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Accidents

1. Overhead travelling crane

A component of the hoisting mechanism failed when a ladle full of molten steel (82 tonnes) was suspended at a height of 20m on the hook of an overhead travelling crane.

The travelling crane operator completed the hoisting of the ladle of molten steel to the continuous casting turret. While directing his crane towards the U-shaped ladle support of the turret (height 20m), he heard a crack, felt a jolt and saw one of the hoisting cables hang loose (Figure 1).

Immediately the alarm was raised. Four maintenance staff went on to the crane to assess the damage. The initial observation was that it was not a cable that had broken but one of the tie rods (Figure 2).

In view of the risk of another tie rod failing and despite the safety factors applied to this crane, the order was given:

- to evacuate the staff present in the turret (apart from five persons at 20 m to ensure completion of the cast in progress);
- to close the whole bay with the aid of the supervisory staff and the works' firefighters;
- to close the main gas and oxygen valves;
- to summon the city fire-fighting service (in the event of the ladle falling);
- to alert the works infirmary.

In the meantime the maintenance service decided to slowly lower the ladle to shop floor level (another solution would have been to bring the ladle onto a fork of the ladle turret but there was too great a risk of one of the remaining three tie rods breaking).

This operation was carried out at a speed of 10 cm/minute. When the ladle arrived at about 5 m from the ground the operator conveyed it onto the ladle transfer car so that it could be removed on the furnace bay side.

Once this was done, all danger was definitively removed. The crane was immobilized for 24 hours to allow examination of the equipment and replacement of the four tie rods.

Further examination showed that tie rod number 3 (Figure 1) was twisted and cracked.

The conclusion following a complete analysis of samples of these components was of fatigue failure following alternating bending.

The works investigation was based on the following fault tree analysis:

Recommendations/Actions

- To investigate a new system for avoiding failure of the fixing point and to implement it as soon as possible.
- To systematically replace the tie rods at intervals to be determined.
- To improve checks on safety components before and during utilization.
- To improve definition of steel quality and its mechanical characteristics.
- To review the system for evacuating staff.
- To organize assistance in the event of a serious accident involving several wounded persons.
- To inform other similar establishments of the nature of this incident.

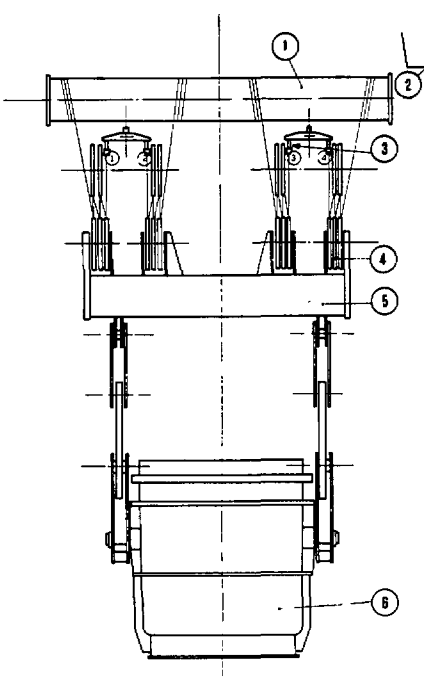


Figure 1
1 Winch
2. Cabin of travelling operator
3. Failed tie rod
4 Pulley system
5 Cross beam
6. Ladle

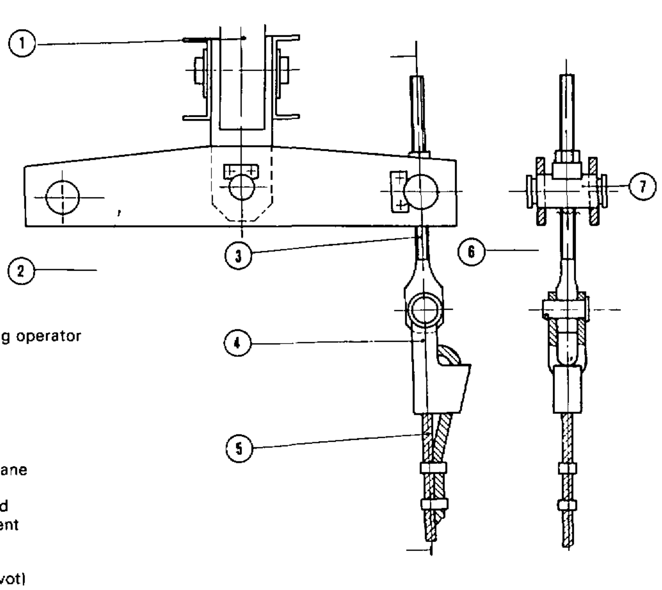
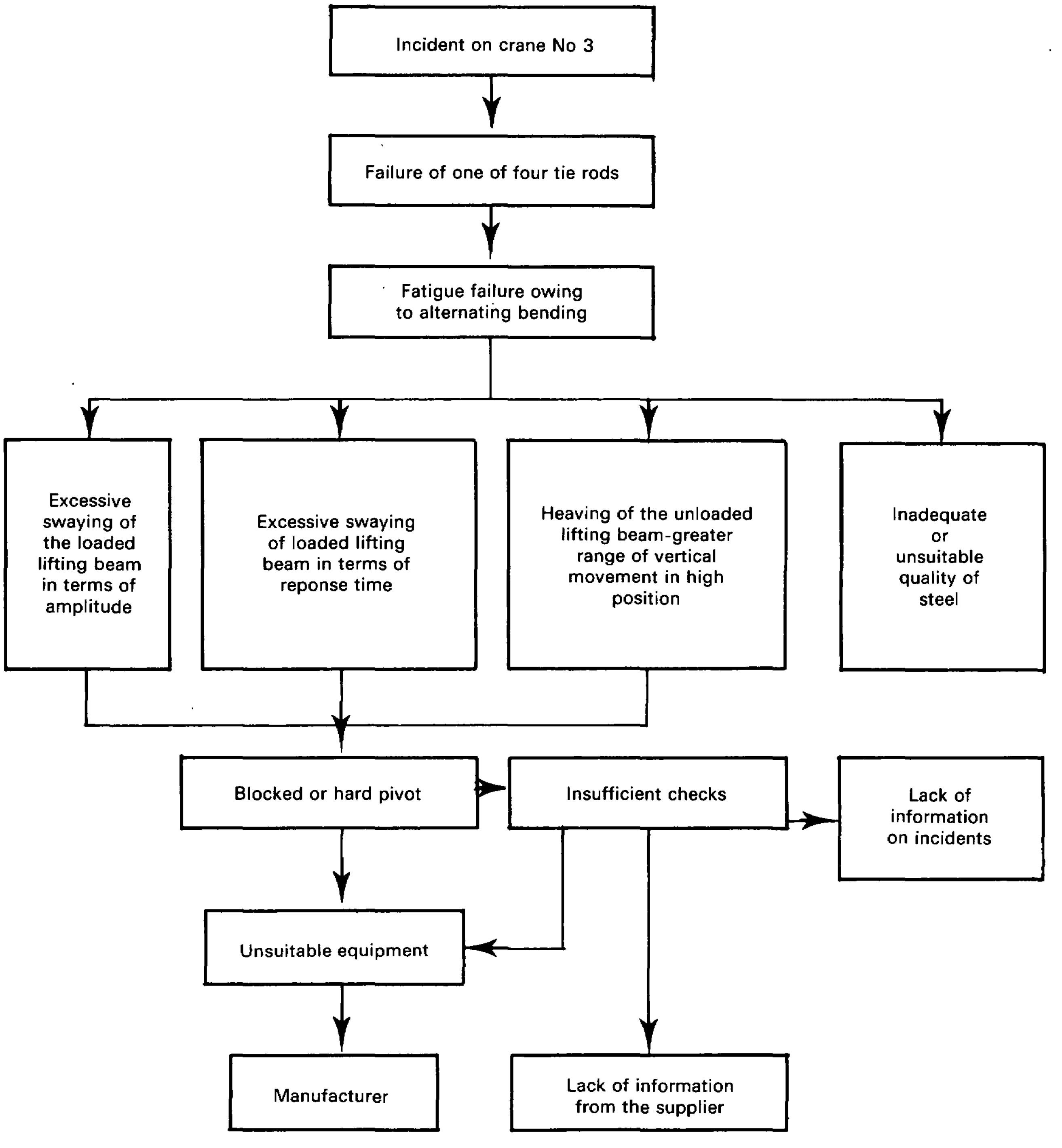


Figure 2
1 Fixed point on crane
2. Beam
3 Regulating tie rod
4 Wedge attachment
5 Cable
6 Failure area
7 Rotating axis (pivot)



2. Man killed by an EOT crane while walking on the travelling track

While a worker was approaching a stationary overhead crane by walking on the travelling track shared by two overhead cranes, he was trapped by the other crane against the metal partition separating two bays.

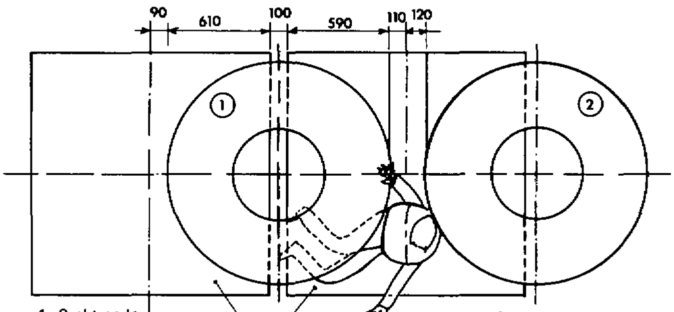
Countermeasures taken:

- Overhead cranes equipped with flashing signals that light up when the cranes move.
- Written reminder that the ladders must be used for access to the cranes and that it is forbidden to walk on the travelling track.
- Prohibition notices placed at all access points to the travelling track.

3. Worker severely injured in the legs and one hand owing to the toppling of a set of slit coils standing on edge

Using a large sheet of paper, a worker was wrapping a set of three slit coils (size 3 x 6 cm, 0 1.3 m) which were standing on edge in the middle of the sheet.

This was exceptional delivery for a single customer. The worker knelt down to attach the protective steel cornerpieces on which the binding wire grips. All of a sudden, the set of coils toppled onto his thighs. The worker then fell backwards and his back hit another set of four coils standing roughly 1.3 m from the first, on another sheet of paper. The worker was jammed under the load (approx. 1600 kg) and suffered multiple fractures of the legs and severe incisions in the right hand.



1 3 slit coils
2 4 slit coils
3. sheets of paper on the ground

4. Explosion of a building site container

A company had placed an overseas container measuring 6 m x 2.5 m x 2.5 m on a steel construction site for use as a tool store. The tools, machines, welding equipment, etc., used on the building site were locked up in this container at the close of work. At one end of the container the gas bottle store for oxygen, acetylene and liquid gas was located.

After work on Saturday at around 1 p.m. the container was locked up and the building site vacated. On Sunday evening around 8 p.m. – i.e. 31 hours after the close of work – the container was blown apart by a tremendous explosion and totally destroyed, with parts flying over 100 m through the air. The gas bottles at the end of the container were hurled through the air and window panes and roofs in the vicinity were destroyed or damaged. It was almost a miracle that nobody was injured by the flying parts and that none of the gas bottles hurled through the air exploded, despite the fact that most of the valves were torn off.

Under normal circumstances, the package comprises four coil and its stability standing on edge is sufficient. In this case, only three coils were involved because the fourth had been discarded owing to damage.

Action taken:

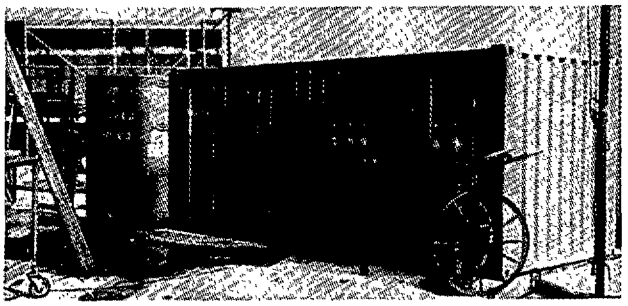
Construction of a steel cradle to prevent the falling of a package standing on edge.

Cause of the accident:

In addition to the tools generally used on a building site, two welding carts with one acetylene bottle and one oxygen bottle each were locked up in the container over the weekend to protect them against theft and unauthorized use.

The valve on one of these acetylene bottles must have been leaking or not properly closed so that acetylene could escape into the container. Acetylene forms an explosible mixture in almost any proportion when mixed with air (explosion limits 2.4 and 83%), but since the container was relatively airtight – it was a so-called overseas container – the mixture could not escape. It is not clear where the necessary ignition spark originated. The electricity supply for the container lighting should have been switched off but this cannot be established with any certainty. Ignition could thus have been caused by a spark from the lighting system or possibly through an electric furnace which had been left switched on by mistake.

One thing is certain, it is extremely fortunate that the explosion happened on Sunday evening and not in the morning as work began. The consequences would have been disastrous.



Container of same design as the one that exploded.

Prevention of accidents:

Leakage of combustible gas from bottles can never be precluded entirely. The German accident prevention regulation on welding, flame cutting and related work states 'Sources of acetylene or other gases, gas or oxygen bottles may not be set up or stored in enclosed spaces'.

Enclosed spaces are defined by the implementing instructions of this regulation as:

'enclosed spaces, e.g. small basement rooms, pipelines, shafts, tanks, boilers and containers, cofferdams and double-bottom cells in ships, chemical apparatus'.

An overseas container as was used here is to be regarded as an enclosed space, at least when it is locked tight.

