes and there is no evidence that this occurred.

In considering the possibility of a rapid emission of firedamp into the return gate stable it was possible that the required explosive mixture could have been formed in the return gate. On ignition the blast ahead of the flame travelling up the return gate could have dispersed and rich firedamp in the stable as to cause it to flame and continue the explosion with the help of coal dust along the face.

Firedamp from the high level in the waste could have been pushed out onto the face but it was felt this would have required a heavy strata movement which would be audible but there was no evidence of this. An emission from the waste could however have taken place quietly had the firedamp been hanging close to the edge of the waste but after the explosion efforts to establish the location of the firedamp were unsuccessful even though probes were pushed up into the waste to a distance of 7 to 8 feet above the seam roof level.

Two other possible sources of firedamp were considered. The first is the return gate ribside. A sudden emission of gas would normally be accompanied by breaks in the coal and surrounding strata. The fact no such breaks were found after the explosion is not however conclusive proof that they did not exist. They could have been near the ribside but concealed by packed material. The second possibility was that could have been some unplugged methane drainage holes. There were five such holes in the return gate between 200 and 350 yards outbye from the face. Separation of the upper beds resulting from the working of No.5 face could have made rich firedamp available to these holes. Relatively high pressures would have been needed to emit the firedamp but it was not thought that this had occurred.

As to the possible causes of ignition other than explosives and frictional heat all others could be dismissed. The use of explosives have long been the possible cause of ignition of gas and there was ample evidence that there was shot firing in the return gate stable at the time of the explosion. It was clear that shots in the stable were fired from a point immediately outbye the ripping debris. The position in which the body of the shotfirer was found that is on top of the debris, face downwards with his head pointing outbye and with the shotfiring key in his pocket suggests that after the explosion occurred he was either going towards or returning from the stable. At the time Fisk was sheltering in the return gate outbye of the ripping said in evidence that the blast came from the stable. The commissioner was satisfied that the rate of emission of the firedamp could have been such as to create adverse conditions in the vicinity of the stable between the shotfirers examination and the firing of the shot.

If shot firing been the cause of the initial explosion, it would have required a flame from firedamp ignited in the stable to communicate with and explode a mixture farther down the gate. The pattern of the blast showed marked signs of movement towards the face does not rule out this possibility as blast from a minor explosion in the return gate stable would have been masked by the effects of a much larger explosion down the

gate. This is of course presupposes two explosions and it is supported by a witness who gave evidence that the doors at the Cut-back opened and closed twice.

A great many pieces of foil of the type commonly used in the wrapping of confectionery and chewing tobacco were found in the return gate including some in the 'quiet zone' referred to by Hartwell. The S.M.R.E. showed that if this material was laid on rusty steel and struck a glancing blow with a hammer a thermite reaction, capable of igniting firedamp may result. Two pieces of foil found immediately on the outbye side of the zone showed signs of fusion which would result from the thermite reaction. No pieces showing signs of fusion were found in the zone but this was not proof that none was present.

In considering whether the firedamp was ignited by frictional heat it must be remembered that, at the beginning of the shift there were empty tubs at the top of the return gate waiting to be taken down to the return wheel. There was evidence that three supplies lads had been sent down early in the shift to collect tubs and that the rope itself which was to be lengthened was found to be fully extended after the explosion. The rope would not have been drawn by hand down the gate solely for recapping by the mechanic. It was more likely that the supplies lads used it to lower the tubs as far as possible and in this event the tubs would then have been at a point not more than a few yards from the outbye fringe of the zone. Had the tubs run uncontrolled from this point and ignited firedamp either by running over aluminum foil or by violent impact with other material the resulting ignition would not have produced the flame and blast pattern described by Hartwell.

The conclusion was that there was either one explosion predominantly of firedamp in which coal dust played a little part initiated at a point 180 yards outbye of the face by thermite flash from aluminium foil or two explosions, a minor one of firedamp and coal dust initiated by shotfiring in the return gate stable followed almost immediately by a major explosion of a large body of firedamp/air mixture in the return gate.

The danger of sparking from aluminium alloys had been known for some ten years and steps had been taken by the N.C.B. to limit as far as possible the use of equipment made from these alloys to situations underground where the danger of gas was remote. In view of the evidence from this disaster it was felt that a revision of the instructions, with particular reference to aluminium equipment should be made. Portable drills should certainly be considered since I understand that manufacturers can now produce then constructed of steel or brass.

The use of metallic foils in wrapping confectionery and tobacco is not clearly within the control in the N.C.B. or the mine owners. Dr. Willett in his submission suggested that various associations and organisations in the industry should jointly consider steps which might prevent aluminium foil wrappings from being taken underground.

