Health and safety in the Humber bridge construction, 1973-1981

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Santé et sécurité sur le chantier du pont suspendu Humber

Gesundheit und Sicherheit beim Bau der Humber-Hängebrücke

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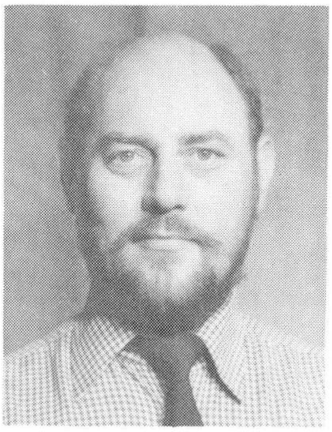
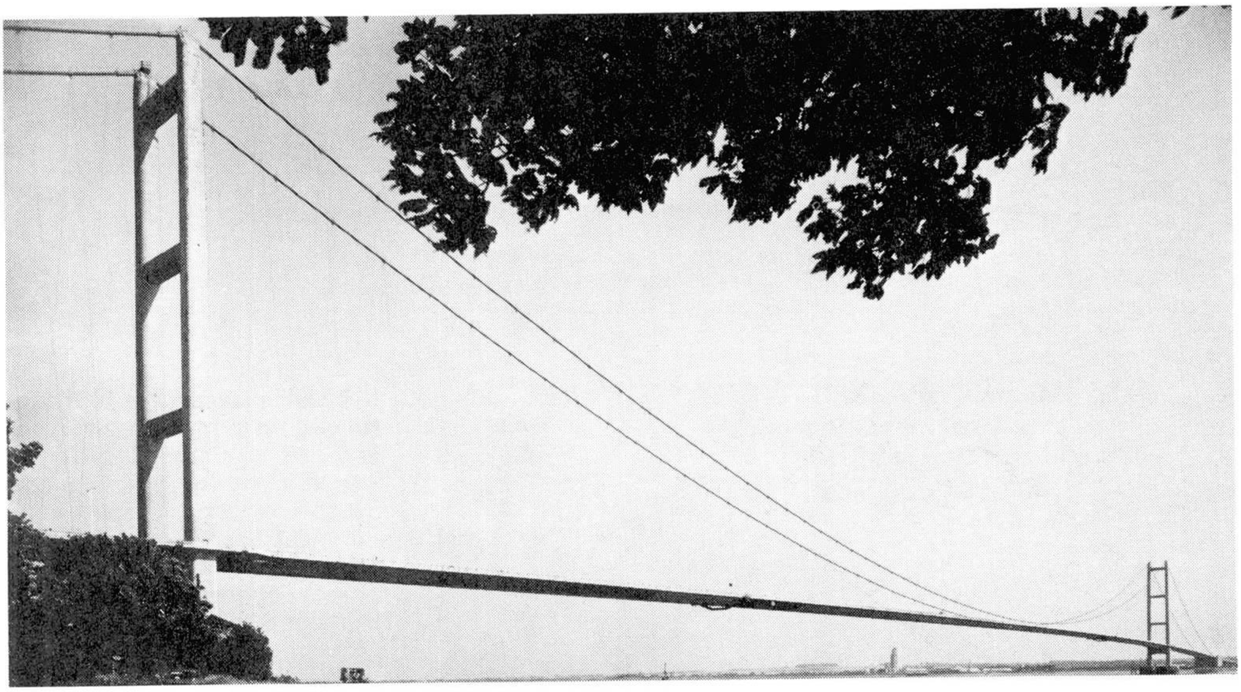


Michael Sparkes, born 1937 took his degree in modern languages and law at Cambridge University, England in 1961 when he joined the Factory Inspectorate. From 1967 he specialised in construction work, inspecting all phases of the erection of the Humber Suspension bridge.

SUMMARY
The construction of the Humber Bridge, UK, with a central span of 1410 m took over 8 years employing a workforce averaging 420 men. At the planning stage already a site safety coordinator was appointed, having jurisdiction for safety over the whole project. The article reviews the phases of construction of the bridge and hazards encountered. Accidents statistics are presented and safety measures recommended.

RESUME
La construction du pont suspendu Humber, GB, avec une portée principale de 1410 m a duré plus de 8 ans et a nécessité en moyenne un personnel de 420 collaborateurs sur le chantier. Dès la phase de projet, un coordinateur de la sécurité sur le chantier a été nommé avec pour tâche d'assurer la sécurité de tout le projet. L'article passe en revue les différentes phases de construction du pont et les dangers encourus. Des statistiques d'accidents sont présentées et des mesures de sécurité proposées.

ZUSAMMENFASSUNG
Der Bau der Humber-Hängebrücke in Grossbritannien mit einer Mittelspannweite von 1410 m dauerte mehr als 8 Jahre, wobei im Mittel 420 Leute beschäftigt waren. Bereits im Projektierungsstadium wurde ein Sicherheitskoordinator ernannt, der für das gesamte Projekt zuständig war. Der Beitrag berichtet über die verschiedenen Bauausführungsphasen und die darin aufgetretenen Gefahrensituationen. Unfallstatistiken werden vorgelegt und Sicherheitsmassnahmen empfohlen.



THE HUMBER BRIDGE

1. INTRODUCTION

This suspension bridge with an unsupported central span of 1,410 metres is located across the tidal estuary of the River Humber in North East England. It has a dual two lane carriageway for vehicles and a cantilevered footwalk and cycle track on either side. The Northern sidespan is 280 metres long and the Southern sidespan is 530 metres, making a total of 2,220 metres. The supporting towers are made of reinforced concrete. There are 16,500 tonnes of steel in the box section deck stiffening girder and 11,500 tonnes in the 2 main support cables. There is 30 metres clearance under the centre of the main span at high water to give adequate clearance for shipping. The tidal flow is at the rate of 5 knots and the river has a rise and fall in level of about 10 metres.

The Bridge took just over 8 years to construct, employing a workforce averaging 420 men, reaching a maximum of 1,000 at one time. The total final cost was approximately £90 million. The Bridge has now been operating for over a year and has been in continual full use.

2. PREPLANNING FOR SAFETY

2.1. The history of bridge construction in various parts of the world reveals a sad story of the heavy toll of lives caused by accidents. At the planning stage of the Humber Bridge it was resolved by all parties, most particularly the Trade Unions, that safety would receive primary consideration. It was decided that an experienced person should be appointed as Safety Coordinator to have jurisdiction for safety over the whole project. Briefly, his main duties were that he would (i) have direct access and would report to the Project or Managing Director in matters of safety; (ii) monitor all work planned and in progress on the site to ensure that correct safety procedures were being followed; (iii) liaise with and advise the safety staffs of all contractors; (iv) maintain contact with Government Health and Safety Inspectors to ensure that all statutory safety requirements were being complied with.

On his appointment in 1973 Mr Drake, the Site Safety Coordinator decided to consult each of the main contractors who were about to commence work to lay emphasis on certain factors concerned with safety which should receive their attention, these factors being:-

2.1.1. That a clear, practical safety policy should be published, declaring the intentions of the management with regard to the safeguarding of the health and safety of their employees whilst at work. It was intended that the safety policy should define responsibilities of the individual members of management and those of the employees in respect of their own safety and that of others.

2.1.2. All employees should be given a thorough safety induction before working on the site.

2.1.3. A balanced safety committee should be formed and should hold regular meetings for the purpose of reviewing the safety performance and for the dissemination of safety information for the forthcoming operations. The proceedings of the safety committee meetings should be published.

2.1.4. The establishment of operational safety codes to cover standard procedures was encouraged, together with the preparation of planned systems of work to cover construction procedures which were out of the normal routine. Some of these will be described shortly.

2.1.5. Temporary works should be given great attention at the design stage in order to plan access and adequate safeguards for working places.

2.1.6. The provision of suitable protective clothing and equipment for the operatives needed careful thought.

2.1.7. Time should be allocated for training purposes, for example to show training films on eye protection, use of cranes etc, and for training in rescue and first aid work.