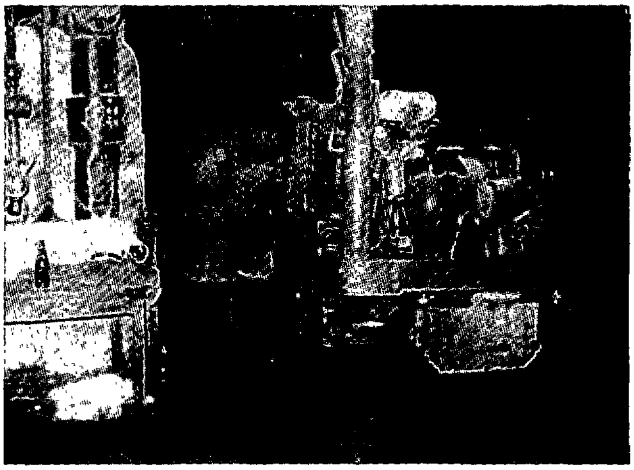
On building sites welding carts must also be stored to preclude unauthorized use or theft. If only small rooms are available for storage these must be naturally ventilated. In the case of the container this would mean that it would have to be provided with sufficiently large ventilation slots. In this respect it should be noted that, unlike liquid gas, acetylene is lighter than air.

This was what was left of the container.

5. Serious accident in forging shop

A hammer was to be converted in a forging shop. The forging manipulator of the hammer had been moved to the side by the operator, who wanted to move the manipulator of the next hammer slightly to one side to allow him to clean the workshop floor in front of the hammer more easily. He switched on the electric drive of the manipulator from the workshop floor. As the back wheel was at an angle, the manipulator rotated and crushed the operator against the furnace. He suffered injuries to the chest and broken ribs.

The accident was due to the victim's improper behaviour. He should have moved the manipulator from the control console. In addition he should have positioned the drive lever in the idle or neutral position before switching on the electricity supply.



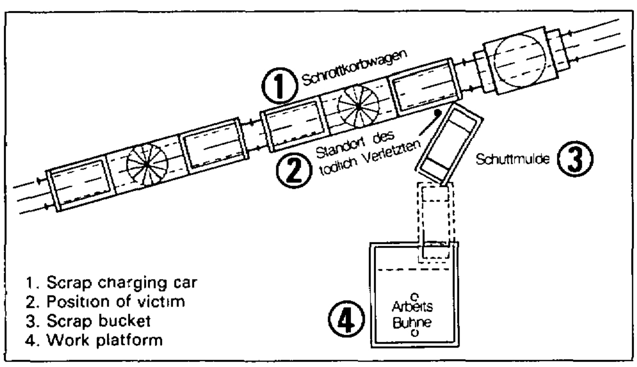
Manipulator with steering wheel at an angle.

6. Fatal accident in an electric steelworks

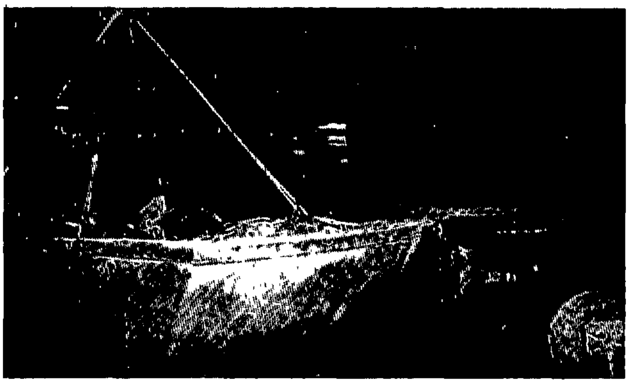
A refractory mason and a colleague had attached a scrap box (with a base 4 x 2 m, approx. 1 m high) weighing approx. 8 tonnes to the auxiliary lifting gear of the scrap charging crane (Figure 1). As one side of the box was underneath a working platform it had to be moved out with the crane. As this was being done, the box rotated and the edge caught on a scrap charging car (Figure 2). The crane driver tried to release the box by reversing the crab but at the same time the refractory mason entered the space between the charging car and the box, probably to push the box free (Figure 3). However, the box rotated further and crushed the mason against the charging car. He suffered severe injuries to the chest, stomach and right hand and died two days later in hospital.

The accident was due to the victim setting foot in the danger zone. The crane driver could no longer prevent the accident. As he started to release the box by reversing the crab, the mason was still outside the danger area.

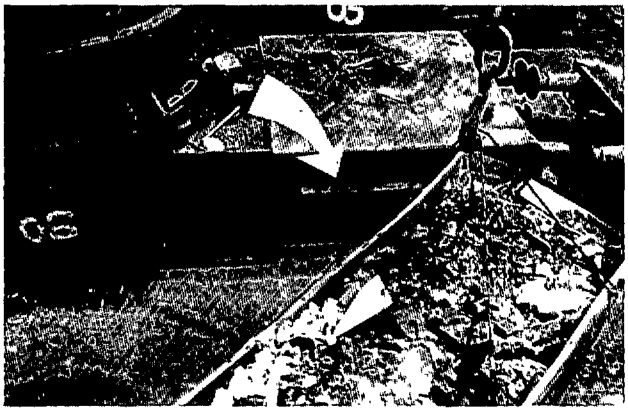
Employees should be reminded again and again that they must leave the danger area when crane loads are being lifted and lowered.



Fatal injuries to a man chaught between the car and the scrap box suspended from the crane.



The scrap box 'caught' under the platform of the scrap charging car.



Arrow indicates the spot where victim was crushed between scrap box and scrap charging car.

7. Fatally injured by falling skull

A driver-shunter for remote-controlled locomotives was directed to drive a full transfer ladle to the vacuum treatment plant. He went ahead of the train to prevent any accidents and remained at the entrance of the vacuum treatment plant bay to allow the train to go past him. As the ladle fell and struck him on the head. As the skull weighed approx. 58 kg, his hard hat did not prevent severe injuries. The man was treated by a doctor immediately and taken to hospital where he died several days later.

When full ladles from the melting shops are transferred to rail cars, the ladles are inspected for skull. If any skull has formed it is removed before transport. In this case the skull was evidently overlooked on inspection or the danger underestimated.

To prevent such an accident in future, all shunting operators at the steelworks are being instructed once again to keep further away from the filled ladle when molten material is being transported by rail.

8. Workman crushed in a sinter sin

A conveyor belt delivers the sinter for the blast furnace to a bin whose base is fitted with a chute which can move horizontally to direct the material either to the blast furnace or to a stockpile. When the conveyor leading to the blast furnace stops, this chute moves automatically to divert the material to the stockpile.

A blockage occured downstream of this moving chute in the fixed delivery chute serving the blast furnace conveyor belt. After assessing the situation, the foreman in charge asked the workman who had been detailed to clear the chute to wait until the conveyor belts had stopped completely before entering the bin. Unknown to the foreman, the workman none the less entered the upper part of the bin and stood waiting on a horizontal metal plate.

He probably slipped on the sinter and fell into the bottom of the bin. His body passed through the movable chute at the moment when the conveyor belts stopped and the chute was automatically displaced in the horizontal plane. It crushed the workman's pelvis and killed him instantly.

Action taken:

- personnel were reminded of the operating and safety instructions;
- a sticker was affixed to every part of the installation to remind workers that it is an automatic device which can operate without warning.

9. Lack of identification of gas lines

A contractor cut into a live six-inch oxygen main which had been mistakenly identified as a purged coke oven gas main. Oxygen was released at high pressure into a service tunnel for approximately 15 minutes but there were no injuries to personnel or damage to the plant.

Events leading up to the incident

As part of the plan to convert the existing coke oven gas supplies at two works to natural gas, a new eight-inch gas main was to be installed from a nearby natural gas meter house to connect with a new six-inch gas main and an existing six-inch coke oven gas main in the service tunnel. The service tunnel is approximately 300 yds long and carries steam, oxygen, gas and compressed air supplies under the main roadway between two works. Because of alterations and additions to pipework services over the years the tunnel was congested. The tunnel is low lying and subject to flooding.

Additionally visibility is impaired by steam emissions from various steam traps on the steam mains. Because of the generally poor conditions in the tunnel, pipework colour coding had become obscured. Therefore, prior to the work being undertaken the pipework was physically traced through with hand torches on three occasions. The pipe chosen as the coke oven gas main was under water on each occasion. Before work commenced the coke oven gas main was purged and the tunnel pumped as dry as possible.

Two contractor's welders who were to undertake the work, having first installed temporary lighting at the place where the work was to be carried out, approximately 50 yds from the nearest place of access, commenced cutting into the gas mains at the place instructed with an oxy-propane torch. As the pipe wall was penetrated there was a flash fire and a large and noisy escape of gas. The welder turned off his burning torch and both men ran from the tunnel. Emergency services were alerted and the work's Fluid Services Department confirmed that the leak must be either compressed air or oxygen and isolated both the services within 15 minutes of the initial report of the accident.

Examination of the site showed that the pipe had been incorrectly identified and as a result work had been commenced on an oxygen main which was subsequently damaged. The poor environmental conditions prevailing in the tunnel had been a contributory factor in causing wrong identification being made. Drawings of the tunnel services which had been available at the time were inadequate.

Recommendations/Action

1. Pipe identification and lagging in the tunnel to be effected immediately.
2. Tunnel to receive immediate attention as follows:
   (a) lighting to be brought up to standard;
   (b) steam leaks to be repaired;
   (c) pumping system to be corrected;
   (d) maintenance procedures for the tunnel to be drawn and implemented on an on-going basis.
3. Drawing of services and isolation procedures to be up-dated and made available to plant engineers.
4. Disaster plan procedures for the two works to be reviewed.
5. Arrangements to be made to allow contact with Fluid Services Engineer to be made on a 21 shift basis at the works.
6. This service tunnel to be designated as a 'confined space' and formal permit to work procedures applied.
7. Check list procedures for working on pipelines to be implemented.
8. On new work being undertaken in areas outside departmental boundaries the Fluid Services Engineer is to be present to confirm pipework selection and the initial break into pipework is to be made by cold cutting.

10. Trapped between an empty mould and an ingot moved by a passing locomotive

An Ingot Stock Controller sustained injuries which resulted in the amputation of both legs after being trapped between an empty mould and an ingot which was moved by a passing locomotive.

Events leading up to the accident

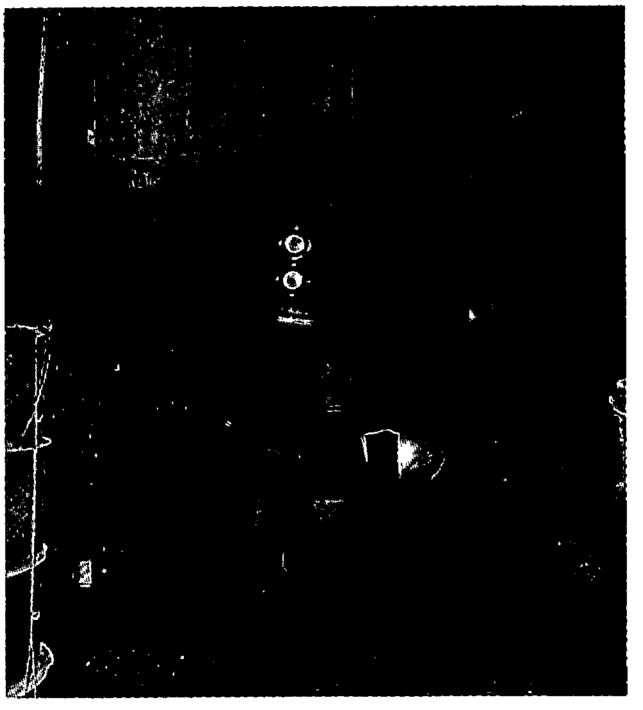
The crew of a locomotive were instructed to propel a damaged bogie, carrying three empty moulds and bottom plates, into the stripper bay. The empty moulds and bottom plates were to be off-loaded there so that the bogie could be taken to the central engineering workshop for repairs. As they entered the bay both the driver and the shunter were aware of moulds positioned in the area but free of the track. They did not see anyone in the vicinity of the moulds. The locomotive stopped beneath a stripper crane and the moulds and bottom plates were unloaded, the operation took about 30 minutes. During this period the locomotive crew did not see anyone working in the vicinity of the moulds. When the off loading was completed they re-boarded the locomotive. Having been told that it was safe to do so, by the shunter, the driver began to move the locomotive slowly, now pulling the damaged bogie. As it moved through the bay the shunter saw the ingot stock controller, who was subsequently injured, painting identification numbers on an ingot approximately 10 to 15 ft away from the locomotive. He also saw that an ingot was lying on the ground with one corner protruding towards the rail track. However, having successfully passed it on the way into the bay he assumed there would be sufficient clearance for the locomotive to pass it on the way out. As the locomotive was about to pass the ingots it rocked and struck the ingot alongside the track and pushed it towards the ingot stock controller, trapping him in a scissor movement against an adjacent mould. He sustained severe injuries which necessitated surgery resulting in the amputation of both legs, one above and one below the knee.

Investigations and conclusions

It was established that the ingot had been stripped and placed in the area in the vertical position on the previous day. It had been observed in this position during the early hours of the day on which the accident occurred. At some indeterminate time after this it either fell or was knocked down into the horizontal position at right angles to the rail track. The crew of the locomotive involved did not observe the ingot near the track neither were they aware of any obstacle impeding the progress of their locomotive as it entered the stripper bay. Whilst the locomotive was being off-loaded the ingot stock controller had taken up a position between the ingot and a mould and became engrossed in his paperwork in order to identify the ingot. Examination of the site showed that the rail track in the immediate area had a series of undulations which would account for the locomotive having rocked. As a result of this the slowly moving locomotive had struck and pivoted the horizontal ingot trapping the ingot stock controller.

