2
Working in the Tunnel

For fifty years the four slowly revolving Westinghouse turbines of the Hawk's Nest power station have provided electrical power to the plant at Alloy. Their antiquity could justify enshrinement in a museum of technology, but their nearly perfect continuous performance has proved beyond doubt that the project was planned with great care and attention to detail by Union Carbide's engineers and executed, under their supervision, with remarkable efficiency by the staff of Rinehart and Dennis. Inspection of the dam, the power station, and the other structures above ground shows that both companies exercised mastery of their crafts and a strong sense of responsibility to maintain the highest level of quality. Though it is impossible to examine the materials or workmanship that were expended inside the tunnel, the continuing flow of water, undiminished by significant collapse or obstruction, demonstrates that here as well engineers and contractor did not stint on materials.[1] Were it not for the dark stain of sickened lungs, the Hawk's Nest Tunnel would be recalled as a grand artifact of the civil engineer's craft.

What of these companies' responsibility to the workmen who made loyalty to these principles possible? To judge that question fairly, it is necessary to investigate, as closely as is possible, just how the tunnel workers lived and labored.

If visibility in the tunnel was clouded by dust, as many workers claimed, a true picture of the working conditions that prevailed there is equally difficult to discern. Although reconstructing the character of life outside the tunnel is hardly easier, that aspect of the workers' existence was less a subject of controversy, so it is simpler to begin there. Little of the evidence can be reliably confirmed. Much of it consists of anecdotal testimony from court proceedings and the House

Committee investigation, in which the informants were mostly litigants against Rinehart and Dennis. These are supplemented by personal interviews with tunnel survivors and, with great caution, by descriptions found in Skidmore's *Hawk's Nest*, published in 1941, seven years after completion of the tunnel. Whatever feeling of authenticity the accounts convey results from frequent repetition of the details.

Company towns had been commonplace in West Virginia for decades. Because of the relative inaccessibility of most coal mines in the sparsely populated mountain regions, housing was not to be found unless it was provided by the mine owners. Because the sites of the Union Carbide operations all lay along a major river, they were less isolated. The town of Gauley Bridge, across from the tip of the oxbow where the Gauley River joins the New, converting it into the Kanawha, was only a mile or so from the power plant. Upriver at Hawk's Nest, where the smaller Mill River flows into the New, was the town of Ansted, not far from the dam and Shaft 4. Both towns provided a limited amount of housing, where, as in most small towns in the state, whites were more welcome than blacks. For local white miners there was some housing to be had in a few small mining camps, now long dead, that bore names like Vanetta and Gamoca. Some inexpensive housing, built earlier for black workers by the Electro-Metallurgical Company, was available in Glen Ferris for married workers and their families, but it was readily accessible only to workers from Shaft 1 and was in any case not nearly enough to provide for the many wives and children who had accompanied black workers to the area.

The total number of beds that could be occupied by blacks in the towns was minimal, and insufficient even for the whites. At any one time more than a thousand men were employed on the tunnel, power station, and dam. There were also New Kanawha staff, the retinues of the subcontractors, and an incalculable reserve of poor men waiting for a job to come free. Therefore Rinehart and Dennis had to follow the custom of building camps for their workers. Three were constructed. Camp 1, located on a picturesque point of land that protruded into the New just upstream from the power plant and Shaft 1, housed 250 to 275 men. Camp 2 served for about 150 workers, who worked in the nearby Shafts 2 and 3. Camp 3, for 350 workers on the dam and in Shaft 4, was built on the outskirts of Ansted.

Sleeping and dining facilities in the camps were both segregated. The shacks for both black and white workers were crudely built and covered with tar paper, with two rooms and a total space of 100 to 150 square feet. All were furnished with two-man bunks. But the accommodations within were quite different. Shanties for white workers boasted electricity and no more than one bunk in each room, four men to a shack. Shanties for blacks had no electricity and normally held two or three bunks per room. Overcrowding was common, and

there are many accounts of more than ten men occupying a single shack. Some white workers recall that for the blacks a single bed might serve two men, one each from the day and night shifts, but surviving black workers do not confirm this. Rumor had it that, because there were no accommodations for women and children in the camps, which were predominantly black, workers who housed families in the towns were also required to pay shack rent at the camps. And in the novel *Hawk's Nest* black workers were forbidden to eat in the shacks and thus had to buy expensive and nutritionally worthless food in the commissary dining hall. These reports, too, black workers today deny. How many such reports of black humiliation should be laid to white contempt and how many denials to black embarrassment is impossible to judge.

Costs of room and board are equally subject to controversy, though between different antagonists. Contemporary representatives of management claim that no rent was paid for shacks and insist that housing was provided free because it was necessary to carry on the job. It is possible, even likely, that managerial staff did enjoy such perquisites and therefore recall nothing of rents. Nevertheless, Phillipa Allen, a social worker from New York, and other observers from outside the area listed a variety of expenses. They recorded that separate accounts were kept for bed linens, coal, and a stove. A shack rented for fifty cents a week, coal cost twenty-five to fifty cents, and electricity, where it was provided at all, was twenty-five cents. These charges were apparently levied to each worker, regardless of the number of occupants in his shack.[2] A surviving black tunnel worker concurs in general with this report, saying that total costs of room and board were about six dollars a week. This would have amounted to about half the weekly salary of a laborer, a quarter of that of a driller.

Effective segregation prevailed in local communities as well as in the camps, but there the victims were white as well as black. Residents of Gauley Bridge, an old, established community and the largest town in the area, traditionally felt superior to their rural neighbors. Even today such residual contempt is commonly directed in West Virginia coal counties toward the "poor coal miner," who is seen either as secretly well off or as too profligate to invest his ample income toward a more secure existence. Gauley Bridge, removed by only one county from Cabin Creek and the violent Mine Wars of the 1920s, represented in the eyes of its own inhabitants a more stable way of life than that found in the mining towns. Disdain for the miners, many of whom were migrants, was easily extended to the migrant tunnel workers.

This disdain was greatly intensified when directed at black migrants. Initially, optimism ran high in expectation of revenues from the expanded population to be lured by the tunnel project. But when a horde of underpaid blacks could not produce such revenues, local attitudes

hardened to something more customary, and more ugly. Among white workers surviving from that period, and among other residents, stories of the "coloreds" and the "niggers" still abound. The fact that black work camps were strictly off limits even to those whites who lived in close proximity to them may have contributed significantly to such feelings of contempt and suspicion.

In popular lore, black workers used a nearby railroad tunnel to store massive caches of contraband stolen from the Chesapeake and Ohio railroad as cars slowed to pass through Gauley Bridge. Several residents recall the erection of a burning cross above Camp 1, a threat that led to the departure of many black workers. Since Fayette County has not been recognized as an area of Ku Klux Klan activity, this must have been an improvised attempt to intimidate tunnel workers.

Yet life in town and camp were not so tightly sealed off from one another as might at first appear. Some of the hostile anecdotes typically related at the expense of the blacks suggest the complicity of local authorities in some of the most notorious excesses of camp life. Rinehart and Dennis retained as an enforcement officer, informally called a "shack rouster," a Georgian named McCloud, who was assisted by a black camp overseer called Big John. McCloud carried firearms and a club. With these he is said to have forced black workers to vacate the camp at the start of each work shift. According to a surviving black tunnel worker, beatings were routinely administered as part of this early morning ritual: "The camps of the colored men were not close to the camps for the white men. If a colored man was sick and really couldn't go to work in the morning, he had to hide out before the shack rouster came around. That fellow had two pistols and a blackjack to force men to go to work."[3]

McCloud's authority was based on his deputization by C. A. Conley, the sheriff of Fayette County. Several local people, tunnel workers and others, tell a consistent story of Sheriff Conley, Deputy Sheriff McCloud, and the Fayetteville Court. McCloud ran a Saturday night gambling and drinking facility for the black workers. Each week there would be one mass arrest, which regularly ended with a fine of one dollar paid to Sheriff Conley and release by Sunday morning without the niceties of an appearance in court.