2.2 All employers agreed to give particular attention to these points. In addition, plans were prepared for the employment of qualified nurses to operate medical centres at 3 separate locations on the project. Experience has shown that in most accident situations, the most critical factor is the time taken to render first aid to the injured person. Accidents invariably occur in difficult locations and under unfavourable conditions. The efforts of well trained rescuers can be nullified and the results to the victim disastrous if the most suitable equipment is not readily available. Each of the 3 medical centres, therefore, was to be equipped with an ambulance, stretchers, resuscitators and all applicable first aid equipment. Emergency rescue and first aid plans were prepared at each separate location on both sides of the river and later each of these was rehearsed regularly in order to give complete and rapid first aid coverage.

2.3. In the United Kingdom we are fortunate in having a comprehensive system of statutes which cover practically every construction process. If the requirements of these statutes are contravened then a Government Inspector can stop the work and can also take legal action in the Courts against the offenders - be they managers or employees. One such Code of Regulations states that all lifting equipment shall be tested before first used and subsequently examined by an expert at regular intervals. This is usually carried out by the inspector of the insurance organisation which has insured the equipment. At the Humber project this system was implemented by identifying equipment which had been examined by a certain colour. Any item which did not bear the correct current colour was removed from service. This practice proved to be a valuable safeguard against the use of faulty or worn equipment which had missed the regular routine inspection.

3. PHASES OF CONSTRUCTION OF THE BRIDGE AND HAZARDS ENCOUNTERED

3.1 Substructure

3.1.1 Anchorages

These are basically large reinforced concrete boxes divided into 2 chambers, each of which incorporates a mass concrete block to which the ends of the main support cables are attached. The Northern anchorage is about 280 metres away from high water mark. It is 65 metres long and 36 metres high, founded in chalk 21 metres below ground level. The Southern anchorage is 30 metres behind the flood bund. This anchorage is 72 metres long, 40 metres wide and 35 metres below ground level on hard clay.

Excavation of the southern anchorage – strulting of longitudinal concrete walls.

Excavation in the chalk for the Northern anchorage was a safe procedure but in the wet clay on the south bank the ground had to be stabilised by sinking reinforced concrete longitudinal walls by Bentonite slurry injection methods to the full depth of 35 metres. Excavation then commenced between the walls which were strutted transversely as the excavation deepened. Both anchorages involved extensive use of scaffolding both below and above ground. Care was taken to ensure that safe access and safe work places were maintained during the use of this scaffolding. Safety committee members were helpful in this respect and reported hazards quickly. Rail mounted Scotch Derricks were used in the excavation process and for raising and lowering materials.

Two fatalities occurred during this phase:-

- A Scotch Derrick collapsed under overload, killing the operator.
- A tipper lorry reversed over 2 men, killing one and injuring another.

These fatal accidents occurred over a period of $2\frac{1}{2}$ years, during which there were 2 site fires, both caused by sparks from welding operations, in which there were no injuries.

3.1.2 Piers

Construction of caissons at the end of the 500 m jetty.

These reinforced concrete structures support the main towers. The Northern piers at high water mark measure 4.4 metres by 16 metres by 11.5 metres high and are founded in chalk 8 metres below ground level. The South piers are located in the river some 500 metres out from the South bank and measure 4.2 metres by 11 metres by 16 metres high, supported on twin hollow caissons about 24 metres in diameter. These caissons were sunk inside steel sheet pile cofferdams by underwater excavation, to a depth of 36 metres below river bed into hard clay. The construction of the caissons involved building a temporary jetty 500 metres long out into the river, capable of carrying heavy traffic. The caisson work involved the use of divers inside and outside the caissons to inspect progress during the sinking operation. Careful thought had to be given, in addition to the hazards involved in the diving operation, to the conventional problems of safe access and safe place of work. This involved the establishment of rigid rules for working over water where conventional safe working platforms could not be established,, such as the provision of safety lines to which harnesses could be attached, the use of life jackets at all working positions where men were liable to fall into the water, and at all times when travelling by water and working from small craft. It also included the provision of adequate illumination for work which was done at night time. The accidents which occurred during this phase included several incidents of men falling into the water, usually when travelling from ship to shore or vice versa. There was one fatal accident during this phase also:- a small work boat fouled the mooring cable of a pontoon and was overturned by the fast current, which swamped the boat. Four of the men on board were saved, but the skipper of the boat was trapped in his cabin and drowned. This accident occurred as darkness approached. Thus rendering unsuccessful the helicopter search for the skipper's body.

