# UNITED KINGDOM ATOMIC ENERGY AUTHORITY

# INDUSTRIAL SAFETY HANDBOOK

A.E.R.E. HARWELL

Copy No_____

MINISTRY OF SUPPLY

ATOMIC ENERGY RESEARCH ESTABLISHMENT

# SAFETY HANDBOOK

This book is issued to you for your use during employment at this Establishment and it must be returned when you leave.

New Sections for the Handbook will be issued from time to time. These must be securely fastened in the book by the loose-leaf binding provided. Loss of or damage to the book must be reported to your Supervisor.

Issued to.. [redacted]

Date.....21/11/55

HD.951

## SAFETY IN WORKING

The Codes of Practice contained within this booklet have been drawn up by the Safety Committee and by the Safety Officer, and are issued to you for your guidance during the course of your duties within the establishment.

I advise you to read them very carefully and to take note of the various precautionary measures which are essential in an establishment such as ours.

Our record of safety in working is such that I feel certain you will bear in mind the advice given herein. I particularly wish to stress that if you should have any doubt about any operation you are carrying out or if a particular job is not covered by the Code of Practice, you should see your Supervisory Officer and get advice.

J. D. COCKCROFT

June, 1951

## PREFACE TO SECOND EDITION

Experience gained in the application of safety precautions and in the use of safety appliances has indicated the need for additional information concerning safety regulations. An additional section entitled "Some Notes on the Factories Acts" has therefore been included. In this Section a note is made on THE DUTIES OF PERSONS EMPLOYED. The latest A.E.R.E. Code of Practice for the Safe Handling of Liquid Sodium has also been included to follow on after the original Primary Rules Notes on Sodium Potassium and related Alloys. (Page 5.1) and the section on Breathing Apparatus (Page 3.1) has been extended to include a description and application of the Harwell Air Hood.

July, 1953

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## SECTION 1

## RADIOACTIVITY AND ITS CONTROL

Despite considerable publicity many people have been left in doubt as to what radioactivity is and as to how it may affect them. These notes are an attempt to explain radioactivity to the non-scientific staff working at Harwell and to outline the arrangements which have been built up to make certain that in harnessing radioactivity for useful purposes, no-one will suffer from its less desirable features.

## WHAT IS RADIOACTIVITY

Radioactivity is the power that certain substances have of giving out invisible rays of a special type. It has been going on for one thousand million years in every part of our world. Besides being produced naturally from radium, the invisible rays can be produced artificially in an X-ray machine or in a pile. For nearly fifty years doctors have used these rays from X-ray machines and from radium for the treatment of disease. Nowadays the rays from new radioactive materials are used for the treatment of disease.

What is new is the attempt to use the invisible rays on a large scale for industrial purposes and it is to this end that all of us are working at Harwell.

## RADIOACTIVE SUBSTANCES

For many years, the only radioactive substances were those like radium (used in hospitals) or thorium (used for making gas mantles) which occur naturally. Before the war, it was found that other radioactive substances could be made artificially in very small amounts in the cyclotron, such as we have at Harwell. Much larger amounts of artificial radioactive substances can now be made in the Pile. Nowadays any substance can be made in a radioactive form and these artificial radioactive substances are called radioactive isotopes. The artificial radio-active substance (radio-isotope) looks exactly like, and can be used in the same way as the non-radioactive substance. Radioactive copper is still copper, radioactive iron is

still iron. The production of these radio-isotopes is one of the main functions of the Harwell pile and the artificial radioactive substances made here are now being sent to hospitals all over the world to assist the advance of medical science.

## WHAT ARE THE INVISIBLE RAYS?

The rays produced by radioactive substances cannot be seen or felt in any way. There are four types:-

### (1) Alpha ($\alpha$) rays

These rays can only travel a short distance, about two or three inches in air. They cannot get through a thin sheet of paper, that is, they are stopped by it. In the same way, they cannot get through the skin, which stops them from affecting the body. As they only reach the outside surface of the skin they do not affect it. They can only affect the body if the substance giving out these rays has been breathed in or swallowed far in excess of any condition that should ever arise at Harwell.

### (2) Beta ($\beta$) rays

These can travel farther than alpha rays, but still not very far. Their maximum range in air is a few yards. They are more penetrating than alpha rays but are easily stopped by a thin sheet of metal. They can penetrate the surface of the body for only a small fraction of an inch. In most parts of the body they cannot get through the skin, but like heat rays and light rays excessive exposure can cause reddening of the skin and burns.

(3) Gamma ($\gamma$) rays

These are identical to X-rays but rather more penetrating. Their range in air is several hundred yards, but they can be stopped by heavy substances such as lead.

(4) Neutrons

These are produced mainly in the piles, but only while the piles are working - they disappear when the piles are shut down. They can also be produced during the operation of the cyclotron and other high voltage machines. Like X and gamma rays, they are very penetrating. They are best stopped by light substances which rapidly slow them up so that they cannot go very far. Concrete contains substances which will stop neutrons.

## IF THESE RAYS CANNOT BE SEEN OR FELT, HOW THEN ARE THEY DETECTED?

The rays from radioactive substances can be detected and measured by their effects on other substances. These effects are electrical, chemical or physical.

(1) Electrical

All types of rays when passing through air or a gas, can indirectly produce a tiny flow of electric current and this can be measured by special instruments. By this means these instruments can indicate exactly how much radiation is present. The instruments vary somewhat according to the type of rays they are used to detect. They are called monitors since their purpose is to give warning.

Common instruments in use at Harwell are:-

(a) Portable beta-gamma radiation monitor, Type 1005, and pistol grip monitor Type 1043. These small monitors are operated by batteries and have scales that read the rate of receiving gamma radiation. They can be adjusted to measure beta rays also.

(b) Slow neutron monitor, Type 1081. This is similar to the Type 1005 except that the design is altered so that it can measure slow neutrons.

(c) Fixed ionisation chambers. Type T.P.A. These monitors consist of large gas filled chambers with an amplifying unit that magnifies that current set up in the chamber by the rays that enter. The contained gas varies according to whether the monitor is intended to detect gamma rays, slow neutrons or fast neutrons.