It was recommended that-

"1). The N.C.B. should undertake further investigations into the effect of borehole drainage on the movement of firedamp where total caving is practised, including the possibility of using lower inclination boreholes aimed at exhausting from the waste cavitation in addition to boreholes into relaxed strata and the continuous monitoring of the firedamp content in return airways from such faces.

2). Mangers of collieries should ensure that stables are always ventilated.

3). Managers of collieries where shotfiring forms one of the principle face operations should review current shotfiring practice and ensure that not only explosives used are efficiently but that the circumstances are such that the shotfirers are not tempted to disregard the requirements of safety.

4). Every effort should be made to hasten the development of robust automatic firedamp detector which is easily maintained and gives a strident audible alar.

5). The N.C.B. should further revise the restrictions imposed on the use of aluminium based alloys so as to exclude them from the face workings from the return roads and from within 300 yards of the face in all other roadways.

6). The several associations and organisations in the industry should conceder ways and means of preventing aluminum foil wrappings from being taken below ground in permitted light mines.

TOWER. Hirwaun, Glamorganshire. 12th. April, 1962.

The Tower Colliery was in the No. 4 Area of the National Coal Board's South Western Division and was situated at the village of Hirwaun about four miles from Aberdare. The seams that the colliery worked were close to the bottom of the coal measures and it was centrally placed along the northern outcrop of the coalfield. Records showed that coal was first mined in 1864. The 'take' of the colliery traversed three large faults which naturally divided the mine into three parts. The natural division and a scheme of reorganisation and modernisation had resulted in the mine being served by six cross measure drifts from the surface and three vertical shafts. The colliery produced about 1,500 tons a day and employed 938 men underground and 234 at the surface.

The ventilation was produced by two fans. At the No.1 upcast shaft a Sirocco single inlet fan produced 95,000 cubic feet of air per minute at a water gauge of 4.1 inches and at the No. 4 upcast shaft a similar fan produced 180,000 cubic feet of air per minute at a water gauge of 2.8 inches.

Safety lamps were used throughout the mine. For general lighting the Oldham Wheat W type electric lamp was used. Senior officials and deputies used Thomas and Williams Cambrian type No.8 flame safety lamps and Thomas and Williams type No.1 flame lamps were used as gas detectors by appointed workmen. The seams that had been worked in the life of the colliery in descending order where the Four feet, the Six Feet, the Red Vein, the Nine Feet, the Bute, the Seven Feet and Five feet. At the time of the explosion the Nine Feet, Seven Feet and Five Feet Seams were being worked. Mr T. Wright was the Area General Manger, Mr. P.R. Weekes the Area Production Manager, Mr. V. Lewis, the Deputy Area Production Manager (Operations), Mr. S. Thomas the Deputy Area Production Manager (Planning) and Mr. T.G. Jones the Group Manager. The Manager of the colliery was Mr. J. T. Ryder and there were three undermanagers of whom Mr. C.J. Bell was responsible for the area affected by the explosion. This part of the mine was known as 'Tower 4' and was served by the No.3 Drift and the No. 3 New Drift and intake airways and the No. 4 upcast shaft. It was known as the 'G' panel and was in the nine Feet Seam.

The 'G' panel was developed following the establishment of a new ventilation circuit of which the no. 3 New Drift formed the main intake with a main return airway by way of a crossmeasure driven to the No. 4 upcast shaft. From these main airways, two levels at 30 yard centres were driven on the strike of the seam to the limit line of the working 850 yards inbye. In this area the Nine Feet Seam was found to vary little in thickness, 7 feet 6 inches, with a strong clift roof and a hard fireclay floor. At the time of the explosion there were two working places in the panel. One to the dip from the levels and worked by a Continuous Miner and was called the 'Miner' heading which was not affected by the disaster. The second working place was developed near the inbye end of the levels to the rise. This heading was known as MC3 which was the area where the explosion occurred.

The panel was under the supervision of an overman and a deputy on the morning shift and on the afternoon and night shifts by deputies and the assistance of an overmen who also had responsibility for other districts. On each shift there was shotfirer and a second official with the status of deputy was employed in the 'Tower 4' part of the colliery to closely supervise the arrangements for the ventilation of the several narrow drivages.

The MC3 heading had been driven at a rising gradient 1 in 10.5 in the full thickness of the seam for 328 feet and was 12 yards wide. The coal was won by shotfiring out of

the solid coal and loaded on to a short scraper chain conveyor by a Sampson MC3 Loader. The conveyor delivered the coal to a belt conveyor down the heading which in turn fed the main gate belt conveyor in the return level. Coal was worked on each of the three shifts. The support in the heading was by straight H section girders, 6 inches by 5 inches, carried on wood props set at the road sides.

All the machinery in the heading was electrically driven and supplied from a 300 kVA 3300/550 volt flameproof transformer in a substation in the 'G' return roadway about 500 yards outbye of the MC3 heading. The neutral point of the 550 volts winding was earthed. On the primary side of the transformer there was an oil-immersed circuit breaker which was fitted with time-lagged overload trips set at 50 amps. and a instantaneous earth leakage device connected to a current transformer in the secondary neutral lead. this was arranged to trip the circuit breaker when a current of 2.5 amps flowed from phase to earth in the 550 volt system.

The secondary side of the transformer was connect by a short length of .15 square inch paper insulated, lead covered, double wire, armoured cable to a flameproof air-break section switch in the same substation. This switch was provided with an isolator and a hand operated circuit breaker, and was fitted with thermal overload trips set at 142 amps., instantaneous earth leakage device designed to trip when a current of 3.5 amps flowed from phase to earth. the earth leakage devices were designed to trip and lock out automatically he respective switches on the occurrence of an earth fault on the 550 volts system and to indicate, by means of a visible flag, that a fault had occurred. A test button was also provided on each switch so that the correct functioning of the devices could be tested.

An armoured cable from the section switch passed inbye along the return to a flameproof gate end switch controlling the 'Miner' heading conveyor. The supply was looped through the busbars of this switch to a coupling box from which the 'Miner' was supplied and the cable continued to the MC3 heading and a flameproof gate end switch controlled auxiliary fan and the MC3 belt conveyor. Both these switched were in the return roadway a few yards from the entrance to the MC3 loader. From the last switch the cable passed up the heading to two coupled gate end switches placed 20 yards back from the face. One of these switches controlled the scraper chain conveyor and the other the MC3 loader. The feeder cable was connected at the end of the busbars of these switches and was looped back on itself.

The MC3 heading was ventilated by a 16 inch diameter Meco axial flow auxiliary fan which forced the air from the intake level through ducting which was 20 inches in diameter. The fan was in the connection between the intake and the return levels about 12 yards outbye of the MC3 heading. The manager had set a minimum quantity of 2,100 c.f.m. to be delivered to the face.

On the night shift immediately prior to the disaster, coal had been filled normally for the first half of the shift but was interrupted by an mechanical breakdown of the MC3 loader. The fault could not be rectified quickly and it was decided to complete the shift by shortening the scraper chain conveyor and lengthening the belt conveyor. The work had not been completed at the end of the shift and was carried on during the morning shift when the normal work force of seven in the heading was added to by two persons from other districts, as well as two fitters who were working on the CC3 loader and the ventilation official, who was later joined by three electricians. Two representatives of the workmen were approaching the heading along the return roadway on inspection duties.

The movement of the conveyors made it necessary to move forward the two coupled gate end switches which controlled the scraper chain conveyor and the MC3 loader required the addition of a new length of cable. Electricians, N. Lewis, (Class I), T. Davies (Class II) and an apprentice, M.A. Pearce were instructed by the electrician, in charge of the mine, to move the switches and extend the cable. Some difficulty had occurred with a pump in another part of the mine and Lewis had first to attended to

that. He made sure that Davies knew how the work should be done in the MC3 heading and told Davies and Pearce to go to the heading and make a start.

Davies arrived at the 'G' panel at about 8 a.m. and found the undermanager, C.J. Bell, in the 'Miner' heading. After some discussion, Davies cut off the power at the section switch in the substation for both the 'Miner' heading and the MC3 heading, removed the connecting pins in the box near the top of the 'Miner' heading and restored the power at the section switch. This cut off all power to the MC3 heading without interfering with the supply to the 'Miner' heading which was able to carry on working. This was at about 9 a.m.

Davies and Pearce them proceeded to disconnect the gate end switch in the MC3 heading and had almost completed the work when Lewis arrived back. He left Pearce to complete the work and Lewis and Davies made a test on a length of cable to be installed, which, at the time was lying along side the main conveyor in the return roadway. They found the cable to be satisfactory and Lewis secured a chain to the end of the cable which was then dragged by a horse for a distance of about 100 yards up the MC3 heading to it's new position. This was a few minutes after 10 a.m.

The underground manager, Mr. Bell, arrived in the heading at this time and was told by the deputy in charge, K. Strong, that the auxiliary fan had been stopped for 15 minutes. The Inspector, M.r C. Leigh commented-

"This statement was hard to believe since the power had been cut off at 9. a.m."