3.1.3 Towers

Each tower consists of 2 tapers vertical reinforced concrete legs braced together with 4 reinforced concrete horizontal portal beams. The legs which were built simultaneously by continuous slip form method, are hollow columns 155 metres high, each with a central access shaft. Their construction work proceeded continuously with 2 x 12 hour shifts for 3 months, climbing at a rate of 4 inches per hour. Access to the mobile platform for personnel was by means of a rack and pinion hoist, whilst materials were raised by a rope guided hoist and by climbing cranes. The principal hazard during this phase was that of falling materials which was countered by enclosing the working platform completely by a mesh fence 1.5 metres high and by providing safety nets and material nets of 6 mm mesh underneath the platform. The portal beams were constructed on falsework which was supported by a suspended steel truss weighing 70 tons, working from the top downwards.

The accidents which occurred during this phase included an electrician whose toes were guillotined during the erection of the rack and pinion hoist, a labourer whose safety helmet and head were split by falling concrete and a dangerous occurrence when a portal beam rig fell 30 metres to the ground before the start of work. This last incident fortunately caused no injuries to personnel.

3.1.4 Fabrication

During the construction of the substructure the box units which make up the deck stiffening girder were being fabricated at a separate location on the river bank nearby. Each unit consisted of stiffened steel plate panels welded together to form a hollow box 22 metres wide, 18 metres long and 4.5 metres deep with 3 metre wide panels cantilevered from each side. Cross girder webs in the form of diaphragms were fitted internally at 4.5 metre centres. 124 boxes were needed to make up the deck girder, the average weight of which was about 130 tonnes. A considerable open space easily accessible to the river was required in which to set up the fabrication area which included:

- A reception area for the raw steel plate.
- A shot blasting and painting factory.
- A further storage area for the painted steel.
- An assembly area big enough to assemble and weld the boxes and match them

end to end.

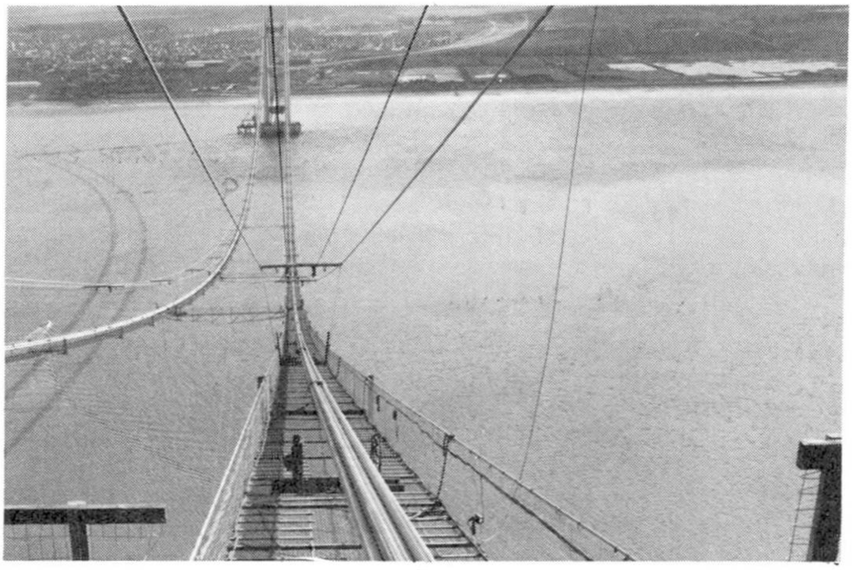
- A storage area for the assembled boxes.
- An overhead travelling gantry to move the boxes out over a main line railway prior to transportation by water to the bridge site 2 miles upstream.

The fabrication operation employed 250 people, including welders, crane drivers, labourers and painters, for a period of 4 years. The safety problems encountered in the fabrication yard were those common to the manufacturing industry and shipyards, namely the handling of heavy loads by crane and vehicle, welding in confined spaces, access inside boxes and risks to the eyes and lungs.

The most common accidents in the fabrication yard were falls of persons caused by tripping or stumbling over obstacles or slipping on wet steel surfaces, with resultant injuries to backs and limbs. Particular attention had therefore to be paid to the provision of suitable walkways and steps and to site tidiness. Precautions were taken to extract toxic welding fumes, shot blasting impurities and paint fumes, and very little trouble was experienced as a result. There was one fatal accident in the fabrication yard when a steel plate fell from a crane on to the man who had slung it. There was also one cabin fire, which resulted in considerable devastation, but no injuries.

3.2 Superstructure

3.2.1 Cable Spinning



Mainspan cable part way trough spinning process.

Each cable comprises 14,948 parallel galvanised drawn 5mm diameter wires, divided into 37 strands each of 404 wires.

To construct these a working platform was required at cable height between the anchorages across the Bridge. A footbridge or "catwalk" was erected with an overhead tramway at a similar level to enable pulleys to travel backwards and forwards across the river to pull individual cable wires into place. Tower top cranes were required to lift all components to cable level, including the tower top saddles.

Initially, single cables were taken across the river and then work cars were erected on to these cables to erect the tramway beams and footwalk transoms. Following this mesh panels were pulled out from the tower tops to the centre of the span and down to the anchorages. Finally, the cable spinning could commence with men stationed at intervals across the bridge to receive the wires. Two 8 hour shifts were worked, each shift involving approximately 70 men. The spinning process lasted nearly 2 years.

The principal hazards anticipated during this phase of the work were:-

- Men falling - this was countered by ensuring that the workplaces were all adequately protected.

- Materials falling - this was catered for by ensuring that working platforms were fully boarded with toe boards and mesh side screens, with provision for boxes for small material which could fall through the openings in the mesh of the catwalk.

- Injuries from handling moving wires - this was catered for by ensuring that the operatives wore suitable protective clothing and used guide sticks wherever possible.

- Injuries from whiplash, from a wire suddenly being brought under tension after being allowed to go slack. This was catered for by ensuring adequate communication between the control position for the spinning operation and each individual station on the mesh.

- Adverse effects on the operatives from exposure to severe weather conditions. Wherever possible, protection from the wind was provided at the wire handling points, with all operatives provided with heavy duty protective clothing.

- Incidents which were liable to occur through lack of coordination between control and operating points. This was catered for by the communication system referred to above which included direct telephone system in addition to the short wave radio voice transmission system used throughout the project.

The spinning process was completed without serious accident or incident. The health and welfare of the operatives was provided for by the establishment of kitchens and mess rooms at each tower top, supplemented by food and drink being distributed across the catwalk by men with backpacks. One problem relating to the health of the operatives which occurred during the spinning process was that of atmospheric pollution from a nearby factory chimney which was discharging nitrous oxides and sulphur dioxide from the factory process. In certain weather conditions the fumes tended to float at cable height, causing extreme breathing irritation and disturbing the spinning operatives. Atmospheric checks were carried out over a considerable period and although the concentrations found were slight and well below the Threshold Limit Value, they did nevertheless affect the workers. Fortunately the prevailing weather conditions resulted in very few occasions when work was seriously affected.

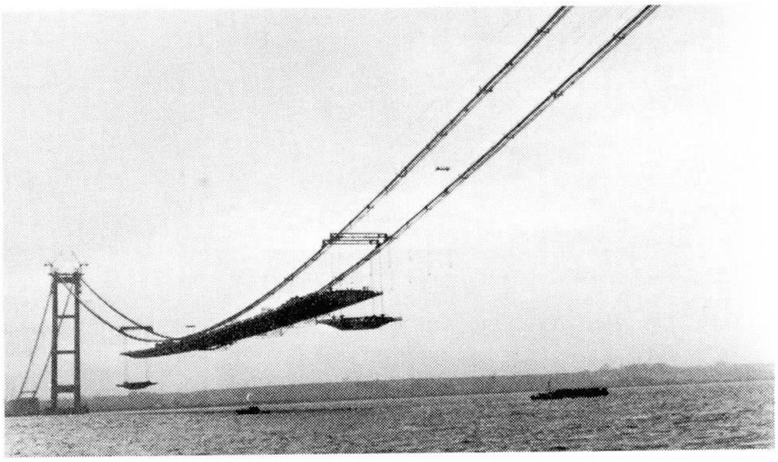
3.2.2 Cable Compaction

Once all the wires had been laid and formed into their strands the total cable was formed into a circular shape by a compaction machine. Cable clamps were then fitted to the cable and the suspension ropes for the deck boxes were lowered through the catwalk and then attached to the cable clamps. Care had to be exercised at this stage when the mesh forming the catwalk was cut to enable suitably sized slots to be formed for the lowering of the suspension cables. The lowering of the cables itself had to be carefully controlled in order to avoid losing the cable through the hole once there was sufficient weight of cable hanging free.

3.2.3 Deck Erection

A lifting carriage of 2 lattice beams spanning between and rolling on the main cables was positioned ready to lift the deck boxes up to the cables for attachment to the suspension hangers. Four winches were located at the base of each tower to operate the lifting tackles attached to the carriage. The deck boxes were lifted from the assembly yard down river by a gantry over the main railway line and moved out on to special pontoons in the river at high tide and then ferried upstream to the bridge site and lifted into place.

The safety measures which were taken for this part of the operation, as with the spinning of the main cables and lifting of the main Caswell cranes to tower top, comprised principally a fully detailed predetermined system of work which clearly defined each stage of the erection. Every man was schooled in his particular role in the operation. Supervision had to be of the highest order since any slight mistake in this type of operation could and did nearly proove fatal.



Erection of the main span during february 1980. Each box is 18.1 m long by 28.5 m wide (including the footpaths along each side). And weighed approximately 140 tons.

After each box was lifted into place and pinned in position on to the correct hanger, the lifting carriage had then to be moved up the cable to its new lifting position by hauling it on its rollers along the cable. The 4 main lifting winches at ground level were used for this purpose, being attached directly to the lifting carriage by tag lines. During the final move of the Northern sidespan carriage the tag lines failed and the carriage fell from the cable through the suspended deck 120 metres below, causing damage to the suspended boxes and severely injuring 2 men on the catwalk. The hangers, cables, pins and boxes did not fail and remained suspended with no damage, although the temporary connection between the 2 box sections affected was broken, allowing the boxes to tilt to an alarming angle. The cause of the accident is believed to be the failure of the several Crosby clamps attaching the haul line to a tag line on the carriage. It would appear that they were not tightened sufficiently to withstand the strain of hauling the 25 ton load up the cable and over the cable clamp on the steepest part of the cable and one side pulled out causing the carriage to roll back down the cable and fall off, dragging the second carriage with it. The winch operators immediately below heard the noise above and ran before the falling debris smashed down on to the 4 winches.

Besides paying meticulous attention to all lifting and hauling tackle in this type of operation, we must bear in mind that we are operating at a critical height above ground and also much of the time over water, so that all practicable measures must be taken against the risk of falling and drowning. On the Humber project arrangements were made for rescue by men with stretchers for the work done on the catwalk, supplemented by helicopter rescue for casualties in the main span. Simulated rescue operations were organised and practised during this phase.

Welding operations started as soon as the deck boxes were in place with all the joints, both inside and outside, being welded. Extraction of fume from inside the box sections was essential. All the lighting and power supplied on the deck was at 110 volts. Welding was by electric arc method. There were some oxygen and propane burners used but these were not allowed inside the boxes. Radioactive sources were kept on the site for use in radiographic checks on the welds, most of which were done when the main workforce had finished for the day. The use of radioactive sources was strictly controlled and each area was cleared and barriers erected by the specialist contractors before any source was energised. The use of radioactive isotopes in this situation is of course governed by a code of regulations enforced by the Factory Inspectorate.

3.2.4 Red Lead Pasting and Wrapping

Whilst welding progressed, work in other areas proceeded simultaneously - cable pasting with red lead paste followed almost immediately by wrapping with soft steel galvanised wire. This task employed a workforce of 100 men working two 8 hour shifts. In this instance the use of red lead, which involved the risk of ingestion and absorption of lead into the bloodstream, the system of work included strict personal hygiene measures which the workforce were obliged to adhere to for their own protection and the protection of other persons. The system of work was prepared and published and the workfoce was trained and instructed in the methods expected of them before they started work In addition, extra clothing was provided to enable sufficiently frequent changes. Separate changing, washing and feeding locations were provided as close as possible to the sites of work. Since lead poisoning is a very real threat to health and because it can quickly enter the bloodstream via the lungs and stomach, the precautionary measures regarding smoking, eating, working and changing of clothes together with the segregation from workers separate from the lead process, had to be strictly enforced. Each man working with the red lead had a blood sample taken at regular intervals so that the level of lead could be monitored and an individual record was maintained for each man. Only one inveterate smoker of hand rolled cigarettes had to be removed from the job when his blood lead level reached 80 microgrammes of lead per 100 ml of blood - the predetermined level of concern. The blood lead levels of all workers increased from the normal average of 10-15 microgrammes per 100 ml to 30-50 level, but each man was told his blood lead level result and was aware of his own increase or decrease. It was noticeable that the more hygienically conscientious men maintained the lowest levels. As cable wrapping progressed the surplus red lead was removed from the cable in readiness for the 5 coats of paint to be applied by hand brushwork. Meanwhile, below, the road surfacing of the steel deck was progressing and the final additions of concrete infill to the anchorages were placed.

3.3 Site Clearance

Finally came the dismantling of the catwalk, tower top cranes, river gantries, temporary jetties etc. In these procedures again it was necessary to prepare systems of work which were fully understood by the men and closely supervised by management. In this type of dismantling work it is all too easy to allow the person in charge or the foreman to improvise his system and to rely on his experience instead of working to a preplanned system. Such improvisation works very well on most occasions but on others it can lead to disaster, as on one occasion when dismantling one of the tower top cranes which had been lowered safely to the ground. A second smaller crane was in use to strip the heavy components and a planned system of work with drawings had been prepared. Unfortunately the plans were not followed and improvisation occurred which resulted in the collapse of a 70 ton crane whilst it was under load. Luckily again no-one was injured, although a considerable amount of damage was done to the crane.

Other hazards and precautionary measures that had to be taken during construction were:

3.3.1 Confined Spaces

In certain parts of the bridge there are areas designated as confined spaces- ie areas underground or under water which do not have natural or forced ventilation and which may remain sealed for long periods. Such areas occur at the bottom of the caissons and underneath the anchorage foundations. In these places there is equipment such as pumps installed which from time to time need maintenance and therefore access is required. In such places it was ruled that atmospheric testing for oxygen deficiency or ingress of methane or carbon monoxide should take place before entry and an "operational safety code" was devised which had to be followed by workers or others who might have to enter such places.

3.3.2 High Voltage Electricity

Similarly, in places where high voltage equipment was installed the "operational safety code" required a "Permit to Work" system before entry could be gained, thus ensuring that proper authorisation and adequate safeguards were observed before and during entry.

3.3.3 Fire Protection Systems

A similar situation exists following the completion of the construction of the bridge in such places as the portal beams spanning between the supporting towers, where high voltage permanent electrical equipment is installed in a relatively confined space. In these areas there are automatic total flooding fire protection systems which can prove dangerous to human life if the proportion of extinguishing vapour is not carefully controlled. In the case of the Humber Bridge the proportions are below suffocation level, but nevertheless a system of key control is provided to ensure that persons within the confined space cannot be subjected to the sudden shock of the noise created by the automatic discharge of a Halon fire protection system, nor can be overcome by a concentration of vapour.

4 ACCIDENT STATISTICS

From the beginning of the project the Site Safety Coordinator decided that a regularly produced summary of accident information covering all workers on the project and giving figures and a performance graph would be of value The summary was designed to give a ready indication of accident trends, to show which was the most prevalent type of accident and in what kind of operation it occurred. It would also include the type and severity of injury received and the increase or decrease in volume etc. All accidents were included in the summary, even those not involving "lost time", mainly because nearly every minor accident could have been major with severe results, and in addition even minor accidents and light injury involved the first aid and rescue machinery The statement was published monthly and posted prominently throughout the project for the information of all the workforce. Statistics for each contractor were recorded separately on the same statement so that an immediate comparison of accident frequency for the period could be drawn. The benefit to management of this publication was that "high risk" activities could be identified quickly and the system of work or the equipment changed accordingly to eliminate the risk. Greater protective measures could be introduced as a result to improve safety and reduce the accident rate. Additionally, by reference to the types and severity of injury which was also recorded, the manpower wastage rate could easily be assessed.

The statement also had the effect of retaining the state of safety awareness among the workers who were able to compare their own safety performance against that of a contractor.

4.1 Facts and Figures

- Total (approx) man hours worked, 8 years	7,870,000 man hours
- Monthly Average	81,980 man hours
- Number of men employed (average) Monthly	424 men
- Average one man monthly	193 hours
- Total all accidents major & minor, 8 years including total of lost time (more than 3 days), 8 years	4,546 348
- Average all accidents monthly	47.3
- Average lost time 3+ monthly	3.6
- Average Incidence rate monthly; all accidents per 10,000 m/hrs over 8 year period	5.8
- Fatalities, 8 years	4

Cranes 2, Drowning 1, Transport 1

5 HIGH RISK ACTIVITIES

From the records and statistics compiled it became readily recognisable that activity risk could be identified in the following order of priority:

- Steel erection (including use of cranes)
- Dismantling or demolition
- Painting
- Scaffolding
- Falsework
- Marine work
- Excavation (including use of heavy transport).

The investigation of every serious accident identified the following causes of the majority, not necessarily in order of priority and not necessarily the sole cause:

5.1 Human Causes

- Haste, or taking changes or short cuts to speed the job.
- Lack of knowledge of the procedure or equipment.
- Lack of concentration or appreciation of the risk.
- Poor or inexperienced or absence of supervision.
- Not working to a prepared or planned system or method, but perhaps relying on the experience of the worker who will improvise to get the job done.

5.2 Material Causes

- Structural or physical failure of material or equipment.
- Unsafe or faulty tools or equipment.
- Misused or misapplied equipment.
- Lighting.
- Weather.
- Lack of, or insufficient, equipment.

6 SAFEGUARDS AGAINST ACCIDENTS

6.1 For Management

- It is vital to establish a clear, practical safety policy with responsibilities well defined and allocated to appointed personnel.
- Safety should be considered at the planning stage of every operation.
- Well organised safety meetings should be held regularly and all business should be efficiently followed up.
- Adequate supplies of serviceable tools and equipment should be provided.
- Systems of work should be established for each operation.
- Training in systems and anticipated operations should be encouraged and organised.
- Supervision of each aspect of the work and inspection of the equipment and results should be thorough and constant.

6.2 For Operatives

- They should be fully familiar with the planned system of work and should be trained and instructed in that method.
- They should be aware of the need for safe access to their place of work and to the safety of that place. They should be prepared to draw attention to defects in access and place of work safety and arrange rapid remedies where possible. They should be aware of the standard expected of the tools and equipment which they are expected to use and should draw deficiencies that they notice immediately to the attention of their supervisor, so that a replacement or repair can be effected. They should also be aware of the effect of their work on other people in the vicinity and organise themselves so that they present the minimum hazard.
- In situations where it is necessary for operatives to wear personal protection, whether it be of the head, eyes, ears, feet, hands, lungs or general body, they should be made aware of the reason for the use of the protection and should co-operate in the use of the personal protective equipment.

The cost of safety during the construction of the Humber Bridge was approximately 1% of the total expenditure on the project.