(d) Pocket condenser chambers. These are small chambers that can be carried in the breast pocket. They are affected by the rays reaching them and at the end of a day the amount of radiation which has fallen on the chamber and user can be measured. They are called M.R.C. Chambers. A similar instrument is the pocket electroscope, called the "fountain pen" electroscope because of its shape and size. This gives an accurate reading of the total amount of radiation that has reached it during a definite period. It should be noted that instruments (a),

(b) and (c) described above measure the rate of radiation falling on them whereas the pocket chambers actually give the total amount over a period.

(e) Transportable beta-gamma monitor, Type 1021. This is a type of detecting instrument very commonly used. The rays can be picked up by a detector which is held in the hand and passed over clothing, benches, etc. The effect produced by the beta or gamma rays can be heard as clicks in a loud-speaker and it also works a meter.

(f) Hand and Foot Monitor. This special instrument embodies counters of the type described above and can check the cleanliness of hands and clothes after washing.

(2) Chemical

Like sunlight, beta and gamma rays can act on photographic film which is exposed to these rays and the film is blackened when it is developed. The amount of blackening shows the amount of exposure, so a film which is worn on the body shows the amount of radiation that has fallen on it and the person wearing it. These films are usually worn for a week and show the total amount of radiation exposure for the week.

(3) Physical

A single alpha ray striking certain materials and especially zinc sulphide produces a flash of light. This action of alpha rays is used in

instruments for counting them. The luminosity of the paint used on watches, etc. is caused by large numbers of these light flashes produced by mixing a very small amount of radium with a zinc sulphide paste. The amount used is exceedingly small and the radiation from the watch is not harmful in any way. The monitors at A.E.R.E. are so sensitive, however, that they can detect the presence of the radium in the luminous paint.

WHAT HARM CAN EXCESSIVE RADIATION CAUSE?

The effect of excessive radiation is fundamentally the same as the effects produced by excessive heat or over-intense light such as causes heat burns and sunburn.

The effects of radiation only differ in that they may be produced in any part of the body instead of the surface alone and the body feels no pain when exposed to the rays. It is for this reason that the safety measures here have been so highly developed. The source of any excessive radiation can be either outside or inside the body.

If outside, as X-rays, gamma rays or neutrons from equipment such as X-ray machines, cyclotrons or piles, it may affect the whole body or the effect of the radiation may be localised to one part of the body. This local effect can arise from handling directly a beta gamma source without proper precautions or from exposure of the bare hands to a narrow beam of X-rays or neutrons.

If the radiation arises inside the body it means that a radioactive substance has been breathed in or swallowed or has entered through

a wound and that this substance is still present in the body.

## WHAT ARE THE EFFECTS OF THE DIFFERENT TYPES OF RAYS?

### Alpha Rays

Since these rays cannot penetrate the skin they cause no trouble if the substance giving them off is outside the body. If an excessive amount of the substance producing alpha rays is inside the body these rays can be harmful unless the body can get rid of the substance within a relatively short time. Uranium is only weakly radioactive and is readily got rid of by the body; it is therefore not a dangerous source of internal radioactivity and any damage caused by an excessive amount is similar to that of any mild poison taken in excess. Plutonium, on the other hand, is more strongly radioactive and is only slowly got rid of by the body. Very great precautions are therefore taken to prevent plutonium dusts from being eaten or breathed. The maximum permissible levels of alpha and beta dusts in the air at A.E.R.E. have been set so that no person working with radioactive substances year after year can accumulate in his body sufficient radioactive materials to cause any harm. It is possible to estimate from the urine the amounts of these substances in a person's body, and if necessary his work can be changed before any damage is done.

### Beta Rays

These cannot get through clothing and so excessive external beta rays affect only exposed skin surfaces which are in close contact with the

substance giving out the rays. Reddening or burning of the skin from excessive exposure to this type of ray will therefore usually be found on the fingers and hands. Burns of this character are like ordinary burns but much slower in developing and also in healing. Like alpha rays, beta rays can cause internal damage if an excessive amount of a substance giving out this type of ray has been taken into the body.

Gamma Rays and Neutrons

Because of their penetrating power these rays can affect any part of the body. Some parts of the body are more sensitive to them than others. The blood-forming tissues of the body are the most sensitive and for this reason blood examination is carried out regularly on all persons exposed to radioactivity.

THE ROENTGEN AND THE "TOLERANCE" DOSE

The unit used in measuring radiation is called the Roentgen (r) in honour of Roentgen, the man who discovered X-rays. It is the quantity of radiation that produces a particular amount of electricity in a particular volume of air.

As a result of examination and observation of large numbers of persons who have been exposed to radioactivity for many years (20-30 years) it has been found that the human body can be exposed to a certain amount of radiation day in, day out for a full working life without any ill effects. Based on this experience an International Commission has put forward the "International Recommendations on Radiological Protection" (British Journal of Radiology, January 1951) which form the basis for the

maximum allowed dose or "tolerance dose" used in Harwell.

For beta and gamma radiation the tolerance dose is 0.5 r. per week or 12½ milliroentgens per working hour measured at the surface of the body. The hands and wrists are allowed to receive 1.5 r per week or 37½ milliroentgens per working hour. The dose allowed to internal organs is 0.3 per week. Allowing for the relative amount of damage caused by internal alphas and by neutrons, corresponding tolerance doses are fixed for these radiations, the level for neutrons being 1200 slow or 30 fast neutrons per square centimetre per second during working hours.

These tolerance doses are based on a full lifetime of exposure and are far below what is a dangerous level of radiation intensity. It is quite safe, for example, to work while exposed to eight times the normal tolerance as long as the worker stays in the exposed position for one hour only. Thus, in one hour he will have received his daily tolerance although exposed to a higher rate of radiation. He has received the same amount more quickly. A common procedure carried out thousands of times a year in hospitals throughout the country is the X-ray examination of the stomach. This procedure which has been shown to be safe by years of experience, involves the patient in the exposure to as much as 50 r or 800 times the daily tolerance at Harwell.

Similar tolerance doses are set for radioactive dusts in air, such as uranium, for which a maximum of 50 micrograms in a cubic metre of air is allowed for a working day of 8 hours.

## WHAT ARE THE METHODS OF PROTECTION?

### (1) Distance

Distance is the best safeguard against external radiation. For this reason, as alpha and beta rays only travel short distances and X and gamma rays rapidly get weaker as they get farther away from the source, control from a distance (remote control) and the handling of radioactive sources with tongs, etc., is practised at Harwell.