Five or six yards back from the face Bell found a concentration of gas near the roof which he estimated at two percent. He instructed the deputy to send everyone except the electricians back to have their food at the bottom of the heading while he remained with the electricians until they completed the connecting of the switch. This was done and he came out of the Heading with the electricians..

Lewis and Davies, having first cut off the power at the section switch in the substation, restored the connecting pins at the box at the top of the 'Miner' heading and went back to the section switch to restore the power to the whole of the 'G' panel. They had not made any tests of the re-erected apparatus.

Davies was the first to reach the section and stated that he tried to close the switch but failed because he 'was too quick'. Lewis closed the switch. He stated that he was watching the ammeter expecting to see the indication of the load of the auxiliary fan starting up when the explosion occurred. At this point he put the switch out. This was at 10.30 a.m.

The undermanager was in the intake level and went back to the scene with the overman who had been in the 'Miner' heading throughout the shift. He telephoned the manger to inform him and then went some distance up the MC3 heading so as to be sure that there was no one there. He found the heading too full of dust to be sure that there was no one there. He saw no sign of flame or burning of any description and the normal ventilation was only interrupted for a moment. The manager immediately went to the scene with other officials and workmen gave first aid treatment to the injured and arranged for them to be taken to the surface.

The Dinas Permanent Rescue Station was informed and the brigade arrived without delay and made an inspection of the heading. Later other brigades assisted in re-establishing the ventilation in the heading and for this a separate auxiliary fan was installed and supplied with current from a separate circuit.

Those killed were-
E. Bond aged 47 years, labourer,
L. Davies aged 37 years, fitter,
T. Jones aged 57 years, collier,
W.J. Maull aged 61 years, collier,
D.J. Price aged 51 years, collier,
L.R. Price aged 27 years, collier,

W. Smith aged 39 years, deputy,
K. Strong aged 32 years, deputy and
D. Williams aged 37 years, fitter.

Those injured-
L.W. Boulton aged 52 years, collier,
E. Davies aged 58 years, transfer point attendant.,
J. Jones aged 52 years transfer point attendant,
A. Lewis aged 52 years ventilation official,
A. Lewis aged 47 years roadsman,
T,. Lewis aged 56 years transfer point attendant.,
R. Morgan aged 26 years, repairer,
M.A. Pearce aged 20 years, apprentice electrician and
W. Strong aged 55 years, chargeman.

The inquest into the deaths of the men was held by M.r T Alwyn John, H.M. Coroner for North Glamorgan on 11th. May 1962. The jury returned the following verdict-
"All nine had died as result on multiple injuries accidentally received in an explosion in the MC3 road at Tower Colliery."

The Report into the causes of and the circumstances attending the explosion at the colliery was conducted by C. Leigh, H.M. Divisional Inspector of Mines and Quarries and presented to The Right Honourable Richard Wood. M.P., Minister of Power in November, 1962.

The explosion area was carefully examined after the disaster by all interested parties and the effects of the explosion were found to have been confined to the MC3 heading and a short length of the return level outbye of the junction with the heading. There was little evidence of flame and violence was apparent only at the junction with the return level and immediately outbye of that junction. The explosion was of gas only and coal dust played no part.

Little gas had been fond in the mine prior to the explosion but on the day before the explosion tests showed that there had been a increase. The heading had been unventilated for about 90 minutes when the power had been cut off and the auxiliary fan stopped and gas could the have built up. This was confirmed by tests a few days after the explosion.

At the time of the explosion there were no persons in the heading and no operations going other except power was being restored. The means of ignition was from a severe short circuit which had blown a hole through the cable a loop formed by a bend in the cable. Further investigations discounted any other means of ignition.

The Inspector, Mr. C. Leigh concluded that-
"I conclude that the explosion resulted from the ignition of inflammable gas in MC3 heading. The igniting source was arching resulting from a short circuit to earth in a newly inserted length of cable serving the electrical equipment in the heading, and occurred on the inside of a loop in the cable where it had been bent back on itself in order to connect it up to the switch in the heading. I think it highly likely that the short circuit was directly due to the insulation of the cable having been weakened as a result of the acute bending to which it had been subjected in making the connection to the switch."

At the conclusion of the inquiry, the Inspector recommended that-
"1). In any system of working requiring the use of an auxiliary fan provision shall be made so that the power supply to the fan may be maintained while any or all of the other plant in that working is shut down.
2). In any system of working requiring the use of an auxiliary fan arrangements should be made whereby the supply of electricity is automatically cut off from all electrical apparatus in that working place whenever the auxiliary fan is stopped.

3). In rapidly advancing headings where short lengths of cable have to be inserted frequently, pliable wire armoured cable or P.V.C. insulated cable should be used. Cable should always be transported in such a manner as to ensure that it is no damaged."