The collusion through deputization between the Fayette County Sheriff's Office and Rinehart and Dennis was in no way unusual. A state constabulary had been authorized in 1919, but, corrupt and underfunded, it played no significant role in enforcing labor discipline in the coal fields. In some ways, deputizing company staffs was less provocative than contracting private police forces. In the early 1920s armed confrontation between miners and agents of the notorious Baldwin-Felts Company of Bluefield, West Virginia, had verged on civil war in nearby Logan and Mingo counties. In contrast, the com-

bination of coercion, racism, and venality that governed camp life at Gauley Bridge may have offered a less inflammatory solution.

Discipline of blacks by whites is similarly recalled by a Gauley Bridge man whose elder brother worked on the tunnel and later died from silicosis. He describes his brother as "not liking the niggers," an attribute which apparently served to qualify him as a foreman for Rinehart and Dennis. He routinely attended to his duties in the tunnel armed with a baseball bat.

In addition to fearing physical abuse, black—and, to a lesser extent, white—tunnel workers lived under a threat of termination of their jobs and eviction by the company's camp agent. Thus work and otherwise unavailable housing were inseparably coupled. Hiring and firing were a foreman's prerogative, and there was no process of appeal. Disease or perceived insubordination meant loss of work and shelter.

Shocking though such living conditions at work seem today, they were probably not atypical for the time in the mining camps of West Virginia or elsewhere in America. Surviving black tunnel workers describe camp life as comparable to that at other construction sites. As for the prevalence of gambling and drinking, they have never been unusual pastimes for single working men. If conditions at the Hawk's Nest camps had been more grim than most, even the desperation of unemployed workers in the depression years might not have been sufficient incentive to apply for work at Gauley Bridge. Yet according to many tales often told there, bleak and probably true, dozens of migrants could be found for the duration of the tunnel project sleeping in fields, under rocks, and in rotting shacks at abandoned industrial sites in the hope that the rapid turnover of workers would offer them the rare chance at a daily wage. For white workers the provocations of camp life were less severe and the unusual hazards and hardships of tunnel work less evident.

The character of workers' lives between their shifts in the tunnel is hard to verify because it seldom seemed worthy of mention in the courtroom. Conditions of work inside the tunnel, because of their possible involvement in the deaths from silicosis, were described again and again in detail during trials in court. Yet that fact made them no less controversial.

The characteristics of tunnel work that can be established without encountering any contradiction are few and simple. The work week was six days and there were two ten-hour shifts a day.[4] The goal of each shift was to place and explode a charge of dynamite and to remove the debris left by that explosion or the previous one. Heavy equipment, duplicated in each heading, included an electrically powered shovel for clearing muck, and narrow-gage dinkey trains for carrying rock to the surface, where it was pulverized in rock crushers. Some trains had gasoline or steam locomotives, and others were powered by storage batteries for work at the headings.

Drilling proceeded by the standard "heading-and-bench" method, named for the vertical and horizontal planes of the drilling axis. Routinely, sixteen drills were in simultaneous operation, ten boring horizontally into the heading face and six into the bench, or stone platform, as yet unexcavated, on which all the drillers worked. Holes were drilled for ten or twelve feet and packed with dynamite by "powder monkeys." Typically a driller would drill 250 feet of "drill steel" in a shift—about twenty holes. Although the eighty-pound Ingersoll drills were equipped with supports, drilling into the heading face required the work of a driller and an assistant. The easier vertical drilling could be done by a single driller.[5]

When a charge was detonated and the debris cleaned away, the first bench would be leveled to the tunnel floor, or *invert*, on which track could be laid for the movement of heavy equipment, and the whole crew would advance. The heading, now cleared of rock, became the new drilling bench. If the tunnel was wide enough, more than one bench could be drilled at a time. The bottom bench segment rose from five to fifteen feet above the floor. Hence, in the narrower parts of the tunnel a single drill crew could suffice. Either two crews were assigned to enlarged sections, or the bottom bench was removed at a later point. This at least describes a "typical" operation; in fact, the drilling functions were subject to the availability of workers for particular jobs and thus could vary considerably.

That these routines were standard was acknowledged by all parties. There agreement ended. Even the number of men working in the tunnel at one time was subject to argument. At the trial, in 1933, over the suit brought by Raymond Johnson, where workers and managers first confronted one another on relatively equal terms in a court of law, the discrepancies in the reported numbers of underground workers were extreme. Plaintiffs described a relatively small work force of two hundred men. In contrast, a timekeeper for Rinehart and Dennis documented the presence of about five hundred men underground at one time. The latter figure coincided with figures quoted in the *Fayette Journal* on 4 April 1930, in the *Fayette Tribune* on 3 March 1931, and in the following table, from a letter dated 3 February 1936 to William P. Connery, Jr., chairman of the House Committee on Labor.

Work Force on the Tunnel Project

	White	Black	Total
Total work force	1687	3244	4931
Largest total employment at one time	463	740	1203
Total in tunnel	500	2000	2500
Largest total in tunnel at one time	150	450	600

At issue was the purported hazard of work in the tunnel. The smaller figure for the work force cited by the plaintiffs would imply an extraordinarily high rate per capita of deaths from silicosis. It is not necessary to assume deliberate misrepresentation of the facts by either plaintiffs or defendants, however, since both figures may have been true. That of Rinehart and Dennis would have included all men working at any point in the tunnel or moving in and out; that of the plaintiffs would have included only those at the drilling face, probably the only workers noticeable to those working there. Since that was the part of the tunnel with the highest concentration of silica dust, the plaintiffs' figure would in any case have been the more relevant of the two. As reconstructed from accounts by surviving workers, the typical force working at the heading face was roughly that shown in the table below.

It seems clear from a comparison of court records, personal accounts, and professional photographs taken by Union Carbide that in each heading about thirty-five men worked at the drilling face, while another twenty-five to thirty-five worked at jobs that required them to move into and out of the tunnel. The number of men working "up-tunnel" at diverse jobs varied considerably from place to place according to whether the section required lining. Drilling crews were considerably increased in the enlarged sections of the tunnel.

Even the length of the working day is disputed. According to the contractor, a ten-hour shift was adhered to without exception. This left two hours after detonation and between shifts when no men were

Underground Employment at Each Heading

Job Title	White	Black
Main motormen/brakemen	3	0
Switchers/pitboys	0	2
Drillers/muckers	2	14
Muckers/driller assistants	0	11
Electric shovel operators	1	0
Electric shovel pitboys	0	1
Steel nippers	1	2
Shovel runners	1	0
Dinkey skinners	3	0
Powder monkeys	0.5	0.5
Runners	3	0
Total	14.5	30.5

allowed in the tunnel. Surviving tunnel workers confirm the contention of plaintiffs in the court cases that hours were not fixed but were determined by the time it took to drill the necessary holes and complete the blasting round. Often these tasks could be completed in nine hours, for which the men received their full pay for ten hours. The work could also extend beyond ten hours. The contractor's insistence that strict ten-hour shifts prevailed probably refers simply to the hours at which the shifts began, and by which wages were determined. In any case, the minor discrepancy in length of shifts now seems unimportant.

What mattered were the conditions of work during each shift as they affected the amount of exposure of the workers to airborne silica dust. By the contractor's own reckoning, a total of two thousand tons of dynamite were used during tunnel construction, under the direction of explosives engineers supplied by Dupont.[6] Six to eight hundred pounds were required for each shot, about three tons a day for the four shafts. According to Rinehart and Dennis, all the men were evacuated from the tunnel at the end of each shift, just before the dynamite charge in the section just drilled was detonated. The vacated shaft was then maintained under positive pressure ventilation for two hours, during which time the dust could settle completely. Only then would the next shift of workers take up the work of removing the debris. This job, together with clean-up and preparation for drilling, normally took about five hours. The muck was lifted by an electric shovel onto rail cars and hauled away. Sixteen of the muckers then turned to drilling, while eleven others served as their assistants. For the white operators of heavy equipment, the first half of the shift was spent in vigorous removal of rock, but the drilling phase was less active, used mainly for transport of equipment and material.