### (2) Shielding

The rays from the big machines such as the pile and the cyclotron etc. are so intense that to obtain protection by distance alone it would be necessary to keep several hundred yards away. This is obviously not practical for many workers, so sufficient shielding is built around the machine to make it completely safe to work close by. The type and thickness of the shielding varies according to the type and intensity of the radiation. Thus, thin aluminium sheeting will cut off beta rays. For gamma radiation lead is commonly used. For neutrons, concrete, water or paraffin wax are the best substances for shields.

### (3) Time

Many substances lose their radiation power fairly quickly. This enables them to be handled safely shortly after their irradiation in a pile or big machine. It must be noted, however, that others decay very slowly indeed and require full protective measures.

(4) Ventilation

In workshops and laboratories special methods of handling or machining radioactive substances are used so that the dust is kept down to a minimum. So as to make conditions doubly safe, elaborate and expensive ventilating systems are installed to remove rapidly any dust which may be created.

HOW IS RADIATION CONTROLLED AT HARWELL?

(1) Design

The first line of control is in the design and structure of the big machines which constitute the major sources of radiation. This is done in such a way that only a small controlled amount of radiation is allowed to escape. For example, the pile is built inside a huge concrete box, having sides over 7 feet thick. This is more than sufficient thickness to make it completely safe to work against the sides of the pile for long periods. For some experiments and for maintenance purposes it is necessary to have a number of holes made in these sides. These holes are normally filled with concrete plugs, but for experimental purposes the pile has sometimes to be operated with these removed. Under these conditions an intense beam of radiation will come out of the hole, but to prevent accidental exposure to this beam the path of the beam is roped off and warning notices put up.

Another large source of radiation is the cyclotron, and in this case, to prevent any unnecessary escape of radiation, it has been built in a hole in the ground which is enclosed by a thick concrete roof.

(2) Red, Blue and White Areas

The site has been divided into Red, Blue and White areas according to the amount of radiation that is likely to be met within the particular area. A building or part of a building is marked "Red Area" by a special notice at the entrance. This means that without taking proper precautions it might be possible to receive more than the daily tolerance in this building or room. A Blue Area is one where it is not possible to receive more than the daily tolerance and where one is unlikely to receive more than one tenth of a tolerance. Areas where the radiation level will never exceed one tenth of tolerance are White Areas.

(3) The Health Physics Division

The control of radiation at Harwell is carried out by a special division, the Health Physics Division. All Red and Blue areas are under the care of a Health Physics Officer who makes a periodical survey of all such areas and advises staff if they are not observing proper precautions. He also arranges for the issue and reading of films and pocket chambers and is available to give advice on all aspects of protection against radiation.

(4) Film Service

All persons working in Red or Blue areas are provided weekly with a film sensitive to radiation. These are developed each week and the result entered on record cards for each worker. Where the radiation for a week is more than one permissible daily dose an investigation is made into the possible cause. In other words, where a person has received more than 1/5 of his permissible

weekly dose, investigations are made at once.

(5) Area Monitoring

Buildings are monitored frequently to detect any spills of radioactive material that may have occurred and to see that no radioactive material has been left in a position where it could cause harm. As a rule, such materials are kept in shielded stores and if, for some reason, materials of this type are taken from stores temporarily, warning notices are attached.

(6) Active Clothing

Where work is such that small amounts of radioactive material may be picked up on one's hands, feet or clothing and so be carried from building to building or be eaten with one's food, special protective clothing is provided. This clothing varies according to the job and includes overalls, caps, shoes, gloves, goggles etc. After use all clothing is monitored and at frequent intervals it is washed in a special laundry within the Establishment. All those engaged on work requiring the use of special clothing are discouraged from smoking, eating or drinking whilst on the job.

(7) Active Waste

Active waste bins are provided in all Red and Blue areas to prevent active waste material (paper etc.) being mixed with ordinary non-active waste. It is essential that these bins be used for the purpose for which they are intended.

(8) Liquid and Gaseous Waste

All liquid waste from operations using radioactive materials is run into special drains which take it to storage tanks. This removes the possibility of radioactive material from A.E.R.E. filtering through to other peoples' drinking water.

Radioactive gases and dusts are carried away by special exhaust systems and where large amounts of dust are produced these systems are fitted with filters to prevent them reaching the outside air.

(9) The Medical Division

Before anyone is engaged on work at A.E.R.E. he is given a thorough medical examination. If the doctor finds any indication that the worker might be extra sensitive to radiation, arrangements are made for him not to work in red areas. These medical examinations are repeated at intervals to keep a watch on everyone's general health. All those who work in red areas are given additional blood examinations to check that their blood shows no damage from radiation, and those who work with certain radioactive materials such as uranium, for example, are given special urine tests at frequent intervals.

## SECTION 2

## CODE OF PRACTICE FOR THE SAFE HANDLING OF CHEMICALS

These notes draw attention to the need for special care in the handling of the chemicals in common use here, and which you may encounter during your duties. Many other chemical substances are in use and, where there is any doubt about the precautions to be taken, advice should be sought from your supervisory officer who, if necessary, will seek guidance from the Medical Division or from the Safety Officer.

### General Rules

The following general rules may be stated for the handling of chemical substances and should always be followed to ensure safe working.

(1) Always use the protective devices, clothing etc. and the methods of handling specified for a particular chemical. It is important to see that such protective devices are in proper working order before using them. Note paragraph (d) on page 13 of the 1947 MOS Industrial Handbook.

(2) Avoid contamination by washing the hands before eating or smoking

(3) Do not smoke in prohibited areas

(4) Do not eat in places other than those authorised

(5) Use the minimum amount of cleaning fluids

(6) Before doing any job make sure that you are familiar with all the precautions required. If in doubt, get advice from your supervisory officer; in the notes given later on the care required in handling specific chemicals, reference is made to the types of poisoning they can produce if care is not taken.

Poisons

Poisoning may be acute (that is, of sudden onset) or chronic (of gradual development). Poisons may enter the human body and cause their ill effects by three possible routes:

(1) through the mouth

(2) through the skin

(3) through the lungs (by breathing in fumes, gases or fine dusts).

The first two pathways of entry are unimportant as a rule. Poisoning through the mouth by swallowing means either suicidal intent or else complete disregard of elementary hygiene such as not washing hands before taking food, smoking in places where a cigarette or pipe can be contaminated, or eating in places where food can be contaminated. Poisoning through the skin is rare and occurs where clothing has been soaked with some substance that can enter the skin. The only poison of this type in common use in industry is oil of mirbane (nitro-benzene) and this is only

used at AERE in small laboratory amounts.

Poisoning by breathing in is, however, a hazard in all industries. Excessive concentration of dust in air renders it unpleasant to breathe, but some types of dust are also very harmful in quite small amounts. Fumes from liquids that evaporate at low temperatures are another source of trouble and, finally, gases may be poisonous in quite low concentration.

Many poisonous substances are in daily use in industry and in the home, but poisoning from their use is rare and, in all cases, arises from ignorance of the potential danger or from failure to take elementary precautions in handling them.

## CLEANING FLUIDS (DEGREASING AGENTS)

### Benzene

This is in common use in the Establishment. It is unlikely to produce acute poisoning, but repeated daily use under bad ventilation conditions can produce chronic poisoning. Occasional use in small quantities is harmless. Benzene is also highly inflammable. Other less harmful solvents can be used and this should be the practice whenever possible.

### Trichlorethylene

Ordinary amounts used in well ventilated spaces are harmless, but in a tank or other closed space, for example, without proper ventilation, acute poisoning can result. These acute effects are similar to those produced by an ordinary anaesthetic and the patient would

complain of faintness and giddiness before falling unconscious. Recovery, however, is rapid if the affected person is moved to a fresh atmosphere and, there are no chronic ill-effects from its use. It is non-inflammable, but smoking should be avoided when using it owing to the possible production of phosgene, which is highly dangerous.

Carbon Tetrachloride

Careless use of excessive amounts in badly ventilated spaces can produce acute and chronic poisoning. Therefore only minimum amounts of this substance should be used with adequate ventilation. It is non-inflammable.

Turpentine and White Spirit

In ordinary use these substances are not poisonous, but can give rise to headaches and sickness under bad conditions.

Skin Hazard

All these cleaning fluids can affect the skin by dissolving the natural protective fats and exposing it to irradiation by other substances. They should not, therefore, be used for cleaning grease from the hands.

Acids.Alkalis

Strong acids and alkalis can cause very severe burning of the skin and the eyes, especially, can be seriously affected; protection by efficient goggles is absolutely essential. The First Aid treatment of acid or alkali splashes consist essentially of very

copious washing with ordinary tap water, and this should be carried out before attending the surgery for further treatment. The fumes of concentrated acids, especially nitrous fumes (yellow), can cause serious irritation of the lungs if inhaled, and call for immediate medical advice. Nitric acid readily attacks many organic materials and has been known to cause fires in this manner.

Hydrofluoric Acid

Burns with this acid are serious, since the initial splash may not be felt and the burn may become deep before discovery. Any suspected splash should be washed off at once and magnesium oxide paste (obtainable from Medical Division) should be rubbed in. All persons with hydrofluoric acid burns should attend the Surgery.

Cyanides

Where cyanides or hydrocyanic acid are in use, special cyanide antidote outfits with instructions for use are available in close proximity to the point of use. Cyanide is a very rapid poison and treatment must be immediate. It is specially important that the Medical Division be notified at once, so that further immediate treatment can be given.

Sodium and Potassium

These substances burn in the presence of moisture and can cause severe ordinary burns of the skin. Special precautions and rules for their use are the subject of a safety circular which should be exhibited in all areas

where these substances are in use and which is reproduced at Section 5 of this book. All persons using these metals must make themselves conversant with these rules.

Gases

Gases may be:

(a) Poisonous, such as carbon monoxide (found in coal gas and many industrial gases), and sulphuretted hydrogen

(b) Lung irritating, such as chlorine, or

(c) Suffocating, such as carbon dioxide.

Carbon monoxide poisons the blood, and early symptoms are headache, giddiness, excitability (often resembling drunkenness), followed by loss of consciousness and failure of breathing. Sulphuretted hydrogen ($H_2S$), which normally has a characteristic "rotten egg" smell, can cause respiratory failure through poisoning of the nervous system and, this can occur without warning, because the sense of smell can tire easily the characteristic odour of the gas may not be noticed. Chlorine is immediately irritating and causes tightness of the chest and a choking sensation. Carbon dioxide is used in the automatic fire protection of parts of this Establishment, and when the apparatus operates it quickly replaces the oxygen in the air. For this reason special breathing apparatus is necessary to enter areas where such a fire system has come into operation.

The treatment of all cases of gassing is essentially the same. It consists of removal

to a fresh atmosphere (not necessarily into the open air), artificial respiration if required and the administration of the oxygen mixture available in many parts of the Establishment as the "Novita" apparatus.

Beryllium

This substance is in use in the Metallurgical and Chemical Engineering Divisions of this Establishment. It has been found (not at AERE that exposure to the breathing-in of relatively small amounts can cause serious lung disease. For this reason, it is treated here with respect. Certain areas have been labelled as Beryllia Areas and only authorised persons are allowed to enter these areas. In them extremely efficient precautionary measures have been adopted, in order to keep the level of the Beryllium in the air as low as possible. This has been easily achieved by these precautionary measures. It should be pointed out that measurements of the atmospheric Beryllium in buildings where such precautions have not been taken have shown that only under very special conditions has the level reached as much as a quarter of the tolerance level. It has also been ruled that no person should work with Beryllium without the agreement of the Medical Division.

Advice

As stated at the beginning of this code, these are only some of the chemical hazards found in this Establishment. Many others may arise, and where there is doubt advice should be sought before the chemicals are actually used.

## SECTION 3

## TYPES AND APPLICATIONS OF BREATHING APPARATUS AVAILABLE AT HARWELL

Although all possible steps are taken at Harwell to ensure that working conditions are satisfactory in every respect, it may be found necessary, on occasion to enter a poisonous atmosphere to shut down plant or machinery or to rescue a person overcome by fumes or gas.

It will be realised that precautions are necessary to enable a person to enter such an atmosphere safely.

There are, therefore, available for use at Harwell four main types of breathing apparatus, which together with their applications are described below.

(SPECIAL NOTE: It is essential that care be taken to ensure that the face mask fits properly, and in case of doubt the Safety Officer should be consulted. If the wearer wears spectacles, these cannot be worn under the mask, but special spectacles can be provided in approved cases upon request to the Safety Officer).

### TYPE I. DUST RESPIRATORS

Poisonous Dusts

(A) Porton Full Face Mask Fitted with Type D/8/41 Filter (Illustration No. 1

Suitable For:- Poisonous and active dusts such as Beryllia, Uranium Oxide

and dusts associated with Fission Products etc.

Obtainable from:- Safety Service Station
Building 60.

This respirator consists of a light rubber facepiece fitted with eyepieces which is connected by a flexible tube to a circular metal canister which contains the filtering material.

This extremely efficient filter, capable of filtering microscopic dust particles was developed especially for atomic energy establishments.

This is the ONLY respirator approved for use at Harwell for use with poisonous or active dusts.

It will be seen that an ivorine label is attached to the facepiece and canister of ALL respirators within the establishment, which denotes the purpose for which the particular respirator is suitable.

Nuisance Dusts

(B) Mark IV and Pyrene Dust Respirators
(Illustration No. 2)

Suitable For:- Nuisance dusts ONLY, such as coal or cement dusts etc.

Obtainable from:- Safety Service Station
Building 60

This type of respirator consists of a 'half-face' mask which covers only the

nose and mouth, leaving the eyes free, the filter being incorporated.

It is rather more comfortable to wear than the 'full-face' dust respirator, but is very much less efficient.

It is ONLY suitable for use against 'nuisance' dusts and is NOT to be used in connection with any poisonous or active dusts whatever.

In common with all other respirators, a label, stating the use of the respirator, is attached to the facepiece.

Paint Spraying

(C) Paint Spray Respirators (Illustration No. 3)

Suitable For:- Vapours and fumes associated with the spraying of cellulose and other paints.

Obtainable from:- Safety Service Station
Building 60.

These, similar in many respects to the Mark IV and PYRENE dust respirators, are, as the name implies, designed expressly for the spraying of cellulose and other paints.

The differences lies in the filter which instead of arresting dust particles, is a chemical cartridge which absorbs any undesirable vapours which may be present when paint spraying is in progress.

TYPE II. GAS (CANISTER TYPE) RESPIRATORS
(ILLUSTRATION NO. 4)

Suitable For:- Wide variety of gases, fumes and vapours, providing the appropriate canister is fitted.

Obtainable from:- Safety Service Station
Building 60.

These, known as the 'PURETHA' MARK IV are identical in most respects with the General Service Anti Gas respirators issued to the Armed Forces, the only difference being in the contents of the chemical filter canister, which varies in accordance with the gas against the filter is designed to give protection.

An important point to note is that the effective LIFE of the canister will vary according to its conditions of use. A SAFE MAXIMUM is 30 minutes ONLY.

The use of this type of respirator is not encouraged where an alternative (such as the Compressed Air type) is available, as they have many limitations.

They do, however, serve a useful purpose for emergency repair work on fixed plant installations such as Methyl Chloride Refrigeration and Chlorine Water Treatment Plants.

Here, again a label is attached to the facepiece and canister indicating the purposes for which the particular respirator and canister is suitable.

After use, the respirator must always be returned to the Safety Service Station, Bldg. 60 where a new canister will be fitted.

This is most important.

NOTE I: Gas (Canister Type) Respirators must on no account be used for work:-

(a) With an INCORRECT TYPE of canister.

(b) Where the GAS CONCENTRATION is likely to exceed 1%.

In addition neither gas, dust, nor paint spray respirators may be used:-

(a) In CONFINED OR ENCLOSED spaces, tanks, vats or stills.

(b) Where the OXYGEN CONTENT of the atmosphere may be low (16% oxygen is the minimum which will support life - normally there is approximately 21% in the atmosphere).

NOTE II: It cannot be too strongly pointed out that the use of any form of respirator, for any purpose other than that denoted on the label is definitely unsafe.

TYPE III. SELF CONTAINED (OXYGEN) BREATHING APPARATUS (ILLUSTRATION NO. 5)

Suitable For:- Emergency repair or rescue work where the canister type of respirator cannot be used, such as in enclosed spaces, tanks, etc. or where an unusually high concentration of gas or lack of oxygen is involved.

One spare set is held by the Safety Service Station Building No. 60 which can be borrowed if its use can be foreseen.

These sets known as the 'Salvus' Half Hour Rescue Sets, consist briefly of a cylinder of oxygen contained within the set and a chemical to absorb the carbon dioxide which is exhaled. The wearer is therefore entirely independent, and can enter any atmosphere however concentrated or poisonous the gas or dust may be.

They are located at convenient points in buildings where the nature of the process warrants.

Its disadvantages are:-

(a) It has an effective life of only 30 minutes after which the absorbent and oxygen cylinder must be replaced.

(b) A course of instruction in its use is necessary.

TYPE IV. COMPRESSED AIR BREATHING APPARATUS (ILLUSTRATION NO. 6)

This consists of an ordinary 'full face mask' connected to a length of ⅜" bore flexible rubber hose, the free end of which has a bayonet type of fitting. This is designed to 'plug-in' to a filter which removes any moisture or undesirable gases from the compressed air.

TYPE V. COMPRESSED AIR HOOD
(ILLUSTRATIONS NOS. 7 & 8)

Instead of using the respirator shown in Illustration No. 6 a hood covering the head and shoulders may be worn instead. The air supply may be from a filter in the Laboratory airline or, alternatively, a belt fastening filter may be used if the laboratory is not provided with fixed filter points.

'Filter-points' are installed when requested in convenient points in laboratories where working conditions require.

This apparatus (compressed air respirator or air hood) is superior to and should be used in preference to any other form of breathing apparatus providing a Compressed Air Service is available.

Its advantages are:-

(a) It can be used as protection against any gas or dust in any concentration.

(b) There is no "time-limit" as with a canister type respirator or self contained apparatus.

(c) It can be used with little or no training.

(d) There can be no inward leakage of dust or gas owing to the pressure of air within the facepiece.

It has only two important disadvantages

- the field of action is limited by the length of the pipeline, and the possibility of failure of the Compressed Air Service.

Arrangements for the installation of this apparatus can be made through the Safety Section or Maintenance Division.

Advice and Training Courses

It should be stressed that the Safety Section will be happy to advise or assist in any problem connected with Breathing apparatus, and it is urged that any person whose duties involve the use of Breathing Apparatus should take advantage of a course of instructions which can be arranged at short notice on application to the Safety Section (Bldg. 329 Ext. 2950).

## SECTION 4

## CODE OF PRACTICE FOR THE SAFE HANDLING OF LIQUEFIED GASES

### General

This code has been compiled for the benefit of all members of Staff concerned with the production, distribution and use of liquid oxygen, liquid nitrogen and what is usually called "liquid air". The copper vacuum vessels used to store and transport these rapidly vapourising liquids lose 5% to 20% per day, according to size. The neck of the vessel is long and narrow with a ½" diameter outlet and there is a tendency for ice to form near the top, possibly forming a blockage, particularly in a damp atmosphere. The evaporation of 1 litre (2.5 lbs approximately) of liquid oxygen releases about 800 litres of oxygen gas; in the event of a blockage a high pressure will eventually be set up inside the vessel, which will burst within a few hours.

The following precautions should be observed:-

(a) The outlet tube should be examined regularly for obstructions.

(b) Any obstruction should be punctured immediately with a clean rod or wire, while standing as far from the vessel as possible. Do not apply heat.

(c) Containers should not be left out of doors, or in places where rain can reach them.

When pouring liquefied gases the hands should preferably be bare. Splashed liquid on the bare skin will evaporate very quickly and cause little damage. If it becomes trapped in a glove or rag serious burns may result.

Special Hazards

(a) Liquid Oxygen

Liquid oxygen is in daily use in some laboratories and because of the risk of fire and explosions, the following precautions should be observed:-

1. Avoid, where possible, the use of liquid oxygen around glass apparatus which may contain organic or other easily oxidisable material. In particular avoid contact with oil.

2. Where liquid oxygen is used in such a way that there is a considerable evolution of gaseous oxygen, provide adequate ventilation.

3. Substitute liquid nitrogen or solid carbon dioxide where possible.

4. Do not use flames etc., near liquid oxygen. In particular, it is suggested that the practice of lowering glowing string into liquid oxygen containers, to check that they contain liquid oxygen, may cause an accident. Liquid oxygen may be recognised by its blue colour. (Sparks alighting on the clothing of work people in factories

where the atmosphere in the vicinity of liquid oxygen plant and containers has been highly oxygenated have caused clothing to blaze furiously and have resulted in serious injuries).

(b) Liquid Air

Liquid oxygen containing substantial amounts of other liquefied atmospheric gases, chiefly nitrogen, is sometimes used for refrigeration. This material contains sufficient liquid oxygen to warrant the same care in handling as pure liquid oxygen.

(c) Liquid Nitrogen

Apart from the general dangers due to rapid evaporation, mentioned above, trouble has been experienced where liquid nitrogen has been used in a vapour trap in a leaking vacuum apparatus. In such conditions oxygen is condensed on the trap, and if the system is shut down before the trap has warmed, dangerous pressures of oxygen may be reached with a risk of bursting the apparatus.

## SECTION 5

## SODIUM, POTASSIUM AND RELATED ALLOYS
## PRIMARY RULES AND NOTES

PRIMARY RULES:

1. Protection

Goggles and moleskin gloves must be worn. In some cases (see Note 1 below) full protective clothing is required.

2. Fire Fighting

Do not use water or portable extinguishers of any description

3. Storage

Keep away from water.

4. First Aid

Avoid moisture, remove sodium or potassium splashes quickly from the skin by brushing. For liquid alloys apply High Flash Point Oil immediately before attempting to remove alloy. If the skin is moist and firing occurs smother flames with Dry Sand or Dry Soda Ash.

NOTES:

1. Protection

Moleskin gloves and eye protection must always be worn. When dealing with other

than small quantities of sodium or potassium complete protective clothing consisting of fireproofed head and face covering, overalls and spats must be worn. Alloys present more serious hazards than sodium or potassium; some are liquid at room temperature and it is essential that clothing should give complete protection to all normally exposed surfaces. The head and neck should be covered with a hood of fire resisting material in which goggles are incorporated.

2. Fire Fighting

Water is suddenly decomposed by sodium or potassium with the evolution of hydrogen which may, in the presence of air, ignite or even explode spontaneously. Ample quantities of dry sand or loose dry soda ash must be available for smothering fires. (Soda ash must be kept in airtight containers, otherwise it will absorb moisture from the atmosphere and "cake"). Fires from large quantities of sodium or potassium are difficult to extinguish as both metals will burn in air. Dry soil may be used if the dry sand or soda ash available is insufficient to extinguish the fire.

3. Storage

Small quantities of sodium potassium may be kept under kerosene or naphtha, larger amounts in airtight steel drums placed in a cool dry situation. Bulk storage should not be in a laboratory or general store-room but in a separate building.

4. First Aid

The only known medical hazard produced by sodium or potassium metals is the burn arising from contact with the skin. Ultimate treatment of such burns, is similar to that for flame burns. As sodium and potassium metals are solid at room temperature they can be removed from the skin by brushing. Some alloys, however are liquid at room temperature and oil (of high flash point) must be applied first. A small bath or basin containing, for example, heavy machine oil, should be placed in the immediate vicinity of the working places.

Disposal of Residues:

Small quantities of up to 2 grm. may be reacted with alcohol in a metal beaker. The alcohol used should be absolute, as some alcohols contain quantities of water which make them unsuitable for the purpose. A loose metal cover should be provided for the beaker in case of ignition, since hydrogen is evolved in the reaction, which may ignite the alcohol vapours. The beaker should be placed in an iron pan to catch overflow if boiling over occurs.

Larger amounts of residues must be burnt in an open fire of coke or charcoal. The residue should be stirred with an iron rod until it will no longer burn.

Residues should not be allowed to accumulate in the laboratory and the Industrial Chemistry Group, telephone 2720 will arrange for collection and disposal when notified.

The attention of all engaged on liquid sodium work is drawn to the A.E.R.E. Code of Practice for the Safe Handling of Liquid Sodium "AERE L.M.S.C. 1", issued March, 1953 which for convenience is reprinted in the following pages.

# CODE OF PRACTICE FOR THE SAFE HANDLING OF LIQUID SODIUM

Prepared by

H.A. Ballinger

under the direction of

The Liquid Metals Safety Committee

## Abstract

This Code specifies the general requirements which must be met at A.E.R.E. to provide safe working conditions for the handling of liquid sodium.

It outlines the hazards involved, deals with the siting of apparatus, the provision of both personal protective clothing and of fire fighting equipment and makes recommendations regarding the methods of disposal of scrapped equipment.

## Contents

1. Introduction

This Code has been issued under the authority of the Liquid Metals Safety Committee to specify handling conditions for liquid sodium at A.E.R.E.

2. Brief Resume of Dangers Involved

When liquid sodium is exposed to air, it may ignite at temperatures as low as 110°C, and in a comparatively dry atmosphere it will burn quietly giving off clouds of dense white, caustic smoke. The temperature of the burning mass increases quickly to 800-900°C, in this condition it will spall concrete, consume asbestos, fire brick, and similar materials, and react with glass.

It also reacts violently with such common fire extinguishers as water, carbon dioxide snow, foamite and carbon tetrachloride. The violence of the sodium water reaction is approximately 1/10 that of T.N.T. while reaction with carbon tetrachloride produces highly toxic phosgene gas.

Sodium also reacts vigourously with unsaturated hydrocarbons (alcohols) halogens, including chlorinated compounds used in degreasers, and acidic oxides. It alloys exothermically with mercury, lead, tin, zinc and bismuth.

No known form of protective clothing gives other than temporary protection from the liquid metal. Fire residues $Na_2O$ is

extremely corrosive to the skin and will rapidly attack most metals. The caustic smoke, sodium monoxide, from fires is very irritating to the nose and lungs, and will damage the mucous membranes. Solid sodium metal touching the skin can cause severe burns due to presence of minute films of moisture and small particles subject to friction may fire.

3. Siting of Equipment

(a) All apparatus containing more than litre quantities of liquid sodium must be installed in a fire resistant enclosure or compound. This is possibly most economically provided by an enclosing brick wall. When more than one rig is installed in the enclosure or when frequent access is essential for operation, splash shields of about 18 gauge M/S sheet should be used intelligently to section off equipment.

(b) This enclosure, must not be sited under any inflammable structure, pedestrian galleries or path of crane cabins, and should be free from water faucets and drains. The installation and use of steam or water space heating is to be discouraged.

(b) The enclosure should where possible be vented out of the building by a system which prevents ingress of the weather. The system need not be in continuous operation but must be available for instant use. As a less

desirable alternative, the equipment must be sited in that section of the building furthest from the principal exits.

(d) All apparatus to be fitted with an enclosed gravity fed dump tank into which the sodium can be released in case of fire. The dump valve should be connected for operation from outside the enclosure-where this is impossible it should be protected from the main body of the installation by an adequate splash shield.

(e) Metal trays capable of holding total volume of sodium in system to be placed under all apparatus. A layer of silver sand is required in base of tray to prevent splashing. Trays may be constructed from any ferrous material. It is reported that a self extinguishing action can be obtained by fitting a perforated steel plate into the top of the tray.

4. Personnel Protection

All persons, including maintenance staff, working in an area where a sodium hazard exists must be issued with and wear protective clothing. The issue is the responsibility of the respective group leaders.

No personnel shall be permitted to operate on an apparatus containing liquid

sodium before they have:-

(1) Read the approved safety code.

(2) Been instructed and questioned on the limitations of their duties (see "Training").

(3) Put on the protective clothing and equipment specified by supervisory staff (see "Clothing").

No unauthorised or unaccompanied person shall be permitted to enter a sodium rig enclosure.

(a) Training

It is very important that personnel are fully trained in the use of safety equipment and in choosing the correct procedure to meet each situation.

Confidence in the wearing of special clothes, handling appliances and in the measures laid down to meet an emergency can come only from practice and familiarity. Therefore, before personnel can be authorised to handle sodium apparatus they must be given training in which all the special clothes are worn and tools used on actual fires.

Training facilities and schedules are to be the responsibility of the Safety Officer and Fire Officer. Periodical refresher courses are to be arranged and attendance to be regarded as of first importance for all personnel.

(b) Clothing

Here the aim is to protect against spattered metal and extension of damage by firing of personal clothing. The items listed below have been selected to this end. If they are used sensibly in an order related to the various degrees of risk (see below) the operator will experience minimum inconvenience and be provided with the best available protection.

| Item No. | Article | Description or Supply Source |
|---|---|---|
| 1 | Goggles, or hard fibre safety hat with a 0.050" Cellulose Acetate face shield and moleskin neck cloth attached. | Safety Officer |
| 2 | Helmet with shoulder cloth, with bayonet fittings for C. Air supply. | Improved R.F.D. Helmet with Glass face piece - Safety Officer. |
| 3 | Salvus breathing apparatus. | Safety Officer |
| 4 | Gauntlet gloves, chrome leather or moleskin. | Stores Item 2-1/0283 |
| 5 | - do - P.V.C. | 2-1/0018 |
| 6 | Fireproofed lab. coats | By arrangement with Laundry. |

| Item No. | Article | Description or Supply Source |
|---|---|---|
| 7 | Clip on antisplash apron of fireproofed canvas. | Safety Officer |
| 8 | Surgeon's type smock of fireproof canvas or moleskin (quick release patt). | Safety Officer. For high temperature work will be superseded by a laminated glass cloth and wire mesh smock, being developed by Chem. Eng. Div. |
| 9 | Stores issue pattern shoes. | Stores Item. |
| 10 | Wellington boots (large size) | - do - |

N.B. An essential point with this protective clothing is that it is loose fitting and can be thrown off easily if burning metal becomes attached to same.

Occasion for use - ascending order of risk.

3rd Degree

Operators or visitors entering an enclosure where there is exposed circuitry or equipment containing liquid sodium.

Items 1, 4 and 6.

N.B. Item 6 should be made a standard issue of all personnel involved.

2nd Degree

When minor adjustments are to be made to a rig:-

Items 1, 4 or 5, 6, 7 and 9.

1st Degree

When dealing with major adjustments, a spillage of metal - fire or other disaster:-

Items 2, 5, 8, 10 - Item 3 available for rescue work, or other operations requiring re-entry into caustic fumes by trained personnel. This equipment may be supplemented if desired by gas masks and a D/8/41 cannister - or compressed or free air lines.

(c) First Aid

In addition to standard kit the following articles should be provided:-

| Item No. | Article | Description or Supply Source |
|---|---|---|
| 1 | Knives | Stores item Patt. 11-1/0295 |
| 2 | Scalpel | 2-7/0104 |

| Item No. | Article | Description or Supply Source |
|---|---|---|
| 3 | Splinter forceps or tweezers | Medical Division 1-1/1987 |
| 4 | Pint of liquid Paraffin in Polythene dispensing bottles | 1-9/1706 |
| 5 | Sterile Burn dressings | Medical Div. |
| 6 | Two, one gallon tins with loose lids filled with a high flash-point, low moisture content mineral oil, e.g. transformer oil. | 1-7/0011 |

Action

In case of operator being splashed by burning sodium:-

(a) Shed any burning garments as quickly as possible or smother in soda ash (see Fire Fighting).

(b) Extinguish burning sodium on the skin by dousing liberally with mineral oil.

(c) Scrape or pick off solidified sodium with knife or forceps, or rub off gently in sand.

(d) After the skin has been scraped clean flood with mineral oil (transformer or liquid paraffin) and apply sterile dressings.

(e) When eye injuries occur instant action must be taken. The person(s) nearest should flood the injured mans eye(s) with liquid paraffin and continue with gentle washing with liquid paraffin for at least 30 minutes.

(f) Call Medical assistance on Tel. No. 2818 or during silent hours dial '0' and ask for Duty Sister.

(g) All injuries however minor must attend surgery as soon as possible.

Note:- Patients may suffer from shock following severe burns, so treat accordingly; ultimate treatment for sodium burns is the same as for flame burns.

5. Fire Fighting

Precautions

(1) All standard fire extinguishers to be removed from area, the only possible exceptions are $CO_2$ bottles required for combating other fire hazards - these extinguishers must be plainly labelled "DANGER NOT FOR SODIUM FIRES".

(2) Warning notices forbidding use of water or extinguishers should be placed on the door of enclosure and by all fairways to the test area.

(3) A local alarm system be installed to summon technical assistance in case of fire.

(4) A board shall be displayed prominently on the enclosure giving the name and location of the officer responsible for the installation.

Preparations

The following equipment should be provided and stored in the immediate vicinity of all sodium rigs.

| Item No. | Article | Description of Source of Supply |
|---|---|---|
| 1 | Damp-proof bin of Soda-Ash* Soda-Ash will be replaced by Pyromet (Ref.5) as it becomes available. | Domestic coke bin - Fire Brigade |
| 2 | Silver sand in lidded buckets | Fire Brigade |
| 3 | Long handled fire shovel. | Fire Brigade |
| 4 | Fire rake and poker | |

| Item No. | Article | Description of Source of Supply |
|---|---|---|
| 5 | Blacksmith's tongs | Stores Item |
| 6 | Seizing wire | Stores Item |

*
Soda Ash. Dampness will cause Soda Ash to cake and minimise smothering action when used on sodium fire - contents of bins should be turned out at regular intervals and inspected.

Quantity - about 8 lb/pound of metal are required.

Action

Every fire must be dealt with on its merits but the general rules are:-

(1) Dump system to tank)

(2) Remove heat source ) By interlock
) when possible
(3) Isolate electrically ) and per fire
) drill order
(4) Ring local alarm system ) when not.

(5) Put on protective clothing

(6) Shovel soda-ash over fire and into drip tray.

(7) Switch on extract ventilation where fitted.

(8) Use silver sand to dyke round area of spill.

6. Disposal of Fire Residues and Scrapped Equipment

(a) Fire Residue

Scrape up the mess of burnt sodium, soda-ash, etc. mix well with dry sand, load into buckets and convey to a suitable burning site. Here, spread out thinly and flood with a fire hose from a safe distance - 1st degree protective clothing to be worn during spreading operation.

Should the residues consist of quantities of contaminated metal they should be first burnt on a coke fire.

(b) Scrapped Equipment

This should under no circumstances be permitted to accumulate as, except when exceptional care has been taken over its storage, a potential fire hazard exists.

The equipment should be cut up with a hacksaw and if humid conditions exist, dipped in oil. Second degree clothing to be worn. The pieces may then be conveyed in a closed container to the approved burning ground and make safe by the following methods:

(1) Place on a coke or charcoal fire and burn; wash down and salvage residue for scrap value.

(2) Place in a shallow tank or depression and flood with water from a safe distance.

The latter method is the more spectacular but should be strictly supervised. A safe distance when applying water to scrapped equipment plugged with metal is 30-40 ft., but can be as little as 3 or 4 ft. when treating fire residues mixed well with sand.

It is recommended that a 3rd and safer method be developed which will have the additional advantage of being less destructive to salvageable items.

This method is, briefly, to construct a container from a length of large dia. iron drain pipe into which equipment could be placed prior to inducing low pressure dry steam with the assistance of a roughing pump and water bottle.

Control of the ensuing slow reaction is automatic.

7. Other Items

Active Sodium Circuits

Recommendations pertaining to normal rigs apply and are in some aspects easier to carry out.

The biological shield, to health physics requirements, will provide a suitable enclosing wall for equipment. The

high specific activity of circulating sodium will prevent any direct viewing of or adjustment to an operating rig and thus obviate risks connected therewith. Disposal of scrapped equipment must be dealt with through existing channels for radio-active wastes.

The fire-fighting aspect, however, does present another problem and the following recommendations are made:

(1) Pending manufacture of a suitable Soda-Ash dispenser, a hopper to contain this material to be mounted above each rig. A dump valve and stirrer fitted to same shall be suitable for remote operation.

(2) A ventilating system to be installed which is capable of exhausting active caustic fumes to a suitably sited washing chamber or tall chimney stack, e.g. Pile exhaust system.

NOTE: This system need not operate during normal working conditions. A further point of importance is that the rig shall have a full time operator in attendance whenever it is running.

8. General Recommendations

Storage of Sodium

On a laboratory scale, the metal may be stored under mineral oil, paraffin or benzene. In quantity sodium is supplied

in metal drums with tightly fitting covers. Drums should be stored and decanted in an enclosure or separate building similar to that specified for operating rigs. Similar fire precautions are required.

It is recommended that no separate storing of metal by Groups occurs but that each section draws in a detachable dump tank the precise requirements of their equipment, from a central dispