

Report of inquiry into the Chinakuri
Colliery disaster under section 24(4)
of the Mines Act, 1952.

X9(D3551):945.262.N58t
J8
65284

X9(D3551):945.262.N58t
J8
065284

3. After a discussion with the representatives of the parties the owners were directed to file ten copies of the documents they were to rely on by the 28th of March 1958, and the parties who appeared before me were each directed to file ten copies of their written statements together with ten copies of the documents to be relied on by the 15th of April, 1958, showing first their interest in the Inquiry, secondly, the exact information and data at their disposal, thirdly, the conclusion which according to the parties concerned followed therefrom, and fourthly, the names and other particulars of the witnesses to be called. It was further decided, in consultation with the representatives of the parties, that the Inquiry would be held in the Mines Rescue Station, Sitarampur, from the 23rd of April onwards and the owners would have to lead evidence first and then the Department of Mines, and thereafter the different workers' organisations represented at the Inquiry, and the witnesses of each party would be liable to cross-examination by each of the other parties.

4. In this meeting it was further considered necessary that there should be a Scientific Observer to observe and take note of any relevant data which the de-watering of the mines, which had been flooded shortly after the disaster, might bring to light. The representatives of all parties agreed that Dr. Whitaker should select a competent person for this purpose and the nominee of Dr. Whitaker should take up the work of observation during the de-watering of the mines and take whatever notes he might think necessary and proper. In due course Dr. G. N. Badami, Ph.D. (London), Senior Scientific Officer, Mining Research Station, Dhanbad, was selected by Dr. Whitaker and entered on his duties as requested by the Court after due notice to the parties. He took up his work on and from the 24th of March, 1958 when he paid his first visit to the Chinakuri Colliery.

5. On an application moved before me on the 15th April, 1958, the Indian Mine Managers' Association was added as a party and permitted to file a written statement. The written statements were filed by the 18th of April by all the parties that had appeared before me at the preliminary hearing and also by the Mine Managers' Association with the exception of the Indian National Mines Overman, Sardar and Shot-firers' Association that did not appear at all after the preliminary hearing on the 15th of March, 1958.

6. On the 23rd of April, 1958, in the morning before the commencement of the Inquiry the two Assessors and myself, in the company of the representatives of the parties, visited Chinakuri pit no. 3 and inspected the surface arrangements at pits nos. 1 and 2, and also those for sand stowing.

7. In the first part of the Inquiry 18 witnesses for the owners, 2 for the Department of Mines, 5 for the Colliery Mazdoor Congress and the Colliery Mazdoor Samiti and 2 as court witnesses were examined, and the statements of 8 men examined by the Regional Inspector of Mines during his enquiry into the accident, of whom 5 were not examined before me, were marked exhibits W-20(1)-(8) on admission. This part of the Inquiry terminated on 16th May, 1958 and the Inquiry stood adjourned provisionally to 1st July, 1958 because it could not proceed further until the mines were de-watered so as to render an inspection of the underground workings possible. On the 17th of May, 1958, there was no formal sitting of the Court and the Assessors did not attend. But I had to sit with the Chief Inspector of Mines and the representatives of the different workers' organisations to decide which of the numerous documents filed by the Department of Mines ought to be brought on the record. Sri Chaudhuri had already informed the Court that he would not have any objection to any of the documents being brought on the record if it were considered necessary for the purpose of the Inquiry. A number of these documents was marked on admission, formal proof being dispensed with.

8. The second stage of the inquiry could not actually begin till the 28th of July, 1958, because the de-watering of the mines took longer than was expected when the first lap of the Inquiry ended. The reports of Dr. Badami, the Scientific Observer and of Mr. Rosser, the Chief Mining Engineer of Messrs Andrew Yule & Co. Ltd., and of Mr. T. P. M. Evans, who was watching the proceedings on behalf of the Indian Mining Association, were submitted on the 28th of July, 1958, and copies thereof were distributed to the rest of the parties. As the representatives of the workers' organisations, including Mr. Lyndon James, the Head of the Safety Department, South Wales National Union of Mine Workers, the Workers' Inspector for 18 years, who had conducted inquiries into several mine explosions during the past five years, and who recently arrived in India as an Expert on behalf of the Indian National Mine Workers' Federation and Colliery

Mazdoor Union, had not yet inspected the underground workings of Nos. 1 and 2 pits, they did so on the 28th of July, 1958, between 9-30 a.m. and 2 p.m. and again on the 29th July, 1958. When the Court sat on the morning of the 29th July as usual, an adjournment had to be allowed till the 7th August 1958 in order to enable them to complete their inspections and to submit their reports. Prof. K. V. Subrahmanyam, Head of the Department of Mining Engineering, Indian Institute of Technology, Kharagpur, who was cited as an expert on behalf of the All India Trade Union Congress and the Indian Mine Workers' Federation, though he never went underground, was also directed to submit a report. The Department of Mines also did not submit its reports, and it was directed to submit the same simultaneously with the others. All the reports were submitted on the 4th August, 1958, and copies of each of the reports were distributed to the other parties.

9. The procedure adopted after discussions with the representatives of the parties at this stage of the inquiry was that after the reports submitted by Mr. Rosser, Dr. Badami, Mr. Evans, Mr. James, Mr. H. B. Ghosh, Regional Inspector of Mines and Mr. H. K. Bhattacharya, Junior Electrical Inspector of Mines, were marked exhibits, without the authors of the reports being examined-in-chief, they were tendered for cross-examination and actually cross-examined on behalf of some of the parties, while their cross-examination was declined by the rest. At the instance of Sri Bikash Roy who cited Prof. Subrahmanyam, Prof. Subrahmanyam was allowed to be examined in chief and his report marked exhibit W-39, and then of course like the rest he was cross-examined on behalf of the other parties. When it came to my notice that Mr. Rosser's report included as Appendix VII a statement of Mr. J. K. Welsh, Supervising Engineer of Messrs Andrew Yule & Co. Ltd., the owners were directed to tender him for cross-examination and he was tendered and actually cross-examined by one of the parties only and re-examined on behalf of the owners. The evidence was closed on 12th August, 1958.

10. On the 13th August 1958 two reports on tests carried out by the Scientific Observer, Dr. Badami, and the Junior Electrical Inspector of Mines Sri H. K. Bhattacharya, on the Siemens' Schuckert Drill found in 16 rise off main east loco level, were submitted and marked exhibits without further examination or cross-examination of the authors of the reports. Then Mr. Lyndon James argued on behalf of the Indian Mine Workers' Federation and the Colliery Mazdoor Union. At the conclusion of his arguments the hearing was adjourned at the instance of the rest of the parties who wanted time to prepare their arguments and for other reasons till the 25th of August, 1958.

11. On the 25th, 26th, 27th and 28th of August, arguments were heard on behalf of the Colliery Mazdoor Congress, the Indian Mine Workers' Federation, the All India Trade Union Congress, and the Colliery Mazdoor Samiti, represented by Sri Deven Sen, Sri Bikash Roy, and Sri Madhu Banerjee respectively. From the 29th of August to the 2nd September, 1958, there was no sitting of the Court as Dr. Whitaker had to be away from headquarters. On the 3rd, 4th and 8th September, 1958, arguments were heard on behalf of the Indian Mine Managers' Association, represented by Sri S. N. Mullick, the Department of Mines, represented by Sri G. S. Jabbi, and the management and the owners represented by Sri Sachin Chaudhuri.

12. I had to make the fullest possible use of the intervals between the sittings of the Court, once or twice with the Assessors, but mostly by myself, in studying, sorting out and trying to sift the large mass of materials placed before the Court during the second stage of the hearing so as to be able to draw up the report as early as possible after the conclusion of arguments. I also visited and inspected the underground workings of nos. 1 and 2 pits on 22nd August, 1958 with the Assessors. It was however not possible to make the report ready earlier than the 18th September, 1958, when I signed it after having given the draft its final shape in full consultation with Dr. Whitaker and Sri Samanta.

B. GENERAL INFORMATION REGARDING CHINAKURI 1 & 2 PITS

(1) Location and Description

13. The Chinakuri Colliery is a combined mine consisting of the workings of Nos. 1 & 2 pits colliery and of No. 3 pit colliery working the Dishergarh seam. The Chinakuri Inclines which work the Bharatchak seam lying some 2,000 ft. above the Dishergarh seam are close to Nos. 1 & 2 pits and these are situated on the eastern bank of the Damodar at a point where it takes a more or less

southerly course. No. 3 pit is three quarters of a mile due north of Nos. 1 & 2 pits though the distance by road is about one and a half miles. The colliery is approached by the Niamatpur-Neturia D.B. Road which takes off from the G.T. Road at a point between the 144th and 145th mile-posts from Calcutta and is about ten miles south-west of Asansol. The depth of No. 1 pit is 1995:16 ft. up to the coal bottom and that of No. 2 pit 2019:13 ft. From plan Ex. O.S.73 which shows the general future layout in the whole area of this colliery, the heavy white lines showing the areas already developed, and the fainter lines the areas still to be developed, the area developed in Nos. 1 & 2 pits is seen to form only a very small part of the whole. The depth of No. 3 pit is 1298:28 ft. to the decking level. Nos. 1 and 2 pits lie to the dip side of No. 3 pit, the seam and the strata dip from north to south. The workings of No. 3 pit are connected with those of No. 1 pit by 2 & 3 dips west. Doors in these two dips normally kept open are provided for isolating in times of danger No. 3 pit Workings from those of Nos. 1 & 2 pits. At the time of the explosion one of these two sets of doors was there, but the leaves of the other set had been taken out for repairs. The shaft of Nos. 1 & 2 pits are both wet.

(ii) Management

14. Nos. 1 & 2 pits and the Inclines are under one Manager and constitute one colliery though Nos. 1 & 2 pits are not directly connected with the Inclines, and No. 3 pit is under a different Manager and treated as a different colliery, the only things in common between Nos. 1 & 2 pits on the one hand and No. 3 pit on the other being the ventilation system and the sand stowing provision. They are all however under one Agent, Sri T. C. Anand. Sri J. D. Taneja, permanent Manager of Nos. 1 & 2 pits and the Inclines, could not on account of a fractured foot work as Manager from the 21st of January to the 27th of February, 1958 and he was during this period doing only the routine administrative work, while Sri O. P. Vasudeva, an Under Manager, was acting as Manager, under the general guidance of Sri J. D. Taneja. These and certain other collieries in West Bengal and Bihar are owned by Messrs. Bengal Coal Co. Ltd. incorporated in India as far back as 1843. Messrs Andrew Yule & Co. Ltd. incorporated in India as far back since their incorporation been the Managing Agents of Messrs. Bengal Coal Co. Ltd. and also of six other coal companies operating in Bengal and Bihar. From Sri T. C. Anand, the Agent, Sri J. D. Taneja, the permanent Manager, and Sri O. P. Vasudeva, the Under-Manager acting at the time as Manager, and were on the supervisory staff of Nos. 1 & 2 pits three other Under-Managers, viz. Sri K. M. Mazumdar, Sri M. N. Rana and late D. C. Bedekar, one Senior Overman, late Tara Singh, four Overmen, one of whom was working as Mining Sirdar, Senior Overman for S. S. Drift, two Overmen for S. S. Drift who were working as Mining Sirdars, eleven Mining Sirdars, three pit Munshis and one Sand Dusting Supervisor. Sri J. D. Taneja, Sri K. M. Mazumdar and late D. C. Bedekar were also responsible for the Inclines. Apart from this supervisory staff of Nos. 1 & 2 pits colliery, there were Messrs. R. P. Rosser, Chief Mining Engineer, F. G. Masson, Deputy Chief Mining Engineer, and L. D. Hughes, Assistant Mining Engineer of the Managing Agents to supervise the technical side of the work of the collieries under Messrs. Andrew Yule & Co. Ltd.

(iii) Production

15. The sinking of Nos. 1 & 2 pits began in 1945 and was completed in 1954. The sinking of No. 3 pit which began in 1947 having been already completed in 1952. Coal raising in Nos. 1 & 2 pits began in April, 1955 and the production figures of these two pits as furnished in Appendix 'A' to the owners' written statements work out at an average monthly output of 1922 tons in 1955, 4159 tons in 1956, 7772 tons in 1957 and the production in January, 1958 was 11,700 tons.

(iv) Method of Working

16. The roadways in Nos. 1 & 2 pits were driven for the composite purpose of ventilation, haulage, travelling, sand stowing, drainage and also of coal raising. Two roadways on the west of the colliery were driven through a large fault in stone. To the dip of the shaft two large sumps or water standages were formed and at the time of the explosion were almost complete. The principal sources of coal raising were the main east levels together with 9 dip workings which were being developed for the purpose of eventually laying out long wall faces, as the Company intends to mine the coal principally by the long wall method.

(v) Coal-getting Machinery

17. The coal was being got principally by under-cutting with FLP coal-cutting machines of Anderson Boyes type. The drilling was done with electrical coal drills of Siemens Schuckert and Huwood types. Coal was conveyed from the

vicinity of the faces by Huwood H.S./6 type Scraper chain conveyors which fed a 26" belt conveyor of Huwood G.B./40 type which in turn delivered the coal to a central loading station. The conveyor system is shown in owners' document, serial No. 4, Ex. O.S.4. All coal was loaded into mine cars of 55 cubic ft. capacity and these were transported from the east side to the No. 1 pit by a "Ruston" mark 20 H.P. diesel locomotive.

(vi) *Sand-Stowing Drift*

18. Sand is necessary for stowing at the time of depillaring and when the long well system is adopted and the proposed method of introducing the stowing sand to the working faces at Chinakuri Nos. 1 & 2 pits is via a drift driven from the surface near the Damodar where separators have been constructed and are in fact already in use for the purpose of supplying sand to Chinakuri No. 3 pit workings via another branch drift. The layout of this drift is shown in owners' document serial No. 9 (Ex. OS-9).

(vii) *Ventilation*

19. The ventilation scheme of Nos. 1 & 2 pits and the general layout of the mine roadways are shown in the ventilation plan, serial No. 3 of the owners' document (Ex. OS-3). The ventilation is produced by an electrically driven exhaust fan with a designed capacity of 400,000 cubic ft. per minute against 2½ inches of water gauge. The specifications of the fan are as follows:—

- (1) Size of the fan—145" diameter,
- (2) Type—aeroto (axial flow),
- (3) H.P. and type of motor—220 H.P. synchronous motor 3,300 volts.

The quantity of air being produced by the fan at the time of the explosion was said to be approximately 240,000 cubic ft. per minute and at the time of the explosion it is said that blades were turned to plus 3°, the range of variation of the blades being from minus 10 degree to plus 10 degree. The fan was placed near the top of No. 2 pit which is 22 ft. in diameter to which shaft the fan is connected by the fan drift. Nos. 1 & 3 pits which are each 20 ft. in diameter are downcast shafts. Nos. 1 & 2 pits are divided into five parallel galleries running east to west, the central gallery being the locomotive haulage road, the two upper levels being designed as intake airways and the two lower levels for return airways. The reason for choosing the upper levels as intakes was to keep the intake air free from the water in the lower levels.

(viii) *Shot Firing*

20. The shot firing was done in Nos. 1 & 2 pits by Mining Sirdars. No separate shot-firer was employed by the Company for firing shots in these mines. When a Mining Sirdar had more than 30 persons underground in his charge, he was exclusively employed as a Mining Sirdar and a separate sirdar would in that case be employed for firing shots. When, however, a Mining Sirdar had less than 30 men underground in his charge, he was employed also for firing shots. The two types of permitted explosives used for shot firing were Polar Ajax and Polar Viking and the Company also used by way of experiment sample consignments of equivalent sheathed explosives—type—'Unifrax'.

(ix) *Stone Dusting*

21. For treatment of the coal dust produced in mining stone-dusting is done under the charge of a Stone Dusting Supervisor with a gang of 22 men, 16 in the first shift and 3 each in the second and the third shifts. Six tons of shale are ground to pass a sieve of 200 meshes to the inch. Stone dust is prepared by three women workers by burning shale on the surface preparatory to crushing and grinding it and three part-time majdurs are employed for taking stone dust from the Ball Mill where burnt shale is ground into stone dust down to Nos. 1 & 2 pits. One tub of stone dust is manufactured daily and three mine cars, two-thirds filled so as to contain about two tons of stone dust, are taken each week for the pits and the remainder is sent to the Inclines. The whole pit has been divided into zones with areas of smaller or greater vulnerability to the accumulation of coal dust marked in the plan, serial No. 2 of the owners, Ex. OS-2. The cleaning is done in the galleries, from the sides, under the conveyors, at the discharge points of conveyors and at the faces by brushing with pieces of brattice cloths and after cleaning, the places are stone dusted. The cleanings are wetted with water and then put into the nearby conveyors to be removed and the insides of the conveyors are cleaned thoroughly and the cleanings put into the conveyors. The conveyors are provided with sprays and pumps are fitted to feed these sprays. Certain loading points are put within C.I. sheet enclosures to prevent dispersal of coal dust. The

details of the stone dusting organization and spraying are given in Appendix 'E' of the owners' written statement.

(x) *Safety Lamps*

22. One thousand and five hundred electric safety lamps were in use at Chinakuri Nos. 1 & 2 pits colliery. It appears from the owners' document No. 29, Ex. OS-29, that from the 5th of February, 1958 up to the 17th the stock of the safety oil lamps was 354 out of which 32 were under repair at the colliery and 68 at the workshop. So the total number of oil lamps available for use on the 17th of February, 1958 was 254. The exact figure that was available for use on the 19th when the explosion took place does not appear from any of the documents. But the Company in its written statement said that oil safety lamps were carried by 35 persons employed in the second shift of the 19th of February, 1958 including those officials who carried electric lamps.

(xi) *Machinery & Plant*

23. All electric, diesel and other plants used in Chinakuri Nos. 1 & 2 pits colliery other than in the area immediate to the downcast pit bottom were claimed to be of modern flame-proof type. The description of the plant and machinery in the mine at the time of the explosion is shown in owners' document, serial No. 63, Ex. OS-63, as far as could be ascertained. To maintain this plant in safe working condition the Company employs three Engineers shown in Appendix 'B 2' of the Company's written statement and they are assisted by mechanical and electrical fitters.

(xii) *Gassy character of the mine*

24. The Disergarh seam is known to produce inflammable gas and its average make in the workings of Chinakuri Nos. 1 & 2 pits was 300 cubic ft. per minute, as appears from Ex. OS-68, prepared by Sri R. R. Khanna, witness No. 21 who says he prepared it from the returns of the east and the west.

C. A NARRATION OF THE EXPLOSION—THE EXPLOSION AS IT APPEARED TO THE MEN ON THE SURFACE AND TO THE SURVIVORS FROM THE WESTERN ZONE OF THE UNDERGROUND WORKINGS AND ITS CONSEQUENCES AS SEEN BY THOSE WHO WENT UNDERGROUND BETWEEN 11-45 P. M. AND 4 A.M. ON THE NIGHT OF 19-2-58.

25. At about 9-45 p.m. on the night of the 19th February, 1958, the first intimations of what was happening in nos. 1 and 2 pits reached on the one hand Sri J. D. Taneja, witness no. 10, the permanent manager living about 2/3 furlongs from the pits, and on the other a group of young officers, viz., Sri D. S. Gill, Welfare Officer, witness no. 2, Sri V. N. Gupta a post-graduate trainee under the Government of India scheme for training of mining graduates, witness no. 3, and Sri P. Chatterjee, Assistant Engineer of the Mines, witness no. 4. This group of young officers heard first a loud hissing sound resembling that of steam under high pressure being released from a boiler and secondly a loud report. Sri Taneja heard only the loud report. All of them rushed to the pits. Sri Taneja in his car, and the rest on foot. On the way Sri V. N. Gupta pointed out to Sri D. S. Gill a tongue of fire about 3 or 4 ft. long in the fan evasee covering almost the whole width of the evasee and also noticed smoke coming out of the evasee. Sri P. Chatterjee also saw this. The flame only lasted for a few seconds having subsided by the time Sri Gupta and Sri Gill reached the canteen. According to Sri Gupta the flame was bluish in colour, while according to Sri Chatterjee it was yellowish and according to Sri Gill it was yellowish and partly bluish. Sri Chatterjee ran to the fan house, under the apprehension that the fan might have caught fire, to examine the electric motor and equipment, and was told by the fan khalashi that he had stopped the fan on hearing the rumbling sound. Sri L. N. Ohri, Manager of no. 3 pit, witness no. 16, living about three-fourths of a mile from nos. 1 and 2 pits by road, mistook the rumbling sound for what he described as "thunder of the clouds", but looking at the sky saw there was not much cloud, and thought blasting was going on. In other words, he appears to have mistaken the sound first for something like thunder-claps and then for the sound of blasting. The approximate time of the stoppage of the fan must thus have been 9-45 p.m. when the rumbling sound was heard. When Sri Taneja arrived at the pits Sri Gill had already started telephoning others about the accident, including Dr. G. C. Sen, a senior member of the Company's Hospital staff, and Mr. L. D. Hughes, Assistant Chief Mining Engineer of Messrs Andrew Yule & Co. Ltd. Sri Taneja sent word to no. 3 pit that the men underground in that pit should be immediately withdrawn, and this withdrawal was completed by 10-30 p.m. as we have it from Sri L. N. Ohri. Sri T. C. Anand, the Agent,

reached the pits at about 10-20 p.m. and Mr. Hughes arrived at 10-40 p.m. Gradually others, including Sri H. B. Ghosh, witness no. 19, Regional Inspector of Mines, also appeared on the scene.

26. At the top of no. 1 pit, for a radius of 50 ft. or so, coarse black particles were lying on the ground in the form of a crust of black substance. One of the cages was resting on the keps at the pit mouth, two loaded mine cars inside it had been derailed. The signal bell for the shaft and the telephone line were out of order. No. 1 pit was downcasting.

27. At the top of no. 2 pit, the upcast, the shaft covers had been blown off, the one on the north side having been pushed right up to the bell box about 60 ft. from the keps level, and the other on the south side having been blown up about half way between the keps level and the bell box and having got jammed there in the guide ropes. Whitish and grey-whitish smoke was coming out of the pit. Both the cages in this pit were kept hanging and were free to move. The signal bell was constantly ringing and Sri Taneja ordered the Colliery Engineer, who was with him, to cut off the underground electric power if it had not been already cut off, and he also directed the cages of this pit to be very slowly wound to touch the pit bottom. But when the cage was wound back to the surface there was nobody in it.

28. No. 3 pit was downcasting. The main fan at no. 2 pit was re-started between 10-45 p.m. and 11 p.m. under the order of Mr. Hughes. At about 10-45 p.m. two Rescue Teams from the Mines Rescue Station at Sitarampur under Sri Sarkar, Superintendent of the Station, witness No. 18, arrived. Gradually, other teams also arrived and in due course when the third and last rescue team that had gone underground returned to the surface at about 4 a.m. there were altogether 27 teams of 5 men each available for rescue work.

29. Under the instruction of Mr. Hughes, the principal officer of the Company present, the first rescue team got ready. The derailed mine cars in the cage in no. 1 pit were re-railed, but the cage in this pit could not be wound as the lower cage appeared to have got jammed. It was found later that at the bottom of no. 1 pit the protection boards had collapsed and entrapped the cage at the bottom of no. 1 shaft. The cages there could not be moved by the winding engine. The shaft covers of no. 2 pit which had been blown upwards were secured, and the cages in this shaft were wound a number of times from top to bottom in order to ensure that the shaft was free from obstructions and that it was safe to send down a team. The signalling arrangements between the mouth of the shaft and the winding engine house also had to be replaced or repaired. By 11-45 p.m. Mr. Hughes felt satisfied that it was feasible to send a rescue party down the shaft and the first party under the leadership of Shri K. M. Mazumdar, Under-Manager of nos. 1 and 2 pits proceeded underground at about 11-50 p.m. and returned within ten minutes, as had been agreed upon, as the signal was buried and no signalling communication could be established with the surface. They brought with them Sri Gouri Mali, witness no. 6, who had taken shelter between the air lock doors in the road leading from the bottom of no. 2 pit to the main loco level east and who did not appear to have suffered very greatly from the effects of the explosion. This Gouri Mali is a stone-cleaner and was working as such in the top west level in the second shift, when he heard a noise, fell down unconscious and after regaining his consciousness without any sense of direction even with the cap lamp alight, he followed a pipe till ultimately, as he says, he came up to the cage, although according to other evidence he was found between the air lock doors. These air lock doors which normally open towards the downcast shaft, i.e., to the east, had been blown in towards no. 2 pit, the upcast shaft, i.e. to the west. The first rescue team went down again at 12-15 a.m. now accompanied by Mr. Hughes and also by Sri Taneja who volunteered to go underground and obtained the permission of Mr. Hughes to do so. Neither Mr. Hughes nor Sri Taneja wore breathing apparatus. Sri Taneja took with him a bird which he brought back alive to the surface with him. The absence of any signalling arrangements in the shaft made it necessary to arrange for the cages to be wound every ten minutes.

30. At the level where the fan drift connects no. 2 pit there was some smoke which was irritating to the eyes. At the pit bottom, the cage landing was jammed with smashed debris and a tipping tub had been blown under the landing and obstructed the proper seating of the cage on the normal landing. The air lock doors, as already stated, had been forced open westwards and in front of the first air lock door several cogging sleepers were found jamming the door. There were two

mine cars on the eastern or intake side of the door, evidently having been bodily lifted over and thrown on to the door side. Two dead bodies were found lying in front of the air lock doors. One span of roof and concrete had smashed at point no. 2 put by Sri Taneja on the plan Appendix I to the owners' written statement, and the girder of the concrete was bent in the shape of 'V', the apex of 'V' being directed towards the west. Further on the way to the sub-station at point no. 3 in the same plan Sri Raghu Nath Singh, an electrician, lay badly burnt and groaning. At the junction of the loco level and the west dip level of no. 1 pit Sri Taneja parted company from Mr. Hughes and the rescue party and proceeded eastward towards no. 1 pit while Mr. Hughes and the rescue party continued to move westward.

31. The shouts of Mr. Hughes proceeding further west along the loco level were responded to and at the junction of the main west level with no. 3 dip of no. 3 pit he came across 6 or 7 men who, questioned whether there were others alive in-by, replied that there were others who were either unconscious or unable to walk. Mr. Hughes then left these men to proceed to no. 2 pit and going down further westward along the main west level found a number of badly injured men between 3 rise and 6 rise west. The air bridge at the junction of 3 rise and the main east level had been completely smashed and a fresh current of cool air was running from no. 3 pit down no. 3 dip and along the main west level to no. 2 shaft and thus to the surface. The breathing conditions were reasonable upto 3 rise west, but they were worse further west between 3 rise and the western extremity of the workings. Mr. Hughes went up to the surface for stretcher parties to carry the injured because he thought that the team wearing breathing apparatus would take a very long time to carry them over the obstructions along the level. He returned underground with a volunteer stretcher party of four and another stretcher party of four also went underground when Mr. Hughes sent a message to the surface asking for more volunteers. Mr. Hughes returned to the surface at about 2-15 a.m. and found that while he was underground his body had become contaminated with a very fine black substance similar in appearance to the soot left by an oil flame on a glass, and he found it very difficult to completely free his eyes of this black substance. By then the stretcher parties had already rescued 17 men and according to Mr. Hughes there was only one injured man underground at that time and this injured man was brought to the surface at about 2-30 a.m. by Sri Taneja. Obviously, he was referring to the injured men he had seen, for as will appear from Appendix 'J' to the owners' written statement, 20 men came out alive from the pit, two of them—Kala Bauri and Della Bauri—having walked out by themselves through the S. S. drift, and another, viz., Tribhuban Das, having come up to the cage himself. Obviously, 17 persons were rescued alive and not 18 as Mr. Hughes says.

32. Sri Taneja, as he proceeded eastward from the junction of the loco level and west dip level of No. 1 pit, heard a human voice coming from the east side of No. 1 pit and by using the bypass to that side he found a man singing and jangling, and he thought the man had either been gassed or was suffering from the effect of shock. He took him to the air lock door and left him there in the fresh air. Proceeding further east he saw that the door on the east of 2 Rise on the loco level at the point he marked 6 on Appendix 'I' to the owners' written statement had "disappeared" along with its brick-work without leaving any traces behind. He could proceed along the loco level only as far as its junction with the cross cut, i.e. point No. 7, and a barrier of very dense smoke coming up from the east and going up along the cross cut prevented his progress farther eastward. He accordingly retraced his steps towards 2 dip east which he found clear. There was a conveyor in this dip. The drive head of the conveyor was lying on the floor and some of the conveyor pans were found smashed on the floor. The stopping in this dip had collapsed. At the junction of 2 Dip and 1 Dip Level which he marked point No. 8 he found dense smoke coming from somewhere, and returning to the loco level, he walked back to the air lock door and returned to the surface with the man he had left near the air lock door. Sri L. N. Ohri witness No. 16, Manager of No. 3 pit colliery, went down into his own pit at about 9-55 p.m. and had his own men numbering about 200 taken to the surface by 10-30 p.m. In that pit at the time the workings were on the western side between 15 level & 14 level where depillaring on the bord and pillar system was going on and also between 6 & 7 level there were some men on the old and the new conveyor faces on the east side. He noticed a lot of white stone dust strewn at this pit bottom and particles thereof in suspension. He found no coal dust. When he had crossed the east haulage brow on his way to the eastern side of the pit bottom, he felt a choking of his ear drum and this he attributed to a change of pressure while passing from one place to another. He says this was about five or ten minutes after he had heard the noise, i.e. the rumbling sound after the first explosion.

Evidently he was not quite accurate here because he went down the shaft at 3-55 P.M., ten minutes after the first explosion, so that he must have felt the choking of the ear drum somewhat more than ten minutes after the first explosion. On the west brow against the rope rollers he found some pieces of bamboo matting about a foot or two feet stuck up here and there having probably been blown up to that place from 3 dip to about 200' below; the distance between their original position in 3 dip and the places where they were found in 2 dip was above 400'. He did not notice any damage in the isolation door in No. 2 dip which was in position. He came up to the surface at about 10-30 P.M. when the last man in this pit was withdrawn. He went down again with the Regional Inspector, Sri H. B. Ghosh at about 11 P.M. to see if Nos. 1 & 2 pit could be entered from No. 3 pit. They had with them safety lamps and a cage of birds but no breathing apparatus. They proceeded along 3 dip west as far as 300 ft. below the isolation door, i.e., 500/600 ft. from the haulage curve, but could not proceed farther as the air beyond this dip was becoming sluggish and warm and as the two birds they had with them were showing signs of distress. When this pit could be re-entered later, not much sign of damage was noticed beyond signs of violence on some doors in 23 level and beyond a cable having been pulled out of the gate-end box and the drill panel in the same level.

33. The second rescue team headed by Sri Nanku Gope, Captain, Rescue Brigade Sitarampur Rescue Station, C.F. 1, went down at 1-25 A.M., presumably as far as the evidence on the record goes to indicate, even before the first rescue team had come back to the surface after their second visit underground, and proceeded mainly westward and on the east only a little beyond 3 Dip. The team noticed smoke coming out from 3 Dip crossing and also from the east level. This party claims to have rescued 5 men from the western side and brought 3 others to the pit bottom alive. It came up to the surface at 2-40 A.M. As altogether 20 living men only had been rescued that night, there must have been a certain amount of overlapping between the number given by Mr. Hughes and that given by Sri Nanku Gope and this overlapping is possibly to be accounted for by the fact that while Mr. Hughes came up to the surface at about 2-15 A.M. the second rescue team which had gone underground at 1-25 A.M. was still underground when Mr. Hughes returned to the surface, with the result that some of the men rescued by the second team or brought to the pit bottom by it may have been included in the number given by Mr. Hughes.

34. At 2-30 A.M. when the second team had not yet returned to the surface but must have been near the pit bottom, the third team headed by Sri A. Krishnan, one of the Under-Managers of No. 4 pit, Sitalpur Colliery, witness No. 14, went down with instructions to proceed to the eastern side, to rescue any survivors they could come across and to find out the conditions generally and particularly as to the existence of any smouldering or active fire in that area. This team proceeded eastwards along the main Level East. They too noticed that between the air-lock doors there was a large quantity of debris, that bricks had fallen, and pieces of timber about 8 or 10 ft. long mostly used for supporting the roof were lying about and that two or three coal tubs lay upturned within about 20 yards of the separation door off the loco level. They also saw the two dead bodies. The visibility was good till the party reached the cross-cut. The travelling conditions, however, were far from easy, the roadway was strewn with bricks that had fallen from the side walls, and at certain points with material that had fallen from the roof. There was also a severe irritating smell. At the cross-cut a brisk current of cool air was coming down it and blowing westward along the loco level. At the cross-cut Sri Krishnan for the first time put on his breathing apparatus because he felt the air to be stagnant inbye. The visibility was still normal. About two pillars beyond the cross-cut there was one log which was smouldering and there was another near the under-bridge which was burning. The team put out the fire of the smouldering log, buried it in a hole and on their way back brought it to the surface. In the rise gallery on the way to the cross-cut, i.e. no. 1 rise off loco level the atmosphere was hazy; a brick wall had fallen and the mouth of the gallery was filled with bricks. Further eastward beyond the cross-cut the conditions changed for the worst. There was smoke and the atmosphere was turning hazy. The side walls had been broken and at certain places the track had been lifted up and pieces of timber lay scattered all over the place. The farthest point that this party reached was about 70 or 80 ft. beyond the under-bridge off the no. 8 rise haulage, the point being marked by the letter 'D' meaning a dead body in the plan, Appendix I to the Owners' written statement. This dead body was merely a dismembered trunk without the head or the limbs and it was covered with coal dust. Thick smoke affected the visibility beyond this point so much so that one could see only 6 to 8 ft. ahead through it and it was also irritating to the eyes. When the party found

further progress eastward impossible, it waited there for a few minutes listening for sounds but it heard nothing. The leader of the team could not say whether there was any one alive in that area. This team returned to the surface at 4 A.M.

35. I have already stated that altogether 20 men were rescued that night and out of them four died later, so that there were only 16 survivors. Out of these 16 survivors only two were examined before me, viz. Gouri Mali, witness no. 6, and Paru Mali, witness No. 7. The reason why any of the others was not examined by any of the parties is that they were all on the western side of the mine, and like the two examined, could not throw any light on the explosion which appears to have been felt from the very beginning on the information available to have occurred somewhere in the eastern region. Gouri Mali and Paru Mali are brothers. Paru Mali was a stone-cutter, driller and stone cleaner in pit no. 2 and he was working in no. 1 west level and loading tubs. There were with him seven others, two of whom were bailing water and five with him were loading tubs. When Paru Mali had finished five tubs he heard the loud report of an explosion and those six of them who were loading tubs fell down unconscious in water about a foot deep. Paru Mali regained consciousness and found that his five colleagues were still unconscious. He could not give the time of the explosion. He helped four of his colleagues to get up. They were at this time at no. 1 west level. After regaining consciousness he and his four colleagues followed a 1" water pipe till they took the first turn to no. 2 west level and when they reached a door they fell down again unconscious. Paru Mali says that although he did not see or smell any smoke his eyes were burning and breathing was also difficult. He further says that the electrical cap lamp which he had was alight. When he regained consciousness "he got full air" and stayed there for an hour. He proceeded further and when returning along the main west level between No. 4 west rise and No. 3 rise at a point where the roof had fallen he collapsed again. He described this place as no. 4 air crossing, but it does not appear from the maps that there was any air crossing at the junction between 4 west rise and the main west level, while there was an air crossing at the junction of no. 3 west rise and the main west level so that it is more than probable that this is where the roof had fallen and Paru Mali collapsed again a third time. At this time he was alone there and his colleagues, he says, were a little behind him. But they did not meet again till he was at no. 1 pit. On regaining consciousness he stayed at the place for some time and then proceeded to no. 1 pit. On reaching the bottom of that pit he found that all the signalling arrangements were broken and one big stone had fallen on the roof of the cage. He saw a dead body on proceeding further and naturally became nervous. Then he proceeded towards no. 2 pit and on the way he found a man who was alive. He could not reach the bottom of no. 2 pit as he found the doors blocked and then he returned to no. 1 pit. At no. 1 pit he was joined by the colleagues he had left behind and after a discussion among themselves they proceeded to try escape by the sand stowing drift connected to the cross cut. They walked along the main loco level east up to the sand stowing cross cut and then turning to the left walked for a distance of about two pillars, and here one of them, Sukur Singh, collapsed. The heat was so great that they could not proceed any further to that side and they returned to the sub-station near the loco garage at the pit bottom and there they remained for an hour or an hour and a half. When he felt all right, they decided to try to escape by No. 3 pit and proceeded westward. On going to No. 5 Rise, he saw about 6 or 7 stone cutters lying near the line. Two of them were dead and while trying to find out whether the rest also were dead or not, he felt fatigued. At this time he noticed the lamp of a sahib and was brought to the surface. On reaching the surface he became unconscious.

36. The distribution of the dead bodies is shown in Appendix 'II' to Mr. Rosser's report, Ex. O.S.72 which appears to have been prepared on 17-7-58 when the dewatering of the mine was very nearly though not quite completed. Another plan, Appendix 'II A' to Mr. Rosser's report showing the 9 dip area was filed on 28-8-58 and a note on this plan, Appendix 'II B' to Mr. Rosser's report was also filed on 28-8-58. These two supplement the plan in Appendix 'II' and show the distribution of the dead bodies and the lamps. There are sectional plans also with a key plan, Appendix 'I' which give the details noticed on re-entry. The disposition of the dead bodies is also shown in Appendix 'I' to the owners' statement and the composite plan, Ex. O.S.71, the first of which was filed along with the owners' written statement and the second of which was prepared on 11-5-58 when dewatering did not progress very far so that these two after all are incomplete. The signs of damage as noticed by the different parties that went underground on the night of the 19th of February, 1958 are shown in the comprehensive plan, Ex. O.S.71 and also in Appendix 'I' to the owners' written statement. Thus, while Ex. O.S.71 shows the distribution of the dead bodies discovered on the 19th February, 1958,

after the first explosion, Appendix II & II A to Mr. Rosser's report, Ex. O.S.72 show between them the distribution of the dead bodies discovered both on the night of the accident and after the dewatering.

D. SEALING AND FLOORING—THE STEPS TAKEN TO PREVENT EXTENSION OF THE FIRE UNDERGROUND.

37. With the return of the third rescue team to the surface, there was a discussion among Mr. Hughes, the principal officer of the mine then present, the Chief Inspector of Mines and other senior officers of Messrs. Andrew Yule & Co. Ltd. as well as of other companies who by this time had arrived on the scene and it was considered by one and all that the possibility of life underground under the conditions reported was nil, and in view of the open flames seen underground by the last team and of the inevitability of further explosions of methane which was building up in the galleries as a result of the derangement of the ventilation system with the destruction of doors and stoppings etc., it would be hazardous to risk any further rescue parties underground. Accordingly, at about 4-30 A.M. Mr. Hughes finally decided that no further rescue team should be sent underground. It was further decided to stop the fan and thus reduce the oxygen supply to the underground workings. The fan was actually stopped at 4-50 A.M. At 5-20 A.M. Mr. R. P. Rosser, the Chief Mining Engineer arrived from Calcutta and took over charge of the operations from Mr. Hughes. He heard from Mr. Hughes what had happened and what had been done so far and then in consultation with Mr. Hughes and others present Mr. Rosser ordered the building of light seals at the mouths of Nos. 1 and 3 pits, the sand-stowing pit and the sand-stowing drift. These seals consisted of rails placed across the shaft mouths at 2 to 3 ft. spacing upon which were placed corrugated iron sheets and bamboo matting which were then covered over by wetted clay about 18" thick. The mouth of No. 2 pit was left open. These seals were completed by 9-30 A.M. on the 20th February, 1958. At about 11 A.M. traces of smoke were seen coming out of No. 2 pit and an attempt was made to tighten up the seals at No. 1 pit to prevent the ingress of air. But at 11-30 A.M. there occurred in rapid succession two explosions which blew off the seal at the mouth of No. 1 pit and the stopping at the mouth of the sand stowing drift. The samples of black particles collected from different places in Nos. 1 and 2 pits of Chinakuri Colliery after the second explosion were collected by Sri Vasudeva on the 9th of March, 1958 and these were analysed and the result of analysis was given in Ex. O.S.30. The explosions were followed by the emission of large quantities of black smoke from No. 2 pit. No. 1 pit still continued to downcast, and as it was apparent from the large volume of smoke coming out of No. 2 pit that there was a substantial fire in the underground workings, it was considered unsafe to engage persons for building up seals at the top of either of the shafts. It was then decided to put out the fire by flooding the mine with water and in the meantime to seal the mouth of No. 1 pit by using a scraper conveyor to dump down the shaft bricks, clay, matting etc. This decision was arrived at by Mr. Rosser in consultation with the Chief Inspector of Mines and all other important Mining Engineers who happened to be present. The first pontoon-mounted pump with a capacity of one million gallons per hour started pumping water into the S. S. Drift at 12-30 P.M. on the 20th February 1958. On the same day at about 5 P.M. the conveyor had started delivering sand etc. into No. 1 pit and the mouth of the S. S. drift was re-sealed by 5-30 P.M. By 3 P.M. on the 22nd February 1958 the introduction of sand etc. into No. 1 pit was completed. At 2-30 P.M. on the 24th February 1958 when it was found on a rough measurement of the water in No. 2 pit that the water had risen above the necessary level, the pumping of water into the sand stowing drift was stopped, and when at 4 P.M. that day the height of water into No. 2 pit was measured by surveyors, it appeared that its height above decking level at the pit bottom was 214.27 ft. and it appears from the composite plan, Ex. O. S. 71, and also from Ex. O.S. 8 that by the 24th of February 1958, 25,195,000 gallons of water had been pumped. It further appears from the diary of events, Ex. O.S. 41, that the smoke or fumes emitted from No. 2 pit between 4-45 A.M. and 6-45 A.M. on the 21st February, 1958, were white with a slight grey tinge and by 7 A.M. that day the fumes became darker. Between 1-55 P.M. and 2-15 P.M. i.e. on the 21st February, 1958, there were several small explosions apparent in No. 2 pit and following these the smoke become dense and black. On the morning of the 23rd February 1958, work started on installing a 4'-7½" Sirocco fan at the sand stowing pit. The pressure on the seals at No. 3 pit and the S. S. drift increased during the day, suggesting the existence of gas which was trying to force its way out, perhaps along with a strong natural ventilation tendency, and also gradual displacement of mine atmosphere by water introduced into the workings.

II. CASUALTIES.

38. In paragraph 4 of the owners' written statement 176 persons are alleged to have lost their lives in the accident and the names of the deceased are set out in Appendix 'F' to that statement and Appendix 'G' is a statement of reconciliation of lamps and persons as shown in what are called lamp registers but what are really registers of attendance of workers underground, in the second shift on the 19th of February, 1958. Appendix 'G' to the written statement of the owners shows that there were 192 persons underground at the time of the explosion. Of them two came out by the S. S. drift themselves and one came up in the cage himself. 17 were rescued alive and one more was brought up to the surface dead. The number of persons missing and believed to have perished underground was accordingly 171. To these are to be added 4 persons who died in hospital after rescue and the persons recovered dead, bringing the total number of casualties to 176. When I was studying the record I found it extremely difficult to follow the calculation in the different statements, viz., Appendix 'G' to the written statement of the owners and Appendix III to Mr. Rosser's report, Ex. O.S. 72 and I called upon an Inspector of Mines to file a statement showing the calculation and the statement was accordingly filed and this has been marked Ex. D.M.I. 46 on behalf of the Court. From this it appears that for the second shift on the 19th of February, 1958 as many as four registers are relevant. The first is the register of attendance of C.R.O. workers which is Ex. No. W. 43. There the total number of entries is 196. It is the register kept both for the Inclines and Nos. 1 & 2 pits. By actual verification by an Inspector of Mines in the presence of an Under-Manager, Sri Vasudeva, the number of men found to have been engaged in the Inclines was 130 and from the recruitment list of C.R.O. workers it was further found that an entry herein was made of a non-existent person. If these 130 men engaged in the Inclines and the wrong entry are left out of account, there is a residue of 65 persons. There was one man whose name was entered in the register as having taken a lamp, but who on verification was found not to have gone down and there was another man who on enquiry was found to have gone down, but whose name was not recorded, so that there were altogether 65 C.R.O. workers who are supposed to have been in Nos. 1 & 2 pits in that shift and who are supposed all to have perished. The next register is the register of attendance of workers in Nos. 1 & 2 pits other than C.R.O. workers. This is Ex. W. 10. The total number of entries in this register is 135. In this register four names were entered twice, once against cap lamps and again against oil lamps, the safety supervising staff being provided with both; three surface workers were wrongly entered in the register and shown as surface workers though the register is meant only for underground workers; four were wrongly entered in the register though they were really surface workers, but were not shown as such in the register and two were entered as having gone down, but were found on verification not to have gone down. Out of the total number of entries, i.e. 135, 13 have thus to be deducted, leaving a residue of 122 persons. The total number therefore that was actually underground in that shift is 122, as far as this register shows. The next register to be considered is the register of attendance of non-C.R.O. workers in S. S. pit and S. S. drift Ex. W. 44. The total number of entries in this register is 14. Two persons entered in the register as having gone down were found on verification not to have gone down. That makes the total number underground from this register to be 12. The next register so be considered is the register of attendance of No. 3 pit. Ex. W. 45. Amongst the persons who are entered in this register are persons who came into the S. S. drift with lamps from No. 3 pit. The total number of such persons is 8. Out of 8 entered as having gone down, two were found on verification not to have gone down. That leaves the total of six from this register. If the figures from these four registers be added up (65+122+12+6), the total number of persons who went down at the beginning of the shift comes to 205. By actual verification it appears that 11 persons mentioned in Ex. W. 10 and 4 persons mentioned in Ex. W. 4 came out before the explosion. That leaves a total of 190 persons underground at the time of the explosion. In addition, two workers who though not in the register are said to have gone down and supposed to have perished because they could not be found were included in this list, making the total number of underground workers at the time of the explosion 192. Of these, as already stated, 20 were brought out alive and one brought out dead and four of those who were brought out alive subsequently died. The total number of casualties thus comes to 176. In Appendix III to Mr. Rosser's report, Ex. O.S.-72, bodies found with skulls are stated to be 164 and those without skulls 6 making a total of 170. Four amongst those who had been rescued died and Vasistha Mohan Dube had been taken out after he had died. This makes a total of 175 and not 176. Actually though the report (Appendix III) shows 164 bodies with skulls, there is, as I shall have occasion to point out later, a discrepancy between this number and the member

of skulls that the doctor holding the post-mortem examination had before him. In this calculation, of course, there appears to me to be a little flaw. Cases are not unknown when after an accident workers, whether they go underground or not in the shift concerned, just make themselves scare just out of fright or for other reasons such as obtaining the compensation payable under the Workmen's Compensation Act. Even workers who go underground and who come out before the accident may quite conceivably do so. It is therefore not improbable that the total number of casualties as calculated above is somewhat less, but this much is clear that the casualties could not have exceeded 176. Appendix VIIIa and Appendix VIIIb to Mr. Rosser's report and an enclosure to the report of Sri H. B. Ghose, state that 139 cap lamps and 17 oil lamps were recovered after the de-watering. Obviously therefore a number of lamps is still unaccounted for even on the basis of these statements. The number of the cap lamps given here is not however quite accurate and the number actually recovered may be held to be 138, for only 111 complete cap lamps were recovered together with 19 lamps with only the head pieces missing and with 8 lamps of which only the covers were available. In addition, only one head piece and two accumulators without cover were recovered. The only head piece that was recovered might well have been the missing head piece of one of the 19 lamps without head pieces and the two accumulators without cover might well have formed part of the 8 lamps of which only covers were available. Clearly then at the most 138 cap lamps only can be said to have been recovered and not 139. It further appears from the Lamp Registers that 32 oil lamps were issued for the second shift of 19th February 1958. Of these, 2, one of Basista Mohan Dubey and one of Tribhuban Das, had been already recovered. Of the remaining 30, 7 appear to have been made over to supervisory staff who also carry cap lamps. Thus, there are 23 oil lamps left; out of these 17 were recovered. It is more than probable that the debris, which is still to be cleared, conceals some at least of the lamps that still remain unaccounted for. If the number of lamps found underground on re-entry is any indication of the number of casualties, then they should be in the neighbourhood of 138+17 i.e. 155.