Recommendations/Action

1. A clearance of three feet must be maintained at all times along each side of rail track. This instruction has been re-issued to all stripper bay personnel and locomotive crews.
2. All ingots stocked in the stripper bay bank will be stacked in the horizontal position.
3. Publicity concerning the vigilance to be exercised by all persons working in the proximity of rail track is to be given new impetus. A survey to be carried out on all existing rail traffic warning signs and renovation to be carried out as required.



Position of shunter as ladle passed by.

Safety in scrapyards

The following report is the work of Ing. O.D. Schoenmaker, head of department at NKF Staal BV, Alblasserdam, to whom our thanks are due. It constitutes a follow-up to the earlier conclusions of the Working Party on Health-Electric Furnaces published in **Pollution and steelworks in electric-arc furnaces** (EUR 7831).

In December 1984 Mr Schoenmaker described his work to a small group of experts. Additional information supplied to the secretariat of the Safety and Health Commission by Dipl.-Ing. B. Lohrum of Krupp Südwestfalen AG and Dr A. Nicholson of the British Steel Corporation, who were at the meeting, is included in the form of footnotes.

Scrapyards

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1. General

1.1 The role of the scrapyard in an electric steelworks

The role of the scrapyard at an electric steelworks is to receive, sort, store and transfer scrap.

Scrap is the main raw material for the electric steelmaking process for which up to 1100 kg of scrap per tonne of crude steel can be required.

As more alloys are used, specific scrap consumption falls. Charging of alloys depends on the alloy specification for the quality of steel required.

Sponge iron can also be used, both in view of the quality required in the steel types to be produced, but also depending on the availability of scrap of suitable quality.

The use of sponge iron is limited strictly by economic considerations and forms less than 1 % of the material used to charge electric furnaces in the Community.

The great variety in type, size and location of electric steelworks in the Community means that the same variety is apparent in scrapyards.

Irrespective of the manner in which the scrapyard must function in the given circumstances, its role remains, in principle, the same in all electric steelworks.

The scrapyard must enable scrap of the correct composition to be loaded into the charging buckets at the correct time.

1.2 The layout of the scrapyard

A well-functioning scrapyard in an electric steelworks must provide weighed scrap in the charging buckets at the correct moment, preferably with the appropriate physical and chemical characteristics to ensure that the manufacturing standards for steel grades can be fulfilled and optimum conditions for the heat are obtained.

The scrapyard can only fulfil these conditions if it is organized to take account of the requirements in the melting shop and has sufficient resources, space and skilled personnel.

As conditions vary from steelworks to steelworks and from country to country there can be no question of a standard model for a scrapyard.

However, there are a certain number of features common to almost all scrapyards.

The following can determine the layout of a scrapyard:

- the area from which scrap is obtained;
- the geographical situation of the steelworks;
- the access facilities;
- the climate;
- the type of electric steelworks;
- furnace capacity;
- furnace size;
- the grades of steel to be produced;
- the casting process;
- the size of the scrapyard;
- the equipment;
- secondary conditions and circumstances.

The simplest form of the scrapyard is a reception area for rail cars, vessels and/or road vehicles, where the load can be transferred directly to charging buckets.

As even in the simplest electric steelworks some sorting facilities and a small stockpile to compensate for delays between supply and charging are required, the size of a scrapyard increases as the demands upon it become more numerous and more stringent.

A scrapyard is often situated directly next to the melting shop and can either be covered over or in the open air.

It can also be located parallel to, or at right angles to, the furnace building.

The scrap must be unloaded quickly (from the road vehicles, rail cars or vessels) at the same place as the respective type of scrap is required.

It must also be possible to load the charging buckets quickly and efficiently with a mixture of different types of scrap.

Normally bridge, semi-portal, travelling and luffing cranes equipped with magnets and/or grabs are used for both operations.

Partitions or even bunkers are used to separate the different types of scrap.

It must be possible to transfer the charging buckets quickly and easily to the immediate vicinity of the furnaces and within range of the cranes where weighing facilities must be available to determine the correct partial and total weights.

As furnace size and production capacity increase a scrapyard can become very large and it is vitally important that the charging buckets mounted on self-propelled transfer cars can get as near to the stockpile as possible to avoid time-consuming crane travel.

Most steelworks' stockpiling strategies provide for supplies for between two weeks and two months.

The stocks must also be easily accessible and many types of scrap cannot be stored for an unlimited period. This scrap must be replaced from time to time.

In many cases the scrap which is supplied can be used without additional processing. In cases where scrap has to be processed for charging, the scrapyard requires suitable equipment.

In some cases the scrapyard also has storage facilities for auxiliary materials such as carbon fuels (coke, anthracite), lime and alloys.

A scrapyard can be either small and simple or large and equipped with a large number of cranes and auxiliary equipment.

1.3 Scrap and its main characteristics

Electric steelworks can only use scrap which meets the requirements for suitability.

The physical characteristics such as dimensions and density, and the chemical characteristics in the form of non-metallic additives and unwanted residues are of great importance.

It is the scrap merchant's job to supply usable scrap to the steelworks. Availability and price are always vital and thus great demands for flexibility are made of electric furnaces.

As regards the physical characteristics, the scrap must not be too large. If the scrap is too light there is a risk of oxidation being excessive and more loads per charge will be necessary than is desirable.

The best melting results are achieved by mixing different types of scrap to obtain the smallest number of loads per charge, preferably only two.

A general classification for scrap was accepted by the Community in 1972. This classification comprises seven main groups, subdivided into 20 categories.

Group I:	Long steel scrap	(4 categories);
Group II:	Short steel scrap	(5 categories);
Group III:	Long, light and loose scrap	(1 category);
Group IV:	Bales	(2 categories);
Group V:	Turnings	(4 categories);
Group VI:	Special steel categories	(4 categories);
Group VII:	Shredder scrap.	

The density can vary from category to category between 0.4 and 2.5 tonnes per cubic metre. The prices also fluctuate considerably.

A salient feature of the groups are the maximum lengths of 1.5 and 0.6 m respectively. Small electric furnaces can not handle pieces of 1.5 m in length and must restrict themselves to 0.6 m pieces, and in some cases 1 m pieces, assuming that the local scrap dealers can supply this intermediate category.

The correct choice of scrap can vary from works to works, depending on production requirements, processing facilities and economic considerations.

Extremes of price, density, scrap quality and production quality play a part here.

The chemical as well as the physical properties are of importance.

Although scrap is not generally purchased in view of the chemical characteristics, most sorts are allocated chemical values.

It is in the interests both of the dealer and the user to segregate alloyed and non-alloyed scrap.

New scrap of known origin can, as is known, be assessed differently chemically from assorted scrap or scrap obtained, for example, from incinerating domestic waste.

Shredder and automobile scrap also has its own characteristic chemical properties.

Non-metallic additives can occur in a large number of forms in scrap, ranging from refuse, fireproof bricks, tyres, plastics and wood to oil and grease.

Non-conductive materials can cause electrode breakage. Excessive quantities of oil and grease can cause excessive flames in charging and additional heat loads on the furnace gas extraction plant.

Revert scrap from the same steelworks is normally chemically pure but can have different dimensions depending on the products and intermediate products in the works.

Examples of the above are: ingot crops, crop ends from billets and blooms, ends cut from pipes, flash from castings, wire bundles, cuttings, etc.

Revert scrap can also be alloyed. In the interests of economy, but also to prevent unwanted elements in charges where they should not be present, alloyed waste should be stored separately.

In principle, the following categories should be segregated:

- Carbon steel scrap (low Ni, Cr and Mo residues);
- Chromium steel scrap (low Ni, and Mo residues);
- Chromium/molybdenum scrap (low Ni as residue);
- Nickel steel scrap;
- Nickel/chromium steel scrap;
- Nickel/chromium/molybdenum steel scrap.

Subcategories are added to these as required.

For the sake of completeness two basic metallic substances mentioned above should also be noted here:

- Carbon carriers;
- Sponge iron.

Almost all pig-iron and cast-iron wastes can be regarded as carbon carriers.

If large pieces of cast-iron waste occur at the same steelworks in non-chargeable form, these should be made chargeable. In addition, carbon carriers should normally be supplied in chargeable form in pieces of up to 60 cm, in some cases to 1 m.

Sponge iron is a special case. As usage in general is very low, this product will not be discussed at length here. Dry storage is preferable to exposing this material to wind and weather.[1]

1.4 Equipment and installations in the scrapyard

The following equipment and installations may be available at an electric steelworks scrapyard, depending on its size and type.

As already mentioned, the simplest type of scrapyard comprises only handling facilities where the scrap, including revert scrap, is supplied in chargeable form.

The other extreme is a scrapyard where all types and sizes of purchased scrap can be delivered and is not yet in chargeable form. Processing is required to reduce the scrap to chargeable dimensions. This type of scrapyard is closer to being a scrap processing plant upstream of an electric steel melting shop.

For the sake of completeness the equipment and installations which occur most frequently are named.

Fixed rail cranes:

- overhead travelling crane;
- travelling crane;
- bridge crane, with or without hinged apron;
- luffing crane, on its own travelling portal, on a mobile trolley or on crane tracks;
- different versions of slewing/luffing cranes (as for luffing cranes);
- tower cranes;
- slewing cranes with travelling bridges;
- portal cranes;
- semi-portal cranes.

Mobile cranes:

- luffing cranes on rubber tyres, locomotives or caterpillar tracks;
- straddle carriers.

Transport equipment:

- rail cars;
- forklift trucks;
- mechanical shovels;
- front loaders;
- trucks of different types;
- locomotives.

Scrap processing equipment:

- shears;
- shredders;
- breakers;
- balers and presses;
- conveyors.

Auxiliary equipment:

- cutting and welding equipment;
- magnets;
- grabs;
- firefighting equipment;
- tools;
- lifting equipment such as hoists, lamps, slings and chains;
- containers.

Miscellaneous:

- drop work (pig breaker);
- bunkers and partitions;
- rail tracks;
- weighing facilities;
- communications equipment;
- haulage gear;
- rail car tipping equipment;
- wharves;
- tools;
- ventilators;
- first-aid equipment.

1.5 Activities in the scrapyard

On delivery the scrap must be unloaded, whether it is chargeable or not, unless the transporter can be unloaded automatically.

Subsequently the scrap must be loaded into charging buckets.

The extent to which other activities, besides these primary functions of a scrapyard, are necessary depends on a number of factors such as:

- scrap processing which might be necessary to reduce it to chargeable dimensions;
- sorting activities, which are more extensive as the number of scrap categories used increases;
- the size of stocks and the production level of the steelworks; larger stocks entail more extensive storage areas and longer transport distances.

If the scrap is purchased from dealers and processors who specialize in delivering scrap in chargeable condition, the steelworks does not need scrap processing equipment itself.

As a result of a variety of local circumstances a steelworks might, for example, need a baling press or might have to do a lot of cutting or shearing.

It will hardly be necessary for electric steelworks to have as large a range of machinery as a scrap dealer.

For the sake of completeness the most important types of machines were named in the previous chapter and if necessary one or more of these should be present at any one plant. Working with these machines entails specific safety requirements.

In selecting, sorting, inspecting and transporting scrap, the transport equipment should, in general, do most of the work. However, a certain amount of manual work is still involved, which entails some risk.

An important aspect is that almost all activities are carried out in shifts, in all times of the year and that work must often be carried out in the open air where all kinds of weather conditions must be reckoned with.

To summarize, the human activities are distinguished between as follows:

[1] Dr Nicholson's comment 'Dry storage is strongly advised because of the susceptibility of this material to reoxidation. In the impassivated state spontaneous combustion can occur in damp conditions. This hazard is greatly reduced by passivation which nowadays is normally carried out prior to delivery.'

- movements within the scrapyard:
  - on ground level,
  - on crane tracks and cranes, via steps and platforms,
  - in the breaking yard,
  - on or in the transport vehicles, i.e. rail cars, ships, etc.;
- presence in the working area of transport vehicles and machinery;
- presence in the path of transport equipment;
- working with machinery, installations and auxiliary equipment;
- inspection, maintenance and repairs of machinery, installations and transport equipment;
- cutting and welding;
- inspections and checks.

2. Nuisances and hazards for scrapyard personnel

2.1 General

Scrapyard workers are, to begin with, exposed to hazards also encountered in working with transport equipment such as cranes, trucks, forklift trucks, rail cars, locomotives and so on but also to specific hazards which are directly associated with scrap and working at night and at all hours in all weather conditions.

The way in which activities are carried out by scrapyard personnel can also affect the safety of the furnacemen.

An example is not removing explosives or closed containers before the scrap reaches the furnace. A number of other examples can be added (see Chapter 4).

The safety rules for scrapyard personnel are generally connected with design, construction, repair and use of different types and sizes of machines used.

The activities are centred around moving large quantities of material of different forms, mostly in bulk but sometimes as single pieces.

The type of machinery and the type of material to be moved, and the working environment, require that the greatest possible care be taken with regard to the safety of operating personnel, auxiliary personnel and other persons in the immediate vicinity of the work. Efficient lighting is, for example, extremely important.

The activities, circumstances, machinery and installation must be analysed to provide a basis on which a safety programme can be established.

This safety programme must reflect plant management philosophy in this field. The responsibilities of management, supervisory staff and workers have to be clearly defined.

In the following chapters various categories of hindrances and hazards will be discussed.

2.2 Transport

Cranes and transport equipment are virtually always needed when moving scrap.

The first point to be noted is that the cranes and the transport equipment must be well designed, suitable for the job and well-maintained.

The operating personnel must be instructed and trained in working with cranes and transport equipment.

Cranes and transport equipment must never be overloaded.

Hoisting cables, chains and slings, hooks, magnets and grabs must be suitable for use with the respective cranes and transport equipment and must be utilized and inspected in accordance with the regulations.

Access facilities to cranes and auxiliary equipment must be kept in good condition and clear of obstacles.

Cranes and transport equipment must be started up and shut down in the proper manner in accordance with the correct regulations and exclusively by persons authorized to do so.

Cranes and transport equipment may never be used for activities for which they are neither suitable nor intended, nor for unusual activities.

Injudicious use of cranes and transport equipment and, in particular, the use of equipment which is not in good condition can cause great risk not only to the operators but also to other personnel in the working area.

Accidents may result in severe injuries.

In all industrialized countries and certainly in the countries of the Community, there are statutory provisions (safety rules) in force for the design, construction, maintenance and use of transport equipment and cranes.

It is vitally important that the management of the steelworks takes account of all the articles in rules governing the use of scrapyard equipment.

2.3 Machinery and installations

In as far as an electric steelworks receives a large percentage of scrap which must be processed before loading into the charging buckets, since it does not arrive in chargeable form, the plant must have equipment and personnel to render the scrap chargeable.

Depending on the type of scrap and the quantity to be processed, the range of machinery available at the scrapyard will be either simple or extensive.

In general, the same remarks as in the previous section (2.2 'Transport') apply to the use of this machinery and equipment.

In the interests of safety, the machines must be of good design.

Arrangements must be made to ensure safe operation and the personnel must be schooled, trained and qualified.

Access roads and paths, and the premises around the equipment, must be clean and clear of obstacles.

Machines may only be shut down and started up in a suitable manner in accordance with the correct regulations.

Injudicious use and in particular, use of machines which are not in good condition involves great risk to operators and others in the working area.

Machining specific types of scrap can cause serious accidents, for instance when cutting closed containers or gas bottles which have not been inspected. Judicious use of machinery must be based on training, instruction and skilled knowledge.

The machinery itself must in all cases meet the statutory safety requirements of the country in question but the use of the machinery in processing scrap requires specific knowledge, specific supplementary rules and procedures.

Machinery can sometimes increase the noise level in scrapyards considerably.

2.4 Noise

Noise in a scrapyard is generated by moving cranes, combustion engines, falling scrap, scrap processing machinery, flame cutters, compressed air and ventilators.

When cranes, machinery, other transport equipment and flame cutters are in operation, there is more or less continuous noise of fluctuating level.

Depending on the noise level emitted from this source, the distance from the source determines the susceptibility of each worker to it.

Falling scrap produces impulse noise, the level of which is dependent on the height from which the scrap is dropped, its mass and type. The frequency, i.e. the number of impulses per unit of time, is determined by the rapidity with which the crane (cranes) drops another load of scrap.

Unloading heavy goods vehicles also produces impulsive type noise but this lasts longer than unloading by a crane.

The noise level in a scrapyard is determined by the following factors:

- the location of the scrapyard with respect to the furnaces (does, for example, the noise from the furnaces reach the scrapyard ?);
- the sum of activities at the scrapyard such as crane movement, operating machinery, combustion engines and falling scrap;
- the location of the scrapyard with respect to the surroundings – for example near a busy road.

Broadly speaking, the noise level can vary between 55 dB(A) and 85 dB(A) with impulsive noise caused by falling scrap of up to 95 dB(A).

Localized measures and the use of personal protective equipment can be necessary to reduce the noise to an acceptable level for the worker. However, scrapyards should not generate noise levels which are injurious to the workers concerned in the long term.

Scrapyard noise is not a primary source of risk for the health, though there are exceptions, depending on local circumstances and working methods.

2.5 Dust

The storing, transferring and transporting of bulk goods, including scrap, causes dust emissions.

For bulk goods such as coal and ore, dust emissions by weight of 0.5 to 1.5 parts per thousand must be reckoned with.

In scrap, the steel does not cause emissions but all the other materials accompanying scrap, such as sand, dirt and rust, can become airborne when the scrap is moved.

When scrap is lifted, usually with magnets, there is little chance of dust emissions occurring. Loose dust particles remain in and on the scrap during lifting and subsequent transport.

As soon as the scrap is released from the magnet, the wind can carry off the dust from the falling scrap if it is dry.

No numerical relationship between moving various types of scrap and airborne dust levels in the immediate vicinity of workers has been established.

As the dispersible elements in scrap are very small in relation to its total weight, compared for example with coal or ores, and only low level emissions can be generated, it must be assumed that normal scrapyard operations, i.e. unloading, storing and loading, do not produce dust emissions unacceptable or dangerous for workers.[1]

In cases where the scrapyard has its own shredder or similar installations, and processes scrapped automobiles and domestic appliances, large quantities of dust can be released. As a rule this dust must be collected in suitable filter plant in good working order.

Over a period of time dust will accumulate at any scrapyard and from time to time it must be removed and disposed of at a tip. This can cause unacceptably high airborne dust levels unless the ground is moistened thoroughly beforehand.

Such accumulations of dust consist of various types of unknown origin including artificial fertilizers, insecticides, dyes, dirt, chemical compounds such as paint, and other substances which can be defined with difficulty or not at all.

As contact with these dusts cannot be avoided, workers should pay special attention to hygiene when eating, drinking and also smoking, so that they come to no harm. This also applies to clothing.

Scrapyard personnel can, in some cases, also be exposed to metal vapours, fumes and dust which are generated in processing scrap with flame cutters, descaling, welding and cutting in which case suitable safety measures are required if the substances released include lead, zinc, cadmium, beryllium or their compounds.

Fumes and vapours from cobalt, manganese and copper are potentially dangerous.

Efficient ventilation of the workstation must be ensured when stainless steel (containing chromium and nickel) or coated scrap (i.e. coated with paints containing mercury compounds) are being cut.

In general, cutting and welding activities where high temperatures are generated causing vapour, fume and dust emissions, can often be unpleasant or hazardous for the health and must be guarded against by suitable measures.

As the operator is not aware of what dusts the scrap contains beforehand, only the most stringent safety measures are good enough when high temperatures are being generated.

2.6 Climate

The countries of the Community are situated geographically between meridians 10° West and 26° East and between latitudes 36° and 58° North.

The entire area has a temperate climate with a small temperate subtropical part.

Although the moderate weather conditions both in winter and in summer can be regarded as quite acceptable for work, even outside, extreme conditions occurring over a short period must still be taken into account.

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1 Dr Nicholson's comment 'In prolonged periods of dry weather dust emissions can become troublesome and the wearing of dust masks may be advisable'

Scrapyard workers can, depending on location and season, be exposed to temperatures of between −20°C and +30°C, to rain and snow, hail, frost, mist and wind velocities of between 90 and 100 km per hour. Compared with many other jobs which are also carried out in the open air, there is a variety of disadvantages.

Work must be carried out uninterruptedly, due to the way in which a steelworks functions, and thus continues both by night and by day.

Delivery and unloading of purchased scrap might only be possible during the day whilst scrap buckets must, as a rule be loaded round the clock.

Delivery, unloading and sorting revert scrap is usually coupled to the operating times for the rolling mills and other processing plants.

Processing scrap to chargeable form, using machinery, torches and cutters is often carried out in the day shift or by two shifts.

In brief, regardless of the weather, a scrapyard worker must be able to remain out of doors to carry out his duties, unless the scrapyard is covered over.

As far as crane, transport equipment and machinery operators are concerned, the only risk they run is that in going to and from the cabins. The paths, steps and platforms are less easily negotiated in poor weather conditions.

Workers on the ground are exposed to adverse weather conditions for the entire working day.

Serviceable equipment (e.g. windscreen wipers in crane cabins), order and cleanliness on paths, platforms and steps, means of combating icy conditions, suitable lighting, serviceable clothing, and adequate shelter and warmth can help to create safe working conditions and alleviate or eliminate hardship caused by the weather.

2.7 Ergonomics

In the context of humanizing work, and, parallel to this, increasing economic efficiency, it is important that auxiliary equipment and conditions at work in the scrapyard are modified in the light of modern findings in ergonomics.

Optimum compatibility must exist between man and tool, man and machine, and man and auxiliary equipment.

Moreover, the stress under which the worker must carry out his duties must be taken into account.

In addition to the physical relationship between man and machine, etc., the psychological factors must also be considered.

The findings in ergonomics are not of course specifically related to scrapyards; however, where steelworks managers regard ergonomics as an integral aspect of operations, this will also apply to the scrapyard.

2.8 Miscellaneous

The following points, which are not mentioned above, can give rise to nuisances or hazards:

- transfer equipment, such as bulldozers and wagon tipplers;
- breaking yard;
- road conditions;
- lighting;
- communications;
- organization;
- segregating equipment;
- weighing equipment;
- tools, including flame cutters and gas bottles;
- fuel storage.

Here, too, the foundations for good working conditions are laid on the drawing board. Expert planning is vital.

Guidance and instruction must be given, and order and cleanliness maintained.

Inspection and repairs must be carried out to ensure or restore serviceability.

In general the normal safety rules for any industrial plant may apply but additional rules will always be required when scrap has to be processed.

3. General recommendation for reduced stress, safety and health at work

3.1 The safety scheme

The management of any steelworks must concentrate its attention on the safety of the workers carrying out their tasks.

It must be the management's aim and duty to create a working environment free of recognizable hazards which could result in injury.

In conjunction with this aim, a safety programme must be established. Generally this type of programme applies to the whole works with detailed rules for the scrapyard.

The safety programme must reflect the management's safety (and health) philosophy and must be based on:

- statutory regulations;
- humanitarian and ethical aspects;
- economical aspects.

A safety programme is an effective way of helping to create safe working conditions and the scrapyard should also meet the most stringent safety requirements.

The aim of the safety programme is to detect potential hazards in advance, to assess them, take account of them and keep them in check.

A suitable safety programme should be prepared in writing and must be available to all those involved, including supervisory staff and the workforce.

The responsibilities of management, supervisory staff and the workforce must be defined precisely.

The following give some items which should feature in an effective safety programme:

- introduction (including: why do we need a safety programme?);
- general description of the working area;
- more detailed description of:
  - premises, roads and paths,
  - transport equipment,
  - manual equipment,
  - machinery,
  - other equipment;
- operating instructions;

- recommendations and personal protective equipment;
- hazards;
- what to do in the event of an accident (first aid, organization).

Training sessions should be held to familiarize the respective personnel with the safety programme.

Regular checks that the rules are being applied are required to ensure over the long term that attention to safety at work is not dwindling.

It is primarily in the interests of the worker that he can work in safety. His own conduct in this respect is no less important than that of management.

Cooperation (between employer and employee) in implementing an effective safety programme should always be the training objective.

3.2 Recommendations to reduce stress at work in accordance with ergonomic criteria

In attempting to adapt work in a scrapyard to suit the worker as far as possible, the relationship between man and tools or machinery should be examined first, followed by psychic stress.

Machinery is, as a rule, not best adapted to humans' natural stature and abilities.

Working methods, too, leave much to be desired due to a lack of proper instruction.

The following examples illustrate this:

- design of seats in cranes and transport equipment;
- excessive noise;
- poor location and design of levers and pedals;
- restricted seating space;
- poor view of the working area;
- inadequate communications and organization.

Consulting a work analyst or an industrial doctor specializing in ergonomics can, if the works has the right attitude, be a great help in obtaining useful and suitable recommendations for humanizing work.

One well-known example for the consequences of ignoring ergonomics is damage to the back.

In the American scrap industry people talk of 'the billion dollar backache'. The Institute of Scrap Iron and Steel (ISIS) issues *inter alia* the following recommendation for its members' employees:

- use machinery to lift and move where necessary, both in production and maintenance;
- avoid repeated rotation and bending of the back;
- ensure that seats in crane cabins or in transport equipment give effective anatomical support to the operator's back.

Apart from physical harm, psychic damage can also occur as a result of poor ergonomic conditions.

This is apparent in sickness (e.g. as a result of stress), possibly preceded by a period where work is carried out less efficiently, during which the worker can be a hazard to himself and others.

The aims of ergonomics are summarized admirably in the English term 'human engineering'.

These aims cannot be defined precisely for a scrapyard but deserve attention in any attempt to create safe and humane conditions at work.

3.3 Recommendations for safety at work

The hazards to which the workforce is exposed in handling scrap are in part general and part specific.

The boundary between general and specific cannot be traced clearly.

In addition, the type of scrapyard can vary enormously from works to works as explained in the previous chapters.

A good starting point for our recommendations could be to study the accident statistics to discover which accidents have occurred with what degree of frequency and gravity in electric steelworks scrapyards.

Although such statistics do exist they are not accessible for general use.

Another starting point could be to make an inventory of all safety regulations applicable to activities in a scrapyard, including regulations specifically compiled for scrapyards.

This provides no better solution. In no time at all one is smothered by laws, provisions and a host of special regulations which can come from different parts of industrial life (e.g. associations for employer and employee cooperation) in each country. It would prove impossible to compile a conclusive summary, quite apart from the language difficulties involved, so that this approach offers practically no hope of a practical result within a reasonable space of time.

Compiling literature on accidents in the scrapyards at electric steelworks appears equally impracticable.

After a great deal of thought we have used the following basic information:

- accidents in the scrapyards of an electric steelworks with four furnaces over a period of five years (production of approximately 320000 tonnes of crude steel per year);
- accidents in a very large scrap processing plant (approximately 200000 tonnes per month) with a great deal of machinery and tools and a workforce of 170;
- accidents in the scrap industry in the United States of America.

These sources provide data which certainly indicate where the black spots lie so that these can be given most attention in accident prevention.

The most complete summary is given in the 'Summary of occupational industries' from the Institute of Scrap Iron and Steel, Inc., USA, reports for 1976 and 1978.

The ISIS has 1 500 members representing 90% of the American scrap industry which employs a total of approximately 70000 persons.

The summary (1978) is based on data from 152 members (plants) with 7 636 employees.

The type and number of injuries registered are given in the table below.

Type of injury	Number of injuries	% of total
Cuts	783	27.5
Bruises	680	24.0
Strains	487	17.1
Foreign objects	353	12.4
Burns	248	8.8
Fractures	214	7.5
Hernias	29	1.0
Amputations	14	0.5
Injuries not specified	10	0.4
Fumes	9	0.3
Concussions	9	0.3
Rashes	8	0.3
Fatal injuries	2	0.1
Total	2847	100

The 7636 employees worked 16506971 hours in 1978, an average of 2161 hours per employee per year.

Of the 2847 accidents, 913 caused downtime (stoppage of activities) resulting in a loss of 15104 working days. Assuming these working days lasted 8 hours, this represents a loss of man hours of 8 x 15104 = 120832 or 0.73% ot the total time worked.

The following table indicates the distribution of injuries over the body.

Part of body	Number of injuries	% of total
Finger	570	20.0
Back	500	17.6
Eye	402	14.2
Leg	296	10.4
Foot	294	10.4
Arm	224	7.9
Hand	191	6.8
Face	116	4.1
Body	88	3.1
Toe	77	2.7
Head	74	2.6
Neck	8	0.3
Internal	7	0.2
Total	2847	100

The type of activity and equipment giving rise to the accident are also of interest.

Despite the widespread use of heavy machinery, equipment and transporters, most accidents in the scrap processing industry are connected with unsafe behaviour, e.g. workers lifting heavy objects incorrectly or not wearing protection for the eyes or feet.

For a scrapyard of a specific electric steelworks one can probably take the table from this chapter with the detailed data as a basis and determine which machines and equipment are not applicable.

One can determine which activities and equipment are relevant and establish targets for safety regulations, rules of conduct, training and whatever else is desirable.

In the following table the frequency with which a particular part of the body is involved in an accident is linked with the machine used, the equipment and the activity or occupation involved.

Direct accidents with machinery represent 15% of all accidents, working with transport equipment 13%, maintenance also 13% and welding and cutting 14%, whilst more manual activities and movement represent 45%.

It may be assumed that the activities presented here cover virtually all those which occur in the scrapyard at an electric steelworks. We thus consider it useful to make the following recommendations, with explanatory notes where required.

Personal protective equipment

Personal protective equipment may not be a substitute for safety measures which have been neglected at an organizational or technical level. Only in cases where organizational and technical rules provide inadequate protection can personal protective equipment be the only effective alternative.

Type of activity or equipment	Number of accidents	% of total
Manual material handling	798	28.1
Maintenance	381	13.4
Burners	348	12.2
Slips and falls	262	9.3
Trucks and forklifts	257	9.1
Lifting and handling containers and drums	131	4.6
Alligator shears	106	3.7
Cranes	106	3.7
Conveyors	98	3.4
Guillotine shears	90	3.2
Loading and unloading trucks and railroad cars	83	2.9
Briquetters	76	2.7
Welding	54	1.9
Balers and presses	39	1.4
Shredders	18	0.6
Total	2847	100

In general, personal protective equipment should be used as an additional safeguard against the risks involved in scrapyard work.

To ensure that personal protective equipment constantly meets requirements, it should be kept in serviceable and reliable condition, and the level of hygiene required, which is particularly important for some items, (e.g. dust filters), should be maintained.

A hard hat must also be worn in a scrapyard due to the hazards presented by falling and flying objects.

Protective gear for eyes and face is required at all locations where there is a possibility of damage to eyes as a result of flying particles, chips, caustic substances and the like.

Naturally, protection for the eyes is required when flame cutting tools are being used, due to sparking, but eye damage can also occur during maintenance work with manual equipment. Situations can also arise where the eyes are endangered through work with presses, shears and shredders. The correct type of protective gear for the eyes should be determined on a case-by-case basis.

Gloves protect the hands against painful injuries which can lead to greater problems if infection occurs. Flame-resistant gloves are recommended for flame cutting and welding work.

Here, too, there are different types and versions, e.g. gauntlet or reinforced gloves. Local conditions and the type of work determine the choice.

Protective footwear is required to avoid injuries when falling objects strike the foot or the foot is jammed.

This footwear must be of stout leather, preferably boots with steel toecaps and a sole tough enough to resist sharp protruding objects such as nails.

Protective clothing[1] can be of various types. It is recommended that jackets or shirts be worn with long, well-fitting arms.

Trousers should preferably not have turnups, should be well-fitting and not too long.

In certain cases, for example for cutters and welders, flame-resistant clothing should be worn with a leather apron.

Leg protectors might also be advisable.

Ear protectors should be worn by workers constantly exposed to high noise levels which cannot be reduced to an acceptable level by any other means.

Respiratory equipment is suitable in all cases where a worker could inhale excessive concentrations of harmful dusts, fumes, vapours and gases and where no other protective measures can be taken.

The plant must provide proper instruction in the use of and hygienic measures required for this equipment.

Machinery

All machinery must be built and maintained in accordance with the statutory safety regulations in the country concerned and as far as possible in accordance with the recommendations contained in standards.

When using machinery in a scrapyard, attention must be paid to specific aspects of the workforce's safety.

The following items, arranged in order of type of machinery and activity, are worth consideration.

Alligator shears

Alligator shears can be mechanically or hydraulically operated.

[1] Dr Nicholson's comment on clothing: 'It is an advantage in situations where visibility may be impaired that clothing should be brightly coloured.'

Part of the body	% of total	Number	Alligator shears	Balers and presses	Briquetters	Conveyor belts	Guillotine shears	Shredders	Cranes	Vehicles and forklift of trucks	Maintenance	Flame cutting	Welding	Lifting and handling containers and barrels	Loading and un-loading vehicles and rail cars	Moving by hand	Slips and falls
Finger	20.0	570	34	3	7	27	27	2	9	24	164	17	5	38	16	202	24
Back	17 6	500	18	7	3	9	12	1	25	56	31	35	2	30	30	176	65
Eye	14.2	402	6	3	51	18	6	3	7	17	63	74	32	0	5	114	2
Leg	10.4	296	8	10	6	6	4	1	11	48	28	50	3	12	7	40	62
Foot	10 4	294	9	2	1	3	3	5	22	39	25	40	0	16	6	54	69
Arm	7 9	224	3	8	4	17	13	1	4	17	9	22	6	14	6	68	32
Hand	6 8	191	11	4	2	3	8	0	13	28	11	49	0	5	2	26	0
Face	4.1	116	10	0	1	3	7	3	5	5	14	27	0	4	4	33	0
Body	3.1	88	6	0	0	3	0	0	0	7	7	17	1	9	2	31	5
Toe	2 7	77	1	1	0	5	1	1	6	1	8	7	1	2	0	43	0
Head	2.6	74	0	1	1	4	9	1	4	15	14	5	1	0	5	11	3
Neck	0 3	8	0	0	0	0	0	0	0	0	0	5	3	0	0	0	0
Chest	0 2	7	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0
	100	2 847	106	39	76	98	90	18	106	257	381	348	54	131	83	798	262
			427						363		381	402		1 274			
			15%						13%		13%	14%		45%			

The material to be cut is placed between the fixed and moving blades. The upper blade is the moving one.

Mechanically operated shears operate continuously unless they are equipped with a clutch to disengage the drive, so that a single cut can be made.

Hydraulically operated shears can be used both continuously and discontinuously. The operator can make a single cut with hydraulically operated shears.

Particular attention to safety is required for shears where the scrap has to be fed in by hand.

The operator must wear a hard hat, safety goggles or face protector, long gloves, protective footwear with steel toe caps and a leather apron reaching down to the shoes.

Cutting hardened material such as springs, axles, crankshafts and alloyed steel must be avoided.

When cutting hardened materials, pieces can be projected and cause serious injury.

The shears must be equipped with adequate protection on the drive side. The shear blades must be fitted with a guard to prevent the operator from coming within the cutting range of the upper blade.

On pedal-driven shears, the pedals must be covered to prevent falling scrap or inadvertent pedalling from operating the shears.

An (adjustable) hold-down device on the feed-in side of the shears must prevent material from rearing up and injuring the operator.

The surroundings to the shears must be freely accessible.

Baling presses

These presses are used to bale loose and light scrap to form more easily-handled bales with a higher metal weight than loose material. The delivery chest dimensions determine the size of the bale.

There are a great number of presses ranging from very small to very large and from extremely simple to extremely complicated in use at scrap dealers and in steelworks.

Steelworks producing revert scrap from rolling mills or other special treatment shops, which is too light and voluminous to be charged directly, will use presses. There can also be other reasons for an electric steelworks having a scrap press.

For safe operation of presses, the following items must be observed:

- The press must be well maintained. This ensures that the latches cannot open during the pressing operation (e.g. as a result of wear) and leaking pressure and hydraulic lines cannot result in uncontrolled operation of the arbor and delivery valve. All the locking devices must be in good working order.
- The operator must have a good view of the press and the immediate vicinity from the control console so that he can ensure that no-one is near, unless he is in safety (e.g. behind a protective screen), when activating the press.
- In the event of someone having to set foot on the press in connection with inspection activities, correcting of faults or malfunctions or for maintenance purposes, there must be totally reliable shut-down and interlock procedures.
- No closed cylinders, containers or tanks may be loaded. During pressing these could explode if flammable substances are contained (e.g. petrol tanks).
- Presses sunk into the ground require special attention to modified safety rules to ensure that no one can fall into the delivery chest and come within the reach of moving parts. If totally reliable protective screening is not possible, readily visible warning signs with clear text must be put up.

- Remote controlled operation of the press is preferable as is loading it by means of a crane. This is generally the case in large installations. This means that no-one must be present in the immediate vicinity of the press except in special cases.

Briquetters

A briquetter is used to press turnings and drillings to compact cylindrical forms. An installation generally comprises bunkers, sieves, conveyors and the press.

The installation can be controlled from a central control console and can be operated continuously.

If auxiliary operators or maintenance personnel move out of the field of vision of the operator of the machine and accessory plant for any reason, they must have a guarantee that effective safety devices will prevent accidents.

On shut-down the switchgear locks must be absolutely reliable. Procedures to ensure this must be discussed and perfected.

Conveyors[1] can either be of the stationary or mobile type. Vibrating or shaker troughs can be used in conjunction with them.

The moving parts consist of the belts or the chains, the surface of the troughs and, finally, the drive units.

Here again the plant must be fitted with effective safety equipment to ensure that all rotating and moving parts and the switchgear is locked when, for any reason, workers are near or on the belts.

Expert operators are required to commission or restart adjustable conveyors or end units.

If possible, the operator should have a free field of vision of the conveyors and the immediate vicinity.

Guillotine shears generally comprise a portal, at the base of which a stationary, horizontal blade is mounted with a second horizontal blade moving between the two uprights. The moving blade is forced onto the material under enormous pressure, exerting loads of between 300 and over 1 000 tonnes, depending on the size of the shears.

The smaller shears can be used in electric steelworks. As installations grow larger and more complicated they will be seen exclusively at scrap processing plants.

The material which is to be cut is brought to the machine in a hopper and fed to the shears by a mechanical or hydraulic ram.

The operator must have a good field of vision of the machine and the immediate vicinity.

He must have the best possible contact with the crane driver who loads the hopper. Other workers may not remain in hazardous positions when the shears are being operated or in the path of the hopper when it is being loaded, or on the output side of the shears.

The operator's cabin must be fitted with safety glass.

At the output side of the shears suitable iron-mesh screens must be provided to catch projected pieces of steel. The clearance between the chains and between links should not exceed 50 mm.

Reliable start-up, emergency and shut-down procedures must be provided for normal operation, emergency situations and for maintenance procedures with the sole aim of providing protection for workers who must enter the hazardous zone.

Closed containers may not be cut.

Operation with damaged or blunt blades must be avoided. In general the shears must be well maintained.

The area around the shears must be kept orderly and neat to ensure safe operation.

Shredders

It is seldom that an electric steelworks has a shredder of its own. For this reason we will not go into this method of processing scrap in any detail.

A shredder is usually fed by crane when bulky articles such as automobile wrecks and domestic appliances must be flattened.

The material to be scrapped passes through a hammer mill which breaks it into small pieces.

The shredded scrap then passes to the magnetic separation phase where magnetic (approximately 70%) material is separated from non-magnetic material.

The shredder is operated from a screened cabin offering a good view of the loading and output side.

The hazards associated with shredders are:

- shredding closed containers such as petrol tanks, gas tanks, gas bottles and similar objects. This can lead to dangerous explosions;
- projectiles from the hammer mill;
- around the conveyor belt, from which items can fall.

The same hazards are encountered on the output belt where the pieces are smaller but nevertheless still dangerous.