Several tunnel workers who testified against Rinehart and Dennis offered a different version of a crucial part of this operation. At the trial in the case of Raymond Johnson they described being required to return to the heading after the explosions to complete the mucking before the shift ended. The detonations took about an hour to complete, while the men waited three to four hundred feet up the tunnel. When they returned, the air was thick with dust of pulverized rock, but neither ventilation nor suppression of dust with water was used to limit their exposure to it.[7] We will return later in this chapter to questions surrounding the accuracy of this account, which would become a key issue in both the trials and the congressional hearings.

An issue of which relatively little was made at the time was racial discrimination. In the account just related, which was told by black and white workers alike, physical force was used against blacks, but never against whites, to force them back into the tunnels. It was also almost entirely black muckers who loaded the dust-filled rubble, by

shovel and by hand, onto the rail cars. A white engineer confirmed that black workers were forced into the most dangerous work by beatings: "I have heard quite a few times that they used pick handles or a drillstead and knocked them in the head with it."[8]

Discrimination was common too in the allocation of work. "Skilled" work—operating heavy equipment and transporting men through the tunnel—belonged in almost every case to whites. The "unskilled" jobs of drilling and mucking, which were also the heaviest and most dangerous, were performed almost exclusively by blacks. In a photograph taken in Shaft 4 of twenty-seven drillers and assistants, all of whom doubled as muckers, only two were white. A similar proportion was evident in photographs from Shaft 1. Apart from differences in assigning skilled and unskilled jobs, white workers reputedly earned about five cents more per hour than blacks for equivalent work.

A less subtle form of discrimination in pay between blacks and whites involved not the amount but the method of payment. White workers received their pay in cash each Saturday, with the first wages paid following the second week of work, a customary procedure. All black workers, however, were paid in scrip. The timekeeper noted the hours worked and the pay scale for the day on a card held by the black worker. Deductions for food and clothing at the camp commissary could be made directly from the scrip ticket. The ticket could also be redeemed for cash—but only at the end of the weekly pay period. Between these times the worker had to pay a 10 percent commission to receive cash. This system served to keep black workers dependent on the company for goods and services. The rationale for this system offered by the company was that the memories of black workers could not last through a pay period and thus the use of scrip would minimize the number of arguments over the amount of the daily wage.

Apart from questions of discrimination, pay scales for all work on the tunnel can be documented with some assurance from company payroll records. In April 1930 the *Fayette Journal* announced that the standard hourly wage for an eight-hour day would be thirty cents.[9] In fact, this wage was marginally more substantial, ranging from thirty to sixty cents an hour for a ten-hour shift. Foremen earned about fifteen cents more per hour than did average workers. Drilling paid forty-five cents, whereas the laborer/mucking job was regarded as worth only twenty-five cents.[10] A few white workers who ran heavy equipment and had long worked for Rinehart and Dennis might earn seventy-five cents an hour and bring in as much as two hundred dollars a month. Pay was potentially highest for a handful of long-term skilled employees of the company. According to testimony often heard in court during the trials, pay scales were selectively lowered—as much

as by half by the summer of 1931—as the heavy work on the tunnel neared completion. These decreases are confirmed to some extent by the company's records.[11] At first they were confined to those jobs, such as drilling and mucking, that already earned the lowest pay and were filled mainly by blacks. White men working in the more skilled jobs were retained longer. As the demand for workers continued to decline, however, it was mainly those who had long been with Rinehart and Dennis who were kept on.

Compared with pay scales in most mining towns and other unincorporated company towns of West Virginia, those of Rinehart and Dennis were fairly generous. A coal miner's pay could be as much as twenty dollars for a week's work, but production was often on reduced shifts. Charles Jones, a local white coal miner who worked in the tunnel with his three sons, testified before the congressional subcommittee that he was paid $1.80 a day in the mines, but eighty cents was withheld to pay for rent, coal, and other fixed expenses. Although thousands of unemployed were in any case desperate for work, the higher rates offered at the tunnel may have accounted in part for the large population of migrant blacks who were said to have waited outside the camps for dismissals that would offer work for a short term at least.[12]

Many of these men must not have waited in vain. The turnover in the Rinehart and Dennis work force is documented in the company's payroll statistics. Sixty percent of the men worked on the tunnel less than two months, 80 percent less than six months, and 90 percent less than a year. The average length of employment was fifteen weeks for a black worker, sixteen for a white worker. More than one factor must have contributed to this extraordinary instability. For example, hiring and firing resulted from decisions made at the lower level of company authority. In the absence of a union, no procedures existed for arbitrating grievances. One local man claimed to have lost his job when he complained over what he considered the unwarranted reduction of his pay. Another blamed his termination on an argument resulting from the contractor's reduction of his pay for time lost while he was assisting in a hospital run at the company's request. Some men may have rebelled against the brutal treatment that others recall. Others may simply have disliked long shifts of exhausting work, though given the desperate need for employment of any kind prevailing at the time, their number is unlikely to have been great. There were also those deterred by the inhalation of dust. It can hardly be doubted that inability to tolerate conditions underground shortened the tenure of many workers, even if the onset of disease had not already shortened their lives.

Although conditions on the tunnel project may not have differed greatly from those in the faltering coal mines of the state, a clear per-

spective makes other comparisons necessary. In 1929, only a year earlier, a railroad tunnel had been built at Peters Creek, in Nicholas County, next to Fayette County. There the drilling teams had been skilled Swedish laborers from Minnesota, and pay was seven dollars a day. But pay was not the only attraction. Robert Nichols, a local veteran of both tunneling projects, recalled in 1984 the meticulous care for safety taken by foremen at Peters Creek, compared with the breakneck and authoritarian operation at Hawk's Nest: "Now on the railroad tunnel, those foremen came with the men and they knew them. They took their time and inspected the tunnel, before they would let any of the men in to start the shift. Now I always liked tunneling, which was why I worked on the Gauley Tunnel, but they used to just run the men in. Most of the drillers were black. I was one of the few white drillers. It was an altogether different thing."[13] Nevertheless, the treatment of workers on the Peters Creek project was probably not comparable to that at Hawk's Nest because of the difference in scale between the projects. Similarly, the small coal mines of southern West Virginia, dusty and stark though they were, cannot be fairly compared. The Hawk's Nest Tunnel was built by one prestigious national corporation and overseen by another. It might best be compared to the federally supervised hydraulic projects of the Southeast and West, even though they were not primarily subterranean. Huge and complex though they were, they remained remarkably free of scandal.

In contrast to the apparent indifference to the danger of disease shown by Rinehart and Dennis, the company's precautions against accidents seem to have been adequate and reasonably successful, given the number of men who worked on the project and the dangers inherent in construction of this kind and scope. Union Carbide later acknowledged that between 1930 and 1935, twenty-seven accidental deaths occurred at the tunnel, dam, and power station sites combined, but only eighteen of these (five whites, thirteen blacks) were said to be related to work. Eleven men died in the tunnel. A count given by the contractor was similar: seventeen accidental deaths by the end of 1932, two of which involved manslaughter.

In November 1934, long after the tunnel drilling had been completed, several employees of the New Kanawha Power Company were drowned when one of the five penstocks—steel conduits dividing water flow to the turbine manifolds—burst during a test. The frame and concrete girdle used to repair the structure still remains in place. The caption of a contemporary photograph of the incident in the company's files describes four men dead; Fayette County records name five who died in the accident. Only two appear in the list of deceased Rinehart and Dennis employees compiled by Union Carbide. This failure to record deaths so widely reported calls into question the accuracy of Union Carbide's accounting of accidents that may have been less visible.

Several episodes of violent death have clothed naked statistics in the trappings of popular legend. A grisly anecdote recalls corpses, both dismembered and intact, being hauled from the tunnels in muck cars and dumped onto slag heaps, with boots and legs protruding. This tale seems likely to represent a conflation of several actual events. A black worker in Shaft 1 was blown to pieces during the premature detonation of a charge of dynamite; parts of his body were later identified as the scattered rock was carried away. A worker in Shaft 4 was dragged into a rock crusher and dismembered, and a few less documented maimings may have occurred. These events were apparently combined in the telling with a familiar sight: rubber boots protruding from piles of slag. Boots provided by Rinehart and Dennis for use in wet parts of the tunnel were unpopular with the workers and were often discarded.

Although other gruesome anecdotes were told of traumatic death in the tunnel, survivors of work there do not recall such incidents as having been frequent. Workers in Shaft 1 believe that approximately a dozen fatal accidents occurred in the eighteen months of drilling. They attribute about half of these to a rock fall in the summer of 1931. No more than two or three accidental deaths are recalled from Shaft 4. Death records at Fayetteville, the county seat, confirm a cluster of six mining deaths at Gauley Bridge in August 1931, but no clear cause is mentioned. It is possible that notice of accidental deaths was withheld from local officials, or that single deaths did not significantly distort accident statistics in the county. But the combined opinion of surviving workers and the lack of public awareness of such incidents at the time makes this unlikely. On the whole, the record of accidental deaths on the Hawk's Nest project may be considered relatively low, particularly if one takes into account the unusual speed with which the excavation progressed, and the harshness generally attributed to Rinehart and Dennis.

But it was never alleged that accidental deaths accounted for the full death toll. That toll was claimed primarily by the disease called acute silicosis, first recognized by the American medical profession as a result of the events at Gauley Bridge. Obviously, the fact that this acute form of the disease was unknown at the time must be taken into consideration in evaluating responsibility for the Hawk's Nest tragedy. But it must also be kept in mind that classical silicosis, a more gradual but no less potentially deadly disease, was widely recognized. Physicians had produced sound and detailed descriptions of it by the mid-1800s, and by 1890 legislation was emerging to encourage its prevention.

Forty years later silicosis went unrecognized, ostensibly at least, in Gauley Bridge, in spite of the fact that Rinehart and Dennis provided

medical services. The quality of these services cannot now be clearly determined, but they were required by the terms of the contract with Union Carbide, which read:

> The Contractor shall provide adequate medical and surgical care for his employees; and for this purpose shall designate one or more approved competent licensed physicians, satisfactory to the Engineer, who shall at all times be in readiness to supply such medical and surgical services, shall have the care of its employees, shall inspect their dwelling, and stables and sanitaries as often as required, and shall supply medical attendance and medicines to the employees whenever needed. The Contractor shall provide from approved plans, one or more rooms properly fitted for the purposes of an emergency hospital.[14]

Hospital services were contracted for with the Coal Valley Hospital in Montgomery. Because this hospital was later incorporated into Montgomery General Hospital, in 1947, no records from the period were maintained. It is thus no longer possible to assess either the number of workers admitted or the reasons for admittance.

Two physicians provided medical services for the contractor. Dr. Mitchell, of Mount Hope, was employed by Rinehart and Dennis; Dr. Simmons, of Alloy, who was associated with the Electro-Metallurgical Company, was hired directly by the New Kanawha Power Company. These physicians were said to have been paid twenty-five cents a head for screening and examining men for work. During the subsequent trials and congressional hearings, many derogatory comments were made on the failure of these two men to appreciate the health hazards connected with tunnel work. Their custom of prescribing "little black devils"—tablets of baking soda coated with sugar—as general therapy has endured in the lore of Gauley Bridge.

Dr. Mitchell was frank in his testimony at the trial of Raymond Johnson, stating that when he undertook work for Rinehart and Dennis he knew nothing whatever of silicosis or other occupational diseases. According to the *Charleston Gazette* for 29 March 1933, he confirmed in retrospect that he had probably seen more than a hundred men affected with silicosis. He claimed to have sent many of them to the Coal Valley Hospital but ascribed to his unfamiliarity with the disease his failure to make effective diagnoses. While engaged by Rinehart and Dennis, Mitchell had routinely assured ailing workers that their symptomatic coughs and pneumonia were a transient condition, "tunnelitis," caused by harmless rock dust. The medical wisdom—comforting and often appropriate—that an undiagnosed but commonly seen condition is therefore benign was betrayed by the "new" disease evolving at Gauley Bridge, acute silicosis.

It may seem remarkable that two physicians who practiced in a coal

mining region and worked either for or with a company expert in tunnel construction should be ignorant of a disease so common as silicosis. Industrial medicine was not wholly unknown in Gauley Bridge. Dr. Leroy Harless, a prominent local physician with a reputation for salty independence, had had some experience with it and had, according to his son, applied for the position of one of the company doctors. To judge from Harless's later testimony during various trials, he was reasonably well informed on pneumoconioses. Yet, though he had worked in the past for the Electro-Metallurgical Company, his application was turned down.

While not unimportant for what it represented as a commitment to workers' health, the lack of acuity on the part of local physicians was not a decisive factor in the evolution of lung disease, because medical competence would not have been a successful first line of defense against exposure to silica dust. It has long been a cardinal principle of industrial medicine that initial measures should rest on the quantification and control of exposures rather than on the recognition and treatment of symptoms of disease. The question of ignorance or knowledge of the danger involved in the tunnel work must be asked once more before returning to an evaluation of what steps, if any, were taken to alleviate it.

Silicosis is one of the more widespread of pneumoconioses, diseases that result from frequent inhalation of either metallic or mineral dusts. It is caused by tiny particles of silica, which are absorbed by cells deep within the lung. For reasons that are still incompletely understood, these cells become impaired and digest themselves, causing damage and scarring known as *fibrosis*. Eventually the capacity to breathe is reduced. The injured lung is also susceptible to infections, such as pneumonia and tuberculosis. Respirable silica, a major component of granite and sandstone, is released by the pulverization of rock that occurs in many industrial processes, of which mining is one of the most common. For a time silicosis was widely known in the United States as anthrasilicosis, because of the high content of silica in anthracite coal and the high prevalence of silicosis in anthracite coal miners. Often characterized by medical historians as the oldest occupational disease, silicosis was mentioned by Herodotus, who noted a connection between the inhalation of dust and the premature deaths of miners. Recent tissue studies on mummified corpses of Indian miners from Greater Peru confirm the presence of silicosis, and with it the statements of Spanish chroniclers in the seventeenth century that the life expectancy of Indian workers in the thick dusts of Spanish mines ranged from six to eighteen months.

The patriarchs of occupational medicine, Agricola in the sixteenth century and Ramazzini in the eighteenth, associated the disease with the dusts created in tool manufacture, as well as in mines and quarries.

In the 1800s silicosis reached epidemic proportions among British potters. Vernacular terms for the disease—grinder's rot, potter's rot, and miner's phthisis—became common in that century, reflecting as well the concomitance of silicosis and tuberculosis. The direct association between exposure to siliceous dusts and morbid fibrosis of the lungs was established in the early 1860s by British physicians. Although silicosis was not yet categorized as a diagnostic entity, its connection with clays, quartz, and sandstone had been clearly identified. The practice of wet drilling to reduce exposure to dust was introduced in England as early as 1897. By 1911 dry drilling had been strictly forbidden in South African mining.[15]

In the United States the control of occupational disease proceeded more slowly than in Western Europe. In many cases this delay was due to limited enforcement rather than to lack of sophisticated recognition of the disease. The authority of federal agencies was often restricted to making recommendations.

An aggressive, often fatal form of silicosis, caused by the milling of quartz dust, was identified in Nevada in the 1890s. Ten percent of the quartzite millers died of lung disease over a period of five years. In a landmark study of zinc miners in Joplin, Missouri, completed in 1915, Dr. Anthony Lanza determined that, of 720 miners surveyed, 433 showed radiographic evidence of silicosis, and that life expectancy was only 9.6 years once a man entered the mines. These results were published and widely distributed as an official bulletin of the United States Public Health Service in 1917.

Not only were silicosis and its causes well known long before 1930, but measures for its prevention through ventilation and moisture were in wide use. By 1914 the Federal Bureau of Mines had begun to recommend yearly physical examinations for workers exposed to dusts containing silica. In 1915 the first workmen's compensation laws provided implicit, though not explicit, coverage for silicosis. The efficacy of preventative measures had also been documented. After the introduction of medical surveillance and strict use of wet drilling, workers in the Missouri mines were again surveyed, from 1923 to 1925. Mortality and morbidity were substantially reduced. In the early 1920s the Bureau of Mines had also published a series of warnings on new dangers resulting from the use of high velocity drills, which dispersed an exceptional concentration of particles small enough to be trapped within the lung.

There was also a body of sophisticated literature detailing the average length of time between the beginning of exposure and the appearance of silicosis on a chest X-ray. Starting in 1917, fourteen thousand South African gold miners were studied for both the first appearance and the progression of silicosis on X-rays. Nine percent of the miners with ten or more years of exposure were affected, but

only 1 percent of men with less than five years of work had begun to show disease. This would have provided a safe margin for detecting early signs of the disease if the exposures at Gauley Bridge had been more routine. But the acute silicosis encountered there was a different and far more virulent disease. Although it had been reported in England, acute silicosis was not yet recognized in the United States. Nevertheless, the experience of the Nevada quartzite miners forty years earlier had indicated the existence of a more aggressive form of the disease than was encountered in coal mining.

Yet New Kanawha engineers did not take the most preliminary step in guarding against the danger: at no time did they measure the levels of dust in the tunnel. Although industrial hygiene was a new field at the time of the drilling, the fact that the air was not sampled did not result from a lack of available techniques. A device called an impinger, developed by the United States Bureau of Mines and the United States Public Health Service in 1916, had been used in the control of mining dusts at least a decade before the Hawk's Nest project was begun. Though newer methods have since been introduced, the impinger, which works by trapping dust particles against a wetted plate, is still an accepted procedure for measuring free silica. If it had been used in the Hawk's Nest Tunnel, it could accurately have assessed the risk to the workers.[16]

The failure to take even this basic precaution might conceivably be interpreted, along with the other signs of unconcern, as evidence of a profound ignorance of the nature and risks of silicosis. Whether that ignorance in fact existed became, for obvious reasons, a major topic during the subsequent trials and hearings. Several workers charged that the engineering staffs of the New Kanawha Power Company wore respirators while in the tunnel. Arthur C. Peyton and Eli D. Carver both testified that, as employees of the company, they were outfitted with respirators and warned about the hazards of inhaling silica dust. They contended, in fact, that the use of respirators was required for all New Kanawha employees. R. E. Buckley, an engineer who defended his employer, conceded that respirators were worn by the engineering staff. He offered, however, the novel explanation that these were meant to protect the eyes from rock and sand and were not issued for dust protection.[17]

In its own defense, Union Carbide would later contend that no commercially available respirator had been officially approved for protection from silicosis at the time the Hawk's Nest Tunnel was drilled. This involved a semantic distinction. The U.S. Bureau of Mines began publishing its recommendations on specific respirators in 1926. In 1934, these recommendations were upgraded to certifications.

That morbidity and mortality might have been affected by the use of respirators is suggested by the experience of one local man who

worked more than a year underground. He constantly covered his nose and mouth with a wet handkerchief to prevent dust inhalation. Sometimes he disposed of as many as three or four dust-matted cloths on a shift. Despite the development of clinical lung disease within a year of finishing work on the tunnel, he survived. A companion, working under almost identical circumstances, but without protection, died within a year from respiratory failure.

If the New Kanawha Power Company was aware of the risks of silicosis, it evidently did not notify its contractor of them. It is well established that neither the staff of Rinehart and Dennis nor its workers wore respirators. This company, noted for its long experience in the construction of tunnels, claimed that silicosis was an entity unknown to civil engineering. Testifying at the trial in the suit of Raymond Johnson, E. J. Perkins, vice president of Rinehart and Dennis, said of silicosis: "I never heard of it."

The denial by both companies that they were aware of any danger of silicosis must be weighed against two claims: that of several staff members and many tunnel workers that Union Carbide issued respirators to its staff, and the repeated insistence by both Union Carbide and Rinehart and Dennis that they had, in fact, taken massive precautions against dust. Allegedly these included strict adherence to the practice of wet drilling and constant use of an advanced system of ventilation. In view of other conditions of work in the tunnel, it seems unlikely that such an effort was expended (if indeed it was) solely for the sake of the workers' comfort.

The employers' ignorance or knowledge of the risk to their workers of silicosis is the most crucial single issue in establishing responsibility for the tragedies that ensued. These questions will perhaps never be answered, except by conjecture. The hazards of exposure to silica dust were widely known and the use of protective methods was commonplace in underground work. Yet the extent of the awareness, if any, on the part of both companies can never be known. If one finds their claim of total ignorance credible, then one may attribute that ignorance to an extraordinary if not criminal degree of negligence. If one cannot credit that claim, a more apt term would seem to be indifference.

Before the claims of precautions taken—and their denials by surviving workers—are examined, a related question of knowledge and resulting responsibility must be considered: the presence of dangerous amounts of silica in the rock through which the tunnel was drilled and the awareness of it by Union Carbide and its contractor.

This issue was one of the bitterest to be raised during the trials and congressional hearings. At the hearings it was reported that the silica content of the rock ranged as high as 99.44 percent. Although this figure probably owes more to popular culture than to scientific as-

sessment, from the standpoint of biological rather than journalistic impact, the distortion is trivial. At the trial of Raymond Johnson, the aptly named B. G. Doom, division superintendent of the Electro-Metallurgical Company, testified that core samples taken from the site of Shaft 1 ranged from 96 to 99 percent pure silica. An assay recently performed at the Mount Sinai Medical School, in New York City, on sandstone from the tunnel showed a silica content of 90 percent or more.[18] It seems clear that the concentration of silica drilled through by the tunnel workers at Gauley Bridge exceeds all other exposures documented by American industrial medicine, with the single exception of those encountered in the silica flour industry and in a more limited sense with sandblasting.

The ratio of the purity of silica in dust breathed to the risk of silicosis is subject to complex variations.[19] It does not, however, cloud the issue of awareness. That Union Carbide knew the value, and therefore presumably the quality, of the silica in Gauley Mountain was never denied. Over the period of excavation the company hauled three hundred thousand tons of the ore to Boncar for eventual use in the electrometallurgical plant it was building there.[20] At the height of drilling the arrival of 175 cars of ore a day regularly overwhelmed the facilities at that site. Former employees who themselves performed assays recall that sampling for quality was carried on regularly both inside and outside the tunnel. The project engineers and also chemical engineers from the Glen Ferris plant swabbed the walls with hydrochloric acid. Effervescence indicated calcination (contamination with limestone), an undesirable property for use in the production of alloys. Rejected rock was crushed and dumped along the river bank. Ore of acceptable grade was shipped to Boncar, where it underwent further analysis for contamination with iron, aluminum, or manganese. Because each carload was assayed separately, so serious a backlog of unanalyzed ore had developed by the winter of 1931 that Union Carbide transferred an additional metallurgical chemist to Glen Ferris from its plant at Niagara Falls, New York.

That the siliceous rock was regarded as a captured natural resource is evident from an article published in the *Fayette Tribune* on 3 June 1931. The effusive style of this item suggests that it may have come directly from a publicity release by Union Carbide.

> Like a tale from the story of Aladdin's lamp, boring of the tunnel has enriched the Union Carbide company with untold wealth. In the process of removing the rock, the workers came across a vast deposit of silica sandstone which assays 99.44 percent pure. It is as fine a grade of sandstone and especially adaptable for steel and glass work, as has been found in the world. Discovery of this sand-

stone in the lower end of the tunnel, brought about a big change in the operations, for the excavations were immediately extended in size and the tunnel considerably enlarged.[21]

The expansion of the tunnel mentioned here was to become a cause for profound resentment on the part of workers. They felt that they had been cynically exploited by the enlargement, making commercial recovery of silica possible at the expense of their health. It is essential, therefore, to examine in detail the character of the enlargement, the reasons for it, and its relevance to the health of the workers. Was, for example, the discovery of high-grade silica an unexpected stroke of fortune, and were the enlargements merely modifications hastily decided upon? Or was the mining of silica a predetermined decision, as integral to the operation as laying rail lines or stringing electrical cable?

The New River Gorge was known to be rich in commercial silica deposits, and sand had been mined for this purpose as early as 1921 in Thayer, upriver from Gauley Bridge. In testimony before the congressional subcommittee, Rush D. Holt, a senator from West Virginia, cited statements of an anonymous Rinehart and Dennis foreman to the effect that "the size of the tunnel was to be 32 feet in diameter. After the rock was tested, the report showed 90 percent silica (glass). At this time, when the workmen were 800 feet or 1000 feet in, the New Kanawha Company, agents for the Union Carbide Company, of New York City, had the tunnel size enlarged to 46 feet, the surplus rock to be shipped to Alloy, West Virginia, for byproduct purposes."[22] These dimensions correspond reasonably well with those cited by the contractor in the *Engineering News-Record* for February 1936 and those in blueprints of the completed tunnel drawn in the previous year by Union Carbide. According to Rinehart and Dennis, 10,700 feet of tunnel were thirty-one feet in diameter, and 5380 feet ranged from forty-two to forty-six feet. (A trivial discrepancy between these figures and those on the blueprint results from ways of measuring tapered sections within the tunnel.) In short, almost exactly one-third of the tunnel was enlarged from the supposedly original specifications. The areas of enlargement do not follow an easily identified pattern. Shafts 1 and 2 were enlarged in mid-course and broken through at a diameter of forty-six feet. Shaft 3 was begun narrow, enlarged, and then tapered down. Shaft 4 was never enlarged.

To anyone seeking a rationale for both the position and the timing of the enlargements, the blueprints of 1935, together with statements by the companies and the workers, would seem at first glance to offer many clues. They show not only the composition of the rock of the tunnel itself, but also of much of the surrounding rock, as it was determined from core samples taken well before drilling began. The

most readily apparent clue to the planning is that the narrow sections of the tunnel were invariably lined, whereas the walls of the widened sections were left as bare rock. From this demonstrable fact it would be easy to assume that the unlined sections were drilled through hard rock—in this case siliceous sandstone—and the others through friable shale, which required lining to prevent erosion and eventual collapse. Such an assumption might suggest in turn that construction of the tunnel was planned from the first with the extraction of ore, as well as the production of hydroelectric power, in mind.

The basic assumption (though not necessarily the added implication) is, however, proved by both blueprints and workers' statements to be untrue. Surviving workers from Shaft 1 claim that, after drilling through a couple of hundred feet of coal and shale, they encountered sandstone, which continued through the rest of the shaft. Yet the tunnel was not widened until a considerable depth had been reached: 800 to 1,000 feet in the workers' accounts, 1,060 feet on the blueprint. In contrast, Shaft 4 was lined throughout its length, though workers and blueprints agree that the last 900 to 1,000 feet were in sandstone. Information on Shafts 2 and 3, which must be derived exclusively from the blueprints, indicates that, like Shaft 1, they were drilled almost entirely through sandstone. But only 2,515 feet of their combined length of over seven thousand feet was enlarged. A retired metallurgist associated with the project confirms that silica was extracted, tested, and used from all four shafts regardless of whether they were enlarged, and that rock from enlarged areas was chemically indistinguishable from samples taken from narrower widths. About 4000 of the 4360 feet of Shaft 1 was drilled through sandstone. The 3150 feet of Shaft 2 and 3700 feet of Shaft 3 were both drilled in their entirety through sandstone. Only in Shaft 4 did conditions differ. Sandstone was first encountered in significant density at about the halfway point of Shaft 4, the longest of the four shafts, covering 5300 feet. At that point, concentrations of silica would have steadily increased up to the final 1000 feet, when hard rock sandstone was the exclusive rock formation, and men would have been exposed to silica concentrations identical to those in the other shafts.

If Union Carbide had intended from the first that the tunnel should serve as a silica mine, as well as an essential part of a hydroelectric project, it clearly lost some opportunities for exploiting the resources of Gauley Mountain. Neither was there a gain for the practical exploitation of hydroelectric power. The widening of only certain sections of the tunnel would not enhance flow of water to the power station; the flow was, in fact, sufficient to power only four turbines, instead of the five that had initially been planned. Further study of the blueprints indicates some possible reasons for the irregular widening. Although Shafts 2 and 3 lie almost entirely in hard sandstone, seams of

shale are found here and there within a few feet of the lined sections. The same is true of the last quarter of Shaft 4, which is lined throughout its length. Lining may have been resorted to—at the expense of extraction—to diminish the risk of eventual erosion of the tunnel. Nearness to the surge basin of a sandstone section of Shaft 2 may account for the fact that it too is lined and narrow. Neither blueprints nor workers' recollections explain why about a thousand feet of the sandstone in Shaft 1 was allowed to remain narrow and was lined instead of being enlarged to permit additional extraction and left bare, although various engineering considerations can be hypothesized.

In spite of these speculations as to engineering requisites and the possible costs of lining reinforcements, an impression remains of a somewhat belated and haphazard attempt on the part of Union Carbide to make the most of the rich lode of ore that surrounded its tunnel. The accumulation of a large backlog of ore and the hydraulic inefficiencies of the enlargement might seem to imply that the company was insufficiently aware in advance of the quantity and quality of silica that would be available. That was demonstrably not the case.

The potential became obvious at least eight months before the groundbreaking. This fact is clearly shown on a blueprint dated July 1929 and entitled "Hawks Nest–Gauley Bridge Development, General Plan of the Profile of Tunnel." All the rock core samples found on the 1935 drawing are recorded on the earlier one. The location of every area of hard rock sandstone was clearly identified. It was known exactly through what rock types the men would be drilling. Specific impurities could not be predicted at this point, but a high potential for profitable extraction of silica must have been abundantly evident to the New Kanawha Power Company well before Rinehart and Dennis was hired. There can be little doubt that the company knew the value of its mountain.

The 1929 document reveals another interesting fact. The tunnel was originally planned to be only twenty-eight feet in diameter throughout. The first 4,600 feet, drilled through the shale of Shaft 4, were to be lined with concrete; the last 120 feet, which led into the manifold at the power station, were to be lined with steel. The rest of the tunnel was to remain unlined.

A tantalizing comment appears on the blueprint: *"Note:—The tunnel diameter may be enlarged above 28'–0" depending upon the contract price for tunnel excavation."* The simplest interpretation of this note is that Union Carbide contemplated buying a larger tunnel, purely for its hydroelectric advantages, if it turned out to be affordable. This hope was realized. Rinehart and Dennis's bid was remarkably low, and the minimum diameter of the tunnel was increased from twenty-eight to thirty-one feet. Yet the bottlenecking in sections of the tunnel from forty-

six to thirty-one feet could not increase the flow and might increase sheer forces along the walls.

In view of later events, it seems that a grander dream may be hinted at in the note: the possibility of an added use of the tunnel, during construction, as a silica mine. This hope, too, was realized. Nevertheless, it still does not necessarily follow that it was planned in advance. Two facts make careful planning seem unlikely. The first is the apparently unsystematic fashion in which exploitation of silica was carried out. The second, which might account for the first, is the extremely demanding schedule that was imposed upon the contractor and was strictly adhered to, at least during the stages in which extraction was practicable.

A third, equally irrefutable fact seems to contradict the implications of the first two. If enlargement of a third of the tunnel by about 40 percent was not provided for in the original contract with Rinehart and Dennis, then the contractor must have been paid a very substantial sum for the additional work. There is no indication that this happened.

Additional blueprints, though less diagrammatically complete, establish beyond any reasonable doubt that the New Kanawha Power Company's decision to enlarge the tunnel was premeditated and not the result of a fortuitous encounter with mineral wealth. It also seems clear that the decision was made after bidding was completed in the fall of 1929. A blueprint, entitled "Plan of Borings and Profile along Tunnel (I–111)" and dated 19 December 1929, documents the geology in an expanse of the tunnel continuing for seventy-four hundred feet from its origin at the dam and portal. The last four hundred feet include part of Shaft 3 that was eventually enlarged, but at this time none of the alterations in the internal diameter are indicated. Another document, dated just six months later (14 May 1930) and entitled "Intake, Tunnel and Penstock Progress Record," indicates all the enlargements with precise dimensions and locations. It was released one month before drilling was started on Shaft 1—earlier than when silica was first encountered, and still earlier than when the tunnel was actually enlarged.

It is unlikely that the precise timing of Union Carbide's decision to enlarge the tunnel will ever be certainly established. It seems to have been made in the early part of 1930, but the available documents do not establish whether it was made prior to the award of the contract to Rinehart and Dennis in March, or was even part of the unpublished conditions of the award. Moreover, the plan of silica extraction was carried out in part independently of the enlargement. In the abstract there was nothing intrinsically reprehensible in the company's decision to mine its own tunnel, although, as an unreported mining operation, it was carried out illegally. What is at issue is the impact on the workers'

health. And that supposed impact—the reason for the workers' indignation over the enlargement— is ambiguous. Either it was less important in the evolution of disease or it was an extension of an already mortal risk. Because silica dust would have been encountered in dense concentration in certain sections of the tunnel even if they had never been enlarged from a width of thirty-one feet, the significant factor affecting the men's health was the excess time the men spent in widening those sections. The exposure to silica was increased about 15 percent by the enlargements. Though by no means trivial, this factor was invested with a distorted significance by the workers, given the overall hazard posed by tunnel work. The decision to enlarge was made for the extra profit of the company, but it was not essentially different from other decisions made as deliberately for the same purpose. Its importance is mostly an ethical one.

Investigation of the enlargement issue has helped to establish one fact beyond doubt: Union Carbide was fully aware of the silica content of the rock through which the tunnel would be dug well before construction began. The significance of this fact cannot, however, be judged apart from two other issues: the company's awareness of the danger of silicosis and the effort, if any, that it made to prevent it. Answers to the first and more basic question, which has already been discussed, will probably always remain conjectural. Though it may seem unimaginable that a major national corporation was unacquainted with occupational lung disease, the patterns of thought of corporate officers can only be surmised. The second question, the measures taken by Union Carbide and its contractor to protect their workers' health, was the most controversial issue in the trials and the congressional hearings.

Because no tests were made for airborne silica dust—a remarkable oversight, given the availability of techniques—evidence for a high concentration must remain anecdotal. Men who worked in the tunnel alleged that dust was so thick that it obscured everything except in the most immediate vicinity. According to typical testimony during the trials, in this case by Dr. Elmer Hayhurst, a specialist in occupational lung disease, "The dust was so thick that a man working in said tunnel could only see a man to distinguish him from ten to twenty feet."[23] Hiram Skaggs, a witness at the congressional hearings, recalled, "The dust was so thick that one could not identify anybody he met when the man was only a few feet from him."[24] At the trial of Raymond Johnson, thirteen former tunnel workers and twelve community residents testified that workers leaving Shaft 1 were so covered with dry, white dust that facial complexion and color of clothing remained indistinguishable.[25]

Testimony from engineers for the New Kanawha Power Company and Rinehart and Dennis presented a remarkably different picture.

O. M. Jones testified at the Johnson trial, held at the courthouse in Fayetteville, that he "never saw dust, or at least not enough to say it was dusty." Not content with this, he declared that the quality of air inside the tunnel exceeded that in the courtroom.[26] Several other engineers estimated normal visibility at three to six hundred feet. Assessments of working conditions presented by managerial personnel from Rinehart and Dennis were equally fulsome and contradicted the workers on every point. Henry Abernathy, the chief electrician, stated that there was little dust and that men leaving the shafts were covered merely with moisture and muck from water used in dust suppression, never with dry dust.[27] W. H. Miller, the timekeeper at Shaft 1, claimed that visibility and lighting were so good that he could easily identify each workman for payroll purposes at a distance of sixty to seventy feet.[28] Since the timekeeper entered the tunnel three times a day—at the start of the 6:00 A.M. and 6:00 P.M. shifts during mucking and at the end of the day shift during drilling, it is possible that on the first and last of these occasions dust levels may have been low because of the absence of recent drilling. But this would not account for a lack of dust during the other visit.

The company's position was corroborated by several outside experts. C. B. Bishop and D. R. Sullivan, inspectors from the West Virginia Department of Mines, held that the air was of good quality, the surfaces were always wet, and there was no visible dust.[29] Robert Lambie, the director of the department, exceeded the claims of his own staff by describing excellent visibility at distances of five to seven hundred feet.[30] An explosives expert, Charles S. Hurter, implied that because there was nothing to create dust, there would have been no need to use water to suppress it. His reasoning was inventive: that it was a physical property of the pneumatic drill to break rock along its seams rather than to stir up pulverized dust. "If there were dry drilling there would be the smallest amount of dust possible to come off under these conditions."[31]

The question of whether wet drilling was regularly practiced was one of those at the heart of the controversy. There is no doubt that the Ingersoll-Rand drill used in the tunnel had an attachment for a water hose. Representatives of the manufacturers maintained that water was always used, and that, moreover, its use was essential to minimize friction and drill wear. W. W. Cunningham, the drill mechanic on Shaft 1, also insisted, typically of Rinehart and Dennis staff, that drilling had always been done wet.[32]

Tunnel workers, however, described the drilling as predominantly dry, and blamed this practice for noxious dust levels. A surviving Rinehart and Dennis employee, while confirming that drilling was routinely performed dry, had an explanation that absolved his employer from any responsibility. It was not the contractor, supposedly

driven to expediency by the imposition of completion dates, but the workers themselves who were to blame, motivated by feats of recklessness in order to complete their shifts as rapidly as possible. In sorting out accounts of surviving workers, it can be concluded that wet drilling was generally in use on holes drilled horizontally into the headings, but not on the vertically drilled bench holes.[33] Water was not generally used to settle pervasive dusts raised by drilling. Neither was it used for that purpose after blasting, though if mining experience is an adequate gauge, drilling poses by far the greater hazard to pulmonary health.

That inspectors from the Department of Mines saw no dry drilling may be quite true. There was much testimony to the effect that water was always used when official inspections were organized. Several workers described an informant system by which dust was controlled and drilling was moist and exemplary whenever the state inspectors appeared. According to Hiram Skaggs, "The evidence was that when the mine inspectors were about to come to the job the men running the gasoline motors would inform the foremen that the mine inspectors were coming."[34]

The use of gasoline motors added significantly to the contamination of the air that the workers breathed. Arthur Peyton, a member of the New Kanawha staff and a witness at the congressional hearings, recalled, "The dust was very bad; the circulation of the air was very poor; gasoline motors were employed there, and they put out an awful fume. The air was very hard to inhale."[35] When eventually Rinehart and Dennis realized that the fumes were in fact interfering with the workers' efficiency, the use of gasoline in the tunnel was stopped.

Apart from wet drilling, the best safeguard against the inhalation of dust was adequate ventilation. Recommendations on requisite air changes for ventilation systems in mines and tunnels published by the Bureau of Mines called for 100 cubic feet of air per minute for a man and 150 for a horse. This would have required about 5,000 feet per minute at a typical heading in the Hawk's Nest Tunnel. Technical descriptions of the system used there were the exclusive prerogative of the contractor's engineers and consultants, so accounts by the workers were necessarily impressionistic, centering on personal discomfort.

Ventilation in each shaft was supplied by a single eighteen-inch fan that drew air from a canvas pipe twenty-four inches in diameter, fed by pumps at the tunnel entrance. According to the workers, these boosters were used only during official inspections. In accounts by Rinehart and Dennis personnel, the hosing supplied seven thousand cubic feet of air per minute. Air released as exhaust by the pneumatic drills added another thousand cubic feet or more.[36] The New Kanawha Power Company supported this claim. In an opening statement for

the defense, the contractor's attorney, C. W. Dillon, simply declared that the system was the finest the firm had ever installed, and that it exceeded conventional standards.[37] In contrast, the explosives consultant, Charles S. Hurter, contended that, to judge from his experience with similar systems, the one in use could in fact deliver only two thousand cubic feet per minute.[38]

Recollections of surviving tunnel workers paint an ambiguous picture. Although there is consensus that dust levels were high, men with previous tunneling or mining experience did not find conditions intolerable, and considered them no worse than those in some dusty mines. The fact that the silica content of bituminous coal dust in the region could range from 3 percent to less than 2 percent had no effect on the degree of discomfort it caused, although the threats to health were in no way comparable.

Similar ambiguity obscures conditions at the drill face. Dust levels were most intensely irritating there, but, paradoxically, workers there had a greater sense of positive pressure ventilation. Because air released under pressure from the drill manifolds was within the worker's breathing zone, it seemed to provide fresher air and greater circulation than was found at job sites distant from the heading. There, ventilation was supplied from a less concentrated source at the end of the canvas tubing.

The real issue was not, however, the theoretical capacity of the system, but its operating capacity. Workers contended that the tubing was often pierced by rocks and that breakdowns were frequent. Engineers who supported the workers' accounts alleged that the ventilation fans were off for three hours or more at a time.[39] This was denied by Rinehart and Dennis at the trial concerning Raymond Johnson, through the agent of the hose supply company, who averred that the hose was still intact when drilling was complete.

Physicians supporting worker plaintiffs at the trials testified that the air was stagnant and loaded with gasoline fumes, especially in Shaft 1, where the motors were used longer than elsewhere. This forced the men to inhale more deeply to compensate for the resulting hypoxic drive, or failure of sufficient oxygen to reach the tissues. Fatigue had much the same effect, increasing the area of aerated lung and the volume of exchanged gas. This was commonly true of coal miners, for whom the greatest hazard from coal dust inhalation comes late in the shift, when cumulative fatigue increases respiratory effort.

Ventilation was not, however, the primary problem. A mile from the surface, cooler and humidified air would tend in any case to stagnate and make change of air at best something of a fiction. The danger was in what the air carried: high concentrations of silica dust. However effective delivery of outside air from a fan might be in a dust-free or dust-reduced environment, it is not a sufficient consideration in a

confined area with high potential for concentrated exposure. The first cases of acute silicosis to be described in Europe occurred among workers with abrasives. For sandblasters and workers in open-air quarries, access to fresh air was not an issue.

In view of the clear impossibility of reconciling the glowing descriptions of conditions in the tunnel offered by owner and contractor with the often appalling ones given by many of the workers, it is appropriate to turn to reports emanating from the West Virginia Department of Mines. In asking permission from the state's Public Service Commission to proceed with the construction project at Hawk's Nest, the New Kanawha Power Company had also requested exemption from supervision by the Department of Mines. The company had argued that it was constructing a tunnel, not a mine. The extraction of vast quantities of silica ore from the tunnel showed no sign of endangering this position. But the department's official indifference ended abruptly in the spring of 1931 upon action of the state's attorney general. Reports of an undue number of deaths on the job, and perhaps of New Kanawha's failure to record them accurately—of which more will be said in chapter 5—led to this development.[40]

This information was sufficient to motivate the department to undertake inspections. The *Fayette Tribune* reported that, in light of the increasing controversy over the tunnel and reports of deaths among black workers, Robert Lambie, the director of the department, was claiming jurisdiction on the grounds that silica removed from the tunnel was actually the product of a sand mine. The local press continued to describe how Lambie personally inspected the tunnel, accompanied by Fayette County Sheriff Conley and the county prosecutor. A group of mining inspectors were assigned to the tunnel for the duration of the project. A full report on their findings was promised. This report was, however, never publicly released. Two years and a subpoena were required before the contents of the Lambie report became available.

On his first inspection, Lambie was said to have engaged in a sharp exchange with C. C. Waugh, a foreman in Shaft 1, over the safety of working conditions.[41] Lambie soon wrote a letter to O. M. Jones of New Kanawha, warning of hazards from the heavy concentration of silica dust in the tunnel and ordering the use of respirators. Jones conceded, during the trial involving Raymond Johnson, that he had disregarded these warnings because they concerned only the contractor.[42] Lambie further ordered new ventilator units, elimination of gasoline motors in the tunnel, and maintenance of accident and sickness records for the workers. Mining inspector Alderson Simms also issued uniformly unfavorable reports on dust and other conditions of work, and issued warnings of the high risk of disease resulting from the dust.[43] Unfortunately, the warnings probably came too late

to alter the course of dust-related disease in those who were already affected. In any event, they were not enforced.

Two years later Lambie, who had meanwhile remained silent about this era of forthright activity, assumed a very different role in public. Testifying on behalf of Rinehart and Dennis for a whole day, on 10 April 1933, he described exemplary conditions in the tunnel, where air was supplied at a face velocity of twenty-seven miles per hour, visibility was from five to seven hundred feet, and water was constantly used to suppress dust. Vigorously cross-examined about the extreme inconsistencies between this testimony and his earlier, condemnatory letters, which had been read into the court record by the attorney for Raymond Johnson two weeks earlier, Lambie blamed inaccurate information supplied by his staff. Although he conceded that he had ordered respirators in writing, he said that he had later countermanded this order orally when he better appreciated the excellent working conditions and clearness of the air in the tunnel.[44]

Two of Lambie's staff inspectors, who had originally filed highly critical reports, now shared in their director's change of heart. Testifying on the following day, C. B. Bishop and D. R. Sullivan joined him in tribute to the admirable conditions at Hawk's Nest.[45] They indicated that Rinehart and Dennis had always cooperated fully, and repeated Lambie's praise of the freedom from dust and the wet drilling. They described the reports they had made in 1931 as purely precautionary and unrelated to actual conditions.

Lambie's startling about-face was never explained to everyone's satisfaction. Less than a week after his testimony, however, the *Charleston Gazette* reported a remarkable coincidence: the former director of the West Virginia Department of Mines had just opened his doors in the prestigious Kanawha Valley Building in the capital city as a private consultant to the leading mining and industrial corporations of the state.[46]

It is evident that, given the almost total lack of objective testimony available, measures taken by Union Carbide and its contractor that might have minimized the risk from exposure to silica dust in the Hawk's Nest Tunnel can never be fully evaluated. Here, as in the questions of the company's knowledge of the danger of silicosis, each individual must base his conclusions on the most judicious balance of conflicting claims he can achieve. There is, however, an objective measure of the efficacy of whatever precautions may have been taken. Even in 1930 silicosis was a preventable disease. Therefore, a reasonable estimate of the number of deaths attributable to work on the tunnel offers an indirect but telling test of the companies' concern for the workers' health and safety.