39. The consolidated report of post-mortem examination of the bones etc., recovered after the de-watering by the Subdivisional Medical Officer, L. M. Hospital, Asansol, submitted under my direction, shows that the hospital received a number of dismembered dead bodies and counted bones etc., of particular kinds, and from the total number they calculated that the minimum number of dead bodies they received must have been 115 and the number might conceivably have been a few more. Of course this calculation is based on the number of skulls which appears to be 115. It may be that all the skulls were not recovered. Some of them may be lying under the debris still to be cleared, and some may have been so crushed and mixed with the debris as to be really incapable of identification as human skulls. In view of these discrepancies, it is far from certain that all these 176 persons were amongst the casualties. But on the data available it appears reasonably certain that the casualties could not have been less than 115 and more than 176, and were probably a few more than 155 which is the number of cap lamps and oil lamps other than those supplied to supervisory staff, found underground on re-entry.

II. THE PROBLEMS FOR INVESTIGATION AS THEY APPEARED TO THE PARTIES AT THE COMMENCEMENT OF THE INQUIRY AND TOWARDS ITS CONCLUSION.

40. That the accident consisted of a series of explosions underground, the first of which had occurred about 9-45 p.m. on the 19th of February, 1958 admits of little doubt and it is common ground amongst the parties. The parties however were not at one when they filed their statements as to whether the first explosion was predominantly methane or coal dust, where it originated and how either the methane or the coal dust was ignited. As the underground workings had not been fully explored when the parties filed their written statements, they were all groping in the dark and whatever opinions they expressed therein were naturally tentative.

41. According to the owners, the first explosion was originally due to methane and was predominantly a methane explosion, coal dust having played little if any part in this explosion; it occurred somewhere on the eastern side to which no one could penetrate on the night of the disaster, and the source of ignition was "some non-recurrent mischance which may never be determined." The Department of Mines agreed with the owners that the explosion was initiated by inflammable gas, but suspected coal dust of having taken a part in it. But it could not throw any light on the source of ignition. The Mine Managers' Association did not put forward any theory at all on any of these points. According to the Indian National Mine Workers Federation and the Colliery Mazdoor Union, probably the explosion

of a small amount of gas started a much larger dust explosion which in its turn started a fire and it suggested that the Court of Inquiry would have to go into the questions whether the necessary precautions prescribed by law were taken by the Management in different matters. The Colliery Mazdoor Congress without advancing any theory at all as to the nature and the origin of the explosion attributed to the Management and the Department of Mines a variety of sins of omission and commission. The Indian Mine Workers' Federation and the All India Trade Union Congress also did the same and suggested that the Chinakuri Colliery was a veritable powder magazine in the winter months when the low surface temperature enabled the downcast or intake air to pick up a large quantity of moisture from the workings so as to dry up the coal dust which intensive mechanization with conveyors and fast haulages produced in large quantities, and gas accumulated in consequence of a defective system of ventilation. They did not clearly say if it was a methane or coal dust explosion, but went on to say that, whatever it was, probably the source of ignition was either shot firing or electricity. They charged the Management with general incompetence and alleged that adequate precautionary measures were not taken. The Colliery Mazdoor Samity also while making some allegations against the Management and the Inspectorate of Mines did not try to make any case as to either the origin of the first explosion or the source of ignition.

42. During the first stage of the inquiry therefore, the main issues were:

- (i) whether it was a gas or coal dust explosion to start with;
- (ii) where exactly it originated;
- (iii) if it was a methane explosion, whether coal dust played a major or a minor part therein; and
- (iv) how far, first the Management could be held responsible for it for not taking the necessary precautions which, if they were taken, would have averted the catastrophe and secondly, the Department of Mines discharged their duties satisfactorily in ensuring compliance with the regulations etc.

At that stage it was hardly possible to try to ascertain the source of ignition. The owners led evidence first to explain with reference to a large number of plans etc. the main lines along which the colliery was worked, and secondly, to place before the Court of Inquiry whatever materials could be collected on the surface and during the underground visit of different parties after the first explosion on the night of the 19th of February, 1958, and on behalf of the workers' organizations strenuous attempts were made to sound the weak spots in the system of working of the mine and to see how far the Management could be held to have strictly followed the rules and regulations in different matters.

43. Two days after the inquiry commenced, viz. on the 25th of April, 1958, Counsel for the owners, Sri Choudhury informed the Court that the make of gas had been increasing in the affected pits and that it would be worth while to observe the phenomenon and try to ascertain its causes which might give a clue to the causes of the accident under inquiry. On this information the owners were directed to submit a written report, and the Mines Department and Dr. Badami, the Scientific Observer, were also directed to examine the position and submit reports and the Mine Managers' Association was also given the option of sending an observer there if it so desired. The owners, however, did not submit any written report. Dr. Badami, Sri H. B. Ghosh, the Regional Inspector and Sri M. K. Bose, President, Indian Mine Managers' Association submitted reports which were marked exhibits on behalf of the Court on admission by the parties. Dr. Badami's report dated the 26th April, 1958 is Ex. C.1. It says that he took samples of gas at (1) the return side of partition wall at the entrance to No. 2 drift, (2) Main return of No. 3 pit about 300 ft. below sand-stowing pit and (3) between 21 and 22 levels in 2 Dip and air measurements were also taken under his supervision by one of the apprentices. The results were as follows:—

Location	Quantity cft./min.	%Methane in gas sample	Quantity of CH ₄ Min.
(1)	3,670	2.85	8670(2.85-0.1 2.3 approx.
(2)	105,000	0.51	0 0 536
(3)		0.51

The total make of gas thus worked out at 740 cft./min. But the original make was of the order of 490 cft./min. so that there was about 50 per cent. increase in the make of gas in all the three pits and more than 80 per cent. in Nos. 1 and 2 pits. He did not make any estimate of the water because Mr. Rosser, Chief Mining Engineer of Messrs. Andrew Yule & Co. Ltd. is said to have done so. But Mr. Rosser did not in fact submit any report, presumably because Sri M. K. Bose and Sri H. B. Ghosh both deal with this matter. The report of Sri M. K. Bose is Ex. C.2. Sri Bose did not himself take any sample of gas, but refers to the samples taken by Dr. Badami and said that from the records of the Company the normal gas emission from the workings appeared to be 500 cft. per minute and from the samples taken by Dr. Badami it was evident at the time of examination of the pits that the gas emission per minute was raised to 740 cft. per minute approximately. As regards the increased make of water, he says that by observing the rise and fall of the water level during the pumping period as well as during the stoppage of the pump the make of water was found to be about 11,000 gallons per hour. Prior to the explosion this was only 2,000 gallons per hour so that there was an extra influx of 9,000 gallons per hour. The report of Sri H. B. Ghosh is Ex. C.3. He says that the total original make of water in Nos. 1 & 2 pits was about 3,500 gallons per hour. On the 2nd of April, 1958 it was observed that a 35 H.P. pump of a rated capacity of 15,000 gallons per hour, but probably not working to full capacity could not prevent the water from rising and on the 7th of April, 1958 on a detailed experiment carried out by the Management it was found that Nos. 1 & 2 pits were making an extra quantity of water of about 9,000 gallons per hour. From these Sri Ghose came to the conclusion that a heavy feeder of water had suddenly been met with in Nos. 1 & 2 pits. As regards the make of gas, he found from the records of first part of January, 1958 that .36 per cent. CH₄ was present in the combined return air (107100 cft./min.) of No. 3 pit workings and Main West district of Nos. 1 & 2 pits, i.e. the total quantity of CH₄ produced from these workings was 385 cft./min. This he marks (A). Similarly, the total quantity of CH₄ from zero dip return which was the total return of the rest of the mine showed .45 per cent. CH₄ in about 45,000 cft./min. so that the total quantity of CH₄ from these workings was about 200 cft./min. and this he marked (B). Adding (A) and (B) together, he found that the total quantity of CH₄ from the workings of No. 3 pit and Nos. 1 & 2 pits was 585 cft./min. and this he marked (C). Then at the time of examination he found that the total quantity of air in the fan evasee of the sand stowing pit was 105,000 cft./min. and on the 24th and 25th of April CH₄ concentration in the main return was .8 per cent. and .72 per cent. respectively. Calculating on the basis of .72 per cent. CH₄ concentration, he found the quantity of CH₄ coming out from No. 3 pit and Nos. 1 & 2 pits to be 756 cft./min. and this he marked (D). Deducting (C) from (D), he found that the make of CH₄ from the workings of No. 3 pit and Nos. 1 & 2 pits had gone up by 171 cft./min. Then on the assumption that only the exposed workings of Nos. 1 & 2 pits were at the time contributing to the make of gas and not also the workings which were still under water he proceeded to calculate the increase in the make of CH₄ on the basis of the normal make of CH₄ from No. 3 pit workings and from No. 5 rise district which was exposed at the time and found this increased make to be 432 cft./min. He concluded by saying that there was no doubt that the make of water and gas had been increased considerably in the workings of Nos. 1 & 2 pits, that the increase in the make of water indicated a certain feeder of water having been encountered, and that the increase in the make of gas might be due to a blower of gas in the workings or to pent-up gas in the coal seam and the strata now issuing at a greater rate than before. This brought the Court of Inquiry and the parties face to face with the possibility of an unusual release of fire-damp gas providing a large body of inflammable gas in the workings. It could, however, be no more at this stage than the first glimmerings of a possible solution of part of the mystery of the explosion.

44. During the second and final lap of the inquiry however, when after an exploration of the underground workings Mr. Rosser, Dr. Badami, Mr. Evans, Mr. James, Sri H. B. Ghosh and Sri H. K. Bhattacharjee submitted their reports along with Prof. Subrahmanyam who never visited the mine after the disaster, the scope of the inquiry somewhat changed. All but one of these reports, viz. that of Prof. Subrahmanyam are full of valuable data. The report of Prof. Subrahmanyam does not furnish any new data, but proceeds to give some opinions on the data he collected from the reports of Messrs. Rosser and Evans. Dr. Badami, the Scientific Observer, submitted only an objective report of the data which came under his observations and this was in accordance with the requirements. The experts examined before the Court now broadly agree that not merely the first, but probably all the ignitions were of methane, and that the evidence of the damaged materials points largely to a source of violence somewhere between 15 and 16 rise off 1 east level. As to the source of methane, there is also unanimity amongst all except Prof. Subrahmanyam that there was an outburst of sudden

release of a large body of methane in 15 rise and perhaps in the dyke face. Prof. Subrahmanyam's is the lone voice which still maintains that the source of the gas was, as usual, the coal being worked, in which gas is occluded and is being constantly emitted and if it accumulated in the eastern region, it was because of defective ventilation which did not ensure that sufficient air would penetrate into that area and dilute the gas below explosive limits. The controversy towards the end of the inquiry thus narrowed down from what it was at the beginning broadly to the source of the gas and the source of the ignition. Although the experts generally agree that the fuel of the explosions was largely methane, in an inquiry of this kind, even this unanimity amongst the experts need not compel the Court's acceptance of this opinion, unless the reasons for the opinion can stand scrutiny. The question therefore that was originally raised, viz. whether it was a methane or coal dust explosion to start with still remains, although no longer in the form of an acute controversy amongst the parties. The points, therefore, for investigation may at this stage be conveniently formulated as follows:—

- (i) whether the explosions were of CH⁴ or of coal dust;
- (ii) whether if the explosions were of methane, there were one or more simultaneous outbursts or releases of gas to account for the large accumulation of gas, or whether gas was allowed to accumulate from its normal make as a result of the fundamentally defective ventilation;
- (iii) what were the site of ignition and the igniting agent of either gas, if the explosions were of methane, or of coal dust, if they were of coal dust;
- (iv) what part, if any, at all, did coal dust take in the explosions if the explosions were initially of methane; and
- (v) whether in the first place there was any general negligence on the part of the Management in following the rules and the regulations and on the part of the Inspectorate of Mines in seeing that the rules and the regulations were duly complied with, and in the second place, whether there was any special negligence on the part of the Management and on the part of the Inspectorate of Mines which could have contributed to the explosions.

45. The facts collected during the examination of the underground workings by Dr. Badami, Mr. Rosser, Mr. Welsh whose report forms Appendix VII to Mr. Rosser's report, Mr. Evans, Mr. James, Sri H. B. Ghosh and Sri H. K. Bhattacharyya are numerous and important in so far as (a) they have excluded numerous possible sites and sources of ignition and (b) have led to the location of the origin of the violence and blast in one area, viz. the eastern district and on the rise side of the main loco level near the dyke. In this all the investigators are agreed. I shall, therefore, confine myself in this report to only such of these facts in connection with the above area as the parties have referred to in the course of their arguments and such other facts as may be either relevant for the purpose of determining the true significance of the facts referred to by the parties or as may appear to us to be otherwise relevant and significant. It is, of course, possible that what in the light of our existing knowledge may not appear to be relevant at all may acquire, from fresh additions to our present store of information and acumen, varying degrees of importance, and it is my considered opinion that this disaster vain if the materials for serious research which it provides particularly in the matter of dealing with sudden releases of gas and of detecting unusual sources of ignition are pursued by duly qualified scientists with the object of extending the frontiers of our knowledge in these matters. The Company in its anxiety to help the Court of Inquiry in discovering the true cause or causes of the accident spared no expense and has prepared a large number of valuable plans for all but one set of which, viz. Appendix I to Mr. Rosser's Report, as many as ten copies were supplied, from which it is possible to have a clear idea of the workings, of what things were like in parts thereof after the explosion on the 19th of February last. (as reported by the rescue teams and others) and again after the dewatering. They also supplied a large portable model of Nos. 1 & 2 pits and the Inclines and another of the workings of Nos. 1 and 2 pits, and these were placed in a conspicuous part of the Sitarampur Rescue Station where the inquiry was being held so that anyone, anxious to refer to it, could easily do so. In order that one could have a general view of the data collected during the inquiry, I have had a statement in tabular form made by Sri H. B. Ghosh, the Regional Inspector of Mines and I make an appendix to this report. The references in that tabular statement and in this report and the depositions of witnesses are to the machine statement and numbers of the cyclostyled copy of the evidence which the owners kindly provided and which is made a part of the record for facility of reference.

III. THE INHERENT DIFFICULTIES OF THE INQUIRY

46. The problems enunciated in the last section are all evidently scientific. Even during the last lap of the Inquiry as it progressed, it became increasingly clear to me that what we have been called upon to do in trying to unravel the mystery of the explosion is to investigate a number of problems some of which are obscure even to those engaged in actual mining work or research, and I kept on stressing this every now and then specially when I thought any of the parties was straying far afield in search of matters not likely to take us anywhere near the solution of these problems. Of course I must at the same time say that while at this stage we were conscious of the problems, if somewhat dimly, the materials available then were not enough to enable any one to say with any precision that exactly the problems were, and as a matter of fact till the mine could be re-entered by the different investigators and fuller data were available to them so as to enable them to give an opinion, it was hardly possible to set out clearly the points for our investigation. I have no doubt that everyone connected with this inquiry came to realise sooner or later as we proceeded that fundamentally our problems were technical and scientific. The first difficulty, therefore, of the Court of Inquiry is that it is presided over by one without any technical equipment at all though of course there was an expert of Dr. Whitaker's eminence to help it across the hurdles it necessarily met. The second difficulty is the application of the purely judicial process in the exploration of purely scientific problems, and I have had, in consultation with my learned colleagues and the parties, to modify it to some extent, particularly when the results of some experiments conducted in the Mining Research Station under the directions of Dr. Whitaker had to be brought on the record from time to time even at late stages. In spite of such modifications I have felt at times that the judicial process is probably not the most effective way of getting at a scientific truth which may and does often elude even the most patient search outside a laboratory or a research institute.

47. The third and major difficulty in the case arises from the fact that there is not a single survivor from the eastern region of the mine to tell us his experience of what happened in that region where, it is now agreed on all hands, the explosion originated. Necessarily, therefore, if a reconstruction of what actually happened there is possible at all on the materials before us, that reconstruction must be made on the basis of the circumstantial evidence before us, and the circumstances have to be properly arranged and interpreted before one can reach a conclusion.

48. The fourth difficulty arises in this case first from the fire caused by the first explosion and also probably by the subsequent explosions, and secondly, from the flooding. The fires and the subsequent explosions could have considerably affected the evidence of the first explosion either by destroying parts of it or by otherwise changing its character. The subsequent flooding may have washed away much of the soot and the coal dust, coked and un-coked. The water pumped into the workings through a sand bunker must have gone down with some force along the sand stowing drift, the cross-cut and a few dip galleries on both sides of the bottom-end of the cross-cut. In the levels and in the rises however there cannot have been such rapid movement of the water, as the up and down movement of the water with pumping and de-watering must have been pretty slow. This was evident from the impressions of the dead bodies on the roof with bits of flesh still sticking to such impressions at places and their corresponding positions after de-watering. In fact the horizontal movement of the dead bodies in the upper levels and the rises seems to have been negligible. Some loose props and timbers may also have floated up and down to some extent. The flooding, therefore, beyond washing away a part of the soot and the coal dust, coked and un-coked, and beyond causing a certain movement of the dead bodies, both horizontal and vertical, in the dips and some movements of the loose props and timbers, does not seem to have affected the evidence in any appreciable degree.

49. The fifth difficulty is that before the Court of Inquiry began its work there could not be a thorough investigation in the matter by the Department of Mines or by anyone else so as to enable any of the parties to come forward with a clear-cut case to start with and with clear-cut or exhaustive evidence on each of the matters involved. The Department of Mines no doubt began an investigation which was discontinued with the announcement of the Court of Inquiry being set up. One of the consequences of this is that no one could possibly have known when the Inquiry began or after it began, what possible evidence could be there on any particular point. The reason why I have to mention this here is that comments have been made on behalf of the workers' organisations during arguments that the owners or the Department of Mines did not produce all available evidence on certain points. These comments evidently lose sight of the fact that none of

the parties, the owners and the Department of Mines, no less than the workers' organisations, can be supposed even now to know all the relevant evidence that may actually be available on any particular point, and the Court could hardly have tried to get hold of all the evidence that may be available on a particular point without prolonging the duration of the Inquiry beyond all reasonable limits. I am far from certain that even if any such attempt were made or could be made, the parties or the Court of Inquiry would have appreciably benefited from it. I have not, in the circumstances, attached any importance to such comments and told the parties as much when they made such comments in the course of their arguments. I have proceeded to examine the reliability of the evidence that is actually before the court and then to see what conclusion does or does not follow from it by itself or in combination with other proved facts. Another consequence of the fact that there was no previous investigation into the accident is that this court is both the Investigator and the Judge, and this dual role is extremely difficult in all conscience, particularly for one without any background of technical knowledge or experience in the line.

50. Attempts have, at times, been made during argument to test a particular fact in the light of a theory and then to say that the fact could not be accepted if it was found not to fit in with the theory. I have no hesitation in saying, that the two learned Assessors agree with me, that this is an entirely wrong approach. It is the theories advanced which have got to be tested against the proved facts, and not facts against the theories. The reason is obvious. When a theory is advanced, it is to be established by means of facts which fit in with it. To try to test a fact against any such theory and then to say that the fact is not proved is really what is known as an argument in a circle which begins with an assumption of the fact to be proved. This is logically unsound. Neither the judicial process nor the scientific could permit it though it might help a party putting forward a particular theory to prove it by sweeping out of the way inconvenient facts which refuse to fit into the theory. The method, therefore, that I have followed is to test each relevant fact on such considerations as may be pertinent for deciding whether the evidence that seeks to prove it is reliable and then to say if it has been established and finally if it has been held to be established to proceed to solve the different problems on the basis of the relevant facts established.

IV. TOWARDS A SOLUTION

51. What I propose to do in this section is to take up the problems enunciated in Section II one by one, to sort out each of the different facts which favour one solution of that problem or another, to discuss the evidence on which each of these facts rests for finding out if the evidence is acceptable or conclusive proof of the fact and then to try to arrive at the solution of the problem on hand on the facts established. When one problem has been disposed of in this way, I shall proceed to the next and deal with it in the same way and so on till all of them are disposed of.

A. WHETHER THE EXPLOSIONS WERE OF CH₄ OR COAL DUST

(a) *Facts that favour the theory of the explosion being of CH₄*

52. (i) *Flame at fan evasee.*—Sri V. N. Gupta (witness No. W-3), Shri B. S. Gill (witness No. W-2) and Sri P. Chatterjee (witness No. W-4) claim to have seen a transient flame at the fan evasee on their way to the pits after they had heard a loud report. According to Sri Gill the Flame was partly yellowish and partly bluish. According to Shri Gupta it was bluish and according to Shri Chatterjee it was yellowish. According to Shri Gill the height of the flame was about 3 ft. or 4 ft., and it was a "streak sort of thing and not continuing". He does not say anything about the width of the flame. Shri Gill in his re-examination says that he stopped to see the flame continuing. He saw it because he stopped there only for a second or two. Shri Gupta says that the flame was covering almost the whole width of the evasee, but it was not very high. Then he says that, as far as he could see, it was about 2½ ft. to 3 ft. Cross-examined by Shri Mullick he says when he saw it the flame was continuous. Then he goes on to say that he saw the flame and continued walking, and looked at the flame and continued walking, till he reached the canteen when the flame subsided, and that they were not continuously looking at the flame. Shri Chatterjee says that when he looked up he saw to his utter astonishment a black smoke coming out of the evasee with a streak of fire, and when he saw a flame he naturally thought that something might have been happening in the

electrical motor running the fan. Shri Chatterjee also does not say anything as to whether the flame covered almost the whole width of the evasee. Shri Dhaneswar Routh (witness No. 20) examined on behalf of the Colliery Mazdoor Congress, who was working as a Bankman in No. 1 pit in the second shift on the 19th February, 1958, and who heard a loud report, says he did not see any flame; nor does Shri Tarapada Rajak (witness No. 23) examined on behalf of the same party, who was near the screening plant of No. 1 pit, when he heard a very loud report and saw dense smoke coming out of both the pits, speak of having seen the flame. There is thus on the one hand the evidence of Shri Gill, Shri Gupta and Shri Chatterjee, who claim to have seen the flame, and the evidence of Shri Dhaneswar Routh and Shri Tarapada Rajak, one of whom says he did not see a flame and the other does not say anything at all as to whether he saw a flame or not though he mentions smoke having come out of both the pits. The question, therefore, arises whether there is a conflict between the evidence of these two sets of witnesses or the evidence of both the sets can be accepted and reconciled. There is hardly any reason why any of these witnesses should tell a lie on this point. On behalf of the Colliery Mazdoor Congress Shri Deven Sen, and on behalf of the Indian Mine Workers' Federation, Shri Bikash Roy, suggested in their arguments that these three witnesses might have been perjuring themselves at the instance of the owners. But, not only is there nothing to support that suggestion, on the other hand there are certain circumstances which, in our opinion, negative that suggestion. The first is that, at that stage it was impossible for any of the parties to see the true significance of this piece of evidence beyond this that possibly the explosion was of methane. The second is that the witnesses have disagreed amongst themselves as regard the colour of the flame. If they had come to the court with a tutored story one would hardly have expected that disagreement on a somewhat vital point. Shri Gill who was put into the witness box before the other two says it was partly bluish and partly yellowish, and then Shri Gupta, who had drawn Shri Gill's attention to the flame, said it was bluish, and then Shri Chatterjee, who was called to the box after both Shri Gill and Shri Gupta, said it was yellowish. Shri Bikash Roy suggests that Shri Chatterjee would say that the flame was yellowish because though Shri Gupta says it was bluish, Shri Gill, before him, had described it as both bluish and yellowish. If the whole thing were got up each of them must have known what exactly they had to say and no occasion could probably have arisen for Shri Chatterjee to try to harmonise the evidence of Shri Gill and Shri Gupta. Besides, if the owners really wanted to cook up evidence in support of a theory, what prevented them from asking Shri Taneja to come forward with the same story? In Mr. Rosser's note giving the reasons for his conclusion that the explosion was predominantly methane and that coal dust played a relatively minor part, Ex. O. S. 56, which was submitted between 29th April, 1958 and 1st May, 1958, there is a mention of the flame having been seen at the fan evasee and that is one of the reasons for his conclusion. Consequently, if the owners actually wanted to rely on got-up evidence they could probably have got hold of senior and more experienced men to support this story. There is yet another consideration for the rejection of the contention that this evidence owes its genesis to the inspiration of the management. It is this that at the time this evidence was recorded none could possibly have known that there would be anywhere in the mine concrete evidence of an outburst such as the big crack in 15 rise off 1 east rise level with some small coal deposited in two places on the western side; and if no such crack was found, the evidence would be extremely difficult to explain even with the additional make of gas reported shortly after the Inquiry began, because the flame at the fan evasee, short-lived as it might have been, distinctly went to show that somewhere in the mine there was such a reservoir of inflammable gas which at one stage filled the mine air with it so much so that it not only caused an explosion underground but in passing out of the fan evasee connected to the upcast shaft it even burnt on the surface. This, to my mind, would prevent any intelligent person from taking the risk of inventing something which might be difficult to explain later on in the event of the absence of any tangible evidence in its support, of which no one could be sure at the moment of the invention because the mine was inaccessible. These facts and the manner in which the owners have throughout helped this Court in its work by a lavish supply of plans and other materials that could possibly throw some light on the disaster, make the learned Assessors and myself thoroughly disinclined to accept any such insinuation against their integrity and good faith. In these circumstances, we are not prepared to hold that any of these witnesses perjured himself on the point. Similarly, there is no reason at all why Shri Dhaneswar Routh or Shri Tarapada Rajak should perjure himself on this point if in fact either had seen the flame. Shri Dhaneswar Routh was questioned by the Court when he said that he did not see any flame, nor does he mention having seen any smoke, although

Shri Tarapada Rajak says that he did see the smoke. From the very fact therefore that Tarapada saw the smoke and Dhaneswar did not, although both of them were very near the pit head, it is possible to argue that there was no smoke at all. On a consideration of the whole of this evidence I am inclined to think, and the learned Assessors agree with me, that it is the old story of 'eyes and no eyes' which is responsible for one set of witnesses seeing the flame and the other not seeing it. The youngmen on hearing the loud report ran towards the pits whence the report had emanated, and the workmen who were practically at the pit head ran away from it, and if Shri Dhaneswar Routh is to be believed he caught hold of the rails and was unconscious. As already stated, he does not speak of having seen even the smoke which Shri Tarapada Rajak saw coming out of both the pits. The fact that Shri Tarapada Rajak speaks of smoke coming out of both the pits may also suggest that when he heard the loud report he turned towards the pit mouths and saw smoke coming out but did not look at the fan evasee which is a little away from the pit mouths and that might account for his not seeing the flame in the fan evasee. Evidently then, while the three youngmen had their wits still about them as they ran towards the pits, these two who were at the pit head were simply frightened out of their wits and at least Shri Dhaneswar Routh admits having lost his senses. In these circumstances, it is hardly to be wondered as if Shri Dhaneswar Routh and Shri Tarapada Rajak missed the short-lived flame which Shri Gupta, Shri Gill and Shri Chatterjee saw. I have therefore no hesitation in holding, on the strength of the evidence of these three witnesses each one of whom speaks of what he saw, that there was a flame in the evasee and that it was partly bluish and partly yellowish. A methane flame is known to have a bluish-yellowish colour. Mr. James, on the other hand in his argument says that the bluish colour indicates a methane flame and the effects of smoke which accompanied the flame might produce the yellowish colour. He further says that if the flame had been due to coal dust it would have left the evasee and taken on the appearance of a ball of flame because in a coal dust explosion the fuel is ejected in front of the flame and that prevents it from becoming stationary. Besides coal dust flame can hardly be expected to come up a thoroughly wet and dust-free shaft about 2000 ft. deep. The flame, therefore, at the fan evasee appears to us clearly to be a methane flame. If there were even a trace of coal dust in suspension the flame would be yellowish and the more the coal dust the more would the flame approach in appearance that of a coal fire.

(ii) *Air sample near s.s. pit and s.s. drift on surface between 12-30 a.m. and 1 a.m. showing 2½ per cent of CH₄*

53. Shri O. P. Basudeva (witness No. 12) says that between 12-30 a.m. and 1 a.m. on the night of the explosion, asked by Shri Anand and Shri H. B. Ghose to test for CH₄ and CO at the s.s. pit and s.s. drift, he went with a safety lamp and tested the gas at a place about 5 ft. away from the pit mouth of s.s. pit and found the atmosphere contained about 2½ CH₄ and a similar percentage near the entrance to the s.s. drift. This statement of his was left unchallenged in his lengthy cross-examination, and there is hardly any reason why it should not be accepted. It would certainly have been better if more air samples on the surface had been taken and if more samples of the underground air had been taken by the Rescue Parties or others who went underground after the first explosion. The fact that near the s.s. drift and the s.s. pit on the surface as much as 2½ per cent of methane was found less than three hours after the first explosion is, by itself, sufficient indication of the percentage of the same gas in the drift itself and the underground workings being very much higher, and it should be borne in mind that a substantial part of the gas in these workings must have caught fire and burnt whether the initial explosion was of this gas or coal dust. Mr. Rosser at page 93 of his evidence says in his cross-examination that he concluded from this that, as in the s.s. shaft itself there was considerable velocity of air upcasting, the percentage of gas in the atmosphere, by which he obviously means, atmosphere in the shaft, was very considerable.

54. The first Rescue Team took, on the night of the accident, one air sample at the main west air crossing. The air crossing had been completely wrecked by the first explosion. The sample, on analysis, showed 1.12 per cent CH₄. The wrecked air crossing means that the intake and the return air were mixing there, and the presence therefore of 1.12 per cent CH₄ in such air would not necessarily mean the presence of gas from any source other than the normal. This is all the more so because the extra supply of gas from the eastern region would mostly pass out of the mine through the upcast shaft and little of it would have a chance of penetrating into the western region.

55. Professor Subrahmanyam at page 451 though at first he was inclined to say that the detection of about 3 per cent of gas on the surface within three hours of the explosion would not necessarily indicate a heavy make of gas underground, had ultimately to admit, somewhat reluctantly, that if 3 per cent gas was found within 5 ft. from the shaft it was a heavy make of gas. Here there is a little inaccuracy both in the question and the answer about the actual percentage which was $2\frac{1}{2}$ per cent and not 3 per cent. But that does not affect the argument. At page 472 the Professor says he based his opinion on the probability of an accumulation of gas in the east face capable of sudden ignition, the word 'outburst' being clearly a misprint for 'ignition'; and yet in the next question he has to admit he cannot explain why any one of the three experienced men, about whose presence in that face we have evidence, could not detect the gas. These men are D. C. Bedekar, the Under Manager, Tara Singh, the Overman, and Riasant Mia, the Mining Sirdar, whose bodies were found in 16 rise off loco level east (vide Appx. II to Mr. Rosser's report, and also sectional plan No. 32). If the gas was accumulating in its normal make from defective ventilation it is really extraordinary that none of these men could detect it and take the necessary action. The Professor cannot explain this, and though this fact goes against his theory of a slow building up of gas in the eastern district, he would still maintain his theory. This tenacity to hold fast to a theory in the face of an established fact which militates against it is really the negation of the true scientific spirit, and naturally the effect of this is largely to discount the value of his testimony not only on this but on other matters as well. One is reluctantly reminded in this connection of the fact that while Mr. James, who happened to be in India only for a short period, could and did spare as many as two days for seeing the underground workings with his own eyes before submitting his report, Professor Subrahmanyam of the Indian Institute of Technology at Kharagpur, only a few hours' journey by train from Asansol, did not think it worth his while to go underground even for a few hours, before submitting his. This contrast between the two was obvious to everyone.

56. (iii) *Inner glass of Oil Lamp No. 574 found broken.*—It appears from the register of persons employed underground (Ex. W-34) for the s.s. drift that to Shri Tribhuban Das Onsetter, oil safety lamp No. 574 was given for the second shift on the 19th February, 1958, and on the same day oil safety lamp No. 596 was given to Shri Basista Mohan Dubey, underground trammer. I have already said that the dead body of Basista Mohan Dubey was recovered from the sand stowing drift, and it appears from the evidence of Shri T. C. Anand (witness No. 12) at page 247, that lamp No. 596 (Ex. ii) was found on the 3rd or 4th March 1958 by a Rescue Team near the door towards the s.s. pit and this door was about 12 ft. away to the north side of the sand stowing pit bottom. This lamp is perfectly in order and no damage could be found in it. The lamp, however, that was given to Shri Tribhuban Das who himself returned alive, presumably with the cap lamp, had been left behind by him and this is lamp No. 574 (Ex. i). The evidence of Shri T. C. Anand on the same page is that lamp No. 574 was found on the morning of the 14th March 1958 by Shri Kuldip Biswas on the north side of s.s. pit bottom. It had been extinguished and it was found that its inner glass was broken into several pieces while the outer glass was in-tact. From this Mr. Rosser concludes that the inner glass was broken because the fire damp must have burnt in it for a considerable time at a percentage near the lower limit of explosibility before the fire damp percentage increased sufficiently to crack the inner glass. Oil was found in the base so that it was not burnt out for lack of oil. If this conclusion of Mr. Rosser is correct it would tend to show that there was a considerable volume of methane in that region. But then, the inner glass might have been broken for other reasons. If, for example, the lamp had been thrown on the ground with some force the inner glass which is much thinner than the outer glass might easily have been broken although the outer glass was in-tact. The fact therefore that the inner glass is broken would not be conclusive proof that the lamp was burning for a considerable time when the percentage of methane inside was less than the lower limit of explosibility and then methane increased sufficiently to crack the glass. It is however one of the circumstances which, though not conclusive may be taken along with the rest for whatever it is worth.

(iv) *Two oil flame safety lamps in No. 5 Rise district*

57. In this connection a point which deserves serious notice is the condition of two oil safety lamps found in the road connecting the cross-cut (s.s. drift) with No. 5 rise district, east. These two lamps are Nos. 371 & 502 which are the only oil lamps found in this area, the other lamps found being cap lamps as will appear from Appx. II to Mr. Rosser's report, Ex. O.S. 72. The description of these lamps, as given in Dr. Badami's report, Ex. C-5 (pp/11-12,

2nd part, dated 16th July, 1958), is as follows: "2 or 3 lamps found in 5 rise area had the wick-shields draped outside down on the wick-holder. The seem to have been blown up and fallen back into place—only upside down. In 2 lamps the wick-shields were found jammed inside the outer gauzes..... Almost all the lamps had their wicks fallen into the fuel reservoir. No explanation was available for this..... Another curious feature of lamps found in 5 rise area was the pieces of cloth found jammed in the vents in the bonnet top. One could not understand how or why these pieces of cloth got there." What Shri H. B. Ghose found in these oil lamps is contained in an enclosure to his report (Ex. D.M.I 37). Against lamp No. 371, the entry in this enclosure is as follows: "Wick-shield turned upside down and partly sticking to the wick guide. Wick not visible, probably pushed inside the guide. Wick fallen inside oil pot. A piece of cloth jammed inside the top of the bonnet. Outer glass—soot deposition near the bottom end inside the glass. Outer gauze—soot below rusting at the top along the periphery. Inner gauze—slightly bent along axis." Against oil lamp No. 502, the entry runs as follows: "Top part of bonnet pushed toward 3 O'clock pieces of jute had gone inside a few vent holes at the top. Wick shield upside down. Wick dropped inside oil pot. Soot inside the glass." The relevant portion of the entry under lamp No. 371 in Appx. VIII(b) to Mr. Rosser's report is as follows: "Bonnet—I.O. (in order). A piece of cloth partly burnt sticking on the top of bonnet. Outer glass—inside the glass soot deposit near the bottom end. The oil pot—in order—water. Wick—wick-shield turned upside down and partly sticking in wick-holder. Wick pushed down into the oil pot. Outer gauge—soot at the top (under rust) round the periphery; otherwise in order. Inner gauge—bent along its length, No. 5 rise, Tehal Ram". Against lamp No. 502, the relevant portion of the entry is as follows: "Bonnet—top part pushed towards 3 O'clock. Jute gone inside the top vent holes. Outer glass—soot deposite inside. Wick—wick-shield turned over inside. Wick in oil pot, No. 5 Rise face—Birbal, Miner." Shri H. B. Ghose was questioned by us during arguments by Shri Sachin Chaudhuri and he informed us that in lamp No. 371 only one hole in the bonnet had pieces of cloth, while in lamp No. 502 three from these reports, first, that both the lamps had their wicks inside their oil pots, one of which contained water; secondly that, in the first there was a partly burnt piece of cloth jamming one of the bonnet vents, though only Mr. Rosser speaks of the cloth being partly burnt, and in the other there were three pieces of jute cloth sticking into three of these vents; and thirdly, that the outer glass of both showed deposit of soot inside; fourthly, soot under rust at top along the periphery in the outer gauge of lamp No. 371. These facts naturally give rise to the questions whether, in the first place, these can be explained away by natural causes or by human handling only, and in the second, if they were due to human handling only, the necessity for the action which they indicate could have arisen only from the entry into the lamps of enough CH₄ to make the flame in the lamps shoot up so as to oblige the miners concerned to make to put out the flame by pulling down the wicks and then by trying to jam the vents with pieces of cloth and brattice. Another fact which need be mentioned here is that the dead bodies in the road connecting the cross-cut with 5 rise district were found in-bye while the two lamps in question were found at some distance from them out-bye. Shri Jabbi, in his argument, suggested that the wicks might have fallen down into the pots as they dried up. But as the lamps were under water some water is likely to have got into the oil vessels and naturally water was found in one of them. It is most unlikely that the wicks would have fallen of their own accord into the oil vessels. Similarly, to suggest the blast of the explosion as having jammed a piece of cloth into the bonnet hole of one and pieces of cloth into three of the bonnet holes of the other would be almost to credit the blast with something like human intelligence. If natural causes of these facts are ruled out, as we think they should be, the probable explanation is that attempts were being made to put out the flame of the lamps by pulling down the wicks completely, and when this failed, to smother the flames of the gas burning in the lamps by means of cloth inserted into the outlets at the top of the bonnet. From this it would appear that gas in considerable quantity, perhaps 20 per cent, was present in the atmosphere. The action in pushing cloth into the top of the bonnet, however, was foolish and fraught with the danger of ignition of the cloth which might cause an external explosion.

(v) *Increased make of gas in the pits*

58. Dr. Badami's report, page 2, 1st part, against the date 7th April, 1958, speaks of his collecting samples from the compressed air main in the s.s. drift.

as his notes against the 6th April, 1958 go to show, and the fan evasee, and of samples from the first showing CH₄ ranging from nearly 33.0 per cent to 46.0 per cent approximately, and those from the second showing CH₄ between 0.5 to 0.7 per cent only. To the discovery of abnormal make of gas in the mine after the Court began its sittings, I have already referred in para. 43 of Section II of this report where it has been pointed out that on the reports of the persons who were called upon to investigate this, there was at least 50 per cent increase in the make of gas in the three pits. The last report of Dr. Badami dated 14th August, 1958 (Ex. C-9) is about a sample of gas he collected in a trial pit in 16 rise of No. 1 dip level on 11th August, 1958, under instructions from Dr. Whitaker. The gas was found issuing continuously under water which had collected in the pit and was sampled by downward displacement of water. The sample was found to contain 2.88 per cent of CO₂ and 93.90 per cent of CH₄ and 3.22 per cent of air, by difference. It is therefore obvious that the make of CH₄ about three hours after the explosion and for some time thereafter, even upto the 11th August, 1958, was considerably higher than its normal make in the mine and that even as late as 11th August, 1958 some gas was bubbling out through water in the trial pit in 16 rise off 1 dip level.

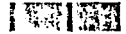
(vi) *Indications from evidence disclosed after de-watering*

59. The second and subsequent explosions do not seem to have interfered much with the damage and evidence left from the first explosion in so far as the district east of the cross-cut is concerned. And this is natural since in the east district there would be little or no air and thus little or no oxygen, after the first explosion; nor would air readily gain access to the district as the necessary doors and stoppings had been blown down and the air current was short-circuiting in areas not too remote from Nos. 1 and 2 shafts. Indeed, much of it must have been simply short-circuiting through the shattered ventilation doors near the shafts. Again, the fan was stopped much of the time; but even if it were running it would probably only increase the above short-circuiting somewhat. Thirdly, the top of No. 2 pit was still open, and much of the air passing through the fan must have been simply surface air drawn down No. 2 pit only as far as the fan drift and then passing through the fan. It was largely on account of the non-interference of the second and subsequent explosions with the effects of the first in the east district beyond the cross-cut that the investigators were able to trace the source of violence there. In the dips and the west side and in the rise district (Nos. 4, 5 and 6) from the cross-cut itself—the above argument does not hold, and the damage and effects of the second and subsequent explosions are largely confused with those of the first. Fortunately, however, Mr. Hughes and the first two Rescue Teams had visited the west side shortly after the first explosion and we have their evidence of the conditions at that stage.

60. Appendix II to Mr. Rosser's report (Ex. O.S. 72) shows the position of the dead bodies of the victims of the accident with their designations wherever the identity of the bodies could be established and also the position of the lamps with their numbers and the designations of the employees to whom they were issued. Shri H. B. Ghose, Regional Inspector of Mines, in para. 3 of his report says that the effects of the explosion and the resultant fire on the mine workings, plants, machinery and other objects were carefully noted during inspections and that all such effects were carefully surveyed and plans incorporating details of field observations have been prepared by the management. No one has questioned the accuracy of these plans and there is not the least reason to doubt that these are substantially correct. It also appears from the reports which we could ourselves verify from what we saw of the underground workings that the position from which a particular dead body was recovered in a large number of cases corresponded almost exactly with the position of the impression of a dead body on the roof with bits of flesh still sticking in some cases to parts of the impressions on the roof. This suggests that there was little movement of the dead bodies except vertically as a result of the rise and fall of the level of the water that flooded the mine and was then pumped out. From the dispositions of the dead bodies in the mine, as found on de-watering, Mr. Rosser concludes that the victims were all at or near their working places save and except those who are engaged in the west loco level, in the s.s. drift connection, and in No. 1 east rise level. What the position was in the west loco level after the first explosion has been largely set forth in the narrative of the explosion and it does not really concern us here. From the drivage meant to connect s.s. drift with 6 rise level, 11 bodies including those of a Mining Sirdar and a Set Rider were recovered, but none of them were found near the face. This suggests that they moved a short distance from the working

place before they succumbed. Shri H. B. Ghose also says this in his report (Ex. D.M.I. 37). We are inclined to think that these men were gassed, i.e., died from oxygen shortage, a short time before the first explosion.