All rotating and moving parts must be effectively screened.

Explosions can have serious consequences for the personnel unless special provisions have been made.

The operator's cabin must thus be of safety glass and be protected by steel latticework. All areas where increased pressure can occur must be fitted with pressure release valves. Firefighting facilities must also form part of standard equipment.

As stated above, the start-up, emergency shut-down, shut-down procedures and safety devices on machinery such as shears and shredders must be described precisely, the workforce must be familiarized with them by means of training and instruction sessions and their implementation checked by supervisors.

Cranes and transport equipment

Cranes and transport equipment play an important role in handling scrap.

In section 1.4 we gave the most important types of crane and transport equipment.

The safety of persons working at ground level is more dependent on the way in which the crane driver works, and the condition of cranes and auxiliary equipment.

In a scrapyard almost all scrap is moved with cranes equipped with hoisting magnets. Grabs are used to a lesser extent. In moving bulky or heavy pieces of scrap, hoisting chains or slings are used. This can be the case with waste (e.g. skull) or discarded moulds.

The pieces to be moved are usually relatively small and lie between 0.5 and 2 tonnes. If production is

[1] Dr Nicholson's commento on conveyors 'The control system should indicate the status of all parts of the system and it should have interlocking mechanisms to prevent pile-ups in the event of one part of the system failing Trip wires alongside conveyors are advisable to stop conveyors in an emergency.'

high the handling rate (number of movements) is greatly increased.

Ground personnel must not remain in the path of a crane and in cases where this is unavoidable, must ensure that they are in safety.

The crane driver should have a good view of the job and the ground above which he is handling the load.

It is useful for the crane driver to know how many people are on the ground and what they are doing. Other people moving around the scrapyard can make a crane driver unsure of what is happening.

Crane drivers should preferably have an effective means of communication and his working area should, at all times, be well lit.

Scrapyard cranes are, moreover, subject to general regulations for lifting equipment. Despite the risk of repetition, the following summarize some important points on safety:

- The maximum permissible load must be visible on each crane.
- The crane driver must be of age and must have proved that he can operate the crane involved (through instruction, training, test operation, etc.).
- The crane must be accessible in safety. The paths, platforms and steps (in some cases ladders) must meet standard safety requirements and must be free from obstacles, fitted with good handrails, well lit and well maintained. The design depends on the type of plant, the type of crane, the number of cranes and numerous other factors.
- Platforms on the cranes must also meet standard safety requirements as must the plating (in some cases grid flooring), stop shoulders, handrails and screening of the rotating parts of the crane mechanism.
- Where special care is called for, warning signs must be used.
- Bare electrified rails must be screened so that persons sitting on and walking on the crane structure cannot come into contact with them.
- Rooms which only maintenance personnel are authorized to enter must be locked and a warning sign must be put up (e.g. electrical control rooms).
- Firefighting equipment in good condition must be present on the crane.
- When a crane driver leaves a crane it must be locked to prevent unsupervised or uncontrolled movement.
- Crane tracks and mobile crane paths (in the working area of scrapyards) must be free of obstacles.
- Ground personnel must take into consideration the fact that the driver of a mobile crane cannot see behind him when the crane is slewing or moving backwards and must therefore not remain within the turning circle of the crane.
- Overload control equipment must be fitted to all cranes.
- When using magnetic cranes, the fact that the weight of the scrap load can exceed the lifting capacity of the crane when the magnet is energized must be taken into account and the overload must be permissible.
- Mobile cranes with adjustable jibs are often used as auxiliary cranes and, if no track cranes are available, as a main crane too. Due to the general character of this type of crane they are sometimes handled in a rather lackadaisical manner. However, it is still a piece of lifting machinery with special safety requirements. Due to its unpredictable behaviour, a mobile crane is more dangerous than a crane on tracks.
- A crane driver should only operate a crane which is technically fully serviceable. Before beginning work he should ensure that this is the case. In the case of more complicated cranes, he must be able to rely on the fact that important parts of the machinery and the electrical plant which are not within his field of vision are kept in good repair by the maintenance service in accordance with the appropriate inspection and maintenance procedures. However, this does not relieve him of the task of ensuring that the main components are serviceable, e.g. the hook, the hoisting ropes, the magnet, the magnet mounting, the supply cables to the magnet, the safety devices, lubrication system, brakes and a number of other parts. It is also recommended that a checklist be used to ensure that nothing escapes attention.
- Pulling loads sideways with cranes is not permitted as this can cause damage to the hoisting gear and, in the case of mobile cranes, to the jib which can later cause hazardous situations.
- Ground personnel may not come near energized magnets. When work is being carried out on magnets they must be de-energized.
- The jib, hoisting ropes and the load must never come into contact with overhead electrified cables. If this should happen, the operator (of a mobile crane) should either stay in the cabin or jump out of the cabin onto the ground. He should never touch the ground when still in contact with any part of the crane.
- When leaving the crane the operator must observe effective shutdown and locking procedures.
- Crane drivers must also be equipped with a hard hat and protective wear for the eyes and feet, which are at least necessary when leaving and approaching the crane via platforms, steps and paths.
- Crane drivers must be well acquainted with arm signals when carrying out hoisting operations.
- The crane driver must be familiar with all regulations governing operation of his crane.
- A crane which is not ready for operation may not be used.
- A crane may not be used for purposes other than those for which it is built.
- A crane must be shut down and the interlock system engaged in accordance with the operating instructions when the wind velocity at a height of 10 m exceeds 20 m/s (that is windforce 8 on the Beaufort scale), unless the crane is designed to operate in higher wind velocities (this is a question of stability and the danger of tipping over).
- Adequate safety measures must be taken to cope with a lightning strike. Specialists must be consulted.

Transport equipment can be divided into works equipment, which is used for transport to the scrapyard or to supply revert scrap from other parts of the plant, chiefly rolling mills, and equipment belonging to third parties supplying scrap from outside.

Drivers of transport equipment must be well aware of the specific hazards involved as soon as they drive their vehicle into the scrapyard.

Driving transport equipment must always be left to trained and qualified persons.

The roads in a scrapyard must be free of obstacles and must be negotiable in safety.

In cases where local hazards are encountered, warning signs must be put up, e.g. at railway crossings and where loads are slewing overhead.

Drivers of vehicles from outside must be told where to go, where they should report and where they can unload or have their vehicle unloaded.

Passengers are not allowed to enter the scrapyard.

In certain cases drivers from outside must also use personal protective equipment such as hard hats or safety goggles.

Drivers from outside must obey the instructions of supervisory personnel and crane drivers.

When manoeuvering, drivers must ensure that there is nobody in the immediate vicinity who could be hit by the vehicle or injured by falling scrap.

Where necessary, the driver should signal manoeuvres and must exercise extreme care in carrying them out.

When forklift trucks and frontloaders are being used it is particularly important that the road surface is in good condition.

Drivers of works equipment and equipment from outside are expected to be familiar with general safety rules and to observe them in carrying out their own job efficiently.

Any person who neglects rules of safety should be warned and, if necessary, denied entry to the scrapyard.[1]

Maintenance

Maintenance work can be divided into:

- inspection;
- correcting defects;
- scheduled maintenance.

In the first two cases maintenance personnel is involved in operations carried out in the scrapyard.

Like scrapyard personnel, maintenance personnel should be familiarized with the way things are run in the scrapyard and should wear personal protective equipment where necessary.

Maintenance workers must carry out their work on site on the machine, crane or transport equipment and, for their own safety, are subject to handling and operating procedures. The maintenance worker can also enhance the safety of others by bearing in mind that they must be able to rely on him, for example when equipment or a crane is started up again, after a fault has been corrected, when they are not expecting it.

For scheduled maintenance on equipment which has been shut down, the situation for maintenance workers is much the same as in the remainder of the plant.

It should perhaps be pointed out that although serviceable tools mean half the job, they also contribute to safety at work.

Hand tools, manual hoists, jacks, welding and cutting tools, torches, ladders and many other articles which are used in maintenance must always be in impeccable condition.

After maintenance work has been carried out, safety devices should be refitted on rotating parts before the equipment or the crane is released for production purposes.

Maintenance workers must at all times be alert to the dangers in a scrapyard.

Effective preventive maintenance can be the first step in creating safe working conditions for others.

Machinery and cranes which may not be used or switched on must be locked or clear warning signs must be put up.

Bravado in carrying out maintenance work will bring its own punishment in time, whereas observing safety regulations will be rewarded by low accident figures.

Maintenance workers are always required to point out to less technically qualified operators in the scrapyard technical defects in machinery and equipment which can create hazardous situations.

Just as ground personnel are heavily dependent on the way in which the crane driver does his job, all scrapyard operating personnel are dependent on how maintenance workers do theirs. It is the management's task to get this across to the maintenance workers.

Cutting and welding

The flame cutter is a widely-known and widely-used piece of equipment in every scrap handling plant and also in steelworks' scrapyards.

When scrap has to be reduced in size further and shears cannot be used for a variety of reasons, a simple aid, the flame cutter, is used.

In certain cases a thermic lance can also be used, for example when making chargeable breakouts from large steel plates.

The flame cutter operates with a mixture of oxygen and gas, the thermic lance with oxygen and iron, the latter being in the form of rods or powder.

Operating a flame cutter can easily result in accidents.

The most common accidents are burns, followed by eye injuries caused by sparks and metal particles.

To increase safety in flame cutting the following recommendations can be made:

- Burning or flame cutting should preferably be carried out in an environment where there are no flammable substances. If this is not possible, assistants must ensure that sparks cannot cause any harm; firefighting equipment must be available.
- Flame cutter operators must be trained to use the equipment safely. Instructions and regulations in writing governing the equipment and its use must be strictly observed.
- The equipment must be complete and in good condition. Gas bottles must be secured in position, must not leak and wrenches, extinguishers (acetylene) and serviceable reducer valves must be provided. A gas bottle may not come into contact with sparks and may not be located near a source of heat

[1] Dr Nicholson's comment at the end of section on cranes and transport equipment 'The adoption of a one-way system for traffic should be considered to simplify traffic flow and reduce the danger of collisions'

(e.g. may not stand in direct sunlight for a long period of time).
A gas bottle may not be in a position where it may be struck by falling scrap.
A backfire or an increase in temperature due to an external heat source can lead to spontaneous decomposition of acetylene which can cause an explosion.
Gas pipes must be undamaged and suitable for the substance and pressure used. Acetylene lines may never be repaired with copper piping.

- A flame cutter must be of a good make, in good condition and may never be used for any other purpose than flame cutting.
- Barrels, cylinders, tanks and containers may not be flame cut unless they are absolutely certain to be empty and clean and do not contain flammable dusts or substances such as grease, tar or acids which could ignite or produce toxic fumes.
- When flame cutting, protective equipment for the eyes must be worn to guard against sparks and flying particles.
- Flame-resistant wear such as gauntlet gloves, aprons (e.g. made of leather) and shin guards help to protect the operator.
- The operator's clothing must be free of grease and oil as far as possible.
- Toxic gases and metal vapours from the material being cut represent potential hazards for operators. Efficient ventilation is thus required and it is recommended that the operator always stand upwind of the workpiece.
  In cases where there is any doubt or where it is certain that toxic dusts are present, suitable dust masks and/or respiratory equipment must be worn. This equipment must be regularly cleared and inspected.
- Gas bottles must be marked clearly and only approved bottles may be used.
- Oxygen cylinders must be stored separately from gas cylinders and must be at least 6 m apart, although national regulations might demand a greater distance.
- All cylinders must be shut off after completion of work and fitted with a sealing cap. Reducer valves must be disconnected.
- Acetylene must not be used at a pressure greater than 1 bar (or 2 bar absolute). Above this pressure acetylene becomes unstable and can explode.

Oxygen must never be used as a substitute for pressurized air since it can ignite spontaneously in conjunction with oil and grease.

Propane can be used as a replacement for acetylene and is less problematic but must still be used with care.

- Flame cutting operators may not smoke whilst working.
- Pieces which have been cut can cause serious injury if they drop. Personnel must always remember that extreme caution is required.
- Gas cylinders must be upright and secured against falling.
- If the flame backfires into the pipe, the burner, and then the bottle must be shut down as quickly as possible.
- Gas and oxygen bottles may never be transported using magnets or hoisting slings but must be placed in crates for safety.

Thermic lances are used to cut skulls, butt ingots and leakage from moulds, etc., which are too thick or contain too much slag to be cut with normal flame cutters.

In a thermic lance the heat is generated by oxidation of iron rods or by adding iron powder to the cutting surface. The greatest hazard here is the shower of sparks from the mouth of the lance into the cut.

Since cutting with a thermic lance is still a spectacular activity it attracts onlookers who are not wearing suitable protective equipment. This must thus be avoided.

Flame cutting is also used in maintenance. This is usually of short duration, but is used in repairing cranes, transport equipment or machinery.

In principle the same rules apply here as mentioned above, bearing in mind that in enclosed spaces the danger of fire is greater and that firefighting equipment must be at hand both for the safety of personnel and to avoid installations or machinery being damaged by fire.

Electric arc cutting and welding is uncommon in a scrapyard and, if at all, is mainly used for repair work. The equipment used must fulfil statutory regulations governing, *inter alia,* the voltage between the connection points for the welding cables which is of great importance and for which strict maximum values for AC or DC current are applicable.

The welder should ensure that he is protected against radiation and burns by using suitable protective equipment such as a face protector, leather gloves, and an apron, preferably of leather.

Suitable safety goggles must be used to reduce excessive radiation harming the eyes but without reducing vision. In most developed countries there are standards for safety goggles.

General regulations applicable to electrical welding equipment can be consulted from case to case. There are extensive statutory regulations for welding as for flame cutting equipment in view of their widespread and frequent use in industry.

It would be going too far to reiterate these regulations here in full.

It is important that the persons operating the welding equipment have the skills required for the job.

Lifting, moving by hand and other activities which place a load on the back

Lifting equipment, tools, accessories and components by hand can lead to strain on the back.

Drivers and crane drivers can also have back complaints as a result of sitting on poorly designed seats for long periods, sometimes having to turn frequently as well.

Movement of the crane or vehicle while the back is poorly supported and the legs outstretched, and vibration due to uneven ground or irregular movement, may be the causes of these complaints, whilst natural degeneration of vertebrae and lack of stomach muscle tone also cause a large percentage of back pains.

A medical examination before taking on personnel will only avoid a small percentage of subsequent incapacitation due to back problems. An examination can reveal the scar of a previous operation but cannot determine the medical history of the worker's back complaint.

Routine X-ray examinations may well be useful in detecting abnormal back conditions, but cannot of course predict back injuries in the future.

It is necessary to train workers how to lift heavy objects.

Mechanical equipment should, in principle, be used to lift up and move objects where possible, both in production and maintenance.

Equipment should be placed so that the back has to be rotated as little as possible.

Seats in cranes, vehicles and control consoles should provide the back with good anatomical support.

Slings and chains

Loads are hitched with a chain or a sling if they cannot be moved with the aid of a magnet, a grab or a forklift truck.

Such loads normally have no hoisting point suitable for the crane hook to be engaged in.

This applies to large steel waste, moulds, scrapped ingots, large pieces of scrap, components of equipment, cranes, vehicles and the like – in brief, loads which have to be hoisted with cable slings or chains.

The people hitching the load must know the weight to be moved and also the permissible load of the cable slings or chains and must be able to use these properly. Aids in the form of, for example, load tables can be a good back-up here.

The following points should be noted in the interests of safety:

- The equipment must be in serviceable condition; this includes the steel cables in slings, which should be undamaged, the strands of which should be correctly and tightly laid, and not have any protrusions or kinks.

  In the case of chains, the links must be undamaged (neither warped nor drawn too tight), neither knotted or elongated, linked or joined to other chains, wire or rope.

  For securing steel wire slings to other parts such as a crane hook they must be fitted at both ends with a so-called thimble, around which the wire is bent and subsequently fixed by clamps or by means of splicing. Instead of forming an eye end with the aid of a thimble, a loop can be made of the desired size and the wire rope spliced.

  For chains, hooks or large rings can be fitted to the ends.
- Damaged slings and chains must be replaced.
- Before being taken into service, slings and chains must be tested in accordance with the pertinent standards and regulations, and a record of the test kept.

  Chains must be tested in their entirety, i.e. including transition links, hooks, rings, shackles and other special parts.
- Whenever slings and chains are not in service, they must be hung on special brackets, preferably equipped with clear instructions for use.
- A skilled operator should be entrusted with the task of inspecting chains and slings.
- When pieces with sharp edges are being hoisted, chains and slings must be protected against damage by materials such as wood, rubber, etc.
- There are a number of special hooks, sliding pieces, brackets, etc., available in the trade for hitching and moving all kinds of components in safety. Whether one or more of these aids is desirable depends on local circumstances.
- When hitching up loads, the chances of an accident occurring are great. This depends a great deal on the appropriate working method.

  The fingers should be kept well away from the attachment point between the hook, load and sling (or chain).

  The load should be secured so that it cannot slip in the event of slewing or bumping.

  Slings should be used whose loops (or the end rings of chains) pass easily over the crane hook.

  A sling should not be wrapped round the crane hook.

  The crane hoisting rope must hang directly above the load when it is being hitched to avoid the load slipping or slewing when the slack is taken up.
- The sling should be located correctly around the load.
- Ground personnel and crane drivers must have a good understanding with one another based on their knowledge, instruction and experience in hitching and uncoupling loads.

A number of minor recommendations are also important which will be familiar to expert personnel and must also be applied.

Magnets and grabs

Lifting magnets are indispensible items in scrapyards for moving iron scrap quickly and efficiently.

Lifting magnets are suitable for practically all cranes provided that the crane is equipped accordingly.

Scrapyard lifting magnets are usually round. They comprise a heavy cast steel body with high magnetic permeability and, if necessary, are equipped with cooling fins.

The electrical coil is inside the body. A magnesium steel shield under the coil protects it from impact and shock.

The magnet is fitted with a junction box which protects the connectors as well as possible against moisture and dirt. There is an opening in the centre to strengthen the magnetic field.

The body is fitted with three or four lifting chains which are attached to a single ring. The ring can be placed over the crane hook.

The lifting capacity of a magnet is mainly determined by the number of windings in the coil.

DC current must be supplied from the crane electrical plant, which is obtained by means of transformers (rotating) or diodes (static).

The voltages required in the magnet coils range between 400 and 500 volts.

Magnet capacity fluctuates considerably, depending on the shape of the steel or iron workpiece to be hoisted. The following table gives some examples of this:

The hazards which arise in working with lifting magnets can be broken down as follows:

- hazards associated with electricity;
- mechanical hazards;
- hazards associated with operation.

Capacity (Watt)	Magnet Diameter (mm)	Magnet weight [1] (kg)	Lifting capacity (kg)		
			Ingots	Various types of scrap	Pig-iron
5 000	1 050	1 350	6 000	320	700
7 200	1 300	1 900	9 000	500	900
11 000	1 660	3 600	13 000	900	1 300
13 000	1 660	3 800	16 000	1 100	1 500

[1] Copper coil.

When the current is interrupted the magnet loses its lifting capacity abruptly and the load falls.

The current can be interrupted for various reasons. There can be a fault in the electrical supply, a defect in the supply equipment to the crane or broken wiring.

Ground personnel always run the risk of being hit by the load when in the operating area of the magnet.

Workers may not remain in the path of the magnet and this must be forbidden at all times. Clear instructions to workers and warning signs must prevent serious accidents from happening. Whether the works wishes to go so far as to cordon off the entire operating area depends on local conditions and national statutory regulations.

An emergency power supply, for example through batteries, can guard against the load falling as a result of a de-energized magnet.[1]

When the power supply to the magnet is interrupted and in turn the magnetic field, a counter voltage is generated which tends to maintain the magnetic field. This is a well known phenomenon.

The voltages that are generated here can be extremely high and the electrical plant must be designed to prevent these voltages causing any additional risks, for example burning of contacts, which in turn can also cause loss of power with all that this involves.

When lifting a quantity of scrap off a stockpile it is recommended that only 75 to 80% of the magnet capacity be switched on. As soon as the load has been lifted, the power can be increased to 100%. This ensures as far as possible that pieces of scrap do not fall from the magnet during subsequent transport.

[1] Comment by Dipl.-Ing B Lohrum. When lifting a load by magnetic force only, i.e without additional safety mechanisms, the load must not be carried over people's heads A net, basket or safety arms may be used as an additional safety mechanism, but an emergency battery must not be regarded as such. Battery-powered lifting magnets and lifting magnets with emergency batteries must be fitted with an automatic warning device to indicate the exhaustion of the power source clearly and in good time Emergency battery design is dependent on individual operating conditions. The warning signal can be visual or acoustic.

In practice this is not a popular procedure as the operator usually wishes to remove as much scrap as possible from the pile and wishes to do so with full power. The ratio of the disengagement to holding force is generally about 2:1.

The mechanical hazards should not be underestimated either.

When the magnet is being moved great acceleration forces can come into play, and vibration and shocks are caused when the crane is moved.

Sometimes the magnet is moved at a great height.

There is a real danger that pieces of scrap can fall off the magnet as a result of interacting forces and it is vital that ground personnel bear this in mind constantly.

One measure that must certainly be taken is to make the wearing of a hard hat mandatory in these danger areas, despite the fact that it will not offer sufficient protection in all cases. It should in fact be forbidden to set foot in and remain in the path of the magnet.

Another mechanical hazard results from the fact that the capacity of a magnet can fluctuate so much in proportion to the material and the shape of the scrap. This entails enormous risks with regard to the load on the crane. Obviously this is where the most stringent rules and instructions have to be issued. The capacity of a magnet can vary from 16:1 to 20:1 when ingots and scrap are compared.

Operating hazards arise in using a magnet for clearing a specific area of loose pieces of scrap by moving the magnet approximately half a metre above the ground. Any persons who are not paying attention can be seriously injured by the magnet which weighs several tonnes.

Using a magnet to allow heavy weights, e.g. in the shape of a ball or a pear, to fall onto pieces of iron to break them also involves great risks, both with regard to the falling weight and the resulting iron projectiles. This work must be carried out in a place specially designed and built for this purpose.

Grabs are used for transporting scrap in the following cases:

- the crane is not equipped to energize a magnet;
- the scrap is non-magnetic (austenitic steel scrap);
- a sea-going ship is being unloaded (e.g. a coaster) and a magnet may not be used as this could affect the compass.

The grab must of course be well designed and maintained.

The grab may not be completely closed after operation.

There is a danger that pieces of scrap can fall from the grab during transport. It is very dangerous to remain in the operating path of the grab, though a grab is less dangerous than a magnet in this respect.

The grab must be connected and disconnected by trained personnel using the appropriate tools and protective equipment, e.g. suitable gloves.

This work must be carried out with the necessary skill and precision to prevent accidents happening at the time and subsequently when the grab is used.

Breaking yard

When iron has to be handled at the scrapyard which is too large or too heavy to be loaded directly into the scrap bucket it must be broken into smaller pieces.

This can be done efficiently by allowing a heavy block, a pear-shaped weight or a ball to drop onto the material. In all cases the weight must be lifted up high by a grab or a magnet, after which it is dropped. Both the falling weight and iron projectiles can cause dangerous situations here.

This sort of work must thus be carried out in an enclosed area which is surrounded with high protecting walls.

To prevent a worker having to release the weight from the hoisting rope by means of a release cable it is safer to carry out this work with a magnet. This can then be done by the crane driver.

When using a weight, all persons in the vicinity must take cover behind a protective wall.

Entry to the breaking yard is only permitted once the crane driver has been warned and has stopped work.

From time to time the yard must be cleared of broken material and then refilled with new pieces.

Clearly legible warning signs at suitable locations are recommended here.

Visitors

People who are not on the scrapyard workforce should not be allowed to visit the scrapyard without the approval of the management as they are unaware of the dangers.

This is even more true of visitors from outside the steelworks.

If such persons do have to visit the scrapyard either on professional grounds or in the course of an excursion, they should be informed of the dangers. The best thing is for them to be accompanied by a person who knows the dangers and is in a position of responsibility.

The scrapyard workforce must also realize that the same regulations apply to visitors as to themselves.

A number of persons may have to set foot in the scrapyard such as personnel from scrap dealers, haulage companies, fitters from outside, hired labour, shippers, clients, people making excursions and others. The way in which the works insures itself against claims in the event of visitors being involved in accidents has to be decided from works to works.

Newcomers to the scrapyard

Newcomers to a place of work are generally more susceptible to accidents than experienced staff.

It is thus important to familiarize a newcomer with his own job and also with the safety aspects.

Management should take time to explain a newcomer's function and the interaction between his and others' jobs.

A newcomer should be told what the safety programme requires of him and what the company does to protect him against high-risk situations and accidents.

He should be given the safety regulations governing his job and asked to confirm that he has read these by his signature.

It should be made clear to him that the safety of other workers depends on the fact that he performs his duties correctly and does not cause safety problems for others.

Management should ensure that a newcomer is given the correct personal protective equipment, wears it and keeps it in good condition.

The management should set a good example in this respect.

A newcomer should be shown his working environment and introduced to future colleagues.

It may not be assumed that a newcomer knows what to do and not to do and he should be tested before he is allowed to start work.

An experienced man should keep an eye on the newcomer to begin with and the management should check up to see how he is getting on later.

Wharves

Several electric steelworks are situated by a canal, a river, the sea or arm of the sea.

In this situation the scrapyard is sometimes on the waterfront, where the scrap is delivered.

Some of the scrapyard workers run the risk of falling into the water when they are performing their duties.

The personnel involved should be able to swim to avoid the danger of drowning. People who cannot swim should wear a life jacket when working at the waterside.

Life saving equipment ready for immediate use, such as life buoys, floating rescue lines and a long pole, must be available at the wharf.

The wharf must be fitted with ladders going down to beneath the water line at not too large intervals.

Rescuing a person from the water has to be practised.

In particular in poor weather conditions such as mist, high winds and gales, snow and ice, work on the wharf is dangerous and requires great care. The first requirement here is good lighting.

Paths, roads, platfoms, steps, railtracks, areas around work stations and scrap heaps

Any person in a scrapyard, irrespective of his reason for being there, has to take into account the extent to which the working area or roads, stairways and steps allow freedom of movement.

Poor surfacing and obstacles can cause danger. For this reason a number of precautions should be taken and certain rules observed to ensure an adequate degree of safety.

Roads and paths must be kept free to ensure that work can be carried out free of obstructions and in safety.

Objects, tools and equipment which are left lying around can lead to accidents which could have been avoided with more care and attention.

The area around machinery, weighing equipment, loading areas and access to buildings and crane tracks may not be rendered unsafe by equipment which is left lying around. The above working areas must be well laid out and workers must be able to move around easily.

Roads, paths and working areas must be well lit.

The ground and the surfacing of roads and paths must be free of dips, holes and bumps which could lead to accidents.

Exits of buildings which immediately adjoin roads or tracks immediately adjacent to roads or railtracks must be fenced off or have warning signs posted.

For access to crane platforms there must be stairs at not too large intervals. The stairs must be in good condition and fulfil reasonable requirements with regards to design and safety, which can differ from country to country. The important point is whether a stairway or a ladder is involved. Handrails, back support, rise and tread, safe transition to the crane platform and the possibility that a crane might move past and the like are to be taken into consideration. The type of plating on the access platforms to cranes, the handrails and lighting should also be taken into account on construction.

For railways, the structure must be such that lateral clearance of half a metre always remains between the car or locomotive and fixed points along the track over a height of at least two metres.

The wall of a scrap heap can also be considered a fixed point.

Cars may not be loaded or unloaded until they have been secured against inadvertent movement using drag shoes. This must not be attempted with pieces of wood or scrap.

There must be adequate space where cars have to place their loads of scrap. When tipper trucks are moved forward to allow the load to slip slowly out of the box pallet, the raised pallet should not be able to cause any accidents by coming into contact with other objects (electric cables, portals, crane tracks, or jibs).

When mobile cranes are slewing near scrap heaps or other fixed points they must maintain sufficient clearance so that workers cannot be jammed between the back of the crane and the heap. The minimum clearance must be half a metre on the sides and two metres in height.

Scrap must be stored carefully and efficiently.

As part of the stock is regularly removed and replaced, the scrapyard resembles a constantly shifting pattern.

The differences in types of scrap can lead to difficulties in stockpiling these in safety.

Basically, measures must be taken to preclude risk to personnel through sliding or falling scrap.

Piles must be located on firm and even ground which cannot subside.

Stacking pipe ends or shell bodies too high without walls around the stack can result in it collapsing and injuring passers by. It is also extremely dangerous to stack the pile too steeply.

It is recommended that stacking areas be partitioned off by soundly built walls. This prevents a pile from collapsing or sliding to one side and thus increases safety.

It is also important that there is a speed limit for traffic in the scrapyard. Depending on the situation this can be between 5 and 15 km/h.

Where there are sharp corners with limited visibility, warning signs calling for special attention, mirrors or signals must help to draw attention to the danger.

First aid in the event of an accident

First aid is the treatment carried out immediately after an accident before the doctor arrives.

Immediate first aid within four minutes can, in certain circumstances, mean the difference between complete recovery and invalidity or death.

Ideally at least one (preferably more) person in each team is trained and holds a certificate in first aid.

First aid equipment must be available on hand in an easily accessible cabinet container or similar storage place.

The first aid equipment must be ready for use but hygienically packed and sealed.

Facilities for rinsing out eyes must be available.

The people who can give first aid must know exactly what first aid equipment is available and where it is.

The people giving first aid must know where first aid ends and medical treatment by a doctor begins.

To enable a doctor to be called the (emergency) telephone number must be clearly marked next to the telephone.

These general recommendations should not present any problems for most plants, as they are doubtless already implemented, either because of the type of plant concerned or in accordance with national regulations.

3.4 Recommendations for protecting health at work

Workers who have to work in the open air are no rarity. Those who do so day and night are less common but people who have to remain on call in all weather conditions such as in a scrapyard, form a minority.

It is unusual for a plant to concern itself with its workforce's clothing unless safety or the plant's image is involved.

However, if the climate is such that unsuitable clothing and the absence of adequate shelter can lead to workers being sick more frequently or incurring damage to their health, it is both in the interests of the plant and the workers that the plant give advice or even directives in this respect.

As far as personal hygiene is concerned one must realize that a scrapyard increases the chances of coming into contact with a variety of substances which can be irritating or injurious to the skin and can impair the health when they get into the mouth and further into the body through eating, drinking or smoking.

For this reason the workforce must have effective means of cleansing the skin. Hygienic rooms must be available where the workforce can eat and drink. This is strongly advised against in unhygienic areas of the plant.

Clothing is important; this should be changed frequently for freshly washed clothes.

Other sources of dangers to the health are smoke, dust, gases and vapours which are generated or dispersed during various activities, such as oxyacetylene burning and cutting, use of thermic lances, exhaust gases from combustion engines, solvents and asbestos residues in scrap.

In the interests of the employees' health it is recommended that the management constantly monitor working methods (e.g. uses of flame cutting equipment), the type of materials being cut and the type of hazardous vapours, gases and dusts which are released. If necessary additional action is necessary to protect personnel, for example monitoring of blood lead where appropriate.

4. The effects of scrapyard activities on the safety and health of steelworks personnel

4.1 Inspection

Scrap in the charging bucket is charged into the furnace without further checks. The melting shop workforce must depend on the contents of the bucket not causing dangerous side effects.

The scrapyard personnel and in particular the supervisory staff and crane drivers can avoid dangerous side effects by due attention and knowledge of their jobs.

Dangerous side effects can arise as a result of the following being present:

- explosives;
- closed barrels, either empty or full of liquids or gas;
- excessive amounts of oil;
- snow, ice and water;
- chemicals;
- excessive quantities of oxygen;
- non-conductive materials such as wood, rubber, concrete, slag and stones.

The side effects can be in the form of explosions, excessive flames in the furnace, toxic fumes and gases and electrode breakage.

If explosives are contained in the scrap this can lead to explosions which can destroy the furnace roof, cause damage to the furnace, break the electrodes, and even destroy the roof, windows and walls of the building. Projected stones, glass, scrap and other parts can cause serious injury.

A closed barrel can also explode in the furnace as a result of the excessive internal pressure caused by increasing temperature which also generates a highly destructive pressure or shock wave and can destroy the top of the furnace and then, depending on the size of the exploding object and the pressure generated, cause further damage.

In the event of water explosions, which arise when a fairly large quantity of water is transformed to vapour, a shock wave is also created. If this happens when there is a bath of molten metal, steel and slag spatters are projected around the area of the explosion. Water coming into contact with slag remaining in the furnace can decompose, releasing hydrogen which causes more danger of explosions.

A gas explosion can occur when a specific quantity of gas or vapour is released so quickly and mixed with air that the mixture explodes immediately. If this process occurs more slowly only a fire is caused. The resulting flame can also be dangerous.

Needless to say all these risks should be avoided and objects that could cause such explosions may not be loaded into the buckets.

Excessive quantities of grease and oil, i.e. more than 2 % of the charge weight, can lead to excessive generation of heat on combustion. As the gas extraction plant is not designed for this, explosions can occur in the gas pipes, cooler and/or filter which can endanger the workforce and cause damage to the installations.

Loading a charging bucket with a large percentage of discarded greasy, tarred steel cables with grease-filled hemp cores can, for example, cause a situation as described above.

In winter snow and ice can be present in the scrap, sometimes in large quantities.

Wet bales can thus contain large quantities of ice after freezing.

Plants with a covered over scrapyard will generally be less effected by snow and ice in scrap than plants with an open-air scrapyard. In a climate where there is considerable snowfall it can be useful in the interest of safety to erect a dry scrap installation. Otherwise there is the risk that water explosions can occur during charging which can even damage the roof above the furnace. Needless to say the safety of the operating personnel cannot be guaranteed in this case.

When charging compressed barrels which have been used for packing chemicals, residues of these products and by-products can be released in the atmosphere of the melting shop and particularly during charging.

Depending on the type of these products, most of which are unknown, some of which are familiar, toxic fume, vapours and gases can be released into the ambient air.

Barrels which arouse suspicion, scrap from chemical plants which have been closed down, etc. should be inspected extremely carefully before a decision is to be made as to whether they be charged or not.

Dirty scrap, thin scrap and old scrap can often contain large quantities of metal oxides. If large quantities of this type of scrap is charged at once it must be borne in mind that these oxides can react with carbon in the bath during melting or subsequently. As soon as this process is initiated at a specific temperature, which mostly happens spontaneously, flashes can come out of the furnace which represent hazards for operating personnel.

Non-conductive materials can lead to electrode breakage. The electrode control system lowers the electrodes until the power setting is reached. When non-conductive materials are present, the electrode will never reach these values with the result that the electrode is likely to be broken. Removing broken electrodes causes extra dangers for the melting shop workforce.

4.2 Loading charging buckets

There are two types of buckets, the orange peel type and the clam shell type.

The orange peel type can be lowered a long way down into the furnace preventing heavy scrap from hitting the bottom of the oven with enormous force. Less force is exerted on the side walls. The shape of the scrap in the furnace is the same as in the bucket. The contents of the bucket fall into the furnace as a compact unit.

One disadvantage of the orange peel type bucket is that the bucket must be closed and held together by a cable or chain. This entails tricky manual work.

There is a risk that the cable is disengaged during transport of the bucket and the contents of the bucket released inadvertently, causing great danger due to falling scrap.

The clam shell type, which is currently used in most plants, has the advantage that the base is totally closed and there is no risk of small parts falling out of the bucket.

The shape of the scrap is not retained on charging. When the clam shells open slowly the scrap pours out of the bucket and tends to form a pyramid with the top sticking out of the furnace. In many plants the closed emptied bucket is then used to push down the top so that the top of the furnace can be replaced.

The clam shell type bucket cannot be lowered deep into the furnace.

Closing the clam shell type bucket does not require any manpower and is thus easier and safer in use.

In principle the buckets must be filled in the following manner:

- at the bottom a layer of light scrap or turnings;
- next heavy scrap iron;
- now a layer of coke or anthracite and subsequently normal scrap; neither too light or nor too heavy;
- at about 60 to 70% of the height of the bucket a ring of lime or limestone, so that this ring is not in the area of the electrodes;
- fill up with normal scrap and finally cover with a layer of light scrap and turnings.

This is of course only an example but illustrates what kind of load is most suitable for the furnace for charging and melting.

The light scrap at the bottom protects the furnace hearth and placing the heavy scrap at a low level prevents it from shifting during melting and breaking the electrodes. Electrode breakage increases the dangers for the melting shop workers and is of course also uneconomical.

As lime and limestone are non-conductive they must be out of the vicinity of the electrodes until melted.

Light scrap as a covering layer has the advantage that the electrodes can bore through the charge quickly which relieves the load on the roof and reduces the noise emitted by the furnace.

The charge structure must ensure that the electrodes do not melt a hole in the bottom of the furnace when fully lowered. There must already be sufficient molten metal at the hearth.

Holes in the hearth have grave consequences such as repairs or difficult working conditions and the possibility of the oven being pierced which is extremely dangerous.

Loading large quantities of long scrap and scrap pieces which can easily interlock can delay the fall.

If this happens abruptly with large quantities of relatively highly oxidized scrap falling in a late phase of the heat, into the bath large flashes can occur which endanger both workforce and plant.

Loading extremely large pieces of scrap such as discarded moulds and ingots, cut sheet waste, leakage from moulds, etc. has to be carried out with extreme care. It can be advisable to charge such pieces separately using slings. If such pieces are loaded willy-nilly in the buckets, they can cause great problems on melting and can break electrodes if they shift and can also cause considerable flashes.

Loading revert scrap which is not sufficiently chargeable, such as quantities of loose steel strip, rolled wires, etc. which bounce on charging, protrude from the top of the furnace, can scarcely be handled properly and have to be cut off so that the furnace can be closed, can cause danger.

Loading revert scrap which contains a lot of ice or snow can lead to explosions which can even damage the building.

5. Inspections and repairs

5.1 Inspections of auxiliary equipment and plant

The job of the maintenance services is to ensure optimum serviceability of production plant, in terms of minimum downtime, reduced wear, improvements and further development of installations and with a view to enhancing safety and health and keeping costs low.

A sudden defect has grave consequences for operation of the plant with its interconnected production phases.

The maintenance services must therefore take precautions to keep such eventualities to a minimum.

Suitable inspection schedules and preventive maintenance to detect and analyse sources of malfunctions should be carried out to prevent unexpected defects.

It is evident that a plant which maintains scrapyard auxiliary equipment and plant in this way ensures that the production workforce can operate under optimum technical conditions and contributes a great deal to safety at work, assuming that the workforce also handles the technical plant and auxiliary equipment correctly. Overall this generates an atmosphere which leaves little to be desired and is ideally suited to create safe working conditions.

Inspections of plant and auxiliary equipment by maintenance workers does not relieve the production workforce of its obligation to report malfunctions and defects, in particular when these involve safety aspects.

Cooperation between production and maintenance workers certainly enhances safety.

5.2 Maintenance

When working on plant, auxiliary equipment and cranes, the maintenance staff must observe certain procedures.

As soon as a piece of equipment is to be inspected by a maintenance worker he should shut down the equipment and engage the interlocks or release the interlocks and switch the equipment on, depending on the situation and his own requirements.

The worker should always take measures to ensure that he is working in safety.

As maintenance workers must work everywhere in the scrapyard they must be familiar with the hazards and the safety rules.

Apart from that he must carry out his work without taking any risks and use appliances, tools and other pieces of equipment which are in good condition.

He should also use suitable personal protective equipment.

His knowledge and ability in carrying out preventive maintenance and repairs can prevent defects and also circumstances in which injuries to others can be caused.

The way in which a repair is carried out can directly affect the maintenance worker's own safety.

It would be going too far to explain the numerous circumstances and situations which can lead to injuries during repairs. See section 3.3 for more information.

The tables issued by ISIS show that the number of accidents in maintenance ranks second (13.4%) under the survey conditions. Of the 381 accidents the most frequent injuries were to fingers (164), eyes (63) and back (28).

It is recommended that these data be taken into account and safety policy established accordingly.

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