61. With regard to No. 1 east rise level, Mr. Rosser says at page 2 of his report, "There is a small quantity of loose coal at the face—not more than a ton or two. There is also a shovel pushed into loose coal and still standing in this position. Two baskets were also found, of which one had coal in it. There are no drill holes. Eight cap lamps which had been issued to C.R.O. Coalmines Recruiting Organisation) labour were found near the face. No bodies were found near the face, but a number of unidentified bodies were found in the level between 15 and 16 rise. (Two bodies without lamp were also found in 16 dip off 1 east rise level). It appears that the floor coal had been blasted and was being loaded out at the time of, or shortly before, the explosion. No drill holes have been found in the floor coal." In item (o) at page 8 of his report (Ex. D.M.I. 37) Sri H. B. Ghosh also confirms the above and adds that some chappals (foot wears) were also found there in No. 1 east rise level. From this Sri Ghosh concludes that the persons working there must have left in a hurry. But why they left in a hurry is more than one can say. Was it because of a sudden apprehension on their part of impending danger or was it something else? Mr. Rosser examines a number of possibilities at pages 11-12 of his report. Sri Devan Sen in his argument suggested that these men must have left in a hurry when there was an explosion in 16 dip off 1 east rise level where, according to him, the first explosion must have originated. He further argues that, if the apprehension of danger came from 15 rise the men would not certainly have run in the direction of the danger itself, but would have gone up 16 rise and moved westward along 2 east rise level. The fact that some of these men not merely left their chappals behind but also their lamps which made them move, for in that case they were likely to have taken their lamps with them, unless of course the extent and magnitude of the danger apprehended scared them completely out of their wits so as to make them leave their lamps behind. If the danger originated, as Sri Devan Sen argues, in 16 dip off 1 east rise to 2 east rise level. But then there also remains the question why they should have left their lamps behind which alone would have enabled them to see their way. If, on the other hand, the danger came from 15 rise they would certainly have been running also towards the danger if they proceeded westwards along No. 1 east rise level; but if they proceeded first along 16 rise off 1 east rise level and then westwards along 2 east rise level, they would have still to pass 15 rise from which the danger had come. That is far from probable for the simple reason that if the apprehended danger came from 15 rise they had no way out of the mine except by passing 15 rise either where it met 1 east rise level or where it met 2 east rise level. They would pass 15 rise more quickly if they moved westwards along 1 east rise level than if they took the circuitous route via 16 rise and then 2 east rise level. It is not unnatural for people in such a situation to try to get out of it as quickly as possible. Another possible reason for their movement along 1 east rise level towards 15 east rise is that miners usually take on their return journey the route they follow in going to the workings, i.e. the travelling road. But again, there remains the question why they should have left their lamps behind. This inclines me to the view that one or the other of the probabilities examined by Mr. Rosser in his report probably explains the situation rather than danger. This disposes of the workers whose bodies were found at some distance from their working places. The distribution of the dead bodies in 16 rise off M.E. loco level, along the M.E. loco level and the rest of the eastern district as shown in Appendix II to Mr. Rosser's report and the sectional plans 31, 32 and 33, goes to show that these bodies with a large number of cap lamps were at or near their working places. This is mentioned in the reports of Messrs. Rosser, Evans and Sri H. B. Ghosh, and the fact was never challenged. That the flooding and the de-watering could not have caused any appreciable horizontal movement of the dead bodies, except along the bottom levels, I have already found. Evidently, therefore, from the position of the dead bodies alone one is entitled to infer that the men died at or near their working places and that there was no attempt on the part of any of them to try to run away from where they were. The fact that most of the workers in this region did not move at all and were found at or near their working places, would seem to prove conclusively that they, at any rate, could not have received any intimation of imminent danger, for if they had they would certainly have moved hither and thither in order to get out as quickly as they could. In other words, as no one appears to have moved from the loco level faces it would follow that these men had no intimation of any great danger. If their colleagues in 1 east rise level had any such intimation at all they must have



been nearer than the rest to the danger zone, and on the assumption that they moved away from their working faces on some sort of warning of a sudden danger, one would be entitled to hold, in the first place, that the apprehension of danger must have come either from 15 rise where a crack about 100 ft. long and 5 inches wide was found after de-watering or from the dyke face where 2 east rise heading meets the dyke and where was found for the first time after de-watering a cavity approximately 3 or 4 ft. across and nearly 2 ft. in depth in the dyke with the hard face rock, about 9 inches thick, of the dyke blown out and a pile of rock lying just below the cavity (*vide* Dr. Badami's report, 2nd part, pages 5-6 dated 21st June 1958, and page 6 of Mr. Rosser's report and Appendix V of his report containing photographs of this cavity). During my visit to the underground workings I saw the cavity and the cracks in 15 rise and 14 rise off the loco level. If the danger apprehended came from an outburst at the dyke face at the point of this cavity, the workers might well have moved westwards along No. 1 east rise level; but if this outburst was a small one, as Dr. Badami suggests, it is hardly likely that the workmen should have been so frightened as to forget to take their lamps with them. If, on the other hand, the apprehension came from 15 rise where the alleged outburst may have produced a very substantial crack in the floor they might well have been too frightened to bother about picking up their lamps in their precipitate bid for safety even though such a bid evidently carried them nearer the danger zone. Though these possibilities cannot altogether be ruled out, the learned Assessors and myself are inclined to think that one or the other of the rest of Mr. Rosser's alternatives afford a more likely explanation of the movements of the men working in 1 east rise level. These alternatives are: (a) that these men might have been moved under the orders of Sri D. C. Bedekar, the Under Manager, whose body was found in 16 rise off the main east loco level and who was known to have always insisted on withdrawing men from the face of dips and rises when these faces were being approached from another direction and shot-firing was about to be done; (b) that the drinking water carrier had arrived in No. 1 rise level and the victims had gone over to him leaving their lamps in the level face, and (c) that there being little blasted coal left in the level face the loaders might have come out on to the level, where it would be cooler, for a rest leaving their lamps in the face, the normal practice of a gang of loaders being to leave a number of their lamps on the floor or sides at the site of the blasted coal to give light to the loading of this coal into baskets and to distribute the rest of the lamps along the gallery where the baskets have to be carried, in the form of street lighting.

62. Then as regards the two bodies found in 16 dip off No. 1 east rise level, Mr. Rosser thinks that probably in this dip, where the make of water was found subsequent to re-entry to be about 100 to 150 gallons per hour, loading from the face was suspended while accumulation of water was being bailed out. He further says that on Monday and Tuesday of the week of the explosion working at this face had been stopped due to water accumulation and this working place had not been cleared of water until about 2 p.m. on the 19th February and a cut had been made in this face at the end of the first shift and it was presumably blasted some time in the second shift. If any one of these explanations is accepted as more than probable as we are inclined to think they should be, these workers, though at the moment of the disaster they were at some distance from their working places, must have been caught completely unawares by the gas. The fact that the large majority of workmen in this zone did not move at all from their working places would, to my mind, show that normal mining operations were going on in the mine and the workmen had not the slightest intimation of unusual danger. This is mentioned by Mr. Evans at page 7 of his report and by Shri H. B. Ghosh at page 9 of his report. That would justify the further conclusion that the danger, whatever it was, must have been too sudden and unexpected to allow the men any time for trying to save themselves by running away from it. Of course, the state of the dead bodies after they were recovered did not permit the Doctor, to whom they were sent for their *post-mortem* examination, to find out the cause of their death with the result that no light on the cause of their death is available from *post-mortem* reports. The suddenness, however, with which the danger burst upon these men and overpowered them in a matter of moments so as to render any attempt on their part to save themselves impossible, entitles one to conclude that either of two things must have happened, namely that the men must have been suddenly overpowered by carbon monoxide from an explosion or that there was a sudden drop of oxygen in the air from an unexpected emission of gas. While the first alternative cannot be altogether ruled out, the fact that even a small percentage of carbon monoxide, for which the affinity of the haemoglobin of the blood is known to be three hundred times as great as that of the haemoglobin for oxygen, affects both the head causing dizziness and the limbs, inclines me to the view that had the men been overpowered by carbon monoxide, there would

have been some movement among them, however slight, before they actually succumbed. The fact that there was none makes it more than probable that this danger was caused by a sudden shortage of oxygen in the air, particularly in that part, and that this sudden shortage of oxygen in the mine air again could only have been due to the sudden release of gas under pressure, this released gas suddenly displacing the normal air.

63. The following table at page 153 of METHODS OF AIR ANALYSIS by J. S. Haldane and J. I. Graham, 7th edition, showing the effect of the drop of oxygen (O₂) in the air is instructive:—

<i>Per cent by volume</i>	<i>Effect</i>
20.93 ..	Normal air Supply.
17.5 ..	Flame lamp extinguished; can be breathed and work done without ill effect for several hours.
13.0 ..	Considerably increased rate of breathing if work is done. Lips distinctly blue; nausea and headache develop gradually and may become very severe.
11.8 ..	Loss of consciousness on exertion. Individual differences.
Below 6 ..	Unconsciousness and death if not quickly removed."

Drs. Whitaker and Willett at page 33 of their book on COLLIERY EXPLOSIONS AND RECOVERY WORK say that when O₂ is 10 per cent in the air and no CO₂ is present, it is precarious to life. It is therefore obvious that before oxygen can drop down as low as 10 per cent men must at least feel uncomfortable and this sense of discomfort is likely to make them do something to find out what it is due to and to take steps to save themselves. If the gas was accumulating from its normal make because defective ventilation did not sufficiently dilute it, the men in the whole area would have felt a certain amount of uneasiness before falling down and some of them at all events would have tried to move away, and particularly the Under Manager Shri Bedekar would have noticed it. I have already pointed out elsewhere that men of experience like Bedekar, Tara Singh, and Riasat Mia could hardly have failed to detect gas in the event of its gradual build-up and that even Professor Subrahmanyam who may be said to have fathered this theory before this Court could not explain this away. In other words, reasoning backward from the fact that the large majority of the men in the eastern district did not make any attempt to save themselves by flight, one is forced to the conclusion that mercifully enough these men (and probably many others in the dip side return air) first fell down unconscious where they stood from the sudden drop of oxygen in the air resulting from the displacement of air by the sudden release of a large volume of gas under high pressure, and thus died from oxygen shortage.

64. I think this is a convenient stage of the discussions where the two theories of Shri Deven Sen that the explosion originated in 16 dip off 1 east rise-level may be disposed of. He advanced these theories for the first time in his arguments and attractive at first sight as they may appear, we think they can hardly bear a close scrutiny. The data on which Shri Deven Sen's two alternative theories are based are these: first, Dr. Badami (p. 14, 2nd report) noted 3 shots had been fired at the bottom and 3 more shots fired at the top without clearing the coal brought down by the bottom shots, and there was on the right hand side as one looked down the dip a socket visible near the top—obviously an attempt having been made to fire a shot to bring down an overhang and dress the roof and in line with this shot hole on the roof at a distance of 5-6 ft. there were marks of sodden stemming material, the stemming at one place having penetrated deep into a horizontal crack or parting in roof coal as if the stemming had been forced into it; secondly, two dead bodies were found in this dip, and as they could not be identified, Shri Deven Sen says one might have been that of a dresser and the other of a mining official. Thirdly, a coal pick was found near the face. Fourthly, there are a missing exploder and a missing box of detonators. These are the four facts on which Shri Deven Sen builds his two alternative theories. The first theory is that the crack noticed by Dr. Badami on the roof must have provided an ideal lodgment for CH₄ that normally emanates from coal in the mine and a blown-out shot from the socket visible near the top might have ignited the gas in the crack into which the stemming material visibly penetrated, and that is how the explosion originated. His second theory is that the presence of the coal pick shows that a dresser had

come along to dress the roof after the blasting and while dressing he let fall large lumps of coal on the detonator box which was lying below in that face so as to explode it and ignite the gas in the crack. If either of these theories could be accepted, the Court's task would be enormously simplified, but there are against these theories unanswerable arguments which make it impossible for me to accept either. In the sectional plan of this dip, no lamps are shown as having been found here. Mr. Rosser distinctly says at page 3 that no lamps are found here. Dr. Badami, however, at page 13, 2nd part, speaks of a cap lamp found in 16 dip off 1 east rise level having had the head piece cracked and some of the contacts inside in little bits and pieces, and Shri Deven Sen naturally makes use of this. It is clear however, from what Dr. Badami says earlier in this page that after having gone to 9 dip and 2 dip off 1 dip level, he came up to the surface and himself did not go to 16 dip off 1 east rise level that day and then when he says "another cap lamp found in 16 dip off 1 east rise level had the head piece cracked and some of the contacts inside were in little bits and pieces; there were signs of what appeared to be sparking or arcing." What he evidently means is that he saw this lamp on the surface after having learnt from some one or other that it had been found in 16 dip off 1 east rise level. As against this, there is Mr. Rosser's distinct statement in his report that no lamps were found here and no lamps are in fact shown in this dip. The lamp found nearest to this 16 dip as shown in plan 33, Appendix I to Mr. Rosser's report is No. 1401 which appears from Appendix VIII(a), (page 7, serial No. 38) to his report to have been perfectly in order. This lamp in Appendix VIII(a) is stated to have been found 130 ft. to 140 ft. east of 15 dip on 1 rise level, though it is so near 16 dip that its location could more conveniently have been described with reference to 16 dip rather than 15 dip. The only other lamp which appears from plan No. 33 of Appendix I to Mr. Rosser's report is No. 40 and this is more or less at the centre of the junction between 16 dip off 1 east rise level and 16 dip, and Appendix VIII(a), (page 8, serial No. 46), also shows that to be the place where it was found. It appears from this Appendix that the fuse of this lamp was blown off, that there was a hairlike crack at the top of the head piece moulding and in the remarks at the bottom of the sheet where this lamp is dealt with it is stated that the cable sheathing was out of the gland at the head piece end, that the gland was missing and there was some deposit on the head piece moulding near the switch and also at the hat-clamp. As this lamp partially, but not fully, satisfies Dr. Badami's description I sent on 2nd September, 1958 for the lamp and it was produced before me on 4th September, 1958. Its internal contacts were not in bits and pieces as stated by Dr. Badami. Evidently then, Dr. Badami must have referred to some other lamp as having been found in 16 dip off 1 East rise level. That evidently is a wrong piece of information he had collected from some one else. In this connection it may also be pointed out that Shri H. B. Ghose says in his report Ex. D.M.I. 37 at page 8 that "no lamp was found in 16 dip off 1 East Rise Level."

65. The absence of any lamp in this dip, as evident from Mr. Rosser's report, would indicate that no work, whether shotfiring or dressing was going on here at the time of the explosion. so that this alone would go to disprove both the theories.

66. The theory of the blown-out shot in which Shri Deven Sen was considerably helped by a missing shot-exploder has been given a crushing blow by the subsequent recovery of this missing exploder from 4 east level between 3 and 4 dips on the night of the 27th July, 1958 (vide Appendix II to Mr. Rosser's report, which was filed by the Management on 29th August, 1958 after Shri Deven Sen's arguments were over). The absence of cables also points to the incorrectness of the theory.

67. The second alternative theory which is built up partly on the presence of a pick and partly also on the fact that a box of detonators could not be accounted for, loses sight of the utter improbability of a box of detonators being placed near a working place where coal had been already blasted and might be dressed, at any time. In the circumstances, neither of these theories can be accepted. It is more likely that the two dead bodies found in this dip floated down into it from 1 east rise level at its junction with this dip than that they were of men actually working in the dip at the time of the explosion.

(vi) *Whether the theory of one or more outbursts or sudden releases of gas should be accepted*

68. All the Experts, except Prof. Subrahmanyam, agree that on the data available there can be no room for doubt that a large volume of gas under high

pressure must have suddenly come out and filled the mine with CH₄, and the external evidence of this is furnished, according to them, by the cracks in 15 Rise and 14 Rise off 1. East Rise Level, and again in the face of the dyke where 1 East Rise Level enters it. Prof. Subrahmanyam, on the other hand, does not feel satisfied on the same data that there must have been an outburst, and he accounts for the cracks found by heavings of the floor due to the lateral stresses on the strata helped by the action of water after the flooding of the mine. Shri Deven Sen, Shri Bikash Roy and Shri Madhu Banerjee representing all the workers' organizations except the Indian National Mine Workers' Federation and the Colliery Mazdoor Union represented by Shri Keshab Banerjee for which Mr. L. James was examined as an Expert, do not accept the outburst as having provided the inflammable gas for the explosion and they agree with Prof. Subrahmanyam that the defective ventilation permitted a sufficient accumulation of gas in the mine from its normal make to render the first and the subsequent explosions possible even without an outburst having occurred. It is the strange contention of Shri Deven Sen, Shri Bikash Roy and Shri Madhu Banerjee that if one or more outbursts occurred at all they may have occurred after the explosion and as a result partly of the lateral stresses on the floor and partly also of the flooding. That the normal make of gas in the mine was sufficient to permit its accumulation for an explosion they deduce from certain reports of the existence of gas in certain regions that very day and earlier and also from certain inspection reports.

69. Before proceeding any further it is necessary to consider this evidence on which the whole of this argument is built up. Shri Sadhan Bauri (Witness No. 22) said in his statement, Ex. W-20(1) to Shri H. B. Ghosh that during the first shift of the 19th Santi Babu as well as Dasarath Mining, by which he evidently meant Mining Sardar, had told him not to cut in No. 16 Rise Loco Level as there was gas in it and he also saw a fencing in it just near the junction, but after gas was cleared from it and Santi Babu informed him he gave a cut in it at about 3 p.m. He further says that the Mining Babu had told him at about 2 p.m. that due to gas in the loco level dyke gallery he had removed stone cutters from there and after that no one had worked in it and he had seen a fencing across it. But he had no further information about gas being found at any other place in his section. So, as far as his evidence goes, he heard of the presence of gas in 16 Rise Off Loco Level, saw a fencing near the junction, and the gas was cleared and he gave a cut, but from the Loco Level Dyke Gallery the Stone Cutters, according to him, were withdrawn at about 2 p.m. and thereafter no one worked in it, and he saw a fencing also there. Shri Dhaneswar Rauth (Witness No. 20) speaks of having received a message from Birbal, the On-setter, some time after 7 p.m., that is, after the second shift had begun, about gas in No. 4 dip and he sent Tarapada to late Bedekar with this information. Tarapada also confirms this. According to these two, therefore, gas was found in 4 dip at about 7 p.m. on the 19th. Shri S. B. Mal (Witness No. 25) also says that while he was with late Bedekar at about 7-30 p.m. on the 19th, a man came along and said there was a report that gas had been detected in No. 4 dip stone gallery. This is all the evidence of reports of gas in the first shift and in the early part of the second shift on the 19th. Shri Taneja was questioned by Shri Madhu Banerjee at page 190 whether on the 15th February last he had a report about accumulation of gas and his evidence at pages 190-191 shows that there was actually no report regarding accumulation of gas and he found out on questioning Bhikhan Ojha who had sent word to him about a "golmal" when he had detected some leaks in the ventilating purdahs and thought it was necessary to have an extra timber mistry, that there was no gas. Although therefore, the cryptic information scribbled for Shri Taneja on 15th February, 1958 took him to the colliery to find out what the trouble was there was actually no report of gas. In the Gas Report Book (Ex. O.S. 38) reports of gas from the 29th November, 1957 to the 10th February, 1958 in different sections are shown and the percentage of gas also is indicated in this book. It further shows what steps were taken to remove the gas. In every case, as far as this book indicates, the brattice was extended and that is how the gas was removed.

70. The letters based on the inspection reports that complain of gas accumulation are dated 9th January, 1957, 29th June, 1957, 9th August, 1957, 23rd November, 1957 and 13th January, 1958. These merely show that 2 per cent. or 2½ per cent gas was detected at certain places during the inspections. The first of these complains that evidently the ventilation of the mine is defective as the presence of inflammable gas in various concentrations is being detected pactly on every inspection and presence of gas in the roof cavity of the Main West Level is persisting for quite a considerable period and gas in No. 5 rise of east rise

section and No. 3 rise of No. 2 east dip section was detected on 29th December, 1956. The rest of the reports also show inflammable gas at different parts. In the first inspection report it is distinctly pointed out that the ventilating fan was then producing 137000 cft. of air per minute with the result that gas in different pockets could not be cleared, but the evidence shows that the total quantity of air produced by the fan at the date of the explosion was 240,000 cft. per minute. The point to be noticed here is that wherever there was excess of gas found, it was due to defective ventilation and not to any extraordinary source of supply of gas.

71. It is thus clear from this evidence that nothing to indicate an extraordinary source of supply of CH₄ was reported from nearly the end of November, 1957 upto the 10th of February, 1958 and on the 19th there were some reports of gas. The book showing emergency withdrawal of men (Ex. W-3) shows that between 29th November, 1957 and 2nd February, 1958 there were withdrawals of men on 9 occasions on account of the presence of gas from the Main East, No. 2 Dip East Level, No. 15 Rise, 9 Dip East Rise Level and Main East No. 15 and 16 Rise. It is noticeable from this book that there were withdrawals of men from 15 East Rise on three occasions, No. 9 Dip East Rise Level on 3 occasions and on one occasion from Main East and Nos. 15 and 16 Rises. It is thus clear from this evidence that gas was occasionally found in the various sections and occasionally men were withdrawn. It further appears that this gas was dealt with by the normal methods of brattice extensions etc. by which the air was taken to the place where gas was found to have accumulated. There was nothing unusual in withdrawals of men in a gassy mine on 9 occasions in two months and if the inspection reports complain of this, it is merely to point out that the ventilating current was either not properly utilised or not quite sufficient for any particular face. In a gassy mine gas is constantly building into the mine from the coalface, and if the ventilation was found not to dilute the gas sufficiently attempts were made to clear the gas by leading additional ventilation to the affected pockets. The question that is to be considered now is whether what happened at about the time of the explosion on the 19th February, 1958 can be explained away by this normal accumulation of gas in the mine. In other words, the question is whether there are circumstances to make one hold that there was in the mine at about the time of explosion a much larger percentage of gas than could possibly accumulate from the normal make of gas. It appears from Ex. O.S.-68, prepared by Shri R. R. Khanna, witness No. 21, that the natural make of gas would take 14.7 hours to flood the whole of Nos. 1 & 2 pits with 5 per cent methane-air mixture. But of course, as he makes clear in his evidence at page 351, the time may be 3 or 4 hours or even less for the atmosphere in the eastern district only to become explosive. As already found, the percentage of CH₄ in the mine atmosphere must have been considerable at about the time of the explosion. Mr. James at page 6 of his report, Ex.W-35, says "Gas is given off from coal surface slowly but continuously. In this mine no pillars had been extracted so that all the spaces within the mine were open and accessible in the form of galleries. Gas produced by this means could only accumulate slowly. An accumulation of the size involved in this explosion would have been largely irrespirable, yet persons were disposed all about the extremities of the workings. As the build-up of an accumulation of gas by the emission of occluded gas is a slow process, distress should have been felt and warning given before the atmosphere became irrespirable. After the first explosion it took some 14 hours before gas accumulated, with the ventilation completely disrupted, to reach an ignition source which was presumably the fire. Again such a build-up of gas should have taken long enough to have given opportunity for detection during the normal inspections of the mine. Certainly had such a build-up occurred in the Main East area where there was a considerable concentration of labour, its pressure would have been felt. It would appear therefore, that the make of gas was too rapid to produce any such reaction." What Mr. James points out struck every one of the investigators except Prof. Subrahmanyam. Evidently then, if the gas was permitted to accumulate from its normal make because of defective ventilation, this accumulation must have been a very slow process and it is most unlikely that the workmen in the faces concerned would not have felt uneasy or sick when the gas was building up due to defective air supply. In the event of an accumulation of gas from its normal make, these men or some of them would have felt uneasy and there would have been signs of movement amongst them if only to get away from the place. As already indicated, there are no such signs of movement except at certain places. The absence of any signs of movement in the eastern district where admittedly the explosion started could hardly be explained away by the slow building up of gas from its normal make because of defective ventilation. It has already been pointed out that the

fact of three experienced men, viz. Bedekar, Tara Singh and Riasat Mia whose dead bodies were found in 16 Rise off Main East Loco Level not having detected this slow accumulation of gas does not fit in with this theory. The distribution of dead bodies on the Loco Level and between 15 and 16 Rise off 1 East Rise Level has already been referred to and it has already been held that in all probability these men first fell down unconscious on account of a sudden drop of oxygen in the mine air and then died in a few minutes. That conclusion which was arrived at from the distribution of the dead bodies in the Loco Level and 1 East Rise Level clearly goes against the theory of a slow building up of gas in the region in the normal manner. There are also other indications, viz. that about three hours after the explosion as much as 2½ per cent of CH₄ was detected on the surface about 5' ft. away from the pit mouth of s.s. pit and near the entrance of the s.s. drift indicating that inside the s.s. shaft and the drift the percentage of CH₄ must have been much higher. This can hardly be accounted for by the theory of a slow building up of gas from its normal make in the mine. The other evidence which goes against this theory is the flame seen at the fan evasee immediately after the first explosion. Of course, as I have already said, on behalf of the workmen's organizations, the evidence which seeks to prove this fact was seriously challenged as unreliable, but on a consideration of the evidence we could not accept the contention that the evidence was unreliable. The facts proved therefore go against the theory of a slow building up of gas in the mine before the explosion.

72. The next question to be considered is whether there is any evidence that in fact there was an outburst, either before or after the explosion. That after the explosion Nos. 1, 2 and 3 pits together were making about 50 per cent more CH₄ and that Nos. 1 and 2 pits were making over 80 per cent more CH₄ are undisputed as the reports of Dr. Badami, Shri H. B. Ghosh and Shri M. K. Bose during the first part of the inquiry, go to show. That is why Shri Deven Sen, in particular, has argued that, if there were an outburst at all, it must have occurred after the explosion; but of course, although I asked Shri Deven Sen several times to place before us the facts from which he concluded that the outburst if it occurred at all must have occurred after the explosion, he did not suggest that there was any particular fact from which he could come to that conclusion. The position therefore, before one can proceed any further is this that if there was an outburst it might have occurred either before or after the explosion, and what this Court has got to consider is whether there are sufficient indications of the outburst having occurred before the explosion. Here comes here also the question arises as to the cause of the cavity in the dyke face where 2 East Rise Level meets it. It is in evidence, and no one questions that evidence, that this cavity was seen for the first time after the de-watering of the mine. It also appears from Dr. Badami's report at page 6, 2nd part against the date 21st June, 1958 that the dyke face consists of hard rock about 9" thick. That it consists of hard rock we have seen for ourselves. It further appears from Dr. Badami's report, and we have seen it for ourselves, that the rock in the cavity was moist and soft. Mr. Rosser's report at page 16 says the rock in the back of the dyke is soft and can be pulled out with the fingers. There is a photograph of the cavity in Appendix V to Mr. Rosser's report. There is a at page 7 of his report that upto a depth of about 9", the stone in the face of the dyke appears to be a normal peridotite dyke but beyond that depth, the stone is loose and laminated and can easily be removed by the hand. It appeared to him to be similar in structure to compressed but not consolidated sand. Dr. Badami says that on examination of a sample of the dyke rock in the laboratory it was pronounced to be Micaperidotite. In other words, beneath about 9" thick of hard rock there is a moist and soft material. Dr. Badami says at the same page of his report that a superficial examination of the cavity did not reveal any cracks or fissures extending further. The fact however, that the hard face of the dyke would be blown away to form this cavity at all and that the underlying splinter seam was found converging to the main seam above and that it proceeded eastward beyond the dyke incline us to the belief that there must have been a crack or fissure in that cavity through which great outward pressure must have been exerted in order to blow off that hard facerock and this outward pressure is in all probability that of gas spent up beyond the dyke, and probably within the underlying splinter seam as it crosses the dyke, and probably from the reports of the different investigators that after the cracks in 15 and 14 rises were discovered, trial pits were sunk into the seam first at the dip end of the heaved portion which revealed presence of a coal seam 2'-3" thick and only 2'-9" below the floor of the main Disergarh seam, (Vide report, page 10) of Shri H. B. Ghosh (Ex. D.M.I. 37) and the plan, Appendix VI to Mr. Rosser's report. Shri Ghosh further says a few more staple pits were put down at other places and it was observed that from 13 Rise to a point 80 ft. in-by-e to

16 Rise the floor parting, that is, the strata between the Main Disergarh seam and the splinter seam had progressively decreased from 6'-5" to 1'-6". This has been shown in Appendix VI to Mr. Rosser's report (Ex. O.S. 72). From this map it is clear that beneath the Disergarh seam that was being worked there was 46' shaley sand stone at the bottom of No. 1 pit and there was no sign of this splinter seam. At that point therefore, the splinter seam may well be taken to be lying at least 46' below, and as it approaches the dyke the two seams had converged, and it is more than likely that the two meet at a short distance further east. The existence of this splinter seam underneath was not known to anyone till the trial pits brought it to light. It appears from the plan, Appendix VI to Mr. Rosser's report, that the shaley sand-stone which lies between the Disergarh seam and the splinter seam under 14 Rise is 4'-3" thick. Under 15 Rise, it appears that first there is a layer of shale with streaks of coal 10" thick; below that there is a layer of soft shaley coal 9" thick; underneath that there is another layer with broken shaley streaks of coal 10" thick and the last layer is shaley coal 4" thick, and just underneath that is the splinter seam which is itself 2'-3" thick at that point. The crack in 15 Rise extends from very nearly the point of the junction between 15 Rise and 1 Rise Level to within about 10 ft. of the junction of this Rise with 2 Rise Level. According to Dr. Badami; the length of the crack is nearly the length of a pillar, that is, about 125 ft. The crack in 14 Rise is about 35 ft. Evidently, therefore, of the two cracks that in 15 Rise is much the more pronounced and it is here that part of the floor has been thrust up some 9". The strata intervening the Disergarh seam and the splinter seam under 15 Rise is only 2'-9" as already pointed out, whereas under 14 Rise it is 4'-3". The facts that a certain amount of small coal was found on the western side of the crack in 15 Rise and that in the intervening strata under 15 Rise coal appears to have got mixed up with shale, go definitely to prove that coal erupted from the splinter seam through the intervening strata and the crack in 15 Rise and got deposited on the western side of the crack. The fact that small coal was deposited only on the western side of the crack, as the reports of Dr. Badami and Mr. Evans show, would indicate that the line of fissure was not vertical and inclined westward from below as it approached the surface. Moreover, some of the small coal erupted might well have been washed away by the water or dispersed by the outburst itself, but still a certain quantity remains. The eruption of small coal from the splinter seam through this crack is definite proof of the fact that an upward pressure was exerted by something or other which caused the small coal to be erupted from the splinter seam upward through the crack in 15 Rise. Dr. Badami's report at page 7, second part, against date 25th June, 1958, is as follows: "In 15 Rise between 1 East Rise Level and 2 East Rise Level, attention was drawn to an upheaval of floor. The crack seemed to extend on the west side of 15 Rise more or less 3 ft. from the side on the floor for nearly a pillar length. In places it has been lifted nearly 9 inches. Some rather small sized coal was found piled on the side right in front of the crack. The deposit of mica-looking shining particles on the sides was even more pronounced here. The sides also looked coated with a coke-like thin deposit of dust." Then against date 28th June, 1958, at page 8, Second Part of the Report, he goes on to say that the mica-looking stuff, examined under a microscope, appeared to be needle-like lath-shaped crystals and were quite brittle, and not mica at all, and the particles when brushed into a watch glass and treated with Benzene, dissolved readily and the bright crystals also seem to sublime off and there was a sulphurous odour as they did so, and Dr. Badami thought that they were organised in nature. Dr. Badami does not appear to have noticed the minor crack in 14 Rise Level, but Mr. Rosser mentions this crack in 14 Rise above 1 East Level, at page 16 of his report (Ex. O.S. 72), and it is shown in the sectional plan. There is no mention of this crack in the report of either Mr. Evans or Shri H. B. Ghosh who however says in the 3rd para of the first page of his report, Ex. D.M.I. 37, that the effects of the explosions and the resultant fire on the mine workings, plants, machinery and other objects were carefully noted during inspections and all such effects were duly surveyed and plans incorporating the details of field observations have been prepared by the Management. We also noticed this crack during our visit underground. There is thus no reason to doubt the accuracy of Mr. Rosser's report and of the sectional plans. It is just possible that the crack in 14 Rise was not mentioned by Dr. Badami, Mr. Evans or Shri H. B. Ghosh because it was not so pronounced. Of the cavity in the dyke face, as I have already stated, there is mention in all the reports. As I was saying, the distinct evidence of coal having erupted through the crack in 15 Rise off 1 East Rise Level, in any event, goes conclusively to prove an upward pressure having thrown up the small coal. The question arises what the nature of this upward pressure could be except gas coming out with considerable force from the splinter seam after having broken through the intervening strata of shale.

Shri Deven Sen, Shri Bikash Roy and Shri Madhu Banerjee attributed the crack solely to the lateral stresses on the floor and also to the action of water. If the action of water had any effect on this heaving it is likely to have affected the dips more than the rises, because water entered the dips earlier and must have been pumped out of it later than in and from the rises so as to leave the dips under water longer than the rises. The likelihood therefore of water having had anything to do with this floor heaving seems to be somewhat remote, and if the floor heaved merely as a result of the lateral stresses on it, it is unlikely to have caused an eruption of small coal unless at the same time there was an eruption of gas through it. Prof. Subrahmanyam in his report (Ex. W-39) page 2, says "The building up of gas pressure on the summit of a roll which brings the lower seam in close proximity to an upper one presupposes the existence of rolls in the seam and the migration of gas through summits where it builds up pressure. The so-called splinter seam in this mine does not reveal any such indication and the shales of the type that constitute the floor of Disergarh seam are, in my opinion, much too hard to permit of such pressure building." The splinter seam has not been yet fully explored and one does not know whether in fact it reveals a roll; but the fact remains that there was a heaving and through the crack caused by that heaving small coal erupted. That by itself would show that the floor at the particular, spot must have been comparatively weak. If that is so, the normal lateral stresses on the floor might have been helped by the upward pressure of the gas pent up underneath in the splinter seam so as to lead to the heaving of the floor, and Prof. Subrahmanyam admits at page 472 that if there are stresses in the strata which would tend to heave the floor and if at the same time there is an underground source of gas in the seam below, the two together will work to the same effect, namely that there will be a crack in the floor and there will be an outburst of gas provided the seam is capable of supplying the gas. There is thus no conflict between the theory of floor-heaving and the theory of an outburst. The only question is whether the outburst occurred after the explosion or before the explosion. The facts that at about the time of the explosion the mine must have been full of methane so as to asphyxiate a large number of workmen who had no time even to make an attempt to save themselves by running away, that on the surface $2\frac{1}{2}$ per cent gas was detected about three hours after the explosion and that a short-lived flame which was evidently a methane flame was found at the fan evasee immediately after the explosion would indicate that a reservoir of gas untapped before must have been struck somehow or other. The evidence of the flame lamps is also confirmatory. Thus, while there are some indications of the confirmatory. Thus, while there are some indications of the outburst or the outbursts having taken place before the explosions so as to fill the mine with CH_4 there are none that the outbursts occurred after the explosions. The reason why I use the expression 'outburst' or 'outbursts' is that there are, as already stated, two cracks, one in 14 Rise of a somewhat minor nature and one in 15 Rise which is much bigger, and there is that cavity in that dyke face which was not there before the explosion. A scrutiny of the sectional plans showed a number of cracks on the floor, most of which must have been old cracks. There is no evidence to suggest that ever before there was any emanation of gas from the cracks on the floor. As there was no trace of small coal anywhere near the small crack found in 14 rise, it is most unlikely that gas and small coal were ejected through it, for whenever there is such emission of gas, small coal in varying quantities comes out with it. On the western side of the bigger crack in 15 rise, there was a quantity of small coal in 2 places. In the cavity in the dyke, of course, there was no coal but some soft and moist rock.

73. Sri Deven Sen has argued that as outbursts have not occurred in Disergarh seam and that as the so-called outburst in this case is admittedly not what is known as a classical or normal outburst, but rather an abnormal outburst, one has to be very carefull before concluding that there has been in fact an outburst. It is admitted by all the experts who are of the opinion that there was an outburst, that this was not a classical outburst but rather an abnormal one. Even normal or classical outbursts are fairly rare occurrences, and those which do not conform to the general or classical pattern and are accordingly described as abnormal are rarer still. This alone would dictate sufficient circumspection on the part of the court before it accepts the theory of an outburst. Prof. Subrahmanyam says at page 435 in answer to questions from the Court that the only case of floor heaving associated with the ejection of small coal he had heard of is the one mentioned in Mr. Rosser's report. Probably he was referring to the outburst at L'Agrappe Colliery in Belgium on 17th April, 1879 mentioned at page 14 of Mr. Rosser's report. Prof. Subrahmanyam then goes on to say that in any coal measures of Gondwana Age,

i.e. in the southern hemisphere, he has never heard of an instance of floor heaving followed by ejection of coal, though he has heard of that in Europe. On this point, evidently, the professor's knowledge is not quite up to date and Dr. Whitaker brought to my notice an article by A. J. Hargraves, Senior Lecturer, Department of Mining Engineering of the University of Sydney, on "Instantaneous Outbursts" in issue No. 186 (June 1958) of the Proceedings of the Australasian Institute of Mining and Metallurgy. This article points out that such outbursts are not new to Australia, although the occurrence is not common and is possibly confined to two operating mines; and the local history of the phenomenon goes back over sixty years with five fatal occurrences. The two outbursts, one at Cohinsville on 13th October, 1954 and the other at Metropolitan on 2nd December, 1954 occurring after 29 years of freedom from them, drew the phenomenon sharply to the notice of the local mining industry. The following factors appear, according to the author, from field observations, to contribute to rendering a seam prone to outburst:

- (1) Presence in seam of gas in suitable quantity,
- (2) Appreciable depth of cover,
- (3) Local faulting and partial crushing of coal at faults,
- (4) Residual or current tectonic forces,
- (5) Contractions of seam, also variations in thickness,
- (6) Sharp dip of the seam,
- (7) Intrusion of the seam by dykes,
- (8) Low moisture content of coal,
- (9) Coal of low permeability to passage of gas,
- (10) Working the seam in a manner which does not allow satisfactory escape of sealed gas;

but only points (1) and (2) appear to be indispensable. In this article there is no reference to the existence of any seam underlying the one being worked as one of the factors which are likely to contribute to an outburst, but when he refers to variations of thickness, he evidently includes cases of splinter seams which may account for such variations. The author admits, however, that the mechanics of instantaneous outbursts are not understood although considerable investigation and research of the phenomenon has taken place, because there are so many indeterminate factors contributing to it.

74. Mr. James at the request of the Court submitted a supplementary report on the conditions and circumstances giving rise to a normal outburst. This is Ex. W-41. He makes it clear that even normal outbursts are very rare, and in Britain, this phenomenon is being experienced in one mine only. According to him, two conditions are necessary for a normal outburst, namely (1) exceptional stress of an area of a coal seam, and (2) coal of a standard that will resist compression. But then, as he says, "very occasionally an outburst occurs in which large volumes of coal are not ejected and many of the characteristics of the normal outburst are not present. Two such outbursts of which he has knowledge were accompanied by floor lift which caused a crack in the floor parallel to the working face and a third from a dyke." Mr. James in his main report, Ex. W-35, at pp. 8-9 speaks of two cases of outbursts known to him personally, one in Lancashire and the other in Durham. These are evidently the two cases mentioned by him in Ex. W-41 as the two abnormal outbursts of which he had personal knowledge. "In both cases cracks developed in the floor of the seam parallel to the face working and in both cases a seam had encroached on the working seam from below." Mr. James thinks that what happened at Chinakuri Nos. 1 and 2 pits is not a normal or classical outburst, as large quantities of small coal do not appear to have been ejected, nor was there a typical fissure. He seems to think that "the presence of the dyke may have contributed to the outburst by entraining gas due to the distillation which occurred at the time of the intrusion. Finally, he concludes by saying that having considered the various possibilities he is of the opinion that the large gas emission is consistent with the seam immediately beneath the Disergarh seam having confined gas under pressure and that the intervening strata had become so thin that it was no longer able to repress the upward progress of the gas and consequently

the floor was lifted, liberating the large volume of gas which caused the explosion."

75. That this view is correct would appear from the facts already established, namely, first, that a bluish methane flame streaked with yellow which is due to the smoke coming out with it was found in the fan evasee for a short while immediately after the explosion; secondly, that about 3 hours after the explosion samples of gas taken on the surface showed 2½ percent. CH₄ indicating thereby that inside the shafts concerned the concentration of CH₄ was much higher; thirdly, the condition of the two oil safety lamps found in 5 rise area suggesting an increase of CH₄ in that area; fourthly, the impossibility of such a build-up of gas in the mine from its natural make without its being detected, particularly by experienced men like Bedekar, an Under Manager, Tara Singh, a Senior Overman and Riasat Mia, a mining sardar, all of whom were in 16 rise off the main east loco level, and fifthly, that the large majority of the dead bodies was found at or near the working faces suggesting thereby that they were overpowered by such an unexpected danger that they could not make the least attempt to save themselves, and that this danger was in all probability a sudden drop of oxygen in the air which a sudden release of gas under high pressure is bound to lead to. All this will be further confirmed by the additional make of gas reported in the mine towards the end of April, 1958 and also the inherent gassy nature of the splinter seam as revealed by Dr. Badami's report, Ex. C-9. Of course, that by itself, would be as consistent with the theory of the outburst having occurred after the first explosion as it would be with the theory that it preceded the explosion so that if by itself it cannot be said to be conclusive of the outburst having preceded the explosion, taken in combination with the other facts mentioned, there can be no doubt whatever that it did in fact precede the first explosion.

76. Admittedly, the shafts of both No. 1 and 2 pits are very wet, the shaft of No. 2 pit being even more wet than that of No. 1 pit. The depth of No. 1 pit is 1995.6 ft. and that of No. 2 pit is 2019.13 ft. as already pointed out. As both the pits are wet it is far from likely that the flame of a coal dust explosion could travel up this shaft so as to be able to show the flame at the top of the fan evasee, but a methane flame might well travel up the shaft of No. 2 pit even though it was wet and the flame might, in that case, travel to the top of the fan evasee. Even Prof. Subrahmanyam feels constrained to admit at page 439 that if there was a flame seen at the fan evasee a large amount of firedamp should have been involved.

B. WHETHER COAL DUST STARTED THE EXPLOSION OR WAS MERELY INVOLVED IN THE PROPAGATION THEREOF ONCE IT WAS OTHERWISE STARTED AND THE PART COAL DUST PLAYED IN SUCH PROPAGATION.

(i) *The possibility of coal dust having started the explosion examined and negatived.*

77. Dr. Whitaker and Dr. Willett in their joint work entitled "Colliery Explosions and Recovery Work", at pages 71-72 of the Second Edition, which is the latest, says as follows: "A dense cloud of dust is required to initiate a coal dust explosion and for all mining purposes we may regard a situation as more dangerous the denser the cloud. In other words, the upper limit of inflammation is a cloud of dust so dense as to be difficult of attainment. To propagate an explosion once started however, only a minute quantity of dust is necessary. As little as 0.09 oz. per cubic ft. of air space has been known to propagate an explosion, a quantity so small as to be quite unnoticeable on the floor, timbers etc. of a mine roadway." Dr. Whitaker tells me that recent researches have shown that even as little as 0.05 ozs. per cubic ft. air space would be enough. If, therefore, the explosion originated by an ignition of coal dust there had to be present in the eastern district of the mine a sufficiently dense cloud of coal dust. Does the evidence before us indicate that there would be such a dense cloud of dust in the region at that time? The only direct evidence of the presence of coal dust in a certain area of the mine comes from Sri N. C. Datta Roy (Witness No. 25). This man has been working in Chinakuri pits 1 and 2 for more than three years, and up to the 19th February last he was working as Conveyor in-Charge, his duty being to repair conveyors. He says that in the morning shift when he used to go to see whether the conveyors were in order and needed repairs, he found coal dust below No. 2 pit conveyors and 9 dip conveyors and that the coal dust he noticed was neither too much nor too little. Questioned by the Court what he meant by 'too much' or 'too little' he says that

if the dust is in heaps he would call it too much, but if the dust is 5" or 6" high then he would call it moderate, and if it is 1" or 1½" thick he would call it too little. He says further that on the 19th February 1958 when he went down in the first shift he noticed coal dust 5" or 6" in depth below 2 dip and 9 dip and he had the coal dust cleaned either himself or by his helper in order that the conveyor might work properly. There has been a good deal of cross examination of this witness on behalf of the Mines Department and on behalf of the owners. Then there is the evidence of Sri P. Chatterjee, who is an Assistant Electrical Engineer in charge of these conveyors. That in the morning shift there used to be an accumulation of coal dust underneath the conveyors is not disputed by Sri Chatterjee; but while Sri N. C. Datta Roy says that the water with which the coal used to be sprayed never reached the bottom layer so that the dust underneath still remained in the shape of dust, Sri Chatterjee would have one believe that the water reached even the bottom layers of the coal and the dust collected in the pans of the conveyors would be in the form of sludge, so that if Sri Chatterjee is to be believed that would not be dispersible in the air. Of course, Sri Chatterjee is a more responsible officer than Sri N. C. Datta Roy. Sri N. C. Datta Roy evidently perjured himself about a pump being used about a week before the explosion for pumping water from 2 dip though according to Sri Chatterjee this pump, lowered no doubt into the dip before the accident, was never put into commission for pumping water at all before dewatering began, and what used to be done before the accident was that a bailing-mazdoor carried water from the bottom level of 2 dip in a kerosene cannister, the capacity of which was about 10 seers. Sri Chatterjee further says that the pump could not be put into commission because there was no sanction from the Mines Inspectorate. It is inconceivable that Sri Chatterjee would have dared to tell a lie on this point when the Department of Mines was there as a check against it. Besides, I must say, and the learned Assessors agree with me in this, that Sri Chatterjee was more impressive in the witness box than Sri N. C. Datta Roy ever was, and we have therefore no hesitation in saying that Sri Chatterjee is likely to be more reliable than Sri N. C. Datta Roy when the two disagree.

78. As to the dust collecting under the pans being in the form of sludge, as Sri Chatterjee says, and in the form of unwetted dust, as Sri N. C. Datta Roy tries to make out, we are however inclined to take the view that it would not possibly all be in the form of sludge, nor in the form of absolutely unwetted dust, so that the truth probably lies between the two extreme positions taken by the two witnesses. The reasons which lead us to this view are first that it is somewhat unlikely that no part of the water sprayed or poured on the coal in the conveyor pans reaches the bottom layers and thence to the dust below, and if a part of the water reaches the dust below the pans, it is likely to be somewhat wet. At the same time for the purpose of maintaining at least 30 per cent. of water in intimate mixture with the dust continual treatment is necessary because of the continued evaporation everywhere in the mine, and though in this mine there may not be any shortage of water we find it somewhat difficult to believe that this continual treatment with water would go on particularly when in the second and the third shifts Sri Chatterjee would not normally be there to see to this being done. Of course in the morning shifts the condition of the dust is bound to give him a fairly accurate idea as to whether the coal is properly wetted during the other shifts, and thus to enable him to take necessary action against those at fault. Theoretically, this may be all right but there is always a gap between theory and practice wherever human elements are involved and it is only the size of the gap that varies from man to man. It is undoubtedly true that wetted coal will not produce as much dust as dry coal is likely to do, but the question here is not the quantity of dust produced and lying under the pans at the beginning of the morning shift, as there is no dispute between Sri Chatterjee and Sri Datta Roy on that point; the question is whether the dust below the pans, whatever its quantity, could be in the form of sludge or not. Secondly, the precautions against dust which are now embodied in rule 123 of the Coal Mines Regulations, 1957, published under Notification S.R.O. 3419 dated 27th October 1957 were not there in the corresponding rule 871 of the Regulation of 1926. Sri Taneja at page 187 says, "The regulations came out in October but were circularised in the last week of December, and we hardly got a month or two. We were preparing the scheme. We had schemes which we had been following before Regulation. We had prepared a coal dust plan which had been submitted. We were doing the thing in a correct manner. In the old Regulation there was no mention of the approval of the Regional Inspector. We were following the old regulations. In addition we had certain plans. We were doing more than what was required". Sri Taneja was no doubt answering here questions as to whether the management obtained the approval of the Regional Inspector of Mines under rule 123(6)

of the New Regulations for the manner in which systematic samples of the dust have to be collected from places mentioned in rule 123(5) (a). This much is however quite clear from these answers that the new regulations which were circularised to them by the end of December 1957 they were not in a position fully to implement by the 19th February 1958 when the accident occurred. Of course, it must in all fairness to the management and the Department of Mines be mentioned here that in spite of the absence of any provision in the old Regulations for water treatment of coal dust, the Mines Inspectorate pointed out time and again the need for water-spraying of coal dust and by way of illustration reference may be made to Ex. D.M.I.-19, serial No. 3, dated 26th June 1957, in which the Regional Inspector of Mines pointed out on the strength of an inspection by Sri Ahuja on 15th June 1957, that the 2 Dip and 5 Rise conveyors should be provided with water-sprays. It is also in evidence that the 5 Rise conveyor was not in existence at the time of the explosion and that although the 2 Dip conveyor was fitted with a spray, it was not in working order on the 19th February 1958. In the circumstances, it will be somewhat surprising if Sri Chatterjee could, in spite of what was required of the management before the introduction of the new Regulations by the Department of Mines ensure that the provision of the new regulations regarding the treatment of coal dust with water, was being fully carried out. Thirdly, in Ex. D.M.I.-19, serial No. 11 dated 6th December 1957 based on an inspection dated 23rd November 1957 by Sri Sinha, Inspector, coal pieces and fine coal dust were found on the loco line in-bye of 2 dip, an accumulation of coal dust near the discharge end of the loco level conveyor, near the discharge end of 9 dip conveyor and under the pans, fresh layers of coal dust on the floor and supports in 9 dip and the sides of pillar were not cleared off coal dust and there was no spray in 9 dip conveyor. There was fine coal dust in 3 West Level off 9 dip and in 2 dip section. The inspection note of Sri H. B. Ghosh dated 13th January 1958, (Ex. D.M.I.-9, serial No. 14) mentions coal dust having been found in several places in 5 Rise and Main East Districts in spite of cleaning of dust and stone dusting. Of course, in 5 Rise there was no conveyor then but in the Main East District there were conveyors working. If in spite of the fact that the incomplete and ineffective handling of the coal dust was brought to the notice of the management in December, 1957 and that the Regional Inspector spoke of this to the Agent over the phone, as mentioned in the inspection report, the same sort of thing was found again in more limited areas in January 1958, this is only an illustration of the usual shortcomings of any organisation, however efficient, to come up to the required standard, particularly when this standard was only recently prescribed. In the circumstances we do not find ourselves in a position to go the whole way with Sri Chatterjee when he says that the dust under the pans in 2 and 9 dips as in the form of sludge and must hold that though it might have been partly wet it would still be not so wet as to be non-dispersable altogether. This much however is reasonably clear from the evidence of both Sri Chatterjee and Sri Datta Roy that most of the coal dust that is raised settles down and though there might be a certain amount of coal dust in suspension in the air it would never be anything like a dense cloud of dust which is needed for a coal dust ignition unaided by any other kind of explosion. It is significant that Sri N. C. Datta Roy never speaks of such a cloud of dust being ever in the air. Besides, a deposit of coal dust varying from 5" to 6" or to say even 9" thick underneath the pans during the three shifts makes it quite unlikely that at any one moment there would be such a cloud of dust. In saying this, I am not at all unmindful of the effect of mechanisation on the production of coal dust, particularly at the loading points when, as pointed out at page 355 of the Report of the Royal Commission appointed in U.K. in December 1935 on Safety in Coal Mines, "the dust may take the form of a dense cloud capable of being carried in the air current for considerable distance." The reasons why in spite of that probability we cannot hold that there could have been a dense cloud of dust at any one or more points at any particular time are, first, that the deposit which has been testified to by Sri N. C. Datta Roy will not justify such a conclusion, and secondly, that if really such a cloud of dust formed at any time it is more than likely that something would have been heard about it from the workers' side, and that it would have been mentioned on some occasions at least in the many reports of inspections of the mine by Inspectors of Mines which were before us.

79. In this state of facts the conclusion would not appear to be unreasonable that in the mine air there must have been a certain amount of fine coal dust in suspension at all times and a much larger amount deposited on the floor, sides and roof so as to be available for the propagation of an explosion once it is started, but the coal dust in suspension could not possibly have been so dense as to start a coal dust explosion unaided by any other kind of explosion except perhaps when blasting, unless the proper precautions were taken.

(ii) *Did coal-dust take a part in the explosion once it was started by CH₄ being ignited and if so, what are the nature and the extent of the part it took?*

80. It has been already stated that the concentration of coal dust in the air which is needed for the propagation of an explosion initiated by ignited methane is, according to the latest research, as little as 0.05 oz. per cubic foot of air space. That a small quantity of coal dust is likely to be always in suspension in the mine air, specially when scraper-conveyors are at work, goes without saying. That a much larger quantity of dust, a part of which at any rate would be likely to be raised into a cloud by the blast of a gas explosion, would be available everywhere except when the mine is thoroughly wet equally admits of no doubt. As soon, therefore, as there is a gas explosion, there will be an appreciable quantity of coal dust raised into the air to take part in the explosion and then to propagate it. The nature and the extent of its propagation again would depend on the amount of oxygen available for the coal dust combustion.

81. It is in evidence that dense black smoke came out of no. 2 pit and also out of the fan evasee a flame was seen by the three witnesses, viz, Sri Gill, Sri Gupta, and Sri Chatterjee. Sri Tarapada Rajak further says that he noticed dense smoke coming out of both the pits. Sri Gill in his cross-examination by Sri Bikash Roy (at page 58) says that the atmosphere at the top of no. 1 pit was a bit smoky and that was unusual. Sri Chatterjee says that he noticed black smoke coming out of the evasee with a streak of fire. Sri Taneja says that when he went first to no. 1 pit he found coarse black substance round about. It appears from the evidence of Mr. Hughes (page 2) that the distance between the top of pit no. 1 and that of pit no. 2 is about 150 ft, that the air coming out of no. 2 shaft was grey-smoky and steamy in appearance and further that round the surface of no. 1 pit over a limited radius of 50 ft, or so he noticed black particles (but coarse) having erupted out of the shaft and lying on the ground. It does not appear that there was any such deposit of coarse black substance round about pit no. 2 after the first explosion and no one speaks of that. Although there is no evidence of any great damage at the top of no. 1 pit, nevertheless two tubs in the cage on the kep had de-railed, and there was also considerable damage at the bottom of no. 1 pit where the air would be fresh. Further, the Belmos weighing about 3 cwt had been hurled from no. 2 dip along the loco level to the bottom of the shaft, a distance of about 500 to 600 ft. [vide Dr. Badami's report (Ex. C-5) page 10, 1st part]. This again probably indicates that coal-dust was playing a part in the explosion, and indeed this is to be expected. It must be stated here that there was considerable violence also in the return airways, such as the hurling of a Belmos weighing about 3 cwt from the junction of 2 east dip and 2 dip level upto the junction of 0 dip and 2 dip level, the smashing of the only protection board at the bottom of no. 2 pit, the blowing in of 2 tipping tubs on the 2 pit bottom landing. It is true that a methane explosion is normally local but that happens only in cases where CH₄ reaches the explosive range in a pocket or in a particular part of the mine. When, however, as in this case, the whole mine more or less becomes flooded with methane and explosive mixtures are formed from the point of the outburst in parts of the intake and the whole of the return right upto the upcast shaft, the CH₄ explosion cannot be expected to be local, either in extent or in manifestations of violence. If coal dust takes a part in the explosion, necessarily the extent and the magnitude of the violence increases and in this case, evidently this is what has happened, but all that it is possible to say with regard to the relative part of CH₄ and coal dust in the explosion is that coal dust played a larger part in the intakes than in the returns, whereas CH₄ played the same role everywhere and the violence near the bottom of the upcast shaft was probably due more to the CH₄ explosion than the coal-dust explosion while that near the downcast was due more to the coal-dust explosion than to the CH₄ explosion.

(iii) *Interpretation of coal dust analysis*

82. Total volatiles consist of the gases and tarry vapours driven off at 900°C. If the temperature is lower or the time duration short, only part of the volatiles will be driven off. When coal is coked thoroughly (as for metallurgical coke), practically all the volatiles are driven off, and the residue is true coke. It contains all the ash of the original coal. In short coke is equal to ash fixed carbon. For a given coal the ratio volatiles/fixed carbon is practically constant and independent of the ash or the moisture. This ratio thus gives an idea of the extent to which the coal has been carbonised or devolatilised. For the Disergarh coal (raw), the ratio is close to 0.75, i.e. for the uncarbonised coal. If it falls to 0.7 or 0.6 or 0.5 the conclusion is that the coal or coal dust has been partly devolatilised either by the heat of a fire-damp flame or by actually taking part in the explosion, or both. The normal ash of the Disergarh coal is about 14 per cent in certain portions, rather less perhaps down to 10 or 11 per cent. If the coal is fully devolatilised, i.e. carbonised completely, the ash in the residue would be normally about

20 per cent. If the coal is only partly devolatilised, the ash will be between 14 per cent and 20 per cent, according to the degree of volatilisation. If the ash is greater than 20 per cent it probably shows that combustion has also occurred, i.e. not merely devolatilisation but also combustion of the fixed carbon—provided always that the sample is one of the original coal. (If we take a shale or rock sample, the ash may be 80 or 90 per cent, however). The moisture is no guide. It can vary so much due to the vicissitudes. In fact, all results are often calculated to a dry basis, i.e. to what the dry sample would have given. Alternatively one can calculate to a constant moisture basis, say 2% moisture for the Disergarh coal.

83. In examining the traces of coking of the coal dust by the flame of the explosion as it travelled from the east westwards, it is necessary to proceed from the extreme eastern workings westwards. Analysis of mine dust collected during recovery from different places in the workings is noted below:—

Samples taken from	M	A	V. M.	F. C.	VM/FC
<i>[Enclosure to the report (En. D.M.I. 37) submitted by Shri H. T. Ghosh, Regional Inspector of Mines]</i>					
I rise level 20 ft. west of 9 dip-roof	3.8	10.0	31.5	54.7	.57
I rise level 20 ft. west of 9 dip-floor	2.8	12.2	34.8	50.2	.69
I rise level 15 ft. west of 11 rise-roof	3.3	8.7	33.4	54.6	.61
I rise level east of 14 dip-floor	2.8	14.8	35.4	47.0	.75
I rise level east of 14 dip-roof	3.8	9.7	33.4	53.1	.63
West junction of 1 rise level and 13 dip roof cavity	4.3	9.1	33.2	53.4	.62
West face of prop at 1 rise level & 15 rise junction	5.0	10.4	32.1	52.5	.61
Prop outbye end at 16 dip of 1 rise level	5.2	15.9	22.4	56.5	.39
16 rise loco level	3.6	6.2	28.2	62.0	.45
E.R. level prop: standing between 15 & 16 dips; coking on east side of prop	2.7	15.4	25.5	56.4	.45
Lagging facing 16 dip/1 R. L.	4.28	16.82	21.16	57.74	.36
Dip side of prop at 6 dip just below loco level	19.82	4.79	23.31	52.08	.44
8 dip x-cut corner facing pit	17.51	2.45	17.69	62.37	.28
Inbye end of north side brick wall 20 ft. inbye of 8 rise in loco level	23.43	3.91	22.53	50.13	.44
1st tub buffer out-by end near No. 9 dip loco level	31.06	3.46	23.48	42.00	.55
Below bottom belt 15 ft. inbye of discharged end	14.34	2.63	34.55	48.48	.71
13 dip conveyor jib end pan	17.88	4.19	26.71	51.22	.52
Transfer point 14 dip	13.75	3.71	28.33	54.21	.52
1 dip level 20 ft. west of 13 dip	9.09	3.65	32.57	54.79	.59
1 rise level face	12.73	2.45	36.77	48.05	.76
Cable scraping outer layer	4.3	9.9	30.7	56.1	.56

Samples taken from	M	A	V.M.	F.C.	VM/FC
Extract from Dr. Badami's report (Ex. C-5)					
East side wall-top of no. 2 door from east	2.5	25.2	13.8	58.5	0.23
Bye-pass. Rise side no. 2 pit (soot like stuff)	1.9	7.0	11.7	79.4	0.15
West side wall. Top of no. 2 door from east	3.0	8.6	14.3	74.1	0.19
Between 2 dip & 2 rise roof loco level	3.1	40.7	11.8	44.4	0.27
Side 2 dip & 2 rise loco level	1.3	14.6	26.1	58.0	0.45
40'-0" beyond 2 rise loco level	3.7	20.8	9.8	65.7	0.15
Sample from roof—empty return in I pit	1.9	8.2	13.4	76.5	0.17

84. From this it will be observed that the degree of coking indicated by V_M/F_C ratio at 16 rise off east loco level is 45. The dust collected from a prop at the outbye end of 16 dip off 1 east rise level shows this ratio to be .39, and that the same ratio is .36 in dust collected from a wooden lagging facing the dip face. Dust collected from the east and the west side of a prop standing in 1 east rise level between 15 and 16 dips indicate this ratio to be .45 and .61 respectively. In 1 rise level 15 ft. to the west of 11 rise the roof dust indicates this ratio to be .61. These ratios from the floor and the roof of 1 east rise level east of 14 dip were .75 and .63 respectively. The dust collected from a roof cavity in 13 dip and 1 east rise level junction shows this ratio to be .62. In 1 east rise level 20 ft. to the west of 9 dip the roof and the floor dust shows this ratio to be .75 and .69 respectively. In 1 rise level face this ratio is .76. In the loco level at its junction with 14 dip, at its junction with 13 dip, from below the bottom belt about 50 ft. inbye of 10 dip, from no. 9 dip junction, from a brick wall near no. 8 dip junction, and from 8 dip cross-cut corner these ratios are .52, .52, .71, .55, .44 and .28 respectively. Dust from the dip side of a prop in no. 6 dip just below the east loco level shows this ratio to be .44. In 1 dip level 20 ft. west of 13 dip this ratio is .59. This ratio at a place in the roof dust collected from 40 ft. east of the junction of 4 east dip and top sump level is .56. The samples which show ash content below 9% were apparently contaminated with soot and hence the VM/FC ratio of these samples does not indicate the degree of coking. The samples collected from any area upto the cross-cut also will not indicate the degree of volatilisation produced by the first explosion as these areas were affected by subsequent fire or fires; and from the analytical results it is not possible to say the extent of the part played by coal dust in the first explosion. But by and large the general results show that coal dust did play some part in the first explosion, particularly (a) near the downcast shaft bottom, and (b) strangely enough, near the dyke face. It must also be remembered that many parts of the mine are naturally wet and this would tend to avert the coal dust explosion. Meanwhile it may be observed that the coal dust produced by the Disergarh coal is highly dangerous and inflammable, and it is unlikely that normal stone-dusting even up to the requirements of the Coal Mines Regulations would arrest a coal dust explosion once started.

C. THE SITE AND SOURCE OF IGNITION

(i) Difficulty of the problems

85. The twin problems of the site and the source of ignition of CH₄ of which, as already found, there was an abundant supply in the mine air in different proportions in different places and which provided the fuel for the first explosion at any rate, constitute, as it were, the hard core of the mystery to be unravelled and have received from the very beginning the most searching attention from everyone of the investigators who have come forward to help the Court of Inquiry. Yet, unlike the outer shell which to all but one of them told the same tale, this inner kernel has presented a somewhat different appearance to each one of the investigators. That only seems to emphasise the real difficulty of this part of the inquiry and to impose upon the Court the utmost caution in its examination of the different possibilities.

(ii) *What the owners thought about them when the inquiry began and what different investigators thought after re-entry*

86. It was evident from what could be seen of the underground workings after the first explosion that the origin of the explosion must have been some where in the eastern district into which no one could penetrate after the first explosion, the farthest point reached by the third rescue team, as already stated, being a point midway between 8 and 9 rises along the loco level. The evidence of Paru Mali and Gauri Mali, the only two survivors examined also goes to show that the blast came from the east. The direction of the blast as far as it can be judged from the signs of damage noticed after the first explosion in the underground workings such as the air-lock doors blown open westward and kept in that position by a quantity of timber blown up to the doors and blocking them, the girder on the loco level a little to the west of the air-lock doors bent into the shape of a 'V' with its apex pointing westward etc. goes to confirm that evidence. Accordingly, the owners in their written statement and the plan (Appendix I to it) showed the entire area between 2 rise level on the north and the bottom level on the west and a few feet to the east of 12 rise and 12 dip off main east loco level on the west and beyond the dyke on the east as the probable site of the explosion. Beyond this, of course, it was not possible for them or anyone else at that stage to say anything, and as a matter of fact, none of the other parties, including the Department of Mines, stated even as much.

(iii) *The views of the different investigators*

87. The area however came to be further restricted as this district was fully explored after the de-watering of the mine. Mr. Rosser after having examined all the possibilities comes to the conclusion that the ignition originated either in 16 dip or 16 rise off 1, east rise level and the source of ignition might have been either an incandive spark produced by the impact on stone on steel or iron or of the latter on aluminium, if sufficient momentum is involved at certain angles of impact or a missing box or detonators exploded by pieces of coal or stone or stone spalling off from the roof or sides as a result of the outburst in 15 rise off 1 east rise level. Mr. Evans in his report, Ex. IMA-6, says at page 8,—“From all this evidence it can be taken that a sudden release of gas from the underlying seam occurred in no 15 rise and perhaps from the dyke in no. 2 rise level directly before the explosion. The released gas swept on in the air current into the loco level workings and no. 1 dip level workings and on into the workings in no. 9 dip and No. 2 dip. . . During this period fresh air was still coming into the area at the rate of about 24,000 cubic feet per minute and eventually reduced the percentage of firedamp until an explosive mixture was formed and something, we do not know what, ignited this explosive mixture in the 1st rise level.” As regards the source of ignition at page 9 he says that the scraper chain conveyor in this 1st rise level may have been working and it is just possible that frictional heat ignited the gas, but no evidence of this has been found. Sri H. B. Ghosh in his report, page 4, suggested, rather than clearly stated, that the ignition probably started in the east section and as regards the source of ignition, at page 12 he stated that there was no indication of the explosion having been initiated by explosives, but the detonators having initiated the explosion could not be ruled out entirely. In page 425 of his evidence Sri H. B. Ghosh said the inbye workings of 15 rise in 1 east rise level and main east loco level was probably the site of the ignition. In his arguments on behalf of the Department of Mines Sri Jabbi thinks with Mr. Rosser that probably the missing box of detonators provided the source of ignition if a stone or a piece of coal fell upon it from the roof or side and that the origin of the explosion was in the eastern workings between 2 rise level and loco level inbye of 15 rise.

88. Mr. Lyndon James in his report says that there appears no conclusive indication that shot firing caused the ignition. But if it did, 16 dip off no. 1 rise level appears the only place in the section where it could have occurred and that ignition in this place is consistent with the fact that the blast appears to have emanated from this area. As regards the fault in the electrical installation of the underground being the source of ignition, he merely says that where violent explosion and fire occur, cables and sometimes apparatus are so damaged that the post-explosion damage marks any defect that may have existed before the explosion and it may well not be possible to rule out entirely an electrical fault as the igniting cause and although amongst various possibilities of the source of ignition he mentions impact friction in his report and although he says in his report that he would regard ignition from this source extremely unlikely under the conditions obtaining in this seam, he concludes his arguments with the following statement: “With the information now available it appears impossible for the explosion to have been caused by shot-firing, electricity, lamps, light alloys, contraband and frictional hot spots due to accumulated heat which leaves impact friction as the

possible source. It is unfortunate that more direct evidence does not exist, but impact friction by ejected rock is the least improbable under the conditions likely to have obtained after the out-burst." As regards the nature of this impact friction, he says that the bursting of the dyke rock or the violent ejection of rock from it or again the ejection of floor rock from 15 rise off 1 rise level are possible sources of force capable of generating incandescence frictional sparking. Thus, although he does not say so in so many words, even according to him the site of ignition was somewhere in 1 or 2 east rise level near and not far from the dyke, and he thinks the least improbable source of ignition to be frictional sparking, either caused by dyke rock ejected with some force from the dyke face or the ejection of floor rock from 15 rise off 1 east rise level.

89. Professor Subrahmanyam in his report, Ex W-39, says at page 1 that he considers from the evidence of the propagation of the explosion that it must have originated in (a) 2 east rise level dyke face, (b) 16 rise off loco level, (c) the extreme point of loco level. In his evidence at page 463 he makes it clear that what he meant to say is that ignition must have occurred at one or other of these three points, but not simultaneously in all of them. Then questioned further by Sri Sachin Chaudhuri, Counsel for the owners, at the same page he says that the most probable site of ignition, according to him, is 16 east rise off loco level because of the condition of the electric drill which was found there. Thus, even according to Prof. Subrahmanyam the site of ignition must have been one or other of the following: 2 east rise level dyke face, 16 rise off loco level and the extreme point of loco level; and according to him the most probable site is 16 rise off loco level so that he also puts the probable site of ignition on the extreme eastern side between 2 east rise level and the loco level. There is thus amongst messrs Rosser, Evans, James, Sri H. B. Ghosh and Prof. Subrahmanyam a unanimity to this extent that the site of ignition was confined to an area bounded on the north by 2 east rise level and on the south by the loco level, on the west by 15 rise and 15 dip off 1 east rise level and on the east by the dyke. While this unanimity is entitled to due consideration it need not however make the Court confine its attention to this limited area unless of course the reasons for the unanimity strike it as unanswerable.

90. Amongst the facts established so far is a sudden release of gas from the splinter seam underneath through the fissure in 15 rise and probably also through the cavity in the dyke face where 2 east rise level meets it. That the quantity and velocity of this release, at least at the initial stages must have been considerable, goes without saying. Dr. Badami's report dated 14-8-58 (Ex C-9) on the sample of gas he collected in a trial pit in 16 rise off 1 dip level on 11-8-58 as it was coming from the splinter seam shows that there was 93.90% CH₄ and 2.88% CO₂ and 3.22% air by difference. Evidently, therefore, the gas so released would at once flood the return and, to some extent, the intake airways, with the result that there would be a sudden drop of the oxygen in the air, and if this reduction were considerable the workers would become unconscious and ultimately succumb.

(iv) Possible sources of ignition eliminated

(a) Contraband

91. The fact that in the eastern region the workers would all lose their consciousness from a sudden drop of oxygen in the air, enables one to eliminate the possibility of any human agency being responsible for the ignition. Contraband, apart from the fact that there is no evidence to favour it as the source of ignition, can thus be ruled out.

(b) Short-firing

92. That would entitle one to rule out also the theory of a blown out shot igniting an explosive mixture of methane and air. As a matter of fact, the only place in the eastern district where shot-firing appears to have taken place shortly before the explosion is 16 dip off No. 1 east rise level, and Sri Deven Sen's theory of a blown out shot having ignited a concentration of CH₄ in a crack in the roof of this gallery has already been discussed and discarded, because the missing exploder on which this was partly built up was discovered on the night of the 27th July 1958 in east level between 3 & 4 dips, and this was brought to the notice of the Court by Appendix II B to Mr. Rosser's report filed on 29th August 1958 after Sri Sen had concluded his arguments. Mr. Rosser at page 24 of his report mentions three other places and concludes from the circumstances that in none of them there was any shot-firing in that shift though in 16 rise off main east loco level where the bodies of Bedekar, the Under Manager, Tara Singh, the Senior Overman, and Riasat Mia, the Mining Sirdar, and others were found, cartridges were being prepared for insertion in the holes which were presumably being drilled in the coal face of 16 rise, one exploder having been

found in 16 rise about 15 ft. from the face together with a stemming rod and a coil of shot-firing cable and the key which was only 4 ft. away, a box containing 12x6 oz. cartridges of Polar Viking in the loco level west of 16 rise and a primed cartridge at the east corner of the mouth of 16 rise. It is needless to look into this matter any further for the Court is fully satisfied that the only place where there was shot-firing before the explosion was 16 dip off No. 1 east level and that must have occurred some time before the explosion as the exploder had been taken elsewhere. To reinforce all these arguments it may be added that at no place was there found the exploder connected to the cable and the detonator heads which would have indicated that blasting was being done. There is thus no difficulty in ruling out shot firing as a possible source of ignition.

(c) Detonators and explosives not accounted for

93. It appears from Mr. Rosser's report, page 27, that 33 lbs. 6 ozs., out of 63 lbs. explosives issued, have been accounted for and 64 detonators have not been traced. Sri Deven Sen built upon this his alternative theory which has been discussed and already negatived. Mr. Rosser in his report at page 39 suggests a theory similar to that of Sri Sen only at a different place, viz., 15 rise where the floor heaved and gas and small coal erupted with considerable velocity. Falls from the roof may then have occurred and stone or coal may have fallen on the box full of detonators thereby causing an explosion which, in its turn, led to the explosion of the gas. 15 rise undoubtedly is a more likely place for the box of detonators to be in than 16 dip off 1 east rise level because no work was going on in 15 rise. But, for this theory to be sound this fall of roof must have occurred when the atmosphere was explosive and not when it was extinctive due to high methane content. Alternatively, the ignition may have taken place at the very start of the outburst before the methane content was high; but this is unlikely as there would not have been enough gas in the air to propagate the explosion throughout the mine. The flame would have been extinguished either by shortage of methane or by excess thereof. It is undoubtedly true that the initial velocity of the outburst, while it might have loosened some rock or coal on the roof or the sides, the loosened coal or rock might not have fallen in the initial stages of the outburst but later when CH₄ reached the explosive range even in that region. Even then, the fall of the coal or rock has to be so timed as to coincide with the formation of an explosive mixture there and at the same time the box of detonators has to be so placed as to be hit by the coal or rock that fell from the roof or sides. It is difficult, in the absence of any indications to that effect, to suggest that there were in fact so many coincidences. It is far more likely that the explosion consumed the detonators and the explosives than that the explosion was caused by them.

(d) Electrical machinery and plant.

94. Mr. Rosser at pages 28—33 of his report, on the strength no doubt of the report of Mr. Welsh, deals with the electrical machinery and plant, and concludes, at page 29 about the conveyors: "The electrical gear of all the conveyors described above, together with their ancillary switch gear etc. was fully flame-proof, new and of modern design. It appears that only the conveyor in 1 east rise level could have been working at the time of the explosion, and nothing has yet been brought to light to indicate that any of the conveyors and their ancillary switch-gear etc. had any connection with the ignition, either due to electrical or mechanical reasons." As to the electric drills and transformers, which he deals with next at pages 29-30, he says that one transformer in 1 east rise level was isolated and partly dismantled being under repair, but the isolator of the other transformer was in 'on' position and the drill plugged into the pommel was lying at some distance back from the faces with the cable lying in a coil and giving the appearance of not being in use at the time of or immediately before the explosion, so that if it was not in use both the drill and the cable could be energised, if at all, by a pilot current only which was intrinsically safe; that the isolator switch in the drill transformer in 1 east dip level was in the 'off' position; that blasted coal was found in the working place in 5 rise section and the isolator of the drill panel was in the 'off' position; that in the coal face of 2 east dip section six holes appear to have been already drilled and preparations for blasting was going on; and that in 9 east dip the isolator of the drill transformer was found in the 'off' position and the drill was at some distance from the face; and from these he concludes that no drilling was going on at any of these places at about the time of the explosion. As to drilling with compressed air drills, he finds that this was going on, if anywhere at all, only in the east main sump drain but nothing could be found to connect the compressed air drills with the ignition. What is stated by Mr. Rosser as regards

these is confirmed by the detailed report (Ex. D.M.I 38) of Sri H. K. Bhattacharyya, the Electrical Inspector of the Department of Mines who subjected the entire electrical machinery and plant to exhaustive examination and we have therefore no difficulty in ruling out these as having had anything to do with the ignition. But in the main east loco level, there were one drill transformer and two drills. The isolator was in the 'on' position and one of the two drills had been plugged in, but both the plug and the socket had been torn off the drill transformer by the force of the explosion, and Mr. Rosser concludes by saying that it was very likely that one of the two drills, though it is difficult to say which, was being used at the time of the explosion or immediately before it. The conveyor in 1 east rise level and the two drills here will be examined further in this report and that will be done after the rest of the electrical equipment has been disposed of.

95. Mr. Rosser then deals one by one with the coal cutting machines, the other electrical plant and the cables, and finds that the 4 coal-cutting machines in the main east section were all isolated at their gate-end boxes, and also in positions where obviously they could not have been cutting coal at the time of the explosion, and the one mentioned in 16 rise off 1 east rise level was disconnected, that none of the 3 coal cutting machines in 5 east rise, 9 east dip and 2 east dip areas was in use at the time of explosion, the machines in 5 east rise and 2 east dip having been isolated at their gate-end boxes. In 9 east dip although the isolator controlling the machine was in the 'on' position, the gate-end box was lying upside down, and that in 4 west rise though a coal-cutting machine was installed the face had not yet been started and the isolator of the controlling switch was in the 'off' position; and from these he concludes that these machines or their ancillary switch gear, cables etc., which are all flame-proof, new and of modern design, had no connection with the ignition. The findings of the Electrical Inspector in EX. D.M.I 38 go to confirm these and these, also, therefore the Court has little difficulty in eliminating as possible source of ignition.

96. It has now to be seen what inferences are possible, first from the condition of the conveyor in 1 east rise level and secondly from that of the two drills etc. in the main east loco level.

(1) CONVEYOR IN EAST RISE LEVEL

97. Mr. Rosser says at page 28 that the isolators of the four chain conveyors in the main east section was in the 'on' position but that the push-button switches of these by which the conveyors are normally controlled during the shift were in the 'off' position. However, for the fourth, i.e. the one in 1 east rise level the push button control was in the 'on' position. That is why Mr. Rosser thinks it could be working at the time of the explosion. Of course, he concludes by saying even in respect of this that no connection between this and the ignition of methane could be established. That both the switches of this scraper conveyor were in the 'on' position is confirmed by Sri H. K. Bhattacharyya in his report at pages 15-16. His findings were as follows:—*"Isolator was 'on' in its reverse position. It was provided with earth leakage protection. On opening the cover of the Belmos panel it was found that the hand operated push button switch contacts were closed indicating that the contactor switch was 'on' and the conveyor motor was probably running at the time of the explosion. Incoming and outgoing, armoured cables and also flexible cable for working the conveyor were found coupled upto the gate-end switch."* On examination of the motor and the flexible cable he noticed nothing wrong and the cut on the rubber sheathing of the cable which he noticed about 5 ft. from the pommel at the motor end was found on dissection not to have extended beyond the outer rubber sheathing, all the inner cores remaining in tact. We were also told that the conveyor pans were empty. The conveyor into which it was feeding coal had its isolator switch and the push-button switch both in the 'off' position, and was therefore not working. Evidently then, the conveyor in 1 east rise level must have been running empty. Mr. Evans at page 9 of his report (Ex. I.M.A. 6) says: *"The scraper chain conveyor in this first rise level may have been working and it is just possible that frictional heat ignited the gas, but no evidence of it has been found."* Evidently, what Mr. Evans means is that no external evidence in the shape of signs of frictional wear and tear in the parts of the scraper conveyor involved in its running was forthcoming. Still, as it was evidently running, it is certainly a potential source of danger and will have to be examined further in the report along with such other sources, if any, after the elimination of whatever can reasonably be said to have had no connection with the ignition of CH₄.

(2) THE SIEMENS-SCHUCKERT & THE HUWOOD DRILLS

98. The Siemens-Schuckert drill was found lying on the floor of 16 rise off loco level about 10 ft. outbye from the face and the other end of a drilling cable attached to it was found near the southern side of main east loco level close to 15 rise. A loose drill bit was also lying about 20 ft. south of the drill. It appears from the report of Mr. Welsh (pages 12-13) which forms Appendix VII to Mr. Rosser's report (Ex. O.S.72) that the drill pommel had been attached to the drill panel and was torn off and found about 6 ft. on the outbye side of the drill panel, that the drill panel isolator was in the 'on' position, that both these panels were opened up and found in normal working condition with the machined faces inside the F.L.P. tolerance limit and that the original pilot circuit fuses of the drill transformer were missing but a thin fuse which had been fitted in lieu was in-tact. It further appears from that report that there were two lengths of drilling cable lying near the drill transformer panel one of which was for the stone drill in the loco level and consisted of two lengths of cable coupled with a flame-proof coupler, one end being joined to the stone drill lying in the face just below the end of a drill rod which was still in position in the stone face and the cable lying slack with spare cable behind the drill, and the other end of this cable having been pulled out from its socket which is normally attached to the drill transformer and was found near the conveyor in 15 rise loco level about 70 ft. outbye from the transformer. Similarly, it appears from this report that the drill transformer end of the coal drill cable was found pulled out of the pommel and lying 5 ft. to the east side (inbye) of the transformer, the other end was attached to the coal drill in 16 rise off the loco level, that there was very little slack cable at the coal drill end and the cable was pulled tight round the corner of the gallery leading to 16 rise off the loco level, that even when the cable was pulled the drill was still 4 ft. short of the drill rod in the face with the cable slack fully taken up, that the drill pommel which had been attached to the drill transformer was found with the drill transformer plug portion inside it about 6 ft. outbye of the drill transformer and the other pommel was found at the 15 dip loco level junction. Mr. Welsh concludes this part of his report with the observation that from the condition of the plant it is not possible to state definitely which drill was coupled to the transformer, but from the position of the cables and plugs the evidence points to the Huwood drill on the stone face having been coupled up to the transformer and as there was only one transformer for two drills, only one drill would work at a time and that both the drills were of the type normally used for drilling coal, Mr. Rosser also repeats in his report at pages 29-30. that it is difficult to say which of the drills was working at the time, but it appears very likely that one was used at the time of explosion or immediately before it. Both the drills were brought to the surface for checking. The Huwood drill which was in the loco level face had one nut at the gear case missing, but this would not have impaired the F.L.P. properties of the drill as stated by Mr. Welsh. Electrically this drill was found to be quite in order by the Electrical Inspector Sri H. K. Bhattacharyya in his report at pages 14-15, Ex. DMI 38. These drills were examined separately at the Central Mining Research Station for 2 or 3 reasons, (1) to see if the electrical equipment were safe and (2) to see whether the aluminium casings of the drill were of metal likely to give rise to incendiary sparks capable of igniting methane should the drill casings have fallen on to rock or metal.

99. It appears from Dr. Badami's report, Ex. C-10, that the magnesium content of the Huwood drill was only 0.40%. If further appears from this report that the metal of this drill when tested against a rock wheel, a carborundum wheel and a steel wheel at 1500 revolutions per minute in methane-air mixture of about 7.5% methane and 92.5% air would not ignite the gas. The Huwood drill therefore, may be left out of consideration altogether as a possible source of ignition.

100. In the Siemens Schuckert drill one stud was missing and the gap between the casing plates was 0.03 in the corner where the stud was missing and 0.21 in other places (*vide* Dr. Badami's report dated 12th August 1958, Ex. C-7). According to Sri H. K. Bhattacharyya (page 12 of his report, Ex. D.M.I. 38) the gap between the flanges was proved to be more than 0.02" throughout and the same was more than 0.25" near about the missing bolt.

101. Professor Subrahmaniam who suspected the Siemens Schuckert drill as having been the cause of ignition suspected it first because one of the studs was missing, secondly because the gap between the casing plates was 0.03 in the corner where the stud was missing and therefore more than the specified safety limit, and thirdly because the normal fuse had been replaced by a temporary copper fuse. Sri Sachin Choudhury quoted a passage in his cross-examination of Prof.

Subrahmanyam from an article by Dr. H. Titman and Mr. R. Torry entitled "Flameproof enclosures for mining electrical equipment: The protection afforded by flanges of one half inch radial breadth for mixtures of methane and air" in Research Report No. 123 in the October issue, 1955 and asked him whether he differed from the observations made therein and the professor said that he did not. The passage in question is as follows:—

"A number of tests have already been made, with various inflammable vapours, to determine the reduction in the 'safe gap' brought about by reducing the radial width of the flanges of an 8-litre sphere from 1 inch to half-inch (E.R.A. 1952-54): in no case was a proportional reduction obtained. For the few gases tested of Group II of B. S. 229:1946: the reduction in the statistical maximum safe gap was on the average about 20 per cent: a greater percentage reduction was, however, observed for some gases of Group III of B. S. 229.

This Standard is now under revision and the object of the present work was to determine, for the purpose of the Standard, the safe gap for methane-air mixtures for flanges of one half-inch radial breadth. For flanges of one-inch breadth a re-determination by Wheeler (1940) showed that the maximum experimental safe gap was 0.046 in.: the corresponding statistical maximum safe gap, calculated by the present method, is 0.035 inch."

102. Thus, this gap, although beyond the permitted size of 0.02" was still unlikely to be dangerous as there is a great margin of safety and the numerous experiments at the Central Mining Research Station to test whether the gap was safe or not failed to give any external ignition when the equipment was placed in highly dangerous mixtures of methane and air. (Vide Dr. Badami's report dated 12th August 1958, Ex. C-7).

103. As regards the copper fuse, Prof. Subrahmanyam was asked by Sri Choudhury whether in the first place one had got to know the rating of the type of the fuse normally used in order to be able to say whether a certain type of fuse was or was not risky and in the second whether there was anything inherent in the lead alloy fuse which made its rating lower than that of any copper fuse and thirdly whether it was necessary to know the rating of the original fuse before one could make any investigation in the matter. Prof. Subrahmanyam answered the first in the affirmative, the second in the negative and the third by saying that he could not venture any definite opinion unless he knew the rating of the two fuses. That together with the fact that even the temporary fuse was in tact would go to show that there was nothing inherently wrong with this drill. Besides, as pointed out by Mr. Welsh in his report, the drill cable was short by about 4 ft. so that even if the drill cable was extended to its full length it would not reach the face. Evidently therefore this drill could not have been in use at the time of the explosion or immediately before the explosion.

104. Regarding the metal of the drill, this was analysed and gave the following composition:—

Magnesium content 0.40% (Dr. Badami's report, Ex. C-10).

The low magnesium content is to be noted. This suggests relative safety. Moreover, attempts to produce frequently sparks from such casing whether by metal or by rock at the Central Mining Research Station and even employing rusty metal were not successful in igniting inflammable mixtures of methane and air. Finally, there is no evidence that the casing did fall on to any rusty metal. There was none present in the neighbourhood concerned nor is there any evidence that the casings were hit by stone or metal. It is further to be pointed out that these metals will only be dangerous if the atmosphere in which they were operating was explosive. The men would be alive at the time of the cutburst, but immediately afterwards the atmosphere would be extinctive and the men would be gassed and the drills would not be in operation. We therefore rule out the possibility of the drills being the source of ignition.

(e) Frictional sparking

105. With regard to frictional sparking, the danger here could arise only from (a) some equipment which was running automatically or (b) friction of the rocks by release of strata stress. The only electrical equipment there was apparently the conveyor in No. 1 level between 15 rise and 16 rise. If this were

responsible for frictional sparkings, such sparkings must have taken place in an explosive-atmosphere, and, we think, some considerable time after the outburst by which time the methane content would have fallen to some point between 5 and 15 per cent. The possibility exists, but in our opinion it is unlikely. It is not easy to produce frictional sparks of the necessary intensity by steel acting on steel or on coal. A more likely source of ignition from the conveyor might have been the heating of the coal-dust under the conveyor due to the continuous running of the scraper chain; but there was no evidence of such heating as judged by decomposition or partial coking or combustion of the coal under the conveyor. It is to be noted however, that this conveyor may have created a small cloud of coal dust, and that this dust may have taken part in the explosion.

106. We may add at this stage that there is no evidence of spontaneous combustion of coal at any part of the mine nor was there any evidence prior to the explosion of unusual smell or other indications that the coal was heating in any district.

107. Thus all the possible sources of ignition that were suggested by the different parties at the Inquiry can more or less reasonably be ruled out.

(iv) *Two more possible sources of ignitions*

(1) *Oil lamps in 5 Rise district,*

(2) *Loco engine.*

108. This brings us to a consideration of only two other possible sources of ignition. Both of these were brought to the notice of the court by one of the Assessors, viz. Dr. Whitaker. The first is the condition of two oil safety lamps in 5 Rise and the second is the diesel loco. I have already referred to the condition of the oil safety lamps found in 5 Rise in connection with the question whether at the time of the explosion there was in the mine a supply of CH₄ in excess of what could possibly accumulate from the normal make of the gas in the mine. Sri Sachin Choudhury in his argument however, laid stress on the condition of these lamps as suggesting a possible source of ignition of CH₄.

(1) OIL LAMPS IN 5 RISE DISTRICT

109. It is therefore, necessary first of all to consider whether ignition of CH₄ could have been due to a burning or charring of the pieces of cloth found in one or the other of the two safety lamps in 5 Rise. Before I proceed to deal with that, it is necessary to give a brief picture of the conditions in the area where the lamps were found as reported by different investigators after re-entry and as depicted in the relevant sectional map. It appears from sectional map No. 12 of Appendix I to Mr. Rosser's report Ex. O.S. 72, that in the gallery connecting 2 rise level with 5 rise district, 3 dead bodies were found close to the face without skulls, and 8 other dead bodies were found further south of these 3 skull-less trunks and the two oil safety lamps were found, a little out-bye, one near the western side of the gallery and the other near the eastern side, some shovels with broken handles were also found there.

110. The condition of the lamps, viz. Nos. 371 and 502 has been already referred to in paragraph 57, Section IV of the report, and need not be repeated here. What needs pointing out is, first, that Mr. Rosser in Appendix VIII-B of his report speaks of a piece of cloth, partly burnt, sticking to the top of the bonnet, neither Dr. Badami nor Sri H. B. Ghose says anything about the cloth being partly burnt. The question therefore arises whether Mr. Rosser's report that the cloth was partly burnt should be accepted. That the condition of these two oil lamps had any special significance had not occurred to any one till Dr. Whitaker pointed this out and I mentioned this in court when arguments had already begun and this fact is not given any importance in any of the reports. There is therefore, no reason why the burnt cloth should have been falsely mentioned in Mr. Rosser's report. A likely explanation of the omission of this fact from the other reports is that Dr. Badami and Sri H. B. Ghose did not notice particularly whether the piece of cloth was burnt. The learned assessors and myself therefore, accept the report of Mr. Rosser on this point. From the facts that in 3 of the bonnet holes of one of the lamps pieces of cloth were found jammed and that a piece of partly burnt cloth was found jammed in one of the bonnet holes of the other, and further that the wicks of both the lamps were inside the oil-pot, and that there was deposition of soot inside the outer glass of both and that there was soot below rust at the top of the gauzes; Sri Sachin Choudhury builds up the argument that evidently the miners were trying to

put out a flame that had shot up inside the lamps by reason of CH₄ inside the lamp being in the region of 5 per cent or more, and when they failed to reduce the size of the flame by drawing down the wicks they tried to shut out further supply of air inside the lamp by stuffing the vent holes with pieces of cloth and that when the percentage of methane in the air became higher the men died of asphyxiation, but the cloth which had been stuffed into the bonnet holes continued to smoulder till a fresh supply of oxygen in the district made the charring cloth shoot up into a flame and this flame ignited an explosive mixture of methane and air. We consider that these lamps were full of flame before the explosion and that efforts had been made both by drawing down the wicks into the oil vessel completely and by insertion of cloth into the outlet apertures of the bonnet to smother the flame. The cloth shows signs of charring especially in one of the lamps. The operations on the lamp by whoever was responsible must have been done before an excessive amount of methane was present—enough to asphyxiate the men or to extinguish the lamps. The methane must have been 5 per cent or more but not in excess of 25 per cent as all flame would then be extinguished. Subsequently, it may be that the methane built up rapidly and extinguished the lamps and asphyxiated the men. The cloth however, might continue to smoulder. It is true that the smouldering would eventually die out unless sufficient fresh air arrived in time. The question is if when such fresh air supply did arrive, it began to revive the combustion of the cloth and eventually to inflame it, so that gas could be ignited externally to the lamp. Smouldering of the cloth might continue when the oxygen had fallen down to low values below 10 per cent and perhaps below 5 per cent. The actual inflammation of the cloth would however, not take place until there is 17 or 18 per cent of oxygen in the air. The period of time involved would no doubt be small, perhaps only 5 minutes, during which the cloth might be smouldering. It is estimated that from the very outburst of the gas until the actual explosion there was only a period of 20 to 30 minutes. The above sequence of events is, to our mind, unlikely because of the narrow limits (of time and oxygen) and also because of the signs of the violence in this gallery in the shape of three skull-less bodies and a number of shovels with broken handles, if they could be attributed to the first explosion, but we cannot rule it out as the direction of travel of the flame and of the subsequent blast can be harmonised both with this as the source of ignition and with the diesel locomotive as the source of ignition, and as the violence noticed here might have been caused by the subsequent explosions.

(2) DIESEL LOCO

111. The other possibility of ignition is provided by the diesel loco. At page 4, Part II of Dr. Badami's report dated the 18th June 1958, he says as follows:

"Between 9 and 10, dips on loco level a number of tubs were found with their front ends knocked or bent forward whereas the back ends were more or less all right (see figure 3). This was the case only with the empties. All the tubs—empties and loaded—were still coupled. The loco looked as if it had been backed ready to haul the loaded tubs—only it was not yet coupled. There was a dent on the bonnet of the loco as if something had fallen on it and the canopy had been thrown in an east-west direction—it was found lying about 2 or 3 feet to the south-west of the loco. The oil cut-out was firmly pushed in (indicating that fuel supply had been cut off and hence the engine stopped) and the decompression lever was down. The brakes appeared to be on and the gear in neutral. The starting handle was on the floor of the loco." In the sectional plan No. 26 a bent angle-iron is shown lying a little to the south-west of the back side of the engine. The radiator end of the engine, as appears from the note no. 1 in this map, was towards the east. Another angle-iron of the loco engine was found lying to the south-east of the front of the engine. The diesel tank appears to have been full of oil, but there was no water in the water tank, the Hose pipe having burst. The front stand carrying the headlight was broken and lying on the south side of the loco. The backstand carrying the light was also broken and bent towards west. The top of the engine cover had bulged out.

112. Amongst bodies found here that Dr. Badami noticed was that of a man in a crouching position with the head bent down and he thinks that the man might have been coupling the tubs when he was killed; and he puts a question to himself whether there was any significance in his attitude. He further notices that in 10 dip the tubs appear to have been down into the dip from the level having been subjected to the blast travelling from the rise to the dip side.

113. At page 33 of Mr. Rosser's report (Ex. O.S. 72) occurs the following passage about the locomotive:

"The Locomotive was found in the East Loco Level between Nos. 9 and 10 Rises and on the cross-over between empty and full tracks. The engine was found to be cut off. The starting handle was lying in its normal place in the driver's cabin. There were 7 loaded cars in front of the loco, to which it was not coupled, although sets of 12 cars are normally worked. It appears most likely, therefore, that the engine of the locomotive was not working at the time of the explosion. The Manager's written instructions to locomotive drivers include, *inter alia*, an order to effect that engines have to be shut off, if a delay of more than 2 minutes is anticipated. The fire extinguisher on the locomotive was found to have been thrown out of its bracket, but it had not been used. Nothing has been brought to light which indicates a connection between the locomotive and the source of the ignition." Mr. Evans says at page 9 of his report (Ex I.M.A. 6) that the locomotive was found with the controls in the off position and the engine could not have been running.

114. During his argument, Sri Sachin Chaudhuri filed a plan, not drawn to scale, Ex. O.S. 74 showing, in the first place, the position of the empties in the empty or northern track where the loco might have left them after having shunted them on to the empty track; and secondly, the position of the empties, the position of the loco and the position of the loaded tubs on the full line, *i.e.* lower or southern track, as found on re-entry. It appears from this plan as also from the sectional plan no. 26 that the loco was not yet fully on the full line, a portion of its back was on the cross-over and its radiator end was on the full line. There were 7 full tubs ready for the loco but the loco was not coupled to them.

115. Before proceeding any further, it is necessary to point out how the loco came to be suspected at all, although none of the parties paid any attention to it. Dr. Whitaker, one of the Assessors, after Shibjog Dubey, Loco Fitter (witness No. 9) examined and cross-examined on the 3rd May 1958, had given the court an idea of the nature of the flame trap on the exhaust side and the arrangements on the loco for cooling the exhaust, suggested that we should see the loco on the surface as it was reported to be exactly the same as the one underground and we did see it on the 12th May 1958. On inspection Dr. Whitaker came to entertain the suspicion that if the flame trap and the cooling arrangements were not properly looked after the heat generated in the exhaust might possibly ignite a deposit of coal dust, particularly in such parts of the exhaust as were without any outer protective cover. Dr. Badami, Scientific Observer of the Court, was accordingly asked to carry out certain tests. One test was carried out on the 19th May 1958, and the results were negative, (*vide* Dr. Badmi's report, Ex. C-5 pages 7-8, last part). The second test was carried out on the 22nd June 1958 (*vide* pages 5-7, 2nd part of his report, Ex. C-5.). The results thereof were equally negative, and naturally, after these tests Dr. Whitaker came to think that there was nothing, after all, in his suspicions about the loco exhaust. Towards the end, however, of the second lap of the inquiry when the different investigators had submitted their reports and a part of the arguments was heard, his mind reverted to the loco and this time he turned his attention to the working of the engine in an atmosphere where CH₄ was rapidly increasing from 0 to 5%, then to 10% and later to 15%, 25% or even more and thought that in the early stages of the engine would probably accelerate due to the presence of the combustible gas in the air drawn into the cylinder; that the operator would probably try to retard the acceleration by reducing the fuel supply, but when the gas would be continually increasing the engine would be likely to accelerate inspite of his attempts to control the speed, and that even if he cut off the fuel supply, the engine might continue to run. He questioned himself what would happen meanwhile with excess of gas in the air feed, and his answer was that some of it would have been combusted but some would pass out of the cylinder as methane, as carbon monoxide and as hydrogen; and hydrogen being a very inflammable gas if it were produced in quantity the flame arrestors would be unable to cool down the flame sufficiently to prevent it from passing and igniting any outside explosive mixture of methane and air. In other words, he then thought that though the diesel engine might be safe in an explosive atmosphere of methane and air provided that the methane was upto 9 per cent or so, it would be dangerous if the methane present was higher in quantity and had decomposed to give hydrogen. Once again, therefore, the loco, or to be more accurate, the loco engine, loomed large in his eyes as the villain of the piece.

116. On the 22nd August 1958, when my learned colleagues and myself went to nos. 1 & 2 pits for going underground there were with us Mr. Rosser, Mr. Hughes

and certain other responsible officials of the Company. On the surface I told them of Dr. Whitaker's new theory and Dr. Whitaker himself explained to them what the position was. There was a full and frank discussion amongst us on the matter. Then, after we came back from the underground workings to the surface we saw the loco which had been underground but had been already brought to the surface, and also again the loco that was always on the surface. On the 25th August, 1958, when the Court sat again after a break of about 11 days I mentioned this matter in open Court although the order-sheet does not show that it was mentioned. It appears from the reply received by the Company from Messrs. Ruston & Hornsby Ltd., Lincoln, England that on the 23rd August 1958 they had been written to about this matter. Evidently then, they must have written on the basis of the discussions that took place at the pit top on the 22nd August 1958. At that time there was no suspicion that the inlet was without the flame trap so that Messrs. Ruston & Hornsby Ltd., Lincoln, England, were not told of this, and their reply does not deal with that question. As Dr. Whitaker thought more of the matter he considered it necessary to examine carefully both the flame traps on the exhaust and the inlet sides of the engine to see if they were in any way defective. He reported verbally on the 28th August 1958 that when the locomotive engine which was underground at the time of the explosion, was opened out at the surface it was discovered that there was no flame trap on the inlet side and that the equipment was opened in the presence of Sri Anand, Sri Taneja, Sri A. N. Sinha, Inspector of Mines, Sri Grewal, Chief Inspector of Mines and Sri H. K. Bhattacharyya, Electrical Inspector of Mines. Dr. Whitaker was then asked to submit a report in writing to his effect, *vide* order dated 28th August 1958. Appendix No. II is Dr. Whitaker's report. Then on the 3rd September, 1958, the Court mentioned for the information of the parties, that Dr. Whitaker was inclined to think that the absence of the flame trap on the inlet side of the diesel locomotive engine underground at the time of the explosion might be the cause of ignition of methane gas which led to the explosion and Dr. Whitaker himself explained the reasons on which his theory was based and said that if considered necessary he would submit a report on it after the hearing of the arguments and the Court approved of that. The owners were then directed by me to submit a statement regarding the locomotive engine with special reference to the flame traps, Ex. O.S.-77 is that statement. Sri Sachin Chaudhuri submitted that day that his clients felt that they could not adequately deal with this new position without obtaining expert opinion on it from England and I pointed out to him that the theory of Dr. Whitaker was communicated to the owners in order that they might deal with it in their arguments as far as possible at this stage without examining experts either here or abroad and that if the locomotive could be shown to be safe without a flame trap on the inlet side there would be an end to the theory; otherwise, it might be included in the Court's report as a probable cause of ignition and the Government might, if they deemed fit, take steps to pursue the matter further in the interests of safety of mines. The matter was left at that at the time. Then during his arguments, Sri Chaudhuri dealt with the matter on the footing that the absence of the flame trap on the inlet side might be a probable cause of ignition if only the engine was running at about the time of the outburst, and not otherwise, and his contention was in the first place that at about the time of the outburst it was not running, and in the second that even if it was running, it would not be as probable a cause of ignition of methane as the two lamps found in the gallery connecting the cross-cut with 5 rise district.

117. The first question, therefore, to be considered in this connection is whether indications are available that the loco might actually be running at about the time in an explosive mixture of methane and air. It may be at once said that the whole question is to be looked at only from the point of view of probabilities because these is no conclusive evidence either way. But this much is clear that the loco had left the empties on the empty line and then moved along the cross-over almost to the full line. Then the empties had been pushed by hand eastward till the first empty which, on re-entry appeared to have been blown towards the dip from the empty line had reached a position just beyond 10 rise level. To move the empties from 9 rise to 10 rise would take a certain amount of time, probably not exceeding 15 minutes for the whole operation as the gradient is somewhat helpful for half the distance (*vide* plan, Ex. O.S. 79). The question is whether the loco after is had moved on partly to the cross-over and partly to the full line was idling all this time or was completely stopped. Bye-law No. 14(4) is as follows: "The engine of a diesel locomotive shall not be kept running when the locomotive is stationery except (a) during brief halts while in use, and (b) while being tested." It further appears that on the full line there were 7 full tubs and there was no other full car either towards the end of the empty line or anywhere east of 10 rise on the full line. A loco is supposed

normally to take a set of 12 loaded tubs so that until the full set was there the loco would not be expected to be in use. There were some empties still to be loaded as shown in Ex. O.S. 74. It appears from note 'F' in Ex. O.S. 74 that on being filled at the conveyor jib-end the cars gravitate to the positions marked 'F' where they are coupled together with couplings previously placed between the tracks while uncoupling the empty set and the full cars were found coupled up in this position on re-entry. The outbye full car is near the loco, but not coupled to it. From this it certainly follows that the loco was not about to start drawing the loaded cars first because there was not yet a full set of 12 loaded cars; secondly because the loco was not yet coupled to the nearest loaded car although all these 7 loaded cars had been coupled up to each other. Before therefore the loco could be expected to move there was likely to be a certain amount of interval. What that interval was, it is difficult to say, nor is it possible to be definite that the engine was in fact running in an explosive atmosphere. It is probable that the outburst had occurred some time before the engine left the empties on the empty line and was moving along the cross-over, and if the outburst had already occurred a certain amount of CH_4 may have backed up against the intake so as to make the engine run in an explosive atmosphere. Besides, the engine has to be started by a handle and in this case it is in evidence that the handle was lying on the floor. The fact that an engine has to be started by a handle is likely to make most engine drivers keep the engine running during halts because if they keep the engine running they would not have to start the engine again by the handle. Then, it is also permissible under the bye-laws to keep the engine running while the engine is being tested. That would also provide the engine driver with an excuse for keeping the engine running. After all, it does not cost him anything to keep the engine running, while, if he stops it between halts, whether brief or not, he has got to start it when the engine is to draw either loaded or empty cars. It is therefore more than probable that the engine was running. But as I have already said this is nothing more than a probability there being no evidence whatever either way to show whether in fact it was running or not.

118. The next question is what would be the effect on the engine if it was running at the time in an explosive atmosphere. It is necessary at this stage to draw attention to the procedure that most of the investigators adopted in attempting to trace the origin of the explosion. They have been governed largely by the direction of the blast and have in almost all cases traced the origin of the blast (as judged by the violence produced) to the east district near the dyke face and probably in no. 1 rise level not far from the face. However, it is important to visualise the probable conditions following an outburst of gas. We have pointed out earlier that we consider that there was a large outburst and most of the personnel were asphyxiated. Such an atmosphere would not be capable of propagating or initiating an explosion. It would not be inflammable. There must have been at least 50 per cent. methane present to asphyxiate the men, and there was probably far more in certain districts. Moreover, the evidence of violence in guiding one to the source of ignition is by no means conclusive as to the origin of a fire-damp explosion, especially as near such region there is generally little violence indeed. The more likely source of the explosion is where the methane-air mixture has been of composition containing 5 to 15 per cent. of CH_4 , and this would be at some distance from the site of the outburst, possibly 1,000 ft. or more away from it. Again, it is more likely that we shall have such explosive mixtures on the intake side rather than on the return as the bulk of the gas from the outburst would pass down the return airways and would make the atmosphere in such roadways extinctive, probably right up to the upcast shaft. On the intake side, however, although the gas may have driven back the intake air to some distance, yet there must have been a certain stage when fresh air, or reasonably fresh air, would be encountered even if only in the vicinity of the downcast shaft as air was downcasting and the fan was running. How far from the downcast one would have to go before meeting an explosive mixture of the gas and air is impossible to state with precision; but in view of the magnitude of the outburst, as shown by the evidence, it is likely that the area only within 1,000 ft. or so from the downcast shaft would be relatively fresh. We therefore feel that the more likely source or region of the original inflammation of gas would be an area lying roughly half-way between the downcast and the working face. This leads one again to consider the possibility of the diesel locomotive as the source of ignition, and as already stated, Dr. J. W. Whitaker went to examine the

diesel locomotive to see if the flame traps were in good condition, or if there were any other means whereby the locomotive might be responsible for the ignition.

119. The locomotive was plying between the pit bottom and no. 9 rise. It would therefore be running mainly in fresh air, but it is possible that at about the area where no. 9 rise crosses the loco level the percentage of gas in the air would be in the region of the explosive range. Examination of the conditions underground goes to show that the locomotive had arrived with 12 empty tubs and that it had been disconnected from these tubs, and it moved to the cross-over in order to pick up the set of full tubs. This set, however, had not been completely filled from the belt conveyor. In fact, only 7 tubs had been coupled, and the locomotive was apparently waiting for the remaining 5 to be filled. The locomotive incidentally was not coupled, to any tubs. It was found that the fuel supply was cut off.

120. When a diesel locomotive runs in fresh air and the fuel supply is cut off and the engine is in neutral gear as it was with the diesel locomotive in question, the engine may continue to run off some 10 or 20 revolutions but without any driving force, the running being due simply to the energies stored in the fly wheel. If however a diesel locomotive is running in an atmosphere containing methane, especially if the methane lie between 5 and 15 per cent, the engine may continue to run and indeed may accelerate due to the fuel supplied as the methane even though the normal oil fuel of the loco is cut off. It is thus possible that the engine was running of its own accord. Moreover, it is not known at what stage the fuel was cut off, i.e. whether it had been cut off only a second before or whether the engine had been rotating for some time. It is well known that under these conditions the normal sound of the locomotive changes to an abnormal one, not unlike the pinking sound of a petrol engine. Under such conditions the locomotive is perfectly safe, provided that it has flame traps in good condition both on the exhaust and on the inlet sides. If however there is no flame-trap on the inlet side it is a potential source of danger, and we are of opinion that the flame travelled through the inlet supply pipe to the air filter and ignited an explosive mixture externally and thus caused the explosion.

121. Messrs Ruston & Hornsby Ltd. Lincoln, England, in their reply dated the 2nd September 1958, which Sri Sachin Chaudhuri produced before us after he had completed his arguments, give the following information:—

- “(1) Methane being lighter than air, we would assume that as the Driver's head is higher than the engine inlet if the concentration of methane was high it is likely he would be overcome before any of this mixture was induced into the engine. He therefore could not have shut down the engine but we are told that he did and therefore it can be assumed that the concentration of methane was low and he was not overcome prior to it being induced into the engine.
- 2) Since a Methane/Air mixture of any proportion by volume is incapable of spontaneous ignition in the cylinder, then ignition could only occur if there was a heat source remaining in the cylinder such as an incandescent particle of carbon.
- 3) This is an extremely unlikely possibility as such a particle of carbon would only remain incandescent so long as the engine remained on load and immediately the fuel was shut off the incoming air would cool the carbon particle below incandescent temperature.
- 4) The more likely sequence of events is that the methane/air mixture present in the mine was drawn into the engine cylinder whilst fuel was still being injected. This would have caused the engine to attempt to accelerate and the governor would have endeavoured to offset this tendency by reducing liquid fuel to the cylinders. The behaviour of the engine from this point would depend upon the horse power it was called upon to develop to pull the load and the percentage of methane present in the atmosphere. The fact that the driver had shut off fuel suggests that the methane/air mixture, ignited by idling fuel, was richer than that required to sustain the load and the engine therefore accelerated. This caused him to shut off the fuel and immediately he did this, the engine stopped. During the period that the engine was running on

combination of methane and liquid fuel the exhaust would be normal and the exhaust conditioner and the flame traps effective. This exhaust conditioner and flame traps, both inlet and exhaust, to the specification provided by us on this locomotive had been tested at the Mines Research Establishment at Buxton in the following manner. The exhaust pipe and conditioner were filled with a critical methane/air mixture. This assembly was then placed in a critical methane/air atmosphere and a charge electrically detonated inside the conditioner. This assembly was approved by the Mines Research establishment as the resulting flame issuing from the flame traps was too cool to ignite the critical methane/air atmosphere outside the assembly.

- (5) Under the conditions described above where the engine could run on a mixture of methane and liquid fuel there is obviously no minimum limit of methane since the engine will run on its idling fuel alone. The upper limit is best defined as the percentage of methane which will completely use up the oxygen in the methane/air mixture when the mixture burns in the engine cylinder. This percentage is approximately 4 per cent by weight. Any concentration in excess of this will result in unburnt methane passing through into the exhaust system together with small quantities of hydrogen and carbon monoxide, but as there is no oxygen left these cannot burn in the exhaust system. Any concentration less than this will mean that all methane has been burnt in the cylinder. In this condition there will be no hydrogen or carbon monoxide in the exhaust but there will be water vapour and carbon dioxide.
- (6) Under the circumstances, therefore, and in view of the details given above, we fail to see how the combustion of methane in the engine could have caused an external explosion provided always that the exhaust conditioner and flame traps were in a fully serviceable condition."

122. The letter, of course, starts by answering some questions put in a letter (Ex. O.S. 78) to which it purports to be a reply. These questions are as follows:

- (a) What limits of methane/air mixture would continue the turning over of one of your diesel engines?
- (b) If the methane/air mixture were greater than the ratio most desirable for combustion in an internal combustion engine, would hydrogen be produced and would this hydrogen inflame in the exhaust?
- (c) If hydrogen be inflamed as mentioned in (b) above, would such a flame pass through the flame trap and exhaust conditioner?"

The answers were as follows:

- "(a) With the fuel supply shut off the engine would stop and during the slowing down process any mixture of methane and air would not ignite.
- (b) and (c) These questions, in view of the answer given above, therefore become irrelevant."

As against this, may be considered the cable reproduced in Ex. O.S. 75:—

"YOURS SECOND RE CHINAKURI CONFIRM INLET FLAME TRAP SUPPLIED STOP IF TRAP REMOVED LOCO UNSAFE FOR OPERATION IN ATMOSPHERE CONTAINING METHANE STOP SPECIFIC ANSWER WHITAKER THEORY ASPIRATED METHANE/AIR MIXTURE WOULD BURN IN CYLINDER ONLY REPEAT ONLY WHILST FUEL INJECTED STOP ASPIRATING METHANE/AIR MIXTURE COULD INDUCE UNCONTROLLED ACCELERATION CAUSING DRIVER SHUT OFF FUEL BUT BEFORE IGNITION OF METHANE/AIR MIXTURE TERMINATED BY SHUTTING OFF FUEL BLOWBACK DOWN INLET MANIFOLD COULD OCCUR WHICH WOULD BE SUPPRESSED BY INLET FLAME TRAP."

Clearly therefore if the oil fuel had been just shut off, the makers, admit the danger of an ignition if there was no inlet flame-trap. Moreover, they also

state that if the trap is removed the loco is unsafe for operation in an atmosphere containing methane.

123. Evidently then, the manufacturers assume in their reply that the inlet was also provided with a flame trap and that the flame trap was serviceable. When, therefore, it was discovered that the flame trap was not there at all, not to speak of its being in a serviceable condition, it would at once follow that there is a very real danger of the flame shooting out through the inlet without being cooled by the flame trap which was simply not there, provided of course the conditions which Dr. Whitaker envisaged were there. That being so, the reply of Messrs Ruston & Hornsby Ltd, does not really even purport to answer Dr. Whitaker's views as regards the probability of a flame shooting out through the inlet of the loco engine and igniting an explosive mixture of methane and air.

124. Incidentally, the inlet and the exhaust valves of the engine, and the condition of the piston cylinder and cylinder head are reported to be in good condition by Mr. B. B. Sen of Messrs Martin Burn Ltd., the suppliers (*Vide Ex. O.S. 77*). But this is to be expected and does not provide material evidence one way or the other, except that if the engine had been faulty the conditions for igniting fire-damp externally might have been still more favourable.

Route of the blast

125. The travel of the explosion was apparently in two directions—one as a relatively mildly felt explosion near the loco level to the region of 15 rise where it met with a good supply of coal-dust possibly from the scraper chain conveyor in No. 1 rise level and from which point the explosion travelled westward largely down No. 1 rise level and No. 1 dip level and through the dip workings and to some degree along the loco level itself; but the second direction of travel of the original ignition seems to have been westward along the loco level towards the pit and here the methane concentration would probably be falling rapidly. Coal-dust however was raised into a cloud, and a coal-dust explosion apparently took place between No. 2 dip (or perhaps earlier) and the downcast shaft. The explosion also burst open the separation doors and allowed fresh air to go up No. 2 upcast shaft. The Belmos switch weighing 3 cwt. was hurled from No. 2 dip to near the sub-station along half way between the downcast and the upcast shafts by the blast of this explosion and a large girder on the loco level near the pit bottom was bent into the form of a 'V'. The flame of this explosion ignited the gas that was in the upcast shaft, and this was seen at the top of the fan evasee. The long rumbling thundery sound heard by certain witnesses, notably by Sri Ohri, implies that there was a number of explosions, and we think that in addition to the above main routes the explosion also travelled into No. 5 rise district. It is likely that most of the gas produced by the outburst had disappeared before this actual explosion; otherwise it is difficult to account for the explosion travelling through the dip districts on the east side as the atmosphere there must have had enough oxygen to provide for the explosion. Meanwhile, it is to be pointed out that the action of the fan would be to pull air from the loco level into No. 1 dip level through the various openings between these two, which openings were far from air-tight, especially where the conveyors came through on No. 9 dip and No. 2 dip to feed the coal into the loco level. This would probably give ample fresh air in No. 1 dip level for the explosion. We may also mention that fresh air would similarly tend to come down from No. 1 rise level. The explosion seems to have caused a fire in No. 2 dip district as Shri Taneja could not proceed beyond 150 ft. below the loco level, and fire was also apparently caused in the loco level itself between No. 9 rise and the dyke face as personnel were unable to penetrate these districts. Thus the third Rescue Team led by Sri Krishnan could not go beyond a point between 8 and 9 rises on the main loco level; nor could Paru Mali proceed up the cross-cut to the sand stowing drift owing to the fumes.

126. Regarding the western side of the pit, the coal dust explosion apparently passed straight along the loco level to the lower western main level and shattered the air-crossing on the way where this level crosses No. 3 dip west. Of the men found around the pit bottom and the western district, some were gassed with CO, some were burnt and some were injured by the blast. Such men of course were alive prior to the explosion because the air passing in that direction was fresh air fed by separate split at the bottom of

no. 1 downcast. It was fortunate that the Rescue Team proceeded to the west as only in that area were they likely to recover any personnel still alive.

127. To sum up the conclusions arrived at:

About 20 or 30 minutes before the actual explosion there was an outburst of CH₄ associated with certain quantity of small coal from the splinter seam which was found converging towards the main Disergarh seam on the eastern side and CH₄ erupting from below as a result of this outburst practically filled the mine with an abundant supply of methane most of which swept out with the return air and part of which backed against the intake. As a result of this large supply of CH₄ in the mine the majority of the workers underground on the eastern side in all probability the workers underground on the explosion. Then, either the flame shooting out from the loco inlet—a likely contingency in our opinion—or a smouldering piece of cloth in one of the two lamps found in the connection between the cross-cut and 5 rise district east which might shoot out into a flame with the access of fresh oxygen in the air as more air came into the area,—a possible but unlikely contingency in our opinion—might have ignited an explosive mixture of methane and air. If the flame from the loco inlet was responsible for the ignition the ignition must have taken place on the loco level between 9 and 10 rises if, on the other hand, the smouldering piece of cloth was responsible for it, it must have taken place near the face of the connection between the cross-cut (s.s. drift) and 5 rise district east. Coal-dust must have taken a part from an early stage and assumed a somewhat important role as the explosion reached the downcast area, that is, the region of fresh air.

128. The second and the third explosions also must have been due to methane, but it is not possible to say whence these second and third explosions emanated. But this much seems to be pretty clear that they could not have originated in the eastern district where there must have been a shortage of oxygen after the first explosion, because the short-circuiting of air in the immediate region of the pit bottom and through the smashed air lock doors would have prevented much air penetrating into the eastern district after the first explosion.

129. It remains to add, first, that unless methane had been liberated in such vast quantity, there would have been no explosion at all, as the ignition occurred on the intake side. Secondly, the original explosion of methane naturally created coal-dust clouds as usual which, no doubt, took part in the explosions, in addition to coal dust probably liberated along with the gas and that created by a conveyor running in the eastern district between 15 and 16 rises at no. 1 east rise level, after all personnel there had been asphyxiated, as the switches were found to be on.

V. NEGLIGENCE ON THE PART OF MANAGEMENT

(a) NEGLIGENCE UN-CONNECTED WITH THE ACCIDENT

130. (i) During the inquiry we have had occasion to notice that the registers of explosives and the attendance registers showing issue of cap and oil safety lamps were not maintained properly, and as a matter of fact there was a certain amount of perfunctoriness in the entries. The state of the explosive registers is of course partly to be explained by the fact that the shot-firers, to whom explosives are issued, are mostly illiterate and they have to get their statements, showing return of explosives, written by others. It seems there is no proper arrangement for checking these statements before the registers are written up.

(ii) The inspection reports show detection of gas on several occasions and on some of these occasions gas was detected in the same areas. This shows that proper steps were not always taken in time to dilute the gas sufficiently by extending brattices or removing the same wherever necessary. The inspection reports further show that coal dust was not properly cleaned in certain areas and that the stone dusting arrangements were not always satisfactory. In this connection, I must make it clear that the accusation levelled against

the Department of Mines for having neglected their duty has been disproved and the representatives of the different workers organisations also found that out after they had examined the reports of inspection placed before us, and the only complaint of Sri Deven Sen against the Department of Mines was that it did not take against the owners drastic enough action for their repeated failures. All that I need say here is that there was really no occasion for any drastic action as the management rectified as promptly as possible any defect pointed out and that penal action, not to speak of the closing of a mine, has to be taken only when it is, in the opinion of the Department imperative and the Department has been vested with full discretion in the matter.

(b) NEGLIGENCE CONNECTED WITH THE ACCIDENT

(i) *The installation of the loco without any flame-trap on the inlet side*

131. Ex. O.S. 76 gives the manufacturers' specifications of the engine and from that it is clear that flame traps must be fitted not only on the exhaust outlet but also on the air inlet side. That the flame trap on the inlet side was never fitted is admitted (*vide* Ex. O.S. 77). Evidently then, the loco was installed underground without a flame trap having been fitted on the inlet side, and it is our opinion that of the two probable sources of ignition, a flame shooting out through the air inlet of the loco is more probable than the flame from a piece of smouldering cloth in an oil lamp in the connection between the s.s. drift and 5 east rise, particularly because the air inlet of the loco, unprovided with a flame trap, is a potential source of danger. Loco bye-law No. 3(3) does not appear to have been infringed because the loco operated about 1,000 ft. away from the face, but bye-law No. 3(2) does appear to have been contravened. It runs as follows: "No locomotive shall be used underground unless it is of a type approved by the Chief Inspector by an order in writing and *unless it is maintained in its designed condition.*" The "designed condition" of the loco evidently includes the provision of a flame trap on the inlet side. When therefore the loco was used underground without any flame trap on the inlet side, it can hardly be said that it was maintained in its designed condition. There is thus a contravention of this part of bye-law no. 3(2). On behalf of the owners it was represented to us that the loco was supplied to them with a flame-proof metal label rivetted to its body and that this misled them into the belief that both the flame-traps had been fitted before the engine was delivered. Secondly, the Instruction Manual, which is Ex. O.S. 64 contains the following passage at page 37:

"D.L.G. models: In addition to the equipment specified above, the D.L.G. models are fitted with a flame trap on the inlet manifold. The trap is fitted between the oil-bath filter and the manifold and, with being in this position, *will require little maintenance other than occasional cleaning as required.*"

It was accordingly represented to us that as the flame trap on the inlet side was supposed to be fitted between the oil filter and the manifold and as it was distinctly stated that it would require little attention except occasional cleaning, as required, the management had no occasion to see whether the flame trap was there, and that they had it installed underground in perfect good faith. It is true that the D.L.G. label rivetted to the body of the loco was misleading particularly if, as we were told, the suppliers did not warn the owners before-hand that the flame trap on the inlet side had been separately supplied and should be fitted before the installation of the engine. It is also true that when the instructions speak of the inlet flame trap requiring "little maintenance" except "occasional cleaning as required", the management was apt to think it would not require as much attention as the flame trap on the exhaust outlet. But then it appears from item (14) at page 20 of the Instruction Manual that "when fitted, air inlet flame traps require cleaning every 50-60 hours (weekly)". Evidently, there was no such weekly cleaning for the very first attempt to clean it would have let to the discovery of the absence of this flame trap. This is the first item of the management's failure to maintain the loco in its designed condition. Secondly, Ex. O.S. 76 shows that a spare exhaust flame trap was supplied but there is no mention of a spare inlet flame trap being also supplied. Now if, as we are told, the inlet flame trap was also supplied separately from the loco, two flame traps must have been so supplied. Yet Ex. O.S. 76 speaks of only one spare flame trap for the exhaust side. A comparison of Ex. O.S. 76 with the parts separately supplied would have enabled the management to detect the suppliers' omission. It is however possible that when a reputed firm like Messrs Ruston & Hornsby Ltd.

supplied a loco which bear their flame-proof certificate the owners might have been lulled into a sense of security that it was in fact flame-proof and they might have had it installed in perfect good faith which we have had no reasons to question. That however would not go beyond explaining the management's failure to detect the omission at the time of the installation of the loco. Moreover, the management could have insisted on the suppliers' sending their representative for testing and installing the engine and then on their certifying that it was flame-proof and in order. The suppliers also should have taken steps to see to the assembly of the engine and its flame traps being absolutely in order. There is thus no doubt that there was lack of collaboration between the suppliers and the Colliery. Yet, with care the management could have detected the absence of the inlet flame trap on the locomotive as supplied. The facts therefore that the suppliers had rivetted the flame-proof (D.L.G.) certificate to the body of the engine without fitting the flame trap on the inlet side and at the same time did not inform the owners before hand of this, can at best be held to be an extenuation but not a full condonation of the breach of bye-law No. 3(2).

132. In this connection I considered the question whether in view of the breach I should make the owners pay at least a part of the cost of the Inquiry under rule 22(1) of the Mines Rules 1955, and if I refrain from making any order to that effect it is because I do not think I am legally entitled to pass such an order under the rule. We have not been able to arrive at a definite finding that the accident was due to any carelessness or negligence on the part of the management, and such a finding is an essential pre-requisite to the making of an order under rule 22(1). The management had no responsibility whatever for the outburst which they could not foresee or prevent, and as regards the ignition of CH₄ ignition was a flame shooting out through the inlet of the loco, and because this inlet was without its usual flame-trap external ignition and explosion developed. At the same time we could not completely rule out another source of ignition, viz. the flame from the piece of smouldering cloth in two oil safety lamps found on the road connecting the s.s. drift with 5 rise east; and as none can say that what we think less probable or even one or the other of what we ruled out as improbable, may not actually have occurred it is impossible to come to the definite conclusion that the accident is really due to any carelessness or negligence on the part of the management. I think I must also add here that even if I could find I was legally entitled under the rule to pass such an order, the discretion of the Court could hardly be exercised justly against the owners who have throughout to the best of their ability co-operated with and helped the Court in arriving at a correct finding. In filing the statement, Ex. O.S. 77 in which they admit that the flame trap was not fitted to the loco inlet they have given conclusive proof of their integrity and good faith.

133. Amongst the responsible officials of either Messrs Andrew Yule & Co. Ltd. or of this Colliery, we have seen quite enough of Messrs. Rosser, Huges and Sri Taneja to be able to say that they know their work thoroughly and that there is in each one of them a full sense of responsibility. The owners may have in their employ other officials of similar calibre. Nevertheless, it is clear that when the loco was taken underground without the flame trap on the air inlet side some-body somewhere was at fault, and this has cost the owners so much in men and money. In an inherently hazardous industry like mining where a slip by one may well undo the valuable work of others and land the management in serious trouble, it is hardly possible to over-emphasise the importance of team-work and the imperative need for extreme care and caution on the part of everyone individually and on the part of all collectively, specially in matters of safety of the miners and the mine. As mines are more and more mechanised and electrified, new sources of danger from new equipment arise and that makes it an absolute necessity for everyone responsible for the installation and maintenance of such equipment, to be imbued with an adequate sense of the importance of their duties and of the great care which they must take at every step in carrying them out.

(ii) Ventilation

134. On behalf of the Indian Mine Workers' Federation and the All India Trade Union Congress, Sri Bikash Roy was critical of the ventilation plan of the fan at the top of No. 2 pit, which is the deepest of the three pits, the ventilation plan did not allow natural ventilation to play as great a part as the regulations required that it should, and he refers in this connection to regulation 131(6) which

is as follows: "Flow of air produced by mechanical ventilation shall, as far as practicable, be so arranged as to aid natural ventilation"; secondly, that the downcast air should have been taken first to the dips and should have been allowed to rise to the higher levels from the dips; thirdly, that the return air of certain working faces was fed back into the intakes of others. It must be borne in mind however that the arrangement of the ventilation system of a mine is a highly complicated piece of work often involving a compromise between a number of factors. As a matter of fact, the problem of coal mining itself may be summarised as the problem of winning coal as economically as possible, but without sacrificing first the safety and health of the miners who have to work underground, and secondly, the safety of the installations underground. For working out the plan of ventilation, therefore, the management has to consider all the factors involved and then to arrive at a decision as to the best method of ventilating the mine at different stages of development regard being had to all the different aspects thereof. It is impossible for this Court of Inquiry within the limits of the space at its disposal to go into this complicated question of ventilation. It is pertinent however to point out that if the ventilating fan had been placed at the top of No. 3 pit instead of at No. 2 pit, first, there is every likelihood of the explosion having extended to No. 3 pit area and killed a number of men there; secondly, that if the downcast air were first taken to the dips and from there allowed to go to the rise districts and ventilate them it would have picked up more moisture from the dips and produced in the mine high humidity which would make the working conditions in the mine more oppressive; thirdly, while the extra air available in both Nos. 1 and 2 pits had been downcast, it is not by any means certain that it would have been sufficient to prevent asphyxiation of most of the men underground, as the outburst of gas was not small. Mr. Rosser at pages 85—89 explains the reasons for adopting this plan of ventilation. It is therefore possible that there are two sides of the question, and that while it is impossible for us to say that there is nothing whatever in the criticism of the ventilation plan, it is equally impossible to say that it is entirely sound. As a matter of fact, it will be for the management and the Department of Mines to reconsider the question of ventilation of the mine in the light of the criticisms made and to decide finally whether the existing plan of ventilation is quite satisfactory or whether it should be modified. The need for a competent Ventilation officer as required by the recent regulations is obvious.

(iii) *Anxiety to increase production at the cost of the safety of the miners.*

135. One of the charges levelled against the management on behalf of the different workers' organisations was that it was always anxious to increase the production in Chinakuri pits Nos. 1 and 2 without paying sufficient attention to those rules and regulations which are prescribed in the interest of the safety of the miners. The owners, in answer, filed a statement (Ex. O.S. 69) showing the output per man shift from 1st February, 1958 to the 19th February, 1958 when the accident occurred, and also another statement (Ex. O.S. 50) showing the output per man shift at Chinakuri Nos. 1 and 2 pits colliery from September 1957 upto January 1958, as compared with the output per man shift in all the collieries of the Bengal Coal Co. Ltd. during the corresponding period, and also a statement of the output of the Baksimulia 11 and 12 pits. From the statement, Ex. O.S. 69, it appears that the output per man shift for 16 days in which there was work in February 1958 was 10.16 so that the average per day was only .635. It appears from Ex. O.S. 50 that the average output per man shift from September 1957 to January 1958 if only underground workers was considered, was .70, and if only the surface workers were considered, 1.37; and if the workers underground as well as those on the surface were taken into consideration, .51, whereas from the Chinakuri inclines the corresponding figures were 1.05, 1.77 and .66, and for all the collieries of Bengal Coal Co. Ltd., the corresponding figures were .77, 1.64 and .53. It is made clear in this statement that the number of men employed on capital works at Chinakuri Nos. 1 and 2 pits averaged to little over 90 during the months under review and the men employed on capital works were not included in the O.M.S. figures. It is obvious from these statements alone that the output per man shift for Chinakuri pits 1 and 2 was lower, if only the underground workers are considered, than that of all the collieries of Bengal Coal Co. Ltd. and also of the inclines. It was also lower than the figures of both if the underground workers and the surface workers were both taken into consideration; but it was higher than both if only the surface workers were considered.

136. The Chief Inspector of Mines provided me with the O.M.S. figures for India for 1956 and 1957 and some foreign countries for 1956 only. In India the figure for 1956 was 0.39 and that for 1957 was 0.41. Of course, the figures for the foreign countries were in metric tons and those for India in tons, so that the figures for India, which are in tons, should be .44 for 1956 and .46 for 1957 when expressed

in terms of metric tons. The corresponding figures for United Kingdom, Belgium, Netherlands, France and West Germany for 1956 were 1.25, 0.84; 0.96, 1.08 and 1.19 respectively. Clearly then, the Indian figures are much lower than those of foreign countries, particularly England, France and West Germany.

137. It appears from the Quarterly Bulletin of Coal Statistics for Europe, Vol. VI, No. 4, 1957, page 8, that the average output per man shift on a consideration of the underground workers only, for Belgium, which has the lowest output of all the European countries mentioned there during the period from October 1956 to December 1957, was 1.152 metric tons. The corresponding figure for Chinakuri No. 1 and 2 pits, as I have already stated, is only .70 which is about a half of the average output for Belgium. It further appears from the Indian Coal Statistics 1957, page 46, that the average output per man shift for underground workers was 6.36 in the United States of America for bituminous and lignite in 1953 and anthracite 2.44. It is therefore obvious that the output per man shift in Chinakuri and for the matter of that in the whole of India is far lower than even in Belgium which has the lowest output amongst European countries mentioned at page 8 of the Quarterly Bulletin of Coal Statistics for Europe, Vol. VI, No. 4, viz., Belgium, France, Saar, Western Germany, Netherlands, Poland and United Kingdom, and is nowhere near the output in America which is far in advance of other countries in this respect. Evidently then, to say that the output in Chinakuri Colliery is such that the management can be accused of having directed their attention only to increased output at the cost of safety regulations etc. is completely to lose sight of the fact that the output in this country is extremely poor when the output in other comparable countries is considered; and even though Chinakuri Nos. 1 and 2 pits have been mechanised, the production does not compare at all favourably with that of the other countries named. In these circumstances it must be held that there is no substance whatever in this accusation.

VI. MATTERS ARISING OUT OF THE INQUIRY

137. In this section I shall deal with matters which arise out of the Inquiry but which have no casual connection with the accident in any way.

A. (i) Rescue operations

138. On behalf of some of the workers' organizations, the rescue operations have been criticized on the following grounds:—

First, that those operations did not commence early enough; secondly, that enough teams were not sent underground so as to render simultaneous exploration of the western and the eastern districts possible and that the first two teams did not go at all to the eastern side and make an attempt to rescue survivors from that region; thirdly, no fresh air base was established underground although it was found that fresh air was circulating at the bottom of Nos. 1 and 2 pits; fourthly, instructions given to the third rescue team headed by Sri Krishnan were so rigid as to make him confine his attention to the loco level east and did not enable him to explore the higher or the lower levels with the result that although there might have been some survivors in the eastern district, no attempt was made to rescue them; fifthly, that the rescue teams did not take sufficient air samples from the underground workings which they visited.

139. The first ground of criticism is based on the fact that although some rescue teams arrived between 10.40 p.m. and 11 p.m., the first rescue team did not go underground till 11.50 p.m. The reason assigned by Mr. Hughes for this delay is that this interval was wholly taken up with the securing of the lids on top of No. 2 pit which had been blown up. After the lids had been secured, the cages in the shaft had to be wound a number of times from top to bottom for ensuring that the shafts were free from obstruction and that it was safe to send rescue teams down (Vide evidence page 4, paragraph 1). Sri Devan Sen of course argued that the securing of the lids should not have taken such a long time and that if Mr. Hughes instead of going to No. 3 pit had remained at No. 2 pit it would have been possible to expedite the securing of the lids. After all, the securing of the lids may not be as easy as Sri Devan Sen seems to imagine and when Mr. Hughes says in his examination-in-chief that at about 11.45 p.m. he became satisfied that it was feasible to send rescue parties down the shaft it does not appear that his statement was anywhere challenged in cross-examination nor does he appear to have been questioned on the point that the lids could have been secured much earlier. On the evidence therefore there is no ground at all for supposing that any time was wasted in securing the lids and then winding the cages up and down several times for ensuring that the shaft was free from

obstruction. There is nothing in the evidence to suggest that the men who were responsible for initiating and guiding the rescue operations were so callous as to forget that precious lives had been trapped underground and unnecessary delay in beginning the rescue operations might make all the difference to them between life and death. Mr. Hughes was also criticized for having gone to No. 3 pit at all instead of having remained at the mouth of Nos. 1 & 2 pits. At the time when Mr. Hughes left for No. 3 pit, the rescue brigades had not yet arrived, as he says at page 3, para. 1, and after all, the withdrawal of about 200 men from No. 3 pit was also an important matter and if anything went wrong there it would have been the easiest of things to criticize Mr. Hughes for that as the principal officer of the mine present there, and it would be somewhat difficult for him to answer that criticism. As there is nothing to indicate that the lids of No. 2 pit could have been secured earlier, it is impossible to hold that Mr. Hughes wasted any time by going to No. 3 pit and that the time he spent in going to and coming back from there could have been more usefully utilized for beginning the rescue operations. On the materials on the record therefore, it has got to be held that the rescue operations were started at the earliest possible time when they were found feasible.

140. As to the second ground of criticism, although there is nothing in the Coal Mines Rescue Rules, 1939 which govern rescue operations, to indicate that only one brigade at a time has to be sent underground for rescue operations, I am told it is the recognised practice that only one team at a time is sent underground, for otherwise confusion may arise. If that is so, the rules should provide that only one team should be sent at a time and a certain amount of discretion should be left to the superintendent of the Rescue Station or any other responsible officer in the absence of the superintendent himself, for sending an additional team if he is satisfied that the circumstances permit and require it. The fact that there is no such rule would seem at first sight to be a sufficient justification for the criticism. But as a matter of fact in this case even if two teams had been sent underground at the same time, the possibility of any survivor being rescued from the eastern district would be extremely remote, because in the first place there is a likelihood of the workers in that region having been asphyxiated to death by the time the rescue operations began and secondly because of the fire which must have started in that region immediately after the first explosion. Sri Deven Sen pointed out that after all there were two teams underground at one time. It is undoubtedly true that the second team which went underground at 1-25 a.m. did not come out till 2-40 a.m., while the third team went underground at 2-30 a.m. Thus between 2-30 a.m. and 2-40 a.m. two teams must have been underground at the same time. This much is however, clear from the evidence that while the third team went underground the second team was somewhere near the pitbottom as they came out ten minutes after the third team had gone underground. In other words, when the third team went underground, the second team was on its way back to the surface so that although for about ten minutes the two teams were underground those who were directing the rescue operations must have known that the second team was to return shortly. As regards the criticism that the first two teams confined their attention to the western region only and made no attempt to rescue survivors from the eastern region, all that need be said is that the only object of the rescue teams is to rescue as many survivors and that as early as possible. Mr. Hughes has told us that when he went to the western side he shouted out and obtained response from some men who told him that there were some others who were alive but unconscious or otherwise unable to move about. It was therefore definitely known that there were some survivors in that region and it was the obvious duty of the rescue teams first to rescue those men who they knew were there instead of going out in the eastern direction in search of possible survivors and then finding out that there was actually none there. If it was possible to penetrate into the eastern district they would in all probability have found that there was none alive there and then if they had come back to the western district, some of the survivors in that region might have already collapsed, so that if the rescue teams had gone to the eastern side at all, they might have wasted valuable time which they could have better utilized for rescuing the survivors in the western district. Had they done so, there would have been probably much more violent criticism of the rescue operations and any such criticism would in that case have been fully justified. There is thus no point in this criticism either.

141. As to the third ground of criticism, viz. that the rescue operations were delayed by the non-establishment of a fresh air base in the pit bottom, Sri Bikash Roy asked Sri Krishnan, Witness No. 14 for the owners at page 287 whether during such rescue operations time could be saved if a fresh air base was made at the bottom instead of at the surface, and his reply was in the affirmative. Sri Bikash

Roy then asked him whether he was given any instruction to make a fresh air base at the bottom and he replied in the negative. Sri Bikash Roy did not pursue this question any further. Sri Krishnan further stated in answer to Sri Jabbi at page 289 that he would have tried to make a fresh air base underground if he found there was fresh air there. Dr. Whitaker at page 290 questioned the witness whether there would be any danger in establishing a base either at the pit bottom or even as far as the pit because the air might get contaminated and the witness replied that until the conditions inside were ascertained it would be dangerous and to a question from the Court he repeated the same answer. In answer to a question from the owner's Counsel, he further said that if a fresh air base had been made underground it would be necessary to keep a stand-by team below ground in addition to the rescue team. Rule 48 of the Coal Mines Rescue Rules, 1939 undoubtedly lays down that as soon as possible a base or bases shall be established in fresh air as near to the irrespirable zone or zones as safety permits and that each such base shall, if possible, be connected by telephone if the base is underground to the surface or if the base is on the surface to the shaft bottom. In this case it was found after the first team went underground that air was short-circuiting through the broken air-lock doors, but then until further exploration was made no one could be certain that the air in that zone could not be contaminated later on. Consequently, safety would not permit a fresh air base being established at the bottom till the conditions underground were better known than when the third team went underground. It is therefore obvious that there is no substance in this criticism.

142. The fourth ground of criticism proceeds on the evidence of Sri Krishnan (Witness No. 14 for the owners) who says in answer to counsel for the owners, at page 281, that he could not say whether any one would be alive or not in the eastern region into which he was trying to penetrate but seeing the conditions there at the time he had to return. And then he was questioned whether he could say definitely if there was life in that region or not, and his answer was in the negative. And then, in answer to a question from the court whether he expected anybody to be alive at the east face, he said he could not say. To a further question from the court he said that it was possible that some survivors might be there in the galleries which he did not explore. Then at page 288, Sri Bikash Roy questioned him whether he would have explored and gone through the galleries on the rise and dip side if he had been given instructions to do so, and he said he would have done it; and further questioned whether in that event he might have come across life, he said if there had been life he would have rescued it. From this it has been argued that the rigidity of the instructions given to Sri Krishnan prevented him from exploring the rise and the dip sides to find out whether there were survivors there. But when Sri Samanta pointed out to him (at page 289) that he had power to deviate from the route, he said that having studied the plan he would not have deviated. Rule 47(5) of the Coal Mines Rescue Rules, 1939 provides that the Leader shall not deviate from the instructions received by him except when such deviation is necessary for the purpose of saving human life. From this Sri Jabbi rightly argued that had Sri Krishnan found it necessary to go into the rise and the dip sides for saving human life, although his doing so might mean deviation from the instructions given to him, he could have done so under the rule, and it was obviously this that Sri Samanta was pointing out to him at page 289. The answer of the witness to this question as well as the fact that he did not go into the rise or the dip sides would entitle one to conclude that he felt convinced that there was no possibility of life either on the rise or the dip sides or further in-by to the eastern working faces, although he would not commit himself either while deposing in court or when reporting to the authorities that there was no such possibility. In his report (Ex. W-18) he does not say anything at all as to whether there was or was not life and his evidence is that he said on his return to the surface, when questioned on the possibility of life, that he could not say. There is thus no substance in the contention that the rigidity of the instructions given to Sri Krishnan, leader of the 3rd team, prevented him from exploring the dip and the rise sides of the loco level.

143. As regards the fifth ground of criticism that the rescue teams did not take sufficient air samples from the underground workings which they visited, it is true that only the first team took an air sample at main west No. 3 pit air crossing. This team did not take any other sample and the other two teams did not take any sample at all. It has been argued that the main task of the rescue teams is to rescue people. Even so, it is useful not merely for subsequent investigations but also for rescue operations themselves that sufficient air samples should be taken and the mere taking of samples does not involve any appreciable loss of time, so that it can hardly be held that this criticism is altogether unjustified. In

our opinion, sampling equipment should be part and parcel of the breathing apparatus donned, at all events, by the leader of the brigade.

144. As a matter of fact, on a consideration of the entire evidence relating to the rescue operations, we are fully satisfied that whatever it was possible to do for rescuing survivors underground, was done and done with all possible speed, so that those who guided the rescue operations hardly deserve the criticism to which they have been subjected, and in the opinion of the learned assessors and myself they rather deserve to be complimentated on what they did for rescuing survivors under extremely difficult circumstances.

(ii) *Sealing.*

145. On behalf of the workers' organizations the adequacy of the sealing operations has been questioned. As regards the sealing operation, it has been contended that the sealing could not possibly have been effective when one of the openings, namely pit No. 2 was not sealed, and Professor Subrahmanyam as well as Mr. Lyndon James pointed that out. On behalf of the management and the Department of Mines it has been argued that pit No. 2 was the up-cast shaft and as it was upcasting even after the explosions little air could go in through that shaft although it was left unsealed. It has also been pointed out that as there was a possibility of further explosions, the sealing of the up-cast shaft would have involved danger to the workers who might be entrusted with its sealing. Thirdly, it has been pointed out that the Management as well as the Department of Mines had always in view the beginning of early recovery work, and if No. 2 pit had also been sealed the strata temperature in the mine would have taken much longer time to come down and recovery operations would consequently have been delayed; and further that the sealing of the other pits was not intended to be the final operation of sealing of the mine and the Department of Mines would have definitely asked the Management to seal No. 2 pit if conditions so demanded. It is undoubtedly true that if the matter be looked at from the point of view of the effectiveness of sealing alone, No. 2 pit also should have been sealed, because otherwise a certain amount of air, though not much, is likely to go into the workings even though the upcast shaft so that the oxygen supply in the underground workings would continue thereby to feed the fire. But then, the sealing operation has to be viewed not merely from that standpoint but also from other standpoints, namely, (1) providing immediate access to the mine in case this should be found necessary or desirable, (2) early starting of recovery work, and (3) if possible and necessary, further rescue work, and the course of action that was ultimately decided upon must be taken to have been a compromise between all these points of view; and as usually happens, these compromises are not satisfactory if the matter be looked at from any one point of view, but may be the best if it is looked at from all the points of view at the same time.

147. Consequently, all things considered it is impossible to say that although the sealing was imperfect the Management was wrong in deciding on sealing all the openings except No. 2 pit or that the Department of Mines was wrong in advising the Management in that direction at the time.

(iii) *Flooding*

148. As regards the wisdom of flooding which also was challenged on behalf of the workers' organizations it is argued on behalf of the workers first that flooding must have drowned any one alive underground; secondly, that it must have destroyed a good deal of the evidence as regards what happened before the explosion. On behalf of the Management and the Department of Mines it has been pointed out that there was no possibility of life underground when the last rescue team came back, that the normal make of water in the mine would have flooded the mine between 50 and 60 days as stated by Mr. Rosser at page 72, but then if the mine was left to be flooded in the normal course in about 50 or 60 days, the raging fire underground would have not merely burnt up a good deal of the coal and the installations underground, but would practically have destroyed whatever evidence was available. Consequently, the Management thought and the Department of Mines agreed with the Management in this, that it would be wiser to flood the mine, particularly when water was readily available, and this quick flooding of the mine would have the effect of quenching the fire underground early enough to prevent it from causing much damage, and also from destroying the evidence. It has been also pointed out that if there was no quick flooding of the mine the fire underground might have spread to No. 3 pit workings and might have caused damage there, and the quick flooding of the mine prevented that.

149. As regards the effect of flooding on the evidence, it is undoubtedly true that although there are indications that a certain amount of coke deposit was washed away by the water, the water, particularly in the levels, rose and subsided gradually so that the movement of the water in these levels would not have been such as to cause appreciable movements of the material evidence.

150. Mr. Lyndon James, in his report (Ex.W-36) page 3, says that it is possible that water may have destroyed some of the evidence of coking although much of the soot deposited from the fire withstood the water in the pit bottom area. It is obvious that the water, when it was pumped, must have come down the sand stowing drift and the cross-cut into the dips pretty fast, but it must have risen to the levels extremely slowly so as to cause little or no movement of the material evidence. From that point of view, apart from a certain amount of the coked dust being washed away and causing a certain amount of movement of the dead bodies in the dips, the flooding did not affect the evidence to any appreciable extent, and as a matter of fact it seems to have preserved a good deal of the evidence from the ravages of the underground fire. We have already found that in the eastern district most of the men in all probability died from asphyxiation even before the explosion, so that there could hardly be any possibility of any one being alive underground when the decision to flood the mine was taken. It must, in the circumstances, be held that the decision to flood the mine was right and proper.

(iv) Stone-dusting

151. This is treated in this section because no amount of stone-dusting could have prevented coal dust taking part in and propagating the methane explosion. Stone-dusting in the mine does not appear to have been adequate even to meet the regulations, and Mr. James in his argument suggests that this should be improved. The mine was not divided into sufficient small districts. However, it is our opinion that even with stone-dusting adequate to meet the requirements of the regulations, there is always the liability of coal dust explosion being propagated as all recent research points in this direction. In addition the dust from the Disergarh coal is known to be highly explosive. It is clear that further research is urgently called for on methods of preventing propagation of coal dust explosion, and we would commend this matter to those responsible for the conduct of the Central Mining Research Station. The use of stone-dust barriers seems to be regarded with increasing favour in Germany and other European countries and to no small extent in U.K. Experiments should also be done on means of coagulating the dust and binding it so that it cannot be raised in cloud, and further experiments with salt (calcium chloride) may be tried as we understand this has proved satisfactory under certain conditions. We may observe at this stage that the whole problem of suppression of coal dust explosions is a difficult one and has not yet been solved in any country of the world. Nevertheless, this does not exonerate colliery managements from the duty of careful observation of the existing regulations and particularly of the new regulations which were promulgated towards the end of 1957.

VII. INSPECTION BY REPRESENTATIVES OF WORKMEN—A DESIRABLE INNOVATION BUT IS IT PRACTICABLE IN EXISTING CONDITIONS?

152. In U.K. the workmen employed at every mine under the Coal Mines Act have had since 1872 the statutory right, to be exercised or not as they may decide, to appoint representatives to inspect mines on their behalf and section 16 of the Coal Mines Act, 1911 provides that "the workmen employed in a mine" may at their own cost appoint two of their number or any two persons not being mining engineers, who are or have been "practical working miners" and have had not less than five years' experience of underground work, to inspect the mine, and if such persons are appointed, the Management of the mine must allow them "once at least in every month" to go to every part of the mine and to inspect. The workmen's inspector are also given rights to have notice from the Management of accidents causing loss of life or serious personal injury and powers to investigate such accidents. The owner, agent or manager, has the right to accompany, or to appoint one or more officials to accompany, the workmen's representatives on all occasions. The Royal Commission of 1935 points out that the extent to which these statutory rights are exercised by the workmen varies greatly and that all the evidence before them supported the view that periodic inspection of the mine by representatives of workmen was a desirable safeguard which ought to be encouraged in every way because of the important part it should play in securing the workmen's co-operation in safety measures

and there was a considerable body of opinion in favour of making some minimum amount of inspection compulsory. It appears to have been already the practice in England that when one of H.M.'s inspectors visits a mine in order to investigate something reported by the workmen's inspectors, for the inspector to arrange for the workmen's inspectors to accompany him during his inspection if they have expressed a desire to do so and of course he has also with him either the Manager or a senior official of the colliery. To the Royal Commission it appeared to be a most desirable practice from the point of view of establishing mutual confidence and they thought that as a matter of administration it should be the normal working rule, for "not only should it afford opportunities to the three parties to study and appreciate their respective points of view and methods of approach to the matter under investigation but it should provide a means by which each of them can enlarge their experience, with consequent profit to the exercise of their future duties." Evidently then, in U.K. the inspections by representatives of the workmen have had the desired result. The question of appointing such representatives, provided they were duly qualified, appears to have also been discussed in a recent conference on "Safety in mines" held in Calcutta on the 5th and 6th of August last and the memorandum on the subject compiled by the Department of Mines is illuminating. It appears that one of the recommendations of the conference was that workmen should have the right to get mines inspected by their chosen representatives, that such representatives should be specifically excluded from dealing with matters relating to labour disputes etc. What is however, interesting in this is that while there was a demand from the workers that there should be such inspectors, as regards the practical implementation of the suggestion there was some difference of opinion amongst the different trade unions.

153. Since the appearance before this Court of Mr. James who was for a period of 18 years a workmen's inspector in England, I have been thinking whether such an institution will not prove equally beneficial for our country. But then I had a somewhat rude shock of unpleasant surprise when I found that even for the limited purpose of this inquiry in which the interests of the different workers' organizations before me must have been absolutely identical, these organizations could not, in spite of my repeated requests, unite so as to be able to afford to engage a duly qualified man to help them in matters beyond the depth of most of them. That revealed to me as in a flash how deep were the differences between the different organizations and as these were each affiliated to a different political party, it does not call for any extraordinary insight for one to be able to say that the differences must have been due very largely, if not solely, to politics.

154. If I am right in my diagnosis of what really prevented the parties from making common cause even in a matter of such vital importance to the miners, namely an inquiry in which the question of their safety played such a major part, it follows that politics instead of unifying the workers of one trade into one compact block divides them and the lines of division go deep indeed. One may be excused in the circumstances for saying that trade-unionism harnessed to politics tends to produce its opposite, namely "trade-disunionism". That, to my mind, is likely to be the first major obstacle to the introduction of a system of workmen's Inspectors as in England. The second major obstacle is likely to be the growing indiscipline and irresponsibility amongst workers which the intrusion of politics into trade-unionism probably encourages. Of course, I must say here that in this inquiry there was no complaint at all from the side of the owners or anyone else that there was any indiscipline amongst the workers of this mine and it did not really come within the scope of our inquiry. What I have in mind here is a matter of common knowledge, namely, the alarmingly increasing manifestations of indiscipline in an ever-widening area of our life. The reason why I think politics probably encourages indiscipline and irresponsibility amongst workers is first that each political party in its attempts to enlist in its favour as much support as it can from the workers who have come, with the introduction of adult franchise, to represent a very powerful political force, is likely to follow the line of least resistance by falling in with their wishes whether those wishes are reasonable or not and thereby to a certain extent whipping up in them a somewhat inflated sense of their rights without any corresponding sense of their obligations and as the workers in this country are mostly illiterate, poor and generally backward and thus unable to direct themselves, it is more than probable that trade-unions will come more and more under political direction and political direction may quite conceivably mean an appeal not to the better part of their instincts and nature but to the lower part. In short then, the alliance of trade-unionism with politics affects both the cohesion and the direction of the workers and until and unless it is

freed from the leading strings of politics, it may not be possible at all to have in our country a system of workmen's Inspectors in mines on the same lines as those in U.K., highly desirable as it is and even if it is possible, the results of the system may be markedly different not only from those in U.K. but from those desired here.

VIII. RECOMMENDATIONS

GENERAL

155. (1) In all gassy mines a continuously automatic recording Water Gauge of approved type should be fitted to the main fan at the surface. Such a recording Gauge if there were one in this mine would have shown at once that there was an outburst of the gas, and removed doubt and arguments and saved much time in the inquiry. It will also show to the management whether the fan is operating normally and whether there are any unusual conditions in the mine. It must be remembered that most of the personnel would probably have been found dead even there had been no explosion at all.

(2) No apparatus to be accepted in India as certified flame-proof without report by the Engineer or representative supplying the equipment that he has personally seen that it is properly assembled and in safe condition. It should be made illegal to attach the official flame-proof label to this equipment unless the whole equipment is rendered flame-proof with all flame-traps and similar devices affixed and in order.

(3) The appointment of one or more Mechanical Engineers to the staff of the Mines Inspectorate. This matter is crucially urgent: mine mechanisation is now proceeding apace. With the growth of mining in India, the Inspectorate should be generally strengthened particularly with specialists in Ventilation, Strata Stresses, Explosions and the like.

RESCUE

(4) There should be a rule compelling the taking of air samples by rescue teams. Sampling equipment should be devised so that it should form part and parcel of the rescue equipment. Rules may be drafted accordingly.

(5) There should be 1 or 2 portable Haldane Gas Analysis apparatus or the like maintained in working order at every Rescue Station, and 1 or 2 members of the rescue station staff should be trained in the correct operation of the apparatus.

(6) The practice regarding sending forward only one rescue team after an extensive mine accident should be reconsidered.

MINING AND RESEARCH

(7) The new regulations (October, 1957) concerning ventilation and especially concerning analyses of the mine air and the appointment of a ventilation officer should be implemented without delay.

(8) Mine dust samples should be taken over a length of roadway not exceeding 100 yds.; and the mine should be divided into convenient zones to be approved by Regional Inspector of Mining. The dust of each zone shall be tested at least once a month.

(9) The Central Mining Research Station may be asked to carry out further research on the suppression of coal-dust explosions. This is urgently needed.

(10) Similarly the Central Mining Research Station may be requested to undertake work on prevention, prediction, control and minimizing the dangers of outbursts and on Methane drainage with a view to increased safety in mines.

(11) In gassy mines, especially where the seam appears to have less than its normal thickness, bore holes shall be put down upto a distance of 10 ft. periodically over 100 yds. to explore whether there is an approaching seam or whether there is excessive liberation of gas.

(12) The Central Mining Research Station should be fully equipped to carry out all kinds of research and all kinds of experiments, investigations and testing of mining equipment so that whenever necessity arises, any important and difficult matter may be referred to it for elucidation.

(13) We have had occasion to notice that the Registers of Explosives and the Attendance Registers where the oil safety lamps and the cap lamps are each to be entered against the worker concerned were not properly maintained. The same thing may be true of other registers and records which did not come to our notice. In view of the number of such registers and records prescribed or required under the Act it is hardly possible for the Manager particularly in mines where the underground workings are such as may require his constant vigilance and supervision, to devote his personal attention to the maintenance of such registers and records without neglecting his more important duties. We therefore think that he should be relieved of these duties in such mines and empowered to authorise one of his Assistant or Under Managers to maintain the registers and records pertaining to technical matters; and another person to maintain the other registers and records. Whenever the Manager has authorised any such person to maintain any registers and records, the maintenance of such registers and records will be the direct responsibility of such a person unless such a person has brought any irregularity in the maintenance of such registers or records to the notice of the Manager in writing and it will be duty of such persons to bring it to the notice of the Manager in writing whenever any irregularity or occurrence is connected with the safety of the mine or of the persons employed therein.

IX. CONCLUDING REMARKS

156. Before I conclude, I must on behalf of my colleagues and myself express our profound sense of gratefulness to everyone who rendered any assistance in this Inquiry, to the owners and to the Department of Mines for their constant readiness and ungrudging efforts to help the Court in its task, and to the Experts, who placed before us valuable materials and views, including Mr. Lyndon James who, though he happened to be in India for a short period only in connection with a Conference, visited the workings underground on two days, submitted a report, offered himself for examination and cross-examination as a witness, and with the permission of the Court, even argued the case for the party that had cited him. To the representatives of the different parties participating in this Inquiry we are sincerely thankful as much for the assistance each has rendered in his own way as for the contribution of each to the smoothness of the proceedings and the general atmosphere of dignity and tranquility in which these were conducted. Last, but by no means least, among those who have earned the thanks of the learned Assessors and myself is Sri S. S. Sarkar, Superintendent of the Mines Rescue Station, Sitampur, where this long drawn out Inquiry was held, for being all attention to us whenever we happened to be here and for treating us to coffee and light refreshments daily as though we were his personal guests.

157. The Court's duty in this connection will not be fully discharged if it does not place on record its profound appreciation of the valuable work done by Dr. G. N. Badami, appointed Court's Scientific Observer, and also of the valuable services of Sri H. B. Ghose, Regional Inspector of Mines, who not merely prepared, at the request of the Court, a summary in a tabular form of the evidence in the case, (Appendix III of this report) and revised my summary of the data collected from the sectional maps (Appendix IV of this report), but always readily placed himself at the disposal of the Court whenever necessary. My learned colleagues and myself came to entertain a very high opinion of both these officers, and we hope their services will be suitably recognised.

158. I must also sincerely thank the Bench Clerk, Sri Sailesh Chandra Roy, and the Stenographers, particularly Sri Monilal Das Gupta and Sri Nimai Chand Rakshit, who never spared themselves in the discharge of their duties.

159. Lastly, it remains for me to express my sincere thanks to Sri S. C. Samanta, M.P. and Dr. J. W. Whitaker for their whole-hearted assistance and co-operation throughout the Inquiry. To Dr. J. W. Whitaker, I am specially thankful for the help I always received from him in scientific and technical matters and if, without being really able to solve, in the absence of any conclusive evidence, either direct or circumstantial, the mystery of the ignition, we could at all lay our fingers on two probable sources of ignition, the credit for both goes entirely to Dr. J. W. Whitaker. It was he who pointed out Dr. Badami's report about the oil lamps in 15 Rise district. Again, it was because

at different stages of the Inquiry, different lines of thought made him suspect the loco as the criminal in this disaster that he had the loco fully examined till ultimately it was discovered that its air inlet was without a flame trap and whether or not we are right in our views of the probable causes of the ignition, this much is clear beyond doubt that Dr. Whitaker has done the owners and the management no less than the miners the signal service of uncovering a serious defect in the loco engine as it was supplied and installed underground and thereby earned their gratitude.

Sd/ S. N. GUHA ROY,
Court of Inquiry Chinakuri Colliery Accident.

Certified that the above report has been prepared in constant consultation with us, and we agree with the conclusions arrived at therein.

Sd/- J. W. WHITAKER.
Sd/- SATIS CHANDRA SAMANTA.

APPENDIX I(a) and I(b)

(Plans not printed.)

APPENDIX II

CENTRAL MINING RESEARCH STATION

Post Box 50, Dhanbad

Bihar, India.

Dated, 28th August 1958.

Inspection of Diesel Locomotive—Chinakuri Enquiry

On the 27th of August 1958, after rising of the Court about mid-day, I went to Chinakuri Colliery to inspect the flame-traps on the inlet and on the exhaust sides of the diesel locomotive. The flame-trap on the exhaust side had already been inspected to some extent and had been detached from the locomotive.

I examined the plates and the spacing. There was a moderate deposit of soot and a certain amount of grooving, but probably not excessive, on the plates. I asked then for the plates of the inlet trap and I was told they had not any knowledge of such plates. I therefore went to the locomotive to obtain them and found there was no flame-trap on the inlet side. In other words, the locomotive did not contain at the time of inspection any flame-trap.

There was a second locomotive about 100 yards away on the pit top, of similar model. I inspected that also, and found that, while on the exhaust the flame-trap was provided, there was none on the inlet side.

The absence of such flame-traps on the locomotives renders them potential sources of ignition when they are operated in an explosive mixture of methane and air.

The other parties present were Mr. S. S. Grewal, Chief Inspector of Mines, Mr. A. N. Sinha, Inspector of Mines, Mr. S. Bhattacharya, Electrical Inspector of Mines, Mr. S. Anand, Agent, Mr. Taneja, Manager, Mr. Chatterjee, Engineer at the Colliery.

(Sd.) J. W. WHITAKER.

APPENDIX III

Summary of evidence

<i>Abbreviations used :</i>	<i>Letters prefixed to the exhibit numbers of documents of :</i>
S for Written Statement	Owners . . . OS
W „ Witness	Workers . . . W
P „ Page	Mines Dept. . . DMI
p „ Para	Observer . . . I.M.A.
App „ Apperdis	Court . . . Court
<i>Parties</i>	<i>Date and time of Explosion</i>
Owners	S-1, P/6, P/1-19-2-58 at 9-45 P.M. Supported by several witnesses.
Indian National Mine Workers' Federation & Colliery Mazdoor Union.	Not contested.
Indian Mine Workers' Federation and All India Trade Union Congress.	Not contested.
Colliery Mazdoor Congress	Not contested.
Colliery Majdur Samity	Not contested.
Indian Mine Managers' Association	Not contested.
Indian Mining Association	X
Mines Department	S-6, P/1, P/3-19-2-58 at 9-45 P.M.
Court	X

Parties

Rescue Operations

Owners	<p>OS-41—Rescue teams arrived at 10.40 on P.M. 19-2-58. Last rescue team returned to surface at 4 A.M. on 20-2-58.</p> <p>S/1, P/6, p/4—Twenty persons rescued alive and one dead body recovered.</p> <p>S/1, P/6, p/4—Rescue operations abandoned when all chances of existence of survivors had ceased. Continuance of rescue operations hazardous to rescue.</p> <p>W-1, P/1-8—Detailed information about rescue operations. Men withdrawn from No. 3 Pit.</p> <p>P/24—Presence of flame underground and smoke showed inevitability of further explosions.</p> <p>W/10, P/150—Informations about rescue work and difficulties corroboration to W-1.</p> <p>W-14, P/276-290—Details of rescue work done by last rescue team under the captainship of Krishnan P/290—Krishnan replied to Dr. Whitaker that it would have been dangerous to establish F.A. Base underground. In reply to Court also stated that it would be dangerous to form underground F.A. Base until further exploration underground made. Reported two burning timbers and intense smoke in loco level near about 9 Dip. P./281—Visibility 6 to 8 ft. where last dead body was seen in loco level.</p> <p>P/284—Near underbridge heard no sound of any one groaning or shouting for help. P/290—After coming up the pit reported that he could not say if there was any life whatsoever underground.</p> <p>W-16, P/302—Attempt to reach 1 & 2 pit workings along 3 dip. Withdrew 500 to 600 ft. of haulage curve due to birds showing distress.</p>
Indian National Mine Workers' Federation & Colliery Mazdoor Union.	No evidence.
Indian Mine Workers' Federation & All India Trade Union Congress	No evidence.
Colliery Mazdoor Congress	No evidence.
Colliery Majdur Samity	No evidence.
Indian Mine Managers' Association	No evidence.
Indian Mining Association	X
Mines Department	<p>W-18, P/312—Reached mine at 10-40 P.M. with ten permanent Brigade members and equipments. First team went down at 11-40 P.M. when cages were available F.A. Base at pit top due to danger of U.C. pit bottom being fouled with noxious gases. 27 teams each consisting of 5 members mobilised 200 rescue men all over the field alerted and kept in readiness. Equipments from Jharia Rescue Station collected.</p> <p>W-19, P/3-4—Generally agrees with W-1, W-5, W-10, W-11, W-12 and W-16 with respect to what happened after explosion. P/327—0.1% Co in the fan drift just before starting main fan.</p>
Court	X

Parties

Sealing of Outlets

Owners	OS=41—Main fan stopped at 4-50 A.M. on 20-2-58. All seals completed (except No. 2 Pit ?) at 9-30 A.M. on 20-2-58 W-1, P/8—On receipt of report of last rescue team a conference was held with C.I.M., D.C.I.M. and other mining engineers of this company and other companies inevitability of further explosions and imprudent to risk lives by continuing rescue work, impossibility of survivors still living underground agreed. P/9—Object of seals is to stop air flowing into the mine. P/54—Decided not to seal No. 2 Pit to keep an outlet available for resumption of early recovery work, <i>i.e.</i> as soon as atmosphere in the mine had become inert. After starting the seals air upcasting by No. 2 pit practically stagnant. After completion of all the seals air in No. 2 pit and fan evasee appears stagnant. No smoke seen in No. 2 pit till 11 A.M. on 20-2-58. Air samples in OS-47 indicates stagnancy of air W-5, P/7—Purpose of sealing shafts is to deny air when fire is underground. Sealing all openings but one—same purpose achieved. Leaving No 2 shaft open would enable entry into the mine within a short period if found possible. P/73—If all openings are closed atmosphere in the shafts will be different up to 600 ft. from the shaft bottom but above that there will be no difference <i>i.e.</i> no difference in mine atmosphere if one shaft is open. P/118—Absence of taking air samples by last rescue team would not have changed decision to seal the pits, except No. 2 Pit.
Indian National Mine Workers' Federation & Colliery Mazdoor Union	Mr. James silent in report. In argument mentioned advisability of simultaneous sealing of all approaches to fire in underground districts. Remarkd in a passing manner that sealing of shafts is different from sealing of underground districts.
Indian Mine Workers' Federation & All India Trade Union Congress	W-29, silent in report. P/431—If all the pits are not sealed, it is no sealing. P/473—experience of sealing one underground district fire in a non-gassy mine. Purpose of sealing is to adequately exclude all oxygen to fire. Sealing of intake will not deny-oxygen. No experience of sealing of pits or details as to how sealing is effected.
Colliery Mazdoor Congress	No evidence.
Colliery Majdur Samity	No evidence.
Indian Mine Managers' Association	No evidence.
Indian Mining Association	No evidence.
Department of Mines	W-19, P/324—Generally agrees with steps taken. P/3-9—It is desirable to seal downcast shafts rather than upcast shaft, all circumstances taken together. P/342—To avoid possibility of explosions of an underground fire district intake and return sides are sealed off simultaneously. This did not apply to sealing of 1 and 2 pit mine

Owners S-1, P/7.—Smoke detected at No. 2 pit on 20-2-58 indicating fire. Re-entry in a gassy mine after fire hazardous unless certain that all coal has been cooled to prevent re-ignition by entry of air. Flooding commenced 8-1/2 hours after explosion (Original). Details given in Ex-OS-41. W-1, P/10—Large quantity of smoke emitting from No. 2 pit proved existence of a substantial fire underground unsafe to engage persons to build seals at either of the pits—decided to quench fire by introducing water underground. P/23—Re-sealing of No. 1 pit by conveyor and flooding done together. With only sealing, the fire would continue and consume all oxygen available underground. Heat of fire would have remained for many years delaying reopening and recovery. Without flooding fire may have spread to 3 pit workings. No possibility of life either then or by the time witness came out of the mine. P/55—Without quenching fire with water it would be imprudent to reopen a mine within four years. With flooding in a matter of months. W-5, P/71—Second explosion indicated that the only way of recovering the mine at an early date would be to flood it. Gives reference to a similar case in Ranipur Colliery. From natural make of water mine would have been flooded within 50-60 days. By then there was danger of fire burning its way into 3 pit workings. OS-72, P/23—Submersion under water may have caused some coke deposit to loosen and drop off. On conveyor idler indication of such deposit having fallen off. Absence of impacted dust on timbers probably due to timbers themselves having been dislodged by explosion. W-5, P/398—Water rose and subsided gradually and hence no question of washing away coal dust, coked or otherwise, as the movement of water was extremely slow. P/399—Does not think that timber to support roof washed away. P/404—Shot-firing cable, batteries, Shot-firer could not have been washed to 16 rise off loco level.

Indian National Mine Workers' Federation & Colliery Mazdoor Union Ex. W-36, P/3—Possible that water may have destroyed some evidences of coking although much of the soot deposited from fire withstood water in the pit bottom area. Evidence of coking not much affected except by supports carrying coking dislodged or replaced.

Indian Mine Workers' Federation & All India Trade Union Congress W-29, P/429—Crack and heaving of floor may be due to effect of flooding. P/433—Agreed that other things being equal floor heaving would be more evident in the dip places than in rise places due to exposure to water for a longer period. P/445—Not agreed that if one set of workings is under water for a longer period than another set the one for longer period will be more liable to heaving. P/475—On flooding no opinion expressed nor competent to do it.

Colliery Mazdoor Congress No evidence.

Colliery Majdur Samity No evidence.

<i>Parties</i>	<i>Flooding and its effects on evidence</i>
Indian Mine Managers' Association.	No evidence.
Indian Mining Association	I.M.A./6, P/7—Two bodies may have floated down to No. 16 Dip off No. 1 East Rise level.
Department of Mines	S-6, P/2—Thick smoke coming up No. 2 pit indicated deterioration of underground conditions and indicating serious underground fire and hence was decided to flood the workings. D.M.I.-37,—Flooding of the mine workings did not destroy any evidence.
Court	X
Owners	OS-72, P/44-46—The plan in appendix IX shows extent of area affected by fire. Coked area is about 600 ft. wide in Nos. 1 and 2 R. levels. Total length of roadway affected is about 5750 ft. which indicates the years that would have taken to cool the mass of coked coal for safe reopening if flooding not resorted to. Heavy soot deposit in the vicinity of the two shafts. Fire probably started by first explosion in No. 2 E. Dip below 1 E.D. Level. Probable cause is timber set alight by first explosion and then coal. Rising water level has pushed fire up in front of it from dip to rise, coal burnt to ash at junction of East Loco Level and 2 East Dip. Coked area also approaches the connection with No. 3 pit. Fall of roof coal and subsequent expansion by coking had completely filled up galleries. Considerable damage to roof along loco level between empty and full junctions, probably due to heat from fire. P/12—Some bodies partially or entirely consumed in the fires. W-5, P/399—Fire did not spread towards east after 7 or 8 rise.
Indian National Mine Workers' Federation & Colliery Mazdoor Union.	EX-W-6, P/2—Severe fire had existed in the area around intersection of S.S. Drift with Loco Level and the rise beyond. Evidence here not easily related to the explosion due to superimposition by fire damage. Considerable fall of roof in the Loco Level affected by fire due to heat on the strata rather than to violence.
Indian Mine Workers' Federation & All India Trade Union Congress.	No evidence.
Colliery Mazdoor Congress	No evidence.
Colliery Majdur Samity	No evidence.
Indian Mine Managers' Association	No evidence.
Indian Mining Association	I.M.A.-6, P/3—Fall of roof coal and stone along loco level inbye of 1 East Rise upto cross-cut practically blocking the roadway. Fire and intense heat for a prolonged period around No. 2 dip junction and between 2 dip and cross-cut. 2 Dip filled with coal ash, coked coal, fallen coal and stone between loco level, and 1 Dip level. Little signs of coking east of 3 dip, 4 rise and rise of loco level. Fire developed in 2 dip area after first explosion, and gradually increased in intensity. Damage around the pits and upto 4 each rise due to fire. The conveyor in 2 Dip badly warped by intense heat from fire.

Parties

Extent and effects of fire

Department of Mines

D.M.I.-37, P/2- Actual burning of coal in situ, in 2 East dip from its junction with loco level to 4 east dip level. More intense around junction of 2 East Dip and East Loco level. Considerable coking around cross cut to S.S. Drift. Heavy deposition of soot at 2 pit bottom and galleries around it. Some soot deposition at No. 1 pit bottom and galleries leading to it. Fire originated somewhere near No. 2 East Dip and probably started from smouldering timber pieces which caught fire from the initial explosion.

Court

C-5, P/1-4 of 2nd report—Agreement with other observers regarding extent and damage due to fire.

Parties

Violence

Owners

W-1 (after 1st explosion), P/2-7—At No. 1 pit in one cage on the keps two mine cars derailed. Shaft covers of 2 pit blown up into the head gear. One thrown 50 ft. to 60 ft. above the pit top and the other half way between the pit top and bell box, both jammed in the guide ropes. Telephone and signalling arrangements from surface to underground inoperative. Main fan had not stopped of its own accord. Four air lock doors at 2 pit bottom blown in towards the pit and passage blocked by blown timbers. On loco level near air lock part of a dead body and another dead body showing effects of violence. A number of badly injured persons in West Loco Level between 3 and 6 rises. Air bridge at junction of 3 rise and west loco level completely demolished. At no. 1 pit bottom protection boards had collapsed and lying on the cage. At no. 2 pit a tipping tub blown on to the landing board. In main loco level slightly to the west of the air lock a 12" x 6" girder bent in V shape with apex pointing towards west.

P/10—Very little damage to west workings. A ventilation wall starting from junction of 6 rise and 6 west level up to 50' inbye had not been completely knocked over.

W-10 (after first explosion), P/149—2 pitcovers blown up into the head gear. General corroboration with W-1. P/152—No. 2 pit landing jammed with smashed protection roofing. A tipping tub normally in operation on the west level brought on the landing platform. Air lock doors of loco garage opened towards 2 pit. Main airlock doors opened towards 2 pit. Collection of cogging sleepers. 2 mine cars jamming door passage. Conveyor chain guard near the door. In west loco level one span of roof concrete had smashed. 'V' shaped bent girder with apex towards west. (One man hysterical at the east side of 1 pit bottom). A door with its brick work on east loco level east of 2 rise non-existent. 2 dip conveyor drive-head found lying on floor. Some conveyor pans found smashed. Stopping in 2 dip had collapsed.

W-14 ; P/278—Air lock doors at 2 pit bottom blown towards 2 pit. In between air lock doors a lot of debris *i.e.*, bricks and timbers. Along ast loco level 2/3 upturned coal tubs within 20 yds. of air

lock doors. East loco level strewn with fallen bricks from side walls. At certain places roof stone had come down. The falls not substantial. Along loco level east of cross-cut side walls broken down at places, track lifted up, timbers strewn together.

W-16, P/300-303—Observed lot of white stone dust strewn at pit bottom. Some particles were in suspension. Felt chocking of ear drum on the east side. Against rope rollers on west haulage brow some bamboo matting pieces 1' x 2' stuck up here and there probably these were blown out to a distance of 400 ft. from no. 3 dip. No other signs of damage or violence noticed on east or west sides. After re-opening 3 pit workings a gate and box and drill panel below no. 20 level in 3 dip were found disturbed—cable connections pulled out.

W-6, P/119-124—While working right inside the face at top west level heard a noise, fell down and became unconscious. Small dust, heavy smoke and gas near air lock. Stones on the eastern side of air lock doors. Noise came from eastern side. Breathing difficulty felt after regaining consciousness.

W-7, P/126-134—While working in 1 west level heard a loud report and fell unconscious. Travelled to the lower level and again became unconscious. Eyes burning and breathing difficult. Roof at No. 4 air crossing had fallen. At No. 1 pit bottom signalling arrangements broken and one big stone had fallen on cage. No. 2 pit bottom gate jammed with cog. Saw smoke, fire and heat 100 ft. inbye towards S.S. pit. At 400 ft. from junction of loco level in cross-cut one man collapsed and the place was very hot. Cannot say from which direction blast came.

OS-72-(after recovery)—Appendix I shown displacement of objects. P/18-22—Extensive damage on west side. Track, pipes, shaker conveyor set verely disturbed which was not noticed after first explosion. Only east side feeder switch tripped. On the east side violence increases from inbye towards outbye. Signs of minor violence on the east section faces. Substantial violence outbye of No. 15 Dip. At Junction of 15 Rise and 1 East Rise level conveyor displaced slightly to the dip. 15 rise conveyor dragged some distance to the dip and pulled westward in loco level. Drill panel, gate-end box at 15 rise and 1 rise level junction slightly displaced but the cables running inbye show little violence. Timber supports in 16 dip off 1 East rise level not disturbed. No sign of violence excepting twisted C.I. sheets in 1 & 2 east rise levels till 5 rise is reached. At junction of 5 rise and 1 east rise level shaker conveyor blown westward. In Loco level violence increases in the outbye direction and also into the dips at junctions. Belt conveyor blown into 11 & 13 dips. 4 empty cars and trolley blown into 10 dip. 2 tub ends knocked in indicating being hit by flying object. Most empty cars at belt conveyor loading points dented towards west. Drive-hear of 9 dip conveyor displaced towards west. A full car near 9 dip moved towards west. Shaker conveyor pans from 5 rise thrown 50 ft. to 250 ft. westwards along loco level. A Belmos switch from 2

Parties

Violence

dip conveyor thrown upto substation. Drive-head of 2 dip conveyor displaced westwards. Roof bolts between 2 east dip and 2 pit airlock in loco level bent towards west. One bolt sheared off flush with the roof 9 & 2 dip conveyors displaced westward at their junction with 1 east dip level and 2 east dip level. Greater signs of violence at 2 pit than at 1 pit. R.C.C. frames of outbye airlock door scarred by flying objects. Similar scarring of sidewall opposite east step gallery.

P/12—Some bodies were subjected to violence. Rescue teams reported seeing two torsos in loco level.

W-5, P/399-401—Greatest violence found in the return. A spade found embedded in a prop in 16 rise off loco level. Does not indicate considerable force.

Indian National Mine Workers' Federation & Colliery Mazdoor Union.

EX. W-36, P/2-3—Conveyor along loco level displaced down-wards opposite each rise heading. Tub similarly displaced opposite 10 rise. From corrugated screens blast appears to have passed towards No. 2 rise level and outwards. Stoppings in the dip galleries off loco level and screens in the rise places destroyed. Violence encountered in places.

Indian Mine Workers' Federation & All India Trade Union Congress.

Ex. W-39, P/4—Explosion gathers in intensity along main east loco level blowing stoppings to the dip and rise (as gathered from reports of Messrs. Rosser and Evans).

W-29, P/440—Violence of explosion would depend upon number of obstacles involved. Violence is more in the intake than along return. Then again states that intake passage was straight and return passage tortuous. Much obstruction in return passage than intake due to conveyor sat 9 and 2 dips, so the violence in the intake comparatively less.

P/496—Shock due to explosion is a probable cause of heaving. The more the shock the more the possibility of heaving. Does not specify the part of the mine where the shock will be maximum. Intensity of violence does not indicate intensity of shock unless there are objects to show it.

P/447—Gathered from reports that violence is more on return side than in 1 rise, 2 rise and loco level.

Colliery Mazdoor Congress

No evidence.

Colliery Majdur Samity

No evidence.

Indian Mine Managers' Association

No evidence.

Indian Mining Association

I.M.A. 6., P/1—On the west side evidence of ravel of blast both from west to east and from east to west. Little sign of violence west and dip No. 2 pit. Great violence around 1 and 2 shafts. Damage immensely greater than reported after first explosion. Little damage in substation. On the east side roof bolts and steel channels bent from east to west. Conveyors east of 2 dip indicated violence by forces travelling from east to west. Violence

Parties	Violence
	great from rise to dip at 11 dip off loco level. All C.I. Sheet stoppings between 2 rise level and 1 rise level blown 2 rise level and to the west. Brick stoppings between loco level and 1 dip level blown to dip.
Department of Mines	<p>DMI-37, P/3, 9, 10—Far greater damage than those reported after first explosion observed on the west side. On the east side violence indicated travel of forces from east to west. Inbye workings of 1 East Rise Level and East Loco Level do not show much violence. Violence of a comparatively mild nature. C.I. Sheet stoppings in the rise galleries off 1 East Rise Level Blown into 2 East Rise Level and carried a good distance west wards.</p> <p>Objects lying in the dip galleries thrown to the dip. Signal brackets in 6 East Dip and Rise off 1 East Rise Level bent towards dip and rise directions respectively. 6 East Dip haulage curve at loco level junction not shifted to the west. Conveyor heads along loco level shifted towards west but to a small extent. Loco not moved at all though on the track. Violence increases from 2 East Dip junction.</p>
Court	C-5, Corroborates in general with the observations of OS-72, IMA6, DMI 37.

Parties	System of Ventilation
Owners	<p>S-1, P/4—System shown in OS-3. An aeroto type of fan producing about 240,000 cft. of air per minute was working at the time of explosion. Installed capacity of the fan 400,000 cft. per minute at 2 1/2" wg.</p> <p>W-1, P/12-14—No. 1 and No. 3 pits are D.C. shaft No. 2 pits is U.C. shaft. Adjustment of fan capacity done by turning blade pitch. From future development plans observed that the area developed from 1, 2 and 3 pits is very small as compared to the total area that is to be developed. Layout shows 5 parallel galleries of which two would be intake, 2 return and 1 loco haulage road. 2 Upper levels as intake so as to prevent increase of humidity by keeping them away from water in the dip side. Essential for deep mines to keep air as dry as practicable in the working faces. On haulage roads air velocities not to be more than 300 to 400 feet per minute to prevent dust being raised in the air. Bulk of the workings laid out in long wall system. In long wall system smaller length of roadway opened at a time and hence smaller gas emission. Coursing of air around the faces dilutes and renders innocuous emission of gas.</p>
	<p>P/43—No one can say that any ventilation system is perfect. Satisfied that the fan was suitable for the task. It is not necessary to provide stoppings in 1 East rise level between 1 rise and cross cut. C.I. Sheet stoppings and brattices would do as the area is on the main intake. Air crossing at junction of 3 dip and main west level was destroyed by explosion and it was an ordinary air crossing. Quantity of air that should reach the working face in a gassy mine depends on circumstances.</p>

W-5, P/85-89—Nos 1 and 2 pits sun approximately in the middle of the taking No. 3 pit at extreme rise. No. 3 pit was intended to be a coal raising shaft with heavy electrical equipments at the pit bottom. 3 pit workings are closed to the shaft and it is good mining practice to take fresh air quickly and by shortest possible route to the working face. Natural ventilation is important in a cold country. India specially West Bengal is not a cold country. At least 9 months in a year natural ventilation plays little or no part in ventilation of these mines. Natural ventilation is due to temperature difference. U.C. shaft was in the middle of the property and within a short time the workings would have reached about 2 miles away from No. 3 pit which would have been too long a distance for noxious gases to be taken out of the mine. 3 pit was designed as D.C. Shaft due to heavy electrical machinery which are necessarily Non-F.L.P. and should be in the intake air. To prevent frequent repairs to pump dealing with sand stowing water containing grit stage pumping was necessary, i.e. high head pumps at 1 and 2 pits was obviated, even though powerful electrical pumps which have to be Non-F.L.P. are installed at No. 3 pit. After explosion, with main fan stopped 3 pit continued to downcast enabling all persons to be withdrawn with safety. It is not uncommon to have more than one district in one ventilating circuit. It is practised in other countries of the world and only one face in the 5 rise district. Preparation of a long wall face and a separate ventilating district was being made. Analysis of air samples at 2 east level 300 ft. east of 3 rise showed 0.18 % and 0.16 % CH₄ only. Ventilation system is definitely not unscientific.

P/106-109—6600 cft. per minute of air recorded at 14 rise in O.S.3. But there is a great addition to that at the working faces. We have no ventilation officer.

W-10, P/174-176—Explanation of apparent discrepancy between fan capacities of 250,000 cft. per minute and the total return of 1, 2 & 3 pits at 1,80,000 cft. per minute explained. Allowing for leakages total quantity comes to 2,10,000 i.e., 80% efficiency.

P/178—Discrepancy in total quantity of air in the first and second part of January explained by mentioning factors such as change in water gauge, total mine resistance keeping doors open etc.

P/181—Natural Ventilating Pressure up S.S. Drift did not matter as air was controlled by a regulator.

P/183—In No. 2 and 9 dips pucca stoppings and in addition a brattice.

Indian National Mine Workers' Federation & Colliery Mazdoor Union.

Mr. James (in argument)—quantity of air available was adequate. There could be gas accumulation at a face due to absence of proper guiding.

Indian Mine Workers' Federation & All India Trade Union Congress.

Ex. W-39, P/2—System of ventilation was such that greater accumulation of gas could be expected on the east side of the workings.

Parties	System of Ventilation
	<p>W-29, P/429-430—National ventilating Pressure produce by S. S. Drift specially in winter short circuits intake air from No. 1 pit, augmented by heat produced by shot-firing in S. S. Drift and 5 rise working faces. A good part of air from east side robbed by S. S. Drift. East side return of 39330 cft. per minute includes leakage from 2 and 9 dips off loco level. Quantity in 2 east rise in measured 6630 cft. per minute and at the working face it would be far less. Moreover this measurement was taken in January, 1958 when S S. Drift was downcasting. R. I. M. and Manager agree that it was upcasting before the explosion.</p> <p>P/474—The quantity of air measured 6600 cft. per minute in loco level would not reach the east working face except through leakage because it is blocked on all sides by brattices. O.S. 3 (ventilation plan) does not depict the condition on 19-2-58. Ventilation is arranged by removing brattice from time to time.</p>
Colliery Mazdoor Congress	No evidence.
Colliery Majdoor Samity	No evidence.
Indian Mine Managers' Association	No evidence.
Indian Mining Association	No evidence.
Mines Department	<p>W-19, P/331—Effect of Natural ventilation pressure produced by S. S. Drift was advised to be checked. P-333—Advice to the management for replacement of brattice by C. I. Sheets particularly at the working faces to prevent leakage.</p>
Court	X

Parties	Coal dust : System of treatment : Explosion-dust
Owners	<p>S-1, P/5—Stonedusting plan in OS-2 and system of organiation in Appendix E. 6 tons of crushed burnt shale at 200 mesh used weekly. One stone-dusting supervisor with 22 persons employed in cleaning and stone dusting. Whole pit divided into zones according to the proneness to coal dust acculation. Cleanings wetted with water and sent up the mine. Sprays fitted at conveyor discharge points. If sprays do not work water is poured on conveyor pans. At places, loading points within C.I. sheet enclosures to prevent dispersal of coal dust. Before blasting stone dusting done by shotfirer helpers. Machine gummings wetted by water. Samples of mine dust collected once a month, OS-42—Galleries mud plastered. To prevent coal dust going down intake cyclone deduster in the screening plant. W-1, P/25—The mine on the whole is wet. Not every portion but in the working faces some water is encountered. P/51—Parts of the mine are wet and parts are dry. It is not under the category of wet mine. P/48-50—Stone dust is not used to counteract coal dust. By application of water coal dust is neutralised while coal is being cut. Possible places for maximum accumulation of fine coal dust are on the return side where a lot of dust is made and conveyor. Does not agree that main east level as compared to No. 2 dip was given secondary importance with respect to stone dusting.</p>

W-5, P/80—Not a very wet mine—Parts are dry and parts are naturally wet. W-10, P/165—Coal and material wound by No. 1 Pit. Only persons and stones raised by No. 2 pit. P/171-172—Ball Mill in the colliery for supply of stone dust—Reserve stations stocking stone dust, stone dusting done manually according to a prepared plan. Also persons cleaning conveyor every shift. No stone dust barrier as efficiency is not believed in. Stone dust barrier is still at a research stage. Thin layer of coal dust on stone dust likely to propagate explosion. Belief in through cleaning Burnt shale as a stone dust is quite effective. P/186-190—No arrangement for testing dispersibility of stone dust in India. Witness used to do it by blowing on it from time to time. Such test is satisfactory. Silica test done once in four months. Test for dispersibility and lightness of colour done more often than once a month. Scheme for treatment of coal dust was under consideration. A formal scheme not submitted to Mines Department. Samples taken covered the whole mine. Main belt conveyor roadway was not more dusty because of sprays. Heaps of stone dust were kept at different places for the purpose of its use. Whole mine is not stone dusted in one day. It is a continuous process. Position of these heaps will vary from time to time. Complaints from Mines Inspector on stone dusting complied with.

P/206-207—Three persons put for cleaning the conveyors are sufficient. Initial cleaning and stone dusting done in first shift with 16 men. The rest of cleaning refers to under the conveyor which is done every shift. Standard of cleaning considered adequate in 1st shift. Men engaged for cleaning and stone dusting conveyor areas. In 2nd shift also this was done. One ton stone dust carried unerground daily. This is considered sufficient on basis of 1 to 12 lbs of dust required per ton of coal raised. Quantity of dust depends on local conditions.

After Explosion: —W-1, P/2—Coarse black particles had erupted from No. 1 shaft and were lying on the ground around the shaft mouth within 50 ft. radius.

P/29—Sample of explosion dust collected from around No. 1 pit on 9-3-58 indicated raw coal (OS document).

OS-72, App X—Analysis results of coal coked by fire and of soot deposits. P/42—Examination of the dust after explosion does not indicate whether it is an entirely coal dust or methane explosion or the extent to which each has played part.

Indian National Mine Workers' Federation & Colliery Mazdoor Union.

Ex. W-36, P/3—Small amount of coked dust—Fire area bears no evidence of extent of explosion done by coal dust. Violence at places consistent with coal dust involved. Little evidence of coking does not prove that coal dust did not take part. Contribution of coal dust to explosion was comparatively small. P/6—Most of coal dust involved was consumed. Probable that dust affected violence rather than extent.

(In argument)—four samples of mine dust used to be analysed. Points out different letters issued by Mines Department to management on coal dust found in the mine during inspections. Quotes some analysis

Parties

Coal dust : System of treatment : Explosion dust

results from Dr. Badami's report and infers that dust was probably considerable along 1 East Rise Level Refers to publications and states that experiments in Poland have shown that dust wetted in a manner not likely to be achieved in a mine was capable of propagating an explosion. Also that 95% of in-combustible in mine dust can propagate an explosion. Importance of analysis of post explosion dusts stressed.

Indian Mine Workers' Federation & All India Trade Union Congress.	W-29, P/440—If just sufficient coal dust to propagate flame there may not be much coke left.
Colliery Mazdoor Samity	W-25, P/360-362—Seen coal dust below 2 and 9 dip conveyors 5" to 6" deep on 19-2-58. Conveyor cleaners and witness helpers cleaned coal dust under conveyors. On 19th did not report dust accumulation to his superiors. P/369—Does not know if cleaners are supplied with scraper to clean dirt and dust from under a conveyor chain, 2 and 9 dip conveyors are jammed every day. Even with spray dust is not suppressed. With 1" or 1½" pipe water spray dust may be suppressed. Never suggested that to Paritosh Babu. Sprays only wet top of coal heap and not the bottom. Spray produces something like mist. In 2 dip spraying done at 150 ft. and at 300 ft. to the dip. In 9 dip conveyor there one spray half way down. On 19-2-58 sprays on 2 dip conveyor were working. Once said that 2 dip pump was working on 19th and then said that he did not notice.
Colliery Majdur Congress	No evidence.
Indian Mine Managers' Association	No evidence.
Indian Mining Association	No. IMA-6—Detection of coked dust at a few places e.g., 16 dip off 1 East rise level etc.
Mines Department	<p>W-19, P/335-337—Arrangements for stone dusting and cleaning of coal dust was basically alright. There was a stone dusting supervisor with several men under him. Requisite stone dust was supplied. If system was followed things would have been in order. There had been local accumulations and had been pointed out. In a working mine such accumulations may occur. Necessity of stone dust barrier was considered. Being a small mine it was not yet feasible. this could have been done if different districts had been opened. Quantity of stone dust available for the pits was sufficient as per accepted standard. If the 1st shift men had done their work regarding stone dusting and cleaning and the persons employed in the back shift had not neglected their work and the sprays were in operation there would have been no cause for complaints. Dust at conveyors were suppressed by water sprays.</p> <p>W-19, P/376—Dusts collected from around No. 1 pit on 22-2-58 indicated practically raw coal (C-4).</p>

Parties

Coal dust : System of treatment : Explosion dust

(After Recovery)

D. M. I. 37—Analysis of mine dust indicating degree of coking at several places in annexure.

W-19, P/424—Violence is not always a criteria if coal dust has been involved. Not much residue of coked dust would be found if coal dust is just sufficient to propagate flame.

Court

No. C-5—Examples of soot and coked dust at a number of places. Also analysis results of some samples. Prominence of coke dust stated in 16 dip off 1 East Rise Level and props in No. 1 East Rise Level.

W-27, P/420—Coal dust must have taken some part sometime. Cannot specify magnitude.

Parties

Places of origin

Owner

OS-72, P/20-22—Violence increases from inbye towards outby on the each side. Signs of minor violence on the east faces. Least signs of violence in 1 East Rise level inbye of 15 Rise. Ignition probably started at 1 East Rise Level and explosion forces have travelled to return side levels.

W-5, P/401-16—Rise off loco level, dyke face in loco level could not be seat of explosion. 16 dip off 1 East Rise Level could be.

Indian National Mine Workers' Federation and Colliery Mazdoor Union.

Ex. W-36, P/2 & 3—Explosion originated in or about the inner end of 1 East Rise Level. Evidence of continuous pressure emanating from 15 Rise area in Main East. Direction of force was from East to West along 1 Rise Level.

(In argument)—Possibility of ignition at 2 Rise Level between 15 and 16 Rises.

Indian Mine Workers' Federation & All India Trade Union Congress.

Ex. W-39, P/1—From evidence of propagation of explosion 3 possible places suggested i.e., 2 East Rise Level, dyke face, 16 Rise Off Loco Level and extreme point of Loco Level.

P 3—Pin points 16 rise off Loco level as origin from condition of the drill in it.

W-29, P/463—Violence appeared minimum in the region around the faces in 2 east, 1 east and main loco level.

P/470—It is probable that explosion originated at a point higher up than loco level and then followed 1 rise level to west and down 15 rise. Movement of 15 rise conveyor to the dip may be due to "Back lash".

Colliery Mazdoor Congress

No evidence.

Colliery Majdur Samity

No evidence.

Indian Mines Managers' Association

No evidence.

Parties	Places of origin
Indian Mining Association	I.M.A.-6, P/5—Between 15 and 16 rise in 1 rise level. W-26, P/419—Ignition could not have taken place in 5 rise area.
Department of Mines	D.M.I.—37, P/4, 9 & 10—Forces of explosion have travelled from east to west along all 6 level galleries. It was more prominent along 1 east rise level than loco level till the junction of loco level and 2 dip is reached. In bye workings of least rise level and loco level do not show much violence. W. 19, P/425—Cannot pin point further than stating that ignition occurred in the inbye workings of 15 rise off 1 east rise level or east loco level.
Court	C/5—Forces travelled out bye along 1 east rise level. No further opinion. W-27, P/11—Somewhere in 1 east rise level between 15 and 16 rise or 16 dip.

Parties	Nature of explosion
Owners	W-3, P/61—Flame seen at evasee top was about 2½ to 3 ft. high & persisted during the time of coming out of Gill's house and reaching the canteen. It had a bluish flame. It appeared a little after the sound W-4, P/63—Blach smoke out of evasee with a streak of fire. Colour of flame was yellow. W-11, P/212—At about 12-30 a.m. on 20-2-58 detected 2½% gas on surface 5 ft. away from S.S. pit mouth. Similar percentage of gas detected at S.S. Drift entrance. OS-72, P/40-43—Explosion predominantly a CH ₄ one and coal dust played minor part due to following e.g. as compared to Poidih explosion which was a coal dust one of which witness has personal experience violence in this case was much milder; burning timber recovered after first explosion showed starting of fire. Fire starting from violent coal dust explosion are infrequent. Methane explosion can be extensive as in this case if there is a large and continuous supply of gas from an outburst; Detection of a flame at fan evasee top in a very wet shaft 2000 ft. deep. A test carried out in an upcast shaft raising 1,000 tons of Disergarh seam coal showed maximum number of suspended dust particle as 1/5000 of the minimum quantity of coal dust required to support inflammation; sufficient mine air samples were not taken after the first explosion but whatever were taken indicate that only CH ₄ was involved; it is not possible to state from the mine dust collected after recovery on the nature of explosion as any flame whether from CH ₄ burning or from coal dust burning will cause coking

Indian National Mine Workers' Federation & Colliery Mazdoor Union	Ex. W-36, P/6 Methane was involved at the initiation at the end of the first explosion. It was being consumed throughout its travel during the first explosion. Dust involved in some localised area indicating increased violence as seen on roof bolts and V shaped bent girders in loco level. Most of the dust involved was consumed and probably its affected violence than the extent of the explosion. Accepting evidence of a flame at fan evasee or some small time it seems to
---	--

Parties	Nature of explosion
Indian Mine Workers' Federation & All India Trade Union Congress	be due to CH ₄ . Coal dust flame expands to form a ball of flame. Upcast shaft, 2,000 ft. deep is wet and water falls in the open space like a rain fall and hence it is highly improbable that coal dust explosion could propagate flame up the shaft.
Colliery Mazdoor Congress	No evidence.
Colliery Majdur Samity	No evidence.
Indian Mine Managers' Association	No evidence.
Indian Mining Association	I.M.A.-6, P/1-3—Second and third explosions were fire damp ones and confined to west section. Their effect was more in this area than by the first explosion. P/5 & 6—No clear evidence of coke dust excepting in 1 east rise level inbye end. Residual coking is very small, skin coking along 1 east rise level. First explosion primarily a CH ₄ one of violence and coal dust played its part. W-26, P410—Coal dust took part at a very early stage.
Department of Mines	D.M.I.—37, P/3—Subsequent explosions were CH ₄ ones. P/9-11—From the path followed by explosion forces, comparative mildness of violence, small residual coke, first explosion considered predominantly a CH ₄ one. Coal dust played a minor part. W-19, P/325—No. 1 pit was coal raising shaft and normally there should be more coal dust in it and at its bottom. Flame of first explosion had come upto sub-station but had gone up 2 pit instead of 1 pit. 2 pit, 2000 ft. deep, is wet. Flame of coal dust explosion should not jump over 2000 ft. wet stone zone. Flame at fan evasee was of a short period.

Parties	Nature of explosion
Court	<p>Ex. C-5, P/1—Analysis of dust collected from 1 pit top by R.I.M. indicated volatilisation of 5% volatiles. This is not conclusive that coal dust did take part in explosion.</p> <p>W-3, P/420—Coal dust must have taken some part some time. Explosion of this magnitude could not have occurred from an outburst of gas from 2 east rise level cavity. The extent to which coal dust took part is unknown. P/421-422-Methane explosion can propagate itself provided the concentrations at different points are within the specified limited distance <i>i.e.</i>, flame of CH₄ ignition can be projected to a distance of 5 to 60 times its original length and if there is sufficient concentration of gas within this distance it can be ignited from the original ignition.</p>
Source of Gas	
Owners	<p>W-1, P/18-40—It is not possible to foretell outburst from occurrence of gas in a place.</p> <p>W-10, P/209—Detection of gas is not necessarily frequent and invariable when coal face and dyke face come close together.</p> <p>W-7, P/134—Persons in zero dip in which gas had accumulated had come up the mine.</p> <p>W-5, P/108—The particular dyke has been passed through 150ft. away and no gas or appreciable quantity of water was struck. It is possible that there may be gas at one place in a dyke and not in another. W-11, P/212—2½% gas detected after 12-30a.m. on 20-2-58 on the surface 5 ft. away from the S.S. Pit mouth. Similar concentration at S.S. drift entrance</p> <p>OS-72, P/16—Outburst of gas from cavity in a dyke face in 2 Rise Level, heaved floor in 15 Rise off 1 East Rise Level and 14 Rise of the same level. A splinter seam below main seam & 2'3" thick, proved to be merging towards the eastside. The parting between Main Disergarh seam and the splinter seam, gradually decreases from 6'6" at 13 Rise to 1'6" near the face on 1 East Rise Level. The position of the workers in which they were found after recovery indicated that they may have been asphyxiated.</p> <p>W-5, P/392—It is not a typical or normal outburst and could not be foreseen. P/406—No previous instance of outburst in Disergarh seam. In this mine the depth is considerable. There is no hard and fast rule about occurrence of outburst. In certain types of coal and in certain areas these may be more frequent.</p>
Indian National Mine Workers' Federation & Colliery Mazdoor Union	<p>Ex. W-36, P/6-9—Slow and gradual accumulation on such a large quantity of gas involved in the explosion is ruled out, as persons were found in the extremities of the workings and in that case they would have felt distress and warning of atmosphere becoming irrespirable. Also such a build up of gas would have been detected in normal inspections. Building up of gas was too rapid. Normal indications of an outburst are not all present in this case. An outburst occurred through the floor upheaval in 15 Rise off 1 East Rise Level. Presence of dyke may have contributed to gas pressure being built up in the splinter seam. Two instances in U.K. of outbursts occurring in the similar manner quoted. W-28, P/423-424—There are</p>

Parties	Source of gas
	underground. Then again says that it could be P/454-Learnt from Labour representatives that M.E. Loco section was fenced off at about 2 p.m. of 19-2-58 in the first shift due to occurrence of gas and some persons vomiting. On this possibility of ignition of gas in 2 Rise Level 16 Rise off loco level and extreme point of loco level has been based. Conditions may have changed in the 2nd shift. P[472—Floor of Disergarh seam is too storging to be heaved by accumulation of gas but not of water. It is possible that heaving of floor by roof pressure and accumulated gas in the seam below may help each other. There is a probability that there was accumulation of gas in the east face capable of sudden outburst. Cannot explain why 3 experienced men in mining in the east face near the point where gas accumulation is alleged to have occurred by the witness could not be detected by them.
Colliery Mazdoor Congress	No evidence.
Colliery Mazdur Simiti	-do-
Indian Mine Managers' Association	C-2,—Reports on increased make of water and gas on 28.4.58.
Indian Mining Association	I.M.A./6, P/6—Sudden release of gas occurred from the underlying seam from 15 Rise off 1 East Rise level and perhaps from dyke in 2 Rise level. The workers were probably asphyxiated.
Mines Department	DMI, 37, P/10-11—Outburst of gas caused by sudden fracturing of floor in 15 Rise off 1 East rise level from the underlying seam. Hissing sound of gas emission noticed from splinter seam. C-3—Report of 27.4.58 on increase make of gas and water.
Court	C-5, P/6. Outburst of gas from 2 East Rise level face must have been a small one as the cavity in it did not reveal any crack or fissures extending further—W-27, P/420—Presence of crack in 15 Rise may have been caused by a sudden emission of a large body of gas. Confidential note to Court—Analysis on 11.8.58 of gas bubbling through water from splinter seam showed 93.90 % CH ₄ .

Parties	Source of Ignition
Owners	W-6, P/124—Never seen any one smoking in the pits. Banksman checks carefully at the top. W-7, P/125 Never seen one smoking underground. Do not smoke because it is forbidden. Checked thoroughly on the surface. Ex. OS-72, P/24—Shotfiring.—No shotfiring was going on underground at the time of explosion. A fairly large quantity of explosives could neither be accounted for nor traced after recovery. Detonators being sensitive to shock and heat may have exploded due to explosion or some of them may have

exploded due to shock and may have initiated ignition. *Electrical Equipments*—In Main East Section all conveyor switches excepting in 1 East Rise level were 'off'. No evidence to show that ignition started from 1 East Rise level conveyor. No evidence to show that excepting the two drills in main east loco level, any drills were working. No evidence to show that any of the drills or transformers could cause ignition. None of the coal cutting machines were working at the time of explosion. No evidence to indicate that either the pumps or lighting equipments were responsible for ignition. Light fittings on the return side were F.L.P. No evidence to show that any of the cables was source of ignition. *Locomotives*.—The engine was found out "off". *Safety lamps*—Several cap and flame safety lamps were found damaged but nothing to indicate that this could be a source of ignition. *Contrabands*—No contraband found. No body of a victim has been found to suggest that he could have been smoking. *Open fire*—Little likelihood of an open fire. *Probable causes*—(1) Incendive spark produced by a piece of rock hitting against another. The rock piece may have been erupted by the outburst or picked up in its path. Incendive spark by impact of stone on steel or iron or the latter on aluminium. In short, outburst supplied source of ignition as well as methane. (2) One or more detonators may have exploded due to shock of outburst, mishandled, being struck by fallen stone etc. A detonator box may have been picked up by outburst and hurt it against some objects. A piece of coal or stone projected due to the outburst may have fallen on a detonator box or on the exposed detonator.

Indian National Mine Workers' Federation & Colliery Mazdoor Union.

Ex-W36, P/9—Possibility of ignition from shotfiring and continuous friction ruled out. Ignition due to electrical equipments, safety lamps, light alloy, sparking pointed out. Possibility due to impact friction considered extremely unlikely in this mine. Igniting source could not be determined. (In argument)—impossible for explosion to have been caused by shot firing, electricity, lamps, light alloys, contrabands and frictional hotspots. Impact friction by ejected rock due to bursting of dyke or the violent ejection of rock from it in 2 East Rise level and ejection of floor rock in 1 East Rise level are possible sources.

Indian Mine Workers' Federation & All India Trade Union Congress.

Ex-W-39, P1/3—Shotfiring is most probable source if explosion started at 2 East Rise level dyke face. If in 16 rise off local level then electricity. Further pin points that the drill in 16 rise off loco level is most probable cause of ignition. W-29, P/452-453—18" socket in 2 rise level dyke face indicates that shotfiring may have been done there. On questioning by the Court agrees that he does not maintain blasting as the cause of ignition. Blasting may have released some gas and filled up the place which got somehow ignited. Does not say that non-detection of contrabands does not prove that this could not be the cause. P/469—The drill in 16 Rise off loco level may have been tried out only. P/474-475—With a fuse of higher rating there will be a spark inside the drill

Parties	Source of Ignition
	which might ignite a gas mixture. If the fuse does not blow off the next switch of higher rating might trip or it might ignite the conductor itself. In this case neither happened. Agrees with the observation of Safety in Mines Research Establishment that the maximum statistical safe gap is 0.035" and experimental safe gap is 0.046".
Colliery Mazdoor Congress	No evidence.
Colliery Mazdoor Samity	No evidence.
Indian Mine Managers' Association	No evidence.
Indian Mining Association	I.M.A. A-6, P/8—Source of ignition remains under terminated. Central Mining Research Station have proved that an explosive mixture cannot be ignited by open sparking across bulb terminals of a cap lamp Part of trailing cable to coal cutter in 16 dip which was suspected examined and found safe. No evidence, of smoking or contrabands found. W-26, P/416—. No evidence of drilling or blasting in 2 rise level dyke face nor in the cavity.
Mines Department	D.M.I. 37, P/11-13—Possible sources examined but exact source could not be determined. D.M.I. 42,— Reports on tests carried by Electrical Inspector on drill found in 16 Rise off loco level—not a possibility.
Court	C-7—Reports on tests carried out on drill found in 16 rise off loco level with the gap found in the flange i.e. 0.028"—gas did not ignite. C-5—P/6-7—Results of detailed tests carried out on surface on a similar loco as one present U.G. with no water in conditioner box. A layer of mine coal dust on top of box showed no smouldering. Maximum temperature after one hour run—156°C.

APPENDIX IV

Summary of data collected from the sectional plans of the mine which form appendix I to Mr. R. P. Rosser's report (Exhibit OS.—72).

SECTIONAL PLAN NO. 33 OF APPENDIX I

No. 16 dip off 1 east rise level

5/6 tons of blasted coal in the face of the dip.

One hole 3'-2" deep on the western side of the gallery about 3 ft. above the floor, with its mouth about 4 ft. from the face of the gallery was found. A coal pick found here. Two dead bodies were found near the face.

4 props were found standing on one of which there was coked deposit. On the "Jatri" i.e. horizontal bars for supporting the roof near the junction of the dip of 1 east rise level coke deposit was found

There was a trailing cable attached to a coal cutting machine. Further to the north of these bars there was a dead body. Against date 9th July 1958 at page 11 para 2. of his report Dr. Badami noticed two props with their south facing sides covered with a thick deposit of coke dust and from the prop at the out-bye end he took a sample of the coke dust which he analysed and found that the moisture content was 5.2 per cent, the ash content 15.9 per cent, the volatile matter content 22.4 per cent and fixed carbon content 56.5 per cent. He also noticed deposits of coke dust on the north facing sides of certain beams in the area and observed, the way coke dust had been deposited was intriguing.

Two empty baskets found near the face, as mentioned in Mr. Rosser's report, are not in the plan.

1 east rise level (between 15 rise and extreme inbye face)

At the extreme eastern end of the level there is a small quantity of loose coal which Mr. Rosser estimates at a ton or two. There is a complete shovel with its business end pushed into loose coal and its handle standing at an inclination with the floor. There were two baskets, one of which had coal in it. 8 cap lamps issued to C.R.O. labour found near the face. There were 4 chappals lying at some distance from one another, one short, a twisted empty tin, a brattice cloth in tact.

In the junction of the level gallery and 16 rise 2 dead bodies with one cap lamp close to them were found. There was an empty basket near the dead bodies. Further west, 16 dead bodies were found between 16 rise and 15 rise off this level.

There were other cap lamps found further west.

A drill machine was found on the level near its junction with 16 rise and 16 dip. Parts of the cable lay coiled at different places out-bye and went right up to S.S. drill panel attached to the cable, and another cable attached to the coal cutter panel also in coils in different places went right down to 15 dip. As many as 16 dead bodies were found on both sides of the conveyor line and the western end of this conveyor line was found displaced towards dip. To very nearly the western end of this conveyor line was found a CM4 for coal cutting machine lying on its edge. Only one of these dead bodies, that of Asstt. Supervisor, R. S. Pandey, could be identified. 5 empty baskets were found on this level between 16 and 15 rise.

Coal cutting machine trailing cable carried over wooden plugs fixed into north side pillar was undisturbed. Coked deposit on cable.

16 rise off 1 east rise level

There was a coal cutting machine at the northern end of the rise and there was a cable attached to it. The cable went right up along 2 rise level and then along 15 dip off 2 rise level right up to a point about 20 ft. to the north of the junction of this dip with 1 east rise level where it was attached to a pommel. A little to the south of this pommel was another drill cable unattached to a S. S. drill panel lying on its side near the western side of the dip. There was a short piece of cable connecting the panel and a Belmos switch lying on its face.

Along 2 east rise level between 16 and 15 dips off this level sign of soots on sides and roof was noticed, and at the 2 rise level face there was a cavity in dyke about 3 ft. in diameter and about 3 ft. deep. There was a small quantity of coked deposit on coal pillar side against 16 dip and near the face dyke. There were pieces of brattice in 16 rise off 1 east rise level and also along 2 east rise level.

In 15 rise off 1 east rise level a prominent crack in the floor was found from about 10 ft. south of the junction of 2 rise level and 15 dip off this level right upto nearly the junction of this dip with 1 east rise level. On the western side of the northernmost part of this crack there was a deposit of slack coal. There was a smaller deposit of slack coal on the western side about 35 ft. or 40 ft. from the southern end of the crack. A piece of twisted C.I. sheet was found just to the west of the northern end of the crack.

15 dip off 1 east rise level

The conveyor pushed towards the dip by about 18 ft. A portion 50 ft. to the dip also pushed westwards. The conveyor chain out of the pan and lying on floor. There were shining particles on roof and sides.

1 east rise level (between 15 & 14 rises and dips)

A number of C.I. sheets found in different places over this length and also about 25 ft. from its junction with 15 rise and 15 deep the Belmos switch for

conveyor was in position. There was a loose conveyor pan upside down about 20' away from the junction of the level with 15 rise and 15 dip and another similar pan was found near the northern side of the level further out-by. There was a trailing cable about 40 ft. from the junction of the level with 15 rise and 15 dip coming up to the southern side of the level. There was a peg in the roof about 50 ft. out-by of the 15 dip junction with a piece of brattice the edges of which were burnt.

2 rise level between 15 and 14 dips off it

On the northern side of 2 rise level near its junction with 15 dip a piece of brattice hanging from roof pin was charred.

C.I. sheet found on the western side of the level near its junction with 15 dip and also at other places. Shining particles were found on the side of the roof.

In 14 dip off 2 east rise level there was found another crack on the floor but no slack coal appears to have been found on either side of the crack. Shining particles, however, were found on the roof and the sides. Portion (42 ft.) of a chain conveyor which was not working was found about halfway down the dip. Its southernmost pan was badly damaged. There were two other pans lying unattached to the rest to the east of the chain conveyor. There were some C.I. sheets at the southern end of this dip near its junction with 1 east rise level.

In 14 dip off 1 east rise level nothing worth mentioning was noticed except that pieces of C.I. sheets brattice were found in several places. Several pieces of timbers were collected near the dip end. A prop was standing near the dip end.

1 east rise level between 14 rise and 14 dip and 13 rise and 13 dip

Timbers lying strewn about all along the level indicating that the timbers which were probably cog supports had been displaced by the force of the blast.

In 13 dip off 1 east rise level apart from pieces of brattice, a piece of bone and a piece of flesh were found. Some timbers collected near dip end.

In 13 rise off 1 east rise level there were C.I. sheets and brattices.

In 2 east rise level between 14 and 13 dips off that level were found brattices, a few timbers and C.I. sheets at different places.

PLAN NO. 32 APPENDIX I

Main East loco level, eastern face

15 cavities of previous blasting on the southern side of the face; 2 new holes of 2 ft. depth on the northern side and 1 new hole of 4" depth on the southern side of the face. A drill was found near the face with a cable trailing along the main east loco level to a drill panel halfway towards west and on the southern side of the level. A part of this cable seems to cross the line of conveyors in certain places. A stemming rod was found near the face of the main east loco level. There was also one primed cartridge near the northern pillar corner at its junction with 16 rise. A drill rod was jammed in a hole about 4" deep.

There were 8 dead bodies at the centre of the gallery at its junction with 16 rise and 16 dip off it and there was also 5 cap lamps found near about. A length of shot-firing cable was found near a cap lamp close to southern pillar corner.

Proceeding westward along the main east loco level it appears that the conveyor chain was displaced from its alignment northward near about the centre. Several props were also dislodged. From the centre of the main east loco level with its junction with 16 rise and 16 dip off it upto its junction with 15 rise and 15 dip 13 dead bodies were found. There was a C.I. sheet just to the north of the conveyor line.

A large number of timbers had collected at its junction with 16 dip.

Coal cutting machine picks in a bundle and a wrench were found together among a heap of sleepers at the junction of the main east loco level with 16 rise and 16 dip off it.

In 16 dip off this level 7 dead bodies including that of Unit Supervisor T. P. Singh and a number of cap lamps were found. A pick, 3 shovels and 10 empty baskets were found in this dip.

In 16 rise off loco level.—At the corner where the northern side of the level meets the western side of 16 rise off it there was a prop penetrated by one "belcha" (shovel) and there was also a "belcha" found lying a little away from it on the level.

About 20 ft. inbye from the junction of main east loco level with 16 rise off it were found 13 dead bodies including those of the Under Manager, D. C. Bedeker, Senior overman, Tara Singh, and Mining Sirdar Riasat Mia. 13 cap lamps and one flame safety lamp were also found here.

At the face there were 3 drill holes in one of which a drill rod was found jammed. A piece of charred brattice was found hanging from the roof 9 ft. out-bye of the face. A drill machine was found lying on the floor about 10 ft. out-bye from the face.

The other end of a drilling cable attached to it was found near the southern side of main east loco level, close to 15 rise. A length of shotfiring cable was found lying coiled up a few feet to the south-west of the drill machine. A stemming rod was lying just to the north of this coiled shotfiring cable. There was an exploder a little to the south of the cable. A loose drill bit was also lying about 20 ft. to the south of the drill. There were also a number of empty baskets. There was another piece of charred brattice 40 ft. outbye of the face.

15 dip off main east loco level

In this dip between main loco level east and 1 dip level there were 4 dead bodies.

There was a heap of fallen coal at the entrance to the dip. There was also a bent C.I. sheet, and a length of armoured cable running from an inverted gate-end box at the junction of main east loco level and 15 rise off it and ending with another gate-end box about 25 ft. to the north of the junction of 15 rise off 1 dip level. From this gate-end box another cable proceeds southwards for some distance and then along the main east loco level connecting with a drill panel lying on the main loco level east about 10 ft. east of the junction of main east loco level and 15 rise and 15 dip. There were several bent C.I. sheets and 1 twisted C.I. sheet.

Conveyor was more or less undisturbed excepting for the dip and which had moved slightly towards west.

15 rise off main east loco level

2 dead bodies were found in it. 2 bent C.I. sheets. There was 1 locked explosive-carrying-box found under the conveyor pan in this rise. As it appears from page 26 of Mr. Rosser's report this box contains 22×6 oz. Polar viking and 15 detonators.

There was a stemming rod lying about 3 ft. to the north of the junction between 15 rise and main east loco level and on the western side of the conveyor line. There was also a chappal and an aluminium "lota". The joint of the last but two conveyor pan was broken and two pans were pointing east-west. The last pan joint was broken and it was lying on a north-west—South-east direction. The rest of this line of conveyors does not show any sign of disturbance excepting as mentioned in 15 dip off 1 east rise level. There was a roof fall in 15 rise off main east loco level.

Along main east loco level westwards from its junction with 15 rise and 15 dip 8 dead bodies were found. There was a broken accumulator under conveyor. There was a loose conveyor pan inverted and there were roof falls. An armoured cable from the inverted gate-endbox a few feet west of the junction between main east loco level and 15 rise off it runs westwards along the whole length of the section of main east loco level between 15 rise and 14 rise and ends in a gate-end box found inverted at the discharge end of the conveyor at 14 dip.

1 dip level—face

Blasted coal was found lying at the face. There were 3 dead bodies near the face with 3 baskets two of which were empty and one loaded with coal. There were also 3 cap lamps near the face. The cap lamps of these men were very near where their dead bodies were found. The obvious indication from this is that these men were actually loading coal in their baskets and had no time to move away from the danger before they were overpowered. Two shovels were found lying crosswise. There was some fallen coal on the southern side of the level. There was a A.B. coal-cutter lying in this level opposite its junction with 16 rise off it. There was another dead body at the centre of the level near this junction

and there were two cap lamps and an empty basket close by. There was a chappal (right) in this level.

In 16 rise off this level 2 picks, an empty basket, a mining hat, and a mining sirdar's roof testing rod were found. There was a drill machine close to which but unattached lay a drill cable coil irregularly. Between 16 rise off 1 dip level and 15 rise off it there were 16 dead bodies. 17 loose conveyor pans were found lying in this level. 2 conveyor pans were lying inverted. A partition was still hanging in 16 dip.

One broken wooden box for carrying explosives with one cartridge inside was standing on one side near the conveyor pan. The lid of the broken explosives box with the lock in tact was found lying close by. This was found to contain 1x6 oz of Polar Viking as mentioned in page 26 of Mr. Rosser's report. There were pieces of scattered timber in the western part of this section of 1 dip level. From a drill panel there was an irregularly coiled drilling cable running first eastwards and then westwards into a switch near the junction of this level with 15 rise. Another cable proceeds westward from this switch.

In 15 rise off this level the conveyor was found inclined to west and the chain was thrown out of the pan. There was a gate-end box about 20 ft. from the junction of this rise with the 1 east dip level from which a cable ran northwards and lay looped over a prop set vertically and stretched towards the rise ended in the inverted gate-end box a few feet to the west of the junction of the main east loco level with 15 rise off it.

In 15 dip off 1 dip level 10 dead bodies were found. The cap lamp of Mining Sirdar A. Basak, was also found here. There were a number of empty baskets: in one of which there was a shovel. There was a certain amount of coal lying at the face. There was one cartridge in a basket and another shovel was lying in a basket.

Proceeding further westwards along 1 dip level from its junction with 15 rise and 15 dip there were only 2 dead bodies. There was a conveyor pan lying on edge facing towards the rise. Several pieces of timber were strewn about.

PLAN NO. 31 OF APPENDIX I

No dead bodies or lamps were found on No. 1 dip level No. 14 rise off it, No. 13 dip off it or No. 13 rise off it.

On the main east loco level east of its junction with 14 rise and 14 dip there were (a broken coupling chain a fall of roof coal and a gate-end box inverted, lying under the conveyor.

In 14 dip there were two cracks showing heavings of floor without any trace of any small coal nearabout. There were some bent C.I. sheets, a certain amount of fallen coal about 15 ft. to the south of one of the cracks and further south of the other. There was a small peg jammed on roof from which a piece of brattice was hanging.

In No. 1 dip level east of its junction with 14 dip off it there was a one foot high brick wall which appears to have been in tact. The other brick wall on the western side of this junction on No. 1 dip level was broken.

In No. 1 dip level a loose conveyor pan was on edge facing towards rise. Further west, there was a piece of unburnt cloth. Near the junction of No. 1 dip level with 13 rise and 13 dip off it there was a tail end of the cover of a conveyor. Here the joint of 2 conveyor pans was dislocated. There was a twisted C.I. sheet at one place and a bent C.I. sheet at another, and a channel iron was inverted.

In 1 dip level apart from some roof falls and some bent and twisted C.I. sheets there were no signs of damage.

At the junction of this No. 1 dip level with 13 rise off it a conveyor pan was on edge and the bent chain was lying out of the pan. There was also a conveyor pan bent and twisted. There was a fall of coal a little to the west of this junction on No. 1 dip level. Further west on this level there was bent and twisted C.I. sheet and further west there was side fall of coal.

13 rise off 1 dip level

There was an unused drill rod in this rise a number of broken and whole props, 2" dia pipe range, a loose conveyor pan and armoured cable lying on the floor.

A length of the conveyor chain about 40 ft. at its southern end was displaced towards the west. The conveyor was not much disturbed otherwise.

In 13 dip off 1 dip level there was an armoured cable the bottom end of which appears to have been torn. The rest of the cable was attached to G.E. box. There was a conveyor pan on edge facing eastward. A channel iron was inverted. A starter switch of the pump lying on edge and facing towards the dip. There were two bent C.I. sheets at different places. A gate end box lying on edge facing towards the rise. A pump (Mono) was at the dip water edge with 2" dia. delivery range wrenched out. The delivery range was intact up to its junction with 1 dip level.

In No. 14 rise off loco level, there was a crack about 36 ft. long but there was no trace of small coal near it. A few feet to the west of the junction of the main east loco level with 14 rise and 14 dip off it there were 2 dead bodies and 2 cap lamps. There was also fall of coal there and a little to the west thereof.

From the junction main east loco level and 14 dip there is a belt conveyor running along the dip end of the level right up to the loading point situated between 11 and 10 rise off this level. The belt was undisturbed for a distance of about 80 ft. from its tail end at the junction of loco level with 14 rise and 14 dip off it, then for a distance of about 40 ft. it was slightly displaced. The belt was far more displaced towards the dip side from this point right up to about 20 ft. east of the junction of the main east loco level with 13 dip off it. The displaced belt of the belt conveyor was twisted at two places on either end of 13 dip. About 10 ft. to the east of the junction there was a loose chain conveyor pan lying under the belt conveyor having apparently been blown downward from the rise end.

The belt conveyor pan joints were also broken at two places near the junction and slightly to its east.

There were roof falls at several places on the main east loco level to the west of the junction between the main east loco level and 13 rise and 13 dip.

SECTIONAL PLAN 34 OF APPENDIX I

Only one dead body and one lamp were found about midway between 11 rise and 10 rise off main loco level.

This section covers the loco level and 1 dip level.

There were noticeable roof falls both on the northern and southern side of the main east loco level west of its junction with 12 rise and 12 dip off it and at the centre of the level west of the junction. From this junction there was no belt on conveyor and it was found that the belt had been blown out of pan partly into 12 dip and lying torn there. A number of timber pieces were lying heaped up about 15 ft. east of loco level and 11 rise junction. Several pieces of timbers were also lying strewn about in the level between 11 rise and 12 rise armoured cable was lying in loops and thrown to the dip at 11 rise junction.

Midway between 12 rise and 11 rise one belt conveyor frame and top sheet were heavily damaged, the top sheet being bent and twisted at places.

Further westwards the belt had been dislocated so much so that the joints were broken and damaged and the pan at one end was displaced and lying on the main pan. A loose chain conveyor pan was lying under the belt conveyor though there was no chain conveyor nearabout. Another loose chain conveyor pan was lying inverted.

A belt conveyor pan right at the junction of 11 rise and loco level was broken open at the joint on either side and thrown towards dip. A pan just to the west was also opened out at the joint. The belt was standing on edge for a distance of about 15 ft. on either of the junction and at the junction A 2" dia pipe range was opened at joints and thrown to the dip at the junction of 11 rise and loco level.

At the junction of the loco level with 11 rise a wire net side guard for belt conveyor was damaged and dislocated. Two such side guards were lying just to the west of the junction. The bottom guard sheet of the conveyor was bent and twisted towards west and damaged at places.

There was no sign of any damage in 11 rise or 12 rise.

Near the discharge end of belt conveyor in main east loco level a rise side suspension bracket was broken but the bolt was bent towards west, three such

brackets on the rise side bent towards east, and on the dip side 3 suspension brackets were slightly bent towards the east and the one nearest the discharge end was broken.

An empty tub was just west of conveyor discharge end with its broad side at right angle to the level and another tub with its end bent inward was partly under the conveyor head.

In 12 dip off loco level there were some blown off brick bats of stoppings and there were some bent C.I. sheets and falls of side coal.

In No. 11 dip off loco level, there were some roof falls, some bent and twisted C.I. sheets, inverted loose conveyor pan, broken props, a heaving of floor, a dislocated 1" dia pipe range and blown up bricks from the stoppings which had hit the roof.

There was only one dead body and only one cap lamp found on the main loco level about 40 ft. and 50 ft. respectively to the west of its junction with 11 rise and 11 dip.

In 1 dip level apart from some falls of coal there were no other signs of damage.

In 12 dip off 1 dip level, apart from roof fall in one place there was some bent and twisted C.I. sheets, and some broken timber.

In 11 dip off 1 dip level, there was a loose conveyor pan broken into pieces and several loose conveyor pans 3 of which were inverted.

At 2 dip level there was a roof fall and there was a conveyor pan on edge near dip side of the pillar.

SECTIONAL PLAN 34 OF APPENDIX I

In this section there are no dead bodies and no lamps, but in 13 dip off 1 rise level there was a piece of bone and a piece of flesh. The nearer dead bodies were on the loco level a few feet to the west of its junction with 14 rise and 14 dip which will be several hundred feet away where the pieces of bone and the piece of flesh are shown in 13 rise.

There is also a floor crack in 13 dip without any sign of small coal nearabout.

There is very little sign of damage in this section except a loose broken conveyor lying upside down in 12 dip off 1 rise level and several brattice and C.I. sheet pieces strewn all over. One shoe was found in 12 rise off 1 rise level.

In 10 dip off 1 rise level, there was a crack in the floor without any sign of small coal.

On 1 rise level between 11 and 10 rises there was a hook for cable bent towards the east. 3 other cable hooks were not bent.

SECTIONAL PLAN NO. 25 OF APPENDIX I

No dead bodies or lamps found in this section.

A crack in the floor was found in 10 dip off 1 rise level.

On the eastern side of 10 rise off 1 rise level near its junction with 2 rise level soots were noticed. Soots were also noticed on the sides and the roof of 2 rise level midway between 10 and 9 dips.

There was a heap of coal on the southern side of 2 rise level about 30 feet to the east of its junction with 8 rise off 1 rise level, and soots were found on the dip end pillar side of 2 rise level midway between 9 and 8 rise off 1 rise level.

A number of flat girder frames of direct haulage under installation was found lying on the floor at the junction of 2 rise level and 8 dip. A piece of C.I. sheet was found streck to a roof bolt at the junction.

There is hardly any other sign of damage except that certain things for fitting a new haulage had been displaced to some extent from where they had been kept and lay scattered to the west of the junction between 2 rise and 8 rise off 1 rise level.

SECTIONAL PLAN No. 26 OF APPENDIX I

In this section 14 dead bodies with 12 lamps were found, all on the loco level, from the easternmost point of that level in this section right up to about 60 ft. west of the junction of the main east loco level with 9 rise and 9 dip.

At the junction of main east loco level with 10 dip or 10 rise off 1 dip level 3 empty tubs and a trolley were lying jumbled together blocking the dip gallery entrance. Of these two had their ends severely bent inside, one facing rise and the other the dip. These tubs appear to have been thrown towards dip and were lying on one another bent and damaged.

A number of loaded tubs on the loco level between 10 rise and 9 rise off 1 dip level were derailed. The loco engine was about midway between 10 rise and 9 rise off 1 dip level. 2 angle irons of the loco engine appear to have been detached from it and one appears to have been bent. A piece of side cover of the loco engine was lying under a tub to its north-west. Half inch coke was found deposited ridged in the eastern side of loco exhaust pipe. The canopy with head light of the loco engine had been thrown close to the south-west side of the loco.

There were 12 empty tubs on the track to the north of the loco track and the loco engine was opposite the 4th and 5th tubs counting from the west. The empty tubs had been derailed and in most of them only western end plates were bent towards the west. A rail joint was broken to the east of the 5th tub from the west and the empty track was pushed to the dip.

To the east of the loco there were 7 loaded tubs but the loco does not appear to have been coupled to them.

A little to the east of the main east loco level where it joint 10 rise off 1 dip level and 10 rise off itself a belt conveyor head hanger had been thrown, and the track for the tubs was broken and thrown towards the dip side at the junction of main east loco level with 10 rise and 10 dip off it.

There was a crack without any small coal in 10 rise of main east loco level.

Apart from roof fall and a broken prop and 2 bent C.I. sheets there was no sign of damage in 10 rise off 1 dip level. There were heaps of bricks lying on the floor which had been blown off from the stoppings and which appear to have struck the roof and the sides.

In 9 rise off main east loco level, there was no sign of damage excepting a broken drum.

In 9 rise off 1 dip level there were bricks lying on the floor which were evidently blown off from the stoppings and hit the roof and sides.

Along the main east loco level at its junction with 9 rise and 9 dip off it, the northern track was covered by debris. Further west along with main east loco level there were a bent C.I. sheet and scattered timbers and gate-end box was lying on its back.

At the junction of the main east loco level with 8 rise of it and 8 rise off 1 dip level there was an overbridge the girders of which were in tact; but the concrete of both sides were broken and a heap of concrete had fallen down. The middle concrete section was undamaged.

In 8 rise off main east loco level there was heavy roof and side fall.

A few feet west of its junction with 8 rise off 1 dip level a piece of rail was bent and the channel fencing for under-bridge had been thrown to the southern side of main east loco level a few feet west of its junction with 8 rise from 1 dip level.

SECTIONAL PLAN No. 27 OF APPENDIX I

In 10 rise and 10 dip off 2 dip level there is no sign of damage except roof fall at two places in 10 rise and dislodged and bent pieces of 1" pipe in 10 dip. There is a heaving of floor at the junction of 10 rise with 2 dip level. There was a heap of broken brick bats in the centre of 2 dip level where it meets 10 rise and 10 dips.

On 1 dip level a little to the east of its junction with 10 rise off 2 dip level there was a heaving of floor. At the junction of 1 dip level with 9 rise off 2 dip

level there was conveyor pan on edge facing towards the rise side of it flattened like flat sheet. A conveyor chain along 9 rise off 2 dip level appears to have been displaced towards the west.

On 1 dip level a little to the west of its junction with 9 rise off 2 dip level one conveyor pan was lying inverted and another was standing on edge damaged. A joint box was lying on the floor of 9 rise off 2 dip level a little to the south of its junction with 1 dip level, with its top cover blown off somewhere.

Lower down in this rise a conveyor pan was lying on edge facing towards the west. Further down, some conveyor pans were on edge facing towards the west pushed towards the side from their original position. There were some bent C.I. sheets near the North Western corner of No. 2 dip level No. 9 dip junction.

On 2 dip level near its junction with 9 rise off it a pan was lying inverted with sides bent and pushed inside and the return wheel lying curve to it. Another conveyor pan was lying about 10 or 12 ft. west of this pan with its side bent inside so much so that it almost touched the bottom sheet.

1 dead body with a lamp was found in 9 rise off 2 dip level and 2 dead bodies on the southern side of 2 dip level a few feet west of its junction with 9 dip. A cap lamp was also found in No. 9 rise off 2 dip level about 15' to the rise of the dead bodies.

There were some broken timber, a piece of broken conveyor pan and broken prop, bent C.I. sheet at different places on 2 dip level further west of these dead bodies.

On 1 dip level at its junction with 8 rise off 2 dip level there was a quantity of debris, and apart from some damaged C.I. sheets there was no other sign of damage in 1 dip level.

In 8 rise there was no sign of damage.

In 2 dip level about 10 ft. to the west of its junction with 8 dip there was a roof fall and there was a certain amount of fall of roof coal in No. 8 dip below No. 2 dip level.

In 9 dip off 2 dip level near its junction with 2 dip level the top of the driving head of a conveyor was blown off. A little to the south thereof the side of a conveyor was bent very badly and pushed westward along with the drive head.

On the other side of 2 dip level at its junction with 9 dip there was a conveyor pan on edge facing towards dip, the top sheet flattened and broken and lying on the bottom sheet. A little lower down in 9 dip the side guard sheet of a conveyor was badly bent. A little further down, both sides of a conveyor pan were bent inside, and just below that the side sheets of another conveyor pan were bent eastward. Lower down in this dip the side of a pan was bent eastward and to the south of that the side of another pan was bent westward. The chain of the conveyor in this dip was thrown out of the pans and was lying to the east of it.

SECTIONAL PLAN No. 28 OF APPENDIX I

Pieces of 1" pipe (no sign of damage) in 10 rise off 3 dip level were lying scattered. Some of them were also bent.

At the junction of 3 dip level with 9 dip off 2 dip level there was a pan upside down.

2 cap lamps were found in this level near its junction with 9 dip, and there was another oil lamp in 9 dip off 2 dip level. The chain of the conveyor in 9 dip was displaced towards the east in its upper end and towards the west at its lower end. The eastern side of a conveyor pan about 20 ft. to the north of the junction of 3 dip level and 9 dip was bent towards east. Another conveyor pan below it was bent towards the west. A conveyor pan at the bottom end was on edge facing towards west the side sheet bent westward. Below that there was a shovel bent westward. At the junction of 3 dip level 9 dip a conveyor pan was inclined towards east and there was another conveyor pan lying inverted. A little to the west of that the eastern side of the conveyor pan was bent towards east and the western side of the conveyor pan below that was bent towards the west. There were some broken props further west in 3 dip level.

Apart from the fall of a quantity of roof coal in 8 dip off 2 dip level and a best C.I. sheet lying in No. 8 rise there was no other sign of damage there. There were a few pieces of timber scattered in the dip.

There was no deadbody in this section.

Appendix 2A corresponding to Sectional Plan No. 29, which was not supplied

23 dead bodies and 21 lamps were found in this section. Details of damage are shown not in this plan.

SECTIONAL PLAN NO. 24 OF APPENDIX I

Broken props on main east loco level east of 7 rise, a lump from the brick stopping blown off from 7 dip off loco level lying a few feet to the south of the original stopping.

No signs of damage in 7 rise.

There were side falls on the northern side of the main east loco level between 7 rise and 6 rise.

There was a partly built brick wall for an aircrossing under construction covering almost the whole width of 6 rise except a portion on the east at its junction with main east loco level. On the eastern side a part of this brick was broken, and the rest of the brickwall was fractured and bulged out towards dip. Its top was broken.

There were broken props here and there on the main east loco level. The north side rail of the loco track had been pushed southward. The armoured cable was lying by the side of the track and at one place it was lying over the track. The pipe line was not much disturbed.

On 6 rise there were some falls from roof and sides.

A signalling bracket on the eastern side of 6 rise was bent to the dip side, and there was a tipping tub with its lower part missing. A door frame and two rollers displaced from their position to the rise were lying a little to the rise of the brick wall.

At the junction of main east loco level and 6 dip there was a fall and there were broken bricks blown off from the south side wall of the aircrossing under construction lying under the fall.

In 6 dip off main east loco level roof stone blasted from the junction for the construction of the aircrossing were kept stacked along the pillar sides and there was a fall in one place.

No dead bodies or lamps are shown in this section.

Lower down in 7 dip off 2 dip level there were some falls and the retaining wall at the junction of 2 dip level and 7 dip was blown down. There were a few pipes in this dip and a prop in position between No. 1 and No. 2 dip levels.

SECTIONAL PLAN NO. 23 OF APPENDIX I

In this section there are no dead bodies or lamps.

No signs of damage on main east loco level east of 5 rise except that the tracks were covered by roof falls. No coking was found from 5 rise. No sign of damage in 5 rise or 5 dip, of main east loco level except for some pans of the Shaker conveyor which was being installed in No. 5 rise were blown down to the loco level.

No sign of damage in 1 dip level except that there were two falls at some distance on either side of its junction with 5 dip. The props marked vertical were set during recovery. A number of props were found scattered in this level and in the rise.

On the main east loco level west of 5 rise and 5 dip wooden slippers nailed to the loco track had been pushed towards the west and both the northern and southern sides of damaged brick walls had coke deposits and the roof also was coked. There were two pans of Shaker conveyors on the track one over the other. The armoured cable going to No. 5 rise was found looped over the track near its junction with loco level.

SECTIONAL PLAN NO. 16 OF APPENDIX I

No dead bodies or lamps in this section.

On 2 rise level east of its junction with 7 dip the two rails of the track brought together and lay side by side and at one place the southern rail is under the northern rail. On the same level between 7 and 6 dips level the track appears to have been partly covered under roof fall.

The rail track proceeding north to south from the junction of 2 rise level and 6 dip off it appears to have been badly disturbed. At the junction the entire track was pushed bodily towards west. At the northern end a detached end of the eastern rail with fish plate and lower down the eastern side of the rail is above the western side of the rail, and about 10 ft. to the north of the northern extremity of this track a detached end of the western rail was found.

In 6 dip off 2 rise level soots were found on both sides. Lower down a signal bracket on the eastern side of 6 dip off 2 rise level was found pushed up towards the rise and made nearly straight. Further down, a signal bracket was twisted and bent to the rise.

At the southern end of this dip at its junction with 1 rise level there was a heap of bricks and there was also a broken piece of C.I. sheet. Here a signal bracket fixed to pillar side had fallen down with side fall.

The track proceeding south from the southern end of 6 rise off 1 rise level along 6 dip off 1 rise level was disturbed. There were detached ends of the track lying at the southern end of 6 rise off 1 rise level where it joins 1 rise level. At the fourway junction 2 rails of the track were thrown west and were lying only 2 inches apart.

There was a roof fall at the lower end of 6 dip off 1 rise level and a signalling bracket bent to the dip side.

On the western side of 2 rise level in this section the gallery was full of roof fall all through.

A piece of burnt wood was lying near the corner of north side pillar at the junction of 6 rise off 3 rise level.

SECTIONAL PLAN NO. 21 APPENDIX I

In the 4 dip level east of its junction with 2 dip there were 4 dead bodies found. There were also 4 lamps found. There was no dead body in No. 2 dip.

A loose conveyor pan to the north of the chain conveyor had its southern side flattened. The conveyor chain appears to have been dislocated from the track between 3 dip and 2 dip. At the junction of 4 dip level and 3 dip the conveyor has been pushed bodily to the dip and was standing almost vertical on side. At its junction with 2 dip conveyor drive head has been pushed into the dip and a length of about 20' had got disjoined from the rest. Armoured cable was also pushed into the dip at 3 dip junction. Conveyor chain was broken about 25 ft. east of 2 dip junction with the level. There was a charred vertical prop in 4 dip level. A pipe also was damaged.

The southern side of the level about 29 ft. to the east of its junction with 2 dip was coked.

In 2 dip near its junction with 3 dip level there was charred timber and there was a conveyor pan vertically on side but curved and side flattened. The conveyor chain in No. 2 dip was dislocated in the middle and also further northward. There were heaps of coke in the dip and there was some roof fall further northwards in this dip. Both sides of the conveyor pans were corrugated over a distance of 600 ft.

The whole length of the conveyor down to 3 dip was covered under thick coke.

SECTIONAL PLAN NO. 19 OF APPENDIX I

In this section no dead bodies or lamps were found.

On 2 dip level at its junction with No. 2 dip off 1 dip level the gallery was full of coke roof high.

The conveyor chain in No. 2 dip off 2 dip level was displaced in several places. There were timber pieces charred in this dip at different places. The western side of a conveyor was flattened at one point. There was a charred edge of an armoured cable on 2 dip off 2 dip level a few feet to the south of its junction with 2 dip level.

In 2 dip off 1 dip level a conveyor was covered with coke and the conveyor chain was coiled and badly displaced. Both sides of 2 dip off 1 dip level was coked.

The conveyor chain in 2 rise off 1 dip level appears to have been dislocated from its position, a conveyor pan was inverted, an angle iron of gate frame appears to have been detached and the leaf of the iron gate damaged badly. The iron gate frame at another place was also damaged badly.

SECTIONAL PLAN No. 18 OF APPENDIX I

Side coal both on the northern and the southern sides of main loco level between the cross-cut and 2 east dip was burnt. There were damaged brick walls on both sides of the loco level and there was no trace of a part of the track. There was heavy roof fall also here. A bolt was hanging and slightly bent towards east and another bolt was hanging from the roof and slightly bent toward the west. A third bolt was broken and only 3" root was out from the roof. Another bolt was bent slightly towards the west. There was another bolt which was broken and only 2" root was out from the roof. Several roof bolts hanging from roof bent towards west. Roof bolt channels fell down. About 50 ft. west of the junction of 2 rise and loco level ends of roof bolts were bent towards west but the channel irons fixed to the bolts were intact.

The northern side of the main loco level was at one place heavily burnt and this was visible on top of walling.

In 2 rise off main loco level the gallery was filled with debris roof high. Of two loose track crossing points one was standing on arm at one place and the other point lying vertical.

On the west side of 2 dip conveyor discharge end two loaded tubs were thrown off the track; the track itself was affected by violence so much so that the bolts of the fish plates were sheared.

At the junction of main loco level and 2 east dip coal was burnt to ashes and even shales and sand stone fused.

Two door leaves lying at junction of 2 rise and loco level. Two empty tubs, one at junction of 2 rise and loco level and the other about 30 ft. to the east of the junction, were lying upside down.

At the junction of 2 dip and main east loco level drive of a conveyor was pushed against west side pillar corner. Along this dip conveyor chain was thrown to the west and out of the pans. The pans were also dislocated at joints. Pieces of material e.g. iron door frame, angle iron, iron hook, sleeper etc., were scattered about.

No dead bodies or lamps were found in this section.

SECTIONAL PLAN No. 17 OF APPENDIX I

No dead bodies or lamps found in this section.

Heaps of coke, at some places roof high, filled 1 rise level both sides of which were coked between the cross-cut and 3 rise. There were heaps of coke in the cross-cut also both sides of which were coked all throughout.

The 3 rise gallery was also filled up with coke up to a height of 2' to 3'. Between 2 rise and 3 rise off 1 rise level both sides of 2 rise level were coked and was full of fallen roof coal.

SECTIONAL PLAN No. 14 OF APPENDIX I

In C rise from 3 rise level there was roof fall throughout. There was burnt wood on roof fall at one place.

On 4 rise level there were roof and side falls throughout.

Similarly, in 5 rise there were sides and roof falls throughout.

Both the eastern and the western pillar sides of 5 rise were coked and two wooden blocks on the eastern side were broken and charred.

In 4 rise also there was roof fall throughout.

No dead bodies or lamps found anywhere in this section.

SECTIONAL PLAN NO. 13 OF APPENDIX I

In 6 rise off 4 rise level there was roof fall throughout and there were broken pieces of C. I. sheets at some places. On the risemost level, which is the barrier level, there were broken props, broken pieces of wood and roof fall throughout from 6 rise to a distance of 360 ft. to the west.

In 5 rise off 5 rise level also there was side and roof fall all through. In 5 rise level also there was roof fall all through.

In 5 rise level rail joints of the track had opened out at a few places and the track itself was severely damaged. The rails were thrown together and were bent. Armoured cable was lying in loops and scattered all over the length. At its junction into 4 dip it was pushed into the dip.

At the northern end of this level near its junction with 6 rise off it there was a brattice not charred. There was also a plug for cable which was not charred.

There was no sign of coking noticed here.

In 5 rise off 4 rise level there was side and roof fall throughout.

Along 5 rise level between 5 rise and 4 rise and also eastward beyond 4 rise there was roof fall throughout.

In 4 rise off 4 rise level there was also roof fall.

There were no dead bodies or lamps in this section.

SECTIONAL PLAN NO. 12 OF APPENDIX I

In 5 rise level between 3 rise and 2 rise there was a certain amount of roof fall.

There was also roof fall on 3 rise and on 6 rise level, and there was a fall of roof coal on 2 rise.

There was one dead body and one lamp with an empty basket on 5 rise level about 40 ft. to the east of its junction with the connection between the sand stowing drift and 5 rise level. This connection proceeds upward for some distance and in that gallery 11 dead bodies were found with 9 lamps. There were 2 empty baskets, a.c.c. machine (not in operation) with two anchor props, some shovels with broken handles, a drill rod, mining sirdars testing rod, timbermain testing rod and a "Basula" (carpenter's tool) in this gallery.

There was roof fall in this connection and there were soots on both sides of the connection below its junction with 5 rise level.

Along 5 rise level commencing from 3 rise off at the track was severely damaged being pushed bodily both towards north and south of the gallery. The rail joints were opened out at a few places. Armoured cable was lying in loops and scattered with a connection wrenched open about 40 ft. west of 2 rise. Within 20 ft. of its junction with S.S. drift connection gallery there were a totally damaged tipping tub, a mine car with folded sides, a drill franel turned upside down, a gate-end box and an exploder.

SECTIONAL PLAN NO. 8 OF APPENDIX I

In the loco level.—Two dead bodies, with cap lamps, one in front of the air lock door and the other at the junction of the loco level and the curve gallery, were found. Starting from a distance of about 190 ft. to the east of air lock doors to a distance of about 90 ft. towards its west most of the roof bolts were bent towards west. Near the eastern end of this distance the channel irons fixed to the roof bolts were intact but on the western side the channel irons were also bent towards west. Midway within this distance one of the roof bolts was completely sheared whereas on the northern

side of the loco level leading to the curve gallery one such bolt was bent to the east and another one was not affected. There was severe fall of roof stone and roof concrete throughout the loco level. About 10 ft. west of its junction with curve gallery the main armoured cable was thrown towards the west around a rail crossing kept leaning against the northern side brick wall. The cable was totally burnt. Nearabout this place the load track on the south side was lifted and thrown towards the north and over the rise side track. In front of the air lock door there were two damaged mine cars and only the body of another mine car. About 25 ft. to the west of its junction with 2 pit east shaft level a roof girder was bent to some extent with its V pointing towards the west. About 13 ft. to the west of this girder another roof girder was severely bent with its V pointing towards the west.

In 2 pit east shaft level—near its junction with loco level both flaps of two air lock doors were badly damaged and were opened towards 2 pit. Similarly both flaps of two such doors near its junction with the step gallery were badly damaged and opened towards the pit. All the door frames were bent towards 2 pit. The space between the air lock doors was full of roof falls and a few pieces of burnt timber. The north side brick side-wall against the step gallery was pitted. 3" dia. compressed air pipe range was forced open from the connection and was lying across the gallery near the shaft bottom.

At 2 pit bottom—2 tipping tubs bodies were found on the landing with one body frame inside the other. There was a collection of timbers on the eastern side of the landing and the east side protection board had fallen down but the girders on which the board had been erected were intact and were in normal condition. The protection board was found under the south side cage. The whole pit bottom was full of debris. The landing sleepers were disturbed and thrown upwards. Two inner side guide ropes of both cages were interwound.

In 2 pit west shaft level—the bottom frames of two tipping tubs were found close to the pit. Several props were found standing upright and a large number of timbers had collected elsewhere. The roof had fallen down at a few places. A cog at the junction of the shaft level and the west step gallery was not disturbed.

In the east step gallery—connecting 2 east shaft level of 1 dip level the side brick walls had fallen down and also elsewhere the pillar sides had fallen down. It was partly filled with coke.

In 1 dip level—there was fall of roof and sides at a few places. Pieces of timber were found at a number of places. One broken prop was found near zero dip junction.

In the zero dip—from its junction with 1 dip level a pipe range was intact. To the rise of the level there were two angle irons and the roof had fallen down.

In the loco garage—three girders were bent towards 2 pit and one girder near the buffer and was also slightly bent towards the west. Lighting cable along with both sides of the garage was found fixed to the side-walls but the Bulk-head lights were broken. A container of diesel oil was found intact in a manhole. The coupboard doors on the south west side were blown off the hinges and the leaves were pushed inside. One of the door leaves of the north east side coupboard was pushed inside and the other leaves were pushed outside. The brick walling inside the coupboard was totally damaged. Near the buffer end the roof concrete had blown down and was hanging there.

After first explosion.—No 2 pit signalling arrangements were damaged. Two tipping tubs had been blown from the West shaft level of No. 2 pit on-to the bottom landing and the cages were landing over them in a tilted position. The air-lock door had been blown in towards No. 2 pit and were damaged. The protection board was also damaged.

No. 2 pit bottom was strewn with bricks and timber. Dislodged timbers and mine cars were blocking the passage through the air lock. On the loco level, near the air lock, one dead body, the stomach of which was extending and part of a second dead body nearby were noticed. Slightly to the west of the air lock along the loco level a 12"x6" girder was found bent in the shape of a 'V' with point of 'V' pointing westward. The concrete roof along with west loco level had fallen down at a number of places. The chain guard of

2 dip scraper conveyor was found in front of the air lock on the loco level. The Belmos of 2 pit conveyor was noticed lying near the sub-station.

The air lock doors of the loco garage had opened towards 2 pit and concrete roofing had also fallen down at some places.

SECTIONAL PLAN No. 5

At the junction of west step gallery and 1 dip level there were a broken regulator, a switch frame, a tri-junction cable box, a pump, a length of pipe line and a few pieces of timber.

At the junction of 1 dip level and 2 west dip a pump was lying turned upside down. About 10 ft. to the east of the junction a prop was standing intact against the dip side pillar. A cable starting from a distance of about 15 ft. from 2 west dip was lying on the floor up to the junction of west step gallery and 1 dip level.

In 2 dip level—a number of timbers and props were found collected at its junction with 2 west dip.

In 4 west dip—a pipe range was intact from the rise up to the junction with 1 dip level. At this junction a length of pipe range was thrown towards east. Further down in the dip the pipe range joints were wrenched open at two places. At the junction of 4 west dip and 2 dip level there were a joint box, a broken piece of pipe length and a piece of C.I. sheet. The roof had fallen at this junction.

There was no dead body or lamp found in this section.

SECTIONAL PLAN No. 9

In this area five dead bodies, two cap lamps and three flame safety lamps were found at the bottom of 1 pit. Another cap lamp was found in 1 pit east shaft level about 90 ft. east of the shaft.

In the tangent gallery—branching off the loco level there was not much damage excepting that the electric blub and outside cover of 2 Bulk-head lights were broken and the lighting cable was thrown from its side-wall fixing onto the floor. A part of the concrete roofing close to its junction with the curve gallery was damaged. At the junction of the curve and the tangent galleries the top of the corner brick wall was cracked.

Along the curve gallery—branching off the loco level Bulk-head light fittings were damaged and the lighting cable was thrown on the floor. Up to its junction with the tangent gallery the concrete roofing had cracked. Two mine cars were on the track. From its junction with the curve gallery up to its junction with 1 pit east shaft level concrete roofing slabs had broken partly or wholly in different sections and had fallen down. There were six mine cars thrown off the track and four empty cane baskets.

In 1 pit east shaft level—from its junction with the bye-pass towards the east the roof girdars were bent downwards in the middle and were very slightly bent towards the east whereas from its junction towards the pit two roof girdars were pushed slightly towards the pit. The first roof giridar near the pit bottom was pushed towards the east and its top was inclined towards the pit. At the junction of the bye-pass and the shaft level the eastern side of the roof giridar was pushed out of the side wall onto the level gallery. The glass cover of a Bulk-head light fixed on the southern side-wall near the junction of the bye-pass and the shaft level was intact whereas both the bulb and the glass cover of a similar light fixed on the northern side wall opposite to the former were intact. The lighting cable fixed on the southern side wall was fused. At the junction of the curve gallery and east shaft level top of two masonry pillars were cracked and bodily shifted by a slight extent.

At the bottom of 1 pit—both east and west side protection boards had fallen down. The south side cage was at the pit bottom. Its side sheets were bent towards east and west. Six mine cars were blown from the east side empty line into the shaft and one upturned tub was found on the west side. One loaded tub was half out of the south side cage towards the east side. In the west shaft level of 1 pit up to its junction with loco level 11 roof girdars out of 16 were slightly bent towards 1 pit. The other five were undamaged. A Bulk-head light on the southern side of the level near the pit bottom had its blub, glass and outside cover broken whereas the one opposite to it on the

eastern side was in good condition. A similar bulk-head light near the junction of the shaft level and loco level had its outside cover broken.

In the bye-pass—connecting east and west shaft levels of 1 pit lighting cable on the west side was torn and burnt. The concrete roofing had broken and cracked at a number of places.

This section covers the loco level between the curve gallery and its junction with west shaft level of 1 pit and shows considerable damage. A slight distance both to the east and west of the junction of curve gallery and loco level parts of body were found. Two roof girdars at this junction were bent towards the west of which reference has already been given in description of sectional plan no. 8. One of the girdars was apparently hit by something and was punctured. Most of the girdars were bent in the middle and had fallen down. The roof concrete was badly damaged practically all throughout and had fallen down. Stone roof above the roof concreting had also fallen down at places. From the junction of the loco level and 1 pit west shaft level up to a distance of about 140 ft. a number of girdars were bent towards the west. The bending of the girdars towards the west progressively decreased from 10" bent near the junction of loco level and 1 pit west shaft level to a slight bent at a distance of about 140 ft. from the junction. Bulk-head fittings were badly damaged. One girdar at the junction of loco level and 1 west shaft level was lifted from its support on a masonry pillar and was thrown bodily towards east. About 30 ft. to the west of the junction of the loco level and the loco garage there were two mine cars. One of the cars was standing on edge and the other one was inverted. One gate and box was found in front of the sub-station.

In the sub-station—situated about 70 ft. to the west of the junction of loco level and curve gallery the switches were intact. In the sub-station there were three expanded metal doors. In the middle door the door leaves were pushed out and one of them was pushed towards east and other towards the west. Of the other two doors the leaves were damaged and pushed inside.

After first explosion.—At No. 1 pit bottom, the concrete protection roofing had been damaged and had fallen along with west side supporting girdar over a part of the south side cage which was then at the pit bottom. A number of loaded and empty mine cars had been blown into the pit bottom which prevented the cage from being raised. The cage had got distorted. There was no damage on the empty line and in the tangent gallery.

SECTIONAL PLAN No. 4

No. dead body was found in this section. A cap lamp was found in 2 rise close to its junction with main west level. From the junction of main west level and 4 rise up to its junction with 1 pit west shaft level the side brick walls were badly damaged. It had fallen down at a number of places on both sides of the galleries and at places it was damaged and still standing. Between its junction with 2 rise and 1 pit shaft level the roof concrete slabs had broken and fallen down. Within this length of the level some roof girdars were pushed towards the west and some towards the east and quite a number of them were bent downwards and were hanging from the side support on one end. At the junction of the level and 2 west rise big lumps of masonry work apparently blown from the side walls were lying over debris. There was a collection of timbers and rails at this junction. A switch was lying inverted here. Part of an armoured cable was lying connected to a T-joint box. About 15 feet to the west of this junction there was a tipping tub and further to the west there was a collection of a large quantity of timbers. A large number of timbers had also collected in a partly driven X-cut gallery off Main West level between 2 & 3 rises. About 70 feet to the east of the junction of main west level and 3 rise a number of roof girdars were in position and in good condition. There was a tipping tub, about 30 ft. to the east of this junction. One side of the tub was bent westward and other side eastward. At the junction of 3 rise and main west level there was debris of concrete roofing of an air-crossing. There were 3 girdars at this air-crossing. Two girdars were bent in the middle and one was lying east and west. The tub frame of a tipping tub was slightly exposed at this junction. Another inverted tipping tub body was lying about 12 ft. to the west of the junction and the frame was lying close to it. Part of the north side brick wall of the air crossing at this junction was not damaged. About midway between the junction of main west level and 3 and 4 rise wire-netting fixed against the roof was intact excepting that its western

end was bent both to the east and west. At the junction of main west level and 4 rise a gate-end box was lying on its back with top facing north. Within 20 ft. of this junction the armoured cable was torn. The drive head of a chain conveyor in 4 rise was thrown towards east. There was an unburnt loin-cloth at this junction. Further to the west of this junction there was a roof fall and a collection of timbers. A pipe line was undamaged over a length of about 100 ft. on both sides of this junction.

At the junction of 3 rise and 1 west level an air crossing (not in function) was demolished. One girder was lying at the junction and part of another bent girder was visible. There were a few pieces of 3", 4" and 6" diameter water pipes. At the junction of 1 west level and 4 rise the chain conveyor was thrown towards east. The pans were opened at the joints and were tilted towards the east. One conveyor pan was bent and broken. A crane with the frame thrown over debris was found at the junction. There were a few pieces of pipes.

In 4 rise between main west level and 1 west level conveyor chain was thrown off the pans and the conveyor was blown towards the east at both the junctions. A few loose conveyor pans were near the rise end. A 4" pipe line was intact till within a distance of about 30 ft. from the junction of 4 rise and 1 east level. Within this distance of 30 ft. the pipe range had opened out at a few joints.

In 4 rise off 1 west level the dip end of the conveyor had been pushed towards east. The chain was thrown out of the pan at a distance of about 30 ft. from the junction.

After first explosion The air crossing at the junction of main west level and 3 rise was completely demolished. Near the stone gallery between 2 and 3 dips, cogs had been knocked down and also some fall had taken place.

SECTIONAL PLAN No. 4A

In this section there were six dead-bodies including that of the mining sirdar, Jiblal Singh. 5 cap lamps and two flame safety lamps were found.

In the main west level between Nos. 5 and 6 rise the track was severely damaged. The rail joints were opened at a few places. A large number of timbers were scattered all over. A pipe line along this length of the roadway was severely disturbed. At places the joints had opened out. The mining sirdar's testing rod was found about 50 ft. to the west of 5 rise junction though his body was found in 6 rise. A chappal and a timber mistry's testing rod was found near 4 bodies about 80 ft. to the west of 5 rise junction. There was a severe roof fall at the junction of main west level and 6 rise.

In 5 rise bricks blown from a stopping was scattered all over.

In 6 rise a shaker conveyor was not much disturbed excepting that near the rise end from a point about 40 ft. to the dip with its junction with 1 west level the end had moved slightly towards west. The pans from a distance of about 60 ft. from its junction with main east level were tilted towards the east. At the junction of 6 rise and 1 west level the frame of a tipping tub was lying against the south west pillar corner and the body of the tub lying apart from the frame was badly damaged. There were two undamaged C.I. sheets. One of the rails at this junction was pushed towards north.

In 1 west level the roof had fallen down at a few places. There were a number of timbers lying scattered or heaped over this length of the roadway. Starting from a distance of about 100 ft. from its junction with 6 rise to its junction with 5 rise there had been a number of roof bolts. These roof bolts were bent towards all directions i.e. some were bent to the east, some to the west and some to the dip. Also some of the bolts were damaged and some were intact.

After first explosion—Practically no damage was noticeable in the Main West shaft level to the West of 4 rise. The brick wall partition in the Main West level to the West of 6 rise was intact. Between 5 and 6 rises off Main West level, there were 4 dead bodies. In 6 rise off Main West level dead body of Jiblal Singh, the Mining sirdar of the district, was found leaning over the compressed air pipe, almost half way in 6 rise gallery.

SECTIONAL PLAN No. 3

No dead bodies or lamp were found in this section. In 4 rise off 1 west level there was a coal cutting machine, a joy loader and a shaker conveyor. At its junction with 2 west level there were a belmos switch and another switch lying on front cover. A drill panel was lying on its back about 18 ft. to the east of the junction. The cable was lying loose.

In 3 west dip there was a length of drill cable and a short length of armoured cable. The drill cable was coiled at its junction with 22 level.

SECTIONAL PLAN No. 2

At the junction of the cross cut and 3 west dip the roof had fallen down. There was a coal cutting machine, an anchor prop, a drill machine and a length of cable lying coiled.

SECTIONAL PLAN No. 1

In the stone drift branching off the main sand stowing drift there were eleven dead bodies. One body was found right near the junction of the two drifts, two bodies were at a distance of about 100 ft. from the junction; five bodies at a distance of about 150 ft. from the junction; another body at a distance of about 180 ft. from the junction and two bodies were found close to the face. Five cap lamps and flame safety lamps were found in this gallery. Two tipping tubs coupled together and attached to the haulage rope were standing on the track. Two shovels, a stemming rod, an air drill, a drill rod and a scraper were found near the face. A pair of shoes and a mining sirdar's testing rod were found close to two dead bodies about 100 ft. from the junction of the two drifts. A 3" pipe line was intact and the ventilation partition of C.I. sheets was undamaged. An angle iron had been thrown into the stone drift and was lying across the gallery close to its junction with S. S. drift. The overman S. N. Sukul's body was found in this gallery.

SECTIONAL PLAN No. 7

No dead body or lamp was found in this section.

In the Zero dip between 2 and 3 dip levels a water pipe line was intact throughout excepting for a distance of about 35 ft. at the dip end. A heap of fallen bricks was lying against west side pillar near the junction of this dip and 3 dip level. A few timbers were found lying on the floor. A C.I. sheet piece was found at the junction of this dip and 2 dip level.

In 3 dip level nothing was shown to have been found excepting that both sides of the level were packed.

Only a part of 2 dip level was shown. Near about the junction of this level and 2 west dip a fairly large quantity of timbers were found collected.

In 2 west dip between 2 and 3 dip levels only one C.I. sheet was found. To the dip of 3 dip level a plank, an empty basket and a few timbers were found. 3 props were standing vertical near the northern corner of the pillar at the junction of this dip and 4 dip level.

SECTIONAL PLAN No. 6

In this section one dead body and a cap lamp were found at the junction of 4 west dip and 4 dip level.

In 2 dip level a large number of timbers were found collected at its junction with 2 west dip. Further to the west of this junction there were a few timbers lying scattered and 4 pieces of C.I. sheet.

In 3 dip level there were no signs of violence excepting that a few timbers were found lying scattered. The roof had fallen down at a place about 50 ft. to the west of the junction of the level and 2 west dip.

In 2 west dip between 2 and 3 dip levels only one piece of C.I. sheet and 3 loose timbers were found.

In 4 west dip a water pipe line was intact up to a distance of about 80 ft. from its junction with 3 dip level. From this point the pipe line had been bodily moved till it reached a distance of 35 ft. from the junction. Within a distance of about 35 ft. both to the rise and dip of its junction with 3 dip level

the pipes were opened out from the joints and were lying scattered. It was intact for a distance of about 60 ft. to the dip and then again at its junction with 4 dip level pipes were opened out from the joints. There were a large number of timbers all over the dip gallery. A displaced switch was found at a distance of about 30 ft. to the rise of the junction of this dip and 3 dip level. There was one pump about 40 ft. to the dip of the junction and another one about 60 ft. to the dip. A cable was found lying on the floor along this dip right throughout and was disturbed all over. Another piece of armoured cable was found from the junction of this dip and 4 dip level upto the first pump.

In 4 dip level there were a few timbers and pieces of water pipe at its junction with 4 west dip. A dead-body and a cap lamp were found at the junction. A cable was found lying on the floor and also looped at one place.

APPENDIX V

Accumulation of gas and coal dust noticed in inspections of Chinakuri pits 1 & 2 held by the Mines Inspectorate during the year immediately preceding the accident.

INSPECTION, DATED 7TH JANUARY 1957 (FLAG 1).

1. *Gas.*—Gas detected in a roof cavity of Main W.L., 3 R in 2 E dip Section and 5 R in E rise Section. On advice men withdrawn from the return side of 3 R in 2 E dip Section.

Management warned to make ventilation adequate at the faces, otherwise employment will be stopped by an order under Section 22(3). Measures suggested to provide C.I. sheets in place of brattice, ventilation screens to be kept advanced up to 10 ft. from all rise galleries of 15 ft. from all level gallery faces and assistants to maintain adequate ventilation in each shift.

Agent replied that gas has been cleared from the places pointed out and suggested measures were being complied with.

Coal dust.—Accumulation of coal dust at discharge ends of conveyors and under pans. Warned issue of order under Section 22(3) unless suitable action taken.

Agent replied that water sprays provided at conveyor discharge ends and intermediate points in addition to wetting of coal at the faces. Replies satisfactory results with the steps taken.

INSPECTION, DATED 2ND, 9TH, 10TH & 22ND APRIL, 1957 (FLAG 2).

2. *Gas.*—Detected in top level of 5 rise section and three other faces. On the advice of Inspector persons withdrawn from level and return side of the level. Disciplinary action suggested against supervisory staff.

The Agent replied suspension of overman for 10 days and assured that such conditions will not recur.

Coal dust.—No stone dusting in the working faces in 3 and 7 dips.

The agent replied that the mining sirdar concerned has been warned.

Reports.—The entries in gas report book, daily inspection book and shotfirer's book did not tally and dust analysis register not up to date after December, 1956.

Agent replied steps taken to remedy the defects.

INSPECTION, DATED 15TH JUNE 1957 (FLAG 3).

3. *Gas.*—Not detected anywhere.

Coal dust.—Film of dust over stacked dyke stone at places. Manager agreed to the Inspector to take certain additional steps regarding provision of sprays and take help of natural make of water in the mine to course along conveyor pans as well as to remove stacks of stone to surface.

The agent replied compliance.

INSPECTION, DATED 4TH JULY 1957 (FLAG 6).

6. *Gas.*—None detected in west. Slight traces in 5 rise section. Men engaged to extend brattice. Other faces free. Management not addressed or gas.

Coal dust.—Watering arrangement in 5 rise conveyor not adequate.

In reply the agent informed that the conveyor had been dismantled.
INSPECTION, DATED 9TH AUGUST, 1957 (FLAG 7).

7. *Gas.*—None in west section and ventilation good. 2 per cent. in 3 dip and near a dyke in 4 dip; in a pocket in main E level immediately after blasting. Inspector advised manager to extend brattice within 10 ft. a face just after blasting and not to allow men to enter immediately after blasting and till the face is found free from gas.

The agent replied compliance.

Coal dust.—No stone dusting in roof and sides in almost all sections. No spray in 10 dip conveyor. Coal dust over coggng pieces.

Agent replied stone dusting done on roof and sides and cleaning of coal dust from coggng pieces. Assured efforts to prevent production of coal dust at conveyors.

INSPECTION, DATED 20TH AUGUST, 1957 (FLAG 8).

8. *Gas.*—None detected.

Coal dust.—Coal dust not cleaned from pillar sides in tugger rise (5 rise district). Intake airway of 5 rise kept clean of coal dust and roadways stone dusted. 2 dip conveyor spray not working.

The agent replied compliance of stone dusting on the pillar sides. Stated that due to shifting of dip pump 2 dip conveyor spray could not be worked.

INSPECTION, DATED 16TH SEPTEMBER, 1957 (FLAG 9)

9. *Gas.*—Traces of gas detected over concrete roofing in Main West level. Manager was advised to provide hurdles and to arrange regular checking of gas at that place.

The agent replied compliance.

INSPECTION, DATED 30TH SEPTEMBER, 1957 (FLAG 10).

10. *Gas.*—Not detected.

Coal dust.—Coal dust near discharge and 2 dip conveyor. Management warned for repeated contravention.

Agent replied cleaning of coal dust and through stone dusting in 2 dip area.
INSPECTION, DATED 23RD NOVEMBER, 1957 (FLAG 11).

11. *Gas.*—Detected at 10ft. from 13 rise face, main east level face, in a pocket in 5 W.L. off 9 dip. The agent was warned on telephone the same day. In letter inadequacy and slackness in the night shift pointed out. Disciplinary action recommended against overman and shotfirer. Also recommended employment of 2 overman and a Second Class night assistant.

In reply the agent reported warning to overman and shotfirer and on further enquiry reported that a Second Class night assistant and two overmen had been employed.

Coal dust.—Coal dust in loco level inbye of 2dip, discharge end of loco level conveyor, at discharge end of 9 dip conveyor and under pans, no spray in 9 dip conveyor and fresh layer of dust on supports. The agent was warned on unsatisfactory treatment of coal dust and asked for considered explanation.

In reply he stated that the mine split into different zones and each zone is treated for coal dust separately.

Arrangements made for water spray at conveyor loading points. Particular attention paid on roof and sides of galleries for cleaning and stone dusting.

INSPECTIONS, DATED 8TH, 13TH 21ST AND 23RD JANUARY, AND 6TH, 11TH AND 17TH FEBRUARY, 1958 (FLAG 14).

14. *Gas.*—Detected 2 per cent at 1 E level face. Gallery entrance fenced off. Also detected in E sump connection gallery. At a few places brattices not extended right upto face.

Management not addressed but on subsequent inspection Inspector was informed that gas was removed.

Coal dust.—Coal dust found at a few places in E district.

SUPPLEMENTARY NOTE DATED THE 23RD SEPTEMBER, 1958
SUBMITTED BY MR. JUSTICE S. N. GUHA ROY

On the 19th September last, Mr. Wright of M/s Andrew Yule and Co. Ltd. saw me in my chamber in the High Court by appointment and told me that they had received certain answers to certain queries they had made, from the manufacturers which the Court of Inquiry should consider. I informed him that I had already signed my report and probably by then it had also been despatched and that in any event, if my Bench Clerk were still at Sitarampur the queries and the answers could be handed over to him in order that he might send the same to the Government. Mr. Wright also asked me if he could send a copy of the queries and the answers to or Whitaker and I said I had no objection to that. I do not remember if he asked me whether he should send a copy also to Shri S. C. Samanta, the other assessor. There the matter rested on the 19th.

On the 22nd, my Bench Clerk saw me at my house and told me that the queries and the answers were submitted on behalf of the owners and that the record had not been despatched yet because he had been asked to send the same to the Government instead of making it over to the Department of Mines and he thought it inadvisable to send it by railway parcel. He accordingly sought for my instructions and I told him it would be better if he could personally go to Delhi with the record, and make it over to the appropriate department of the Government of India. As he is somewhat indisposed at the moment, he proposes to go Sitarampur this weekend and from there to take the record to the Government.

As the view of Dr. Whitaker that the loco, particularly when its air inlet was without its flametrap, was a likely source of ignition, emerged at a very late stage of the inquiry so that the owners did not get a full opportunity of meeting that, I think it is only fair that the reply of the Manufacturers to their queries should be considered for what they are worth. As Dr. Whitaker has expressed his views I should express mine also.

The question put to the Manufacturers was whether the engine would continue to fire after the fuel control was closed if—

- (a) it had been running in an increasing percentage of methane for some time;
- (b) it had been running in a decreasing percentage of methane for some time;
- (c) it had suddenly come into a mixture of 10% to 12% methane air.

The answer is as follows: "(c) negative, (b) negative, (a) unable to say for reasons mentioned para 2/3 in letter second".

As the loco was on the intake side, a part only of the gas released by the outburst was likely to back up against the intake air in that region, so that the conditions in which the loco would be running, if it was running at all, say within 20 or 30 minutes of the outburst are more likely to be those envisaged in question (a) than either of those contemplated in (b) and (c). The reason is that the part of the gas backing up against the intake air would take a little time to reach the higher limits of the explosive range so that the percentage of methane in the mixture will rise gradually. If that be so, the manufacturers' inability to answer (a) leaves the matter exactly where their letter dated the 2nd September last had left it, so that there is hardly any occasion for a modification of the views expressed in my report about the loco being a probable source of ignition. Two questions which occur to me in this connection are:

(1) If the loco is perfectly safe in all circumstances even without a flametrap for the air inlet, why did the Manufacturers at all take the trouble of providing one for the air inlet in the specifications?

(2) Why did the Manufacturers say in their cable reproduced in their letter dated the 2nd September 1958, 'Airmixture could induce uncontrolled acceleration causing driver shut off fuel but before ignition of methane. Airmixture terminated by shutting off fuel blowback down inlet manifold could occur which would be suppressed by inlet flametrap'? To these questions I could find no answer and consequently I am inclined still to adhere to the views expressed in my report.

(Sd.) S. N. GUHA ROY.

23-9-58.

[Shri S. C. Samanta and Dr. J. W. Whitaker agree with the views expressed in the above note.]

[No. MI-5(45)/58.]

SUPPLEMENTARY NOTE DATED THE 23RD SEPTEMBER, 1958
SUBMITTED BY MR. JUSTICE S. N. GUHA ROY

On the 19th September last, Mr. Wright of M/s Andrew Yule and Co. Ltd, saw me in my chamber in the High Court by appointment and told me that they had received certain answers to certain queries they had made, from the manufacturers which the Court of Inquiry should consider. I informed him that I had already signed my report and probably by then it had also been despatched and that in any event, if my Bench Clerk were still at Sitarampur the queries and the answers could be handed over to him in order that he might send the same to the Government. Mr. Wright also asked me if he could send a copy of the queries and the answers to or Whitaker and I said I had no objection to that. I do not remember if he asked me whether he should send a copy also to Shri S. C. Samanta, the other assessor. There the matter rested on the 19th.

On the 22nd, my Bench Clerk saw me at my house and told me that the queries and the answers were submitted on behalf of the owners and that the record had not been despatched yet because he had been asked to send the same to the Government instead of making it over to the Department of Mines and he thought it inadvisable to send it by railway parcel. He accordingly sought for my instructions and I told him it would be better if he could personally go to Delhi with the record and make it over to the appropriate department of the Government of India. As he is somewhat indisposed at the moment, he proposes to go Sitarampur this weekend and from there to take the record to the Government.

As the view of Dr. Whitaker that the loco, particularly when its air inlet was without its flametrap, was a likely source of ignition, emerged at a very late stage of the inquiry so that the owners did not get a full opportunity of meeting that, I think it is only fair that the reply of the Manufacturers to their queries should be considered for what they are worth. As Dr. Whitaker has expressed his views I should express mine also.

The question put to the Manufacturers was whether the engine would continue to fire after the fuel control was closed if—

- (a) it had been running in an increasing percentage of methane for some time;
- (b) it had been running in a decreasing percentage of methane for some time;
- (c) it had suddenly come into a mixture of 10% to 12% methane air.

The answer is as follows: "(c) negative, (b) negative, (a) unable to say for reasons mentioned para 2/3 in letter second".

As the loco was on the intake side, a part only of the gas released by the outburst was likely to back up against the intake air in that region, so that the conditions in which the loco would be running, if it was running at all, say within 20 or 30 minutes of the outburst are more likely to be those envisaged in question (a) than either of those contemplated in (b) and (c). The reason is that the part of the gas backing up against the intake air would take a little time to reach the higher limits of the explosive range so that the percentage of methane in the mixture will rise gradually. If that be so, the manufacturers' inability to answer (a) leaves the matter exactly where their letter dated the 2nd September last had left it, so that there is hardly any occasion for a modification of the views expressed in my report about the loco being a probable source of ignition. Two questions which occur to me in this connection are:

(1) If the loco is perfectly safe in all circumstances even without a flametrap for the air inlet, why did the Manufacturers at all take the trouble of providing one for the air inlet in the specifications?

(2) Why did the Manufacturers say in their cable reproduced in their letter dated the 2nd September 1958. 'Airmixture could induce uncontrolled acceleration causing driver shut off fuel but before ignition of methane. Airmixture terminated by shutting off fuel blowback down inlet manifold could occur which would be suppressed by inlet flametarp'? To these questions I could find no answer and consequently I am inclined still to adhere to the views expressed in my report.

(Sd.) S. N. GUHA ROY.

23-9-58.

[Shri S. C. Samanta and Dr. J. W. Whitaker agree with the views expressed in the above note.]

[No. MI-5(45)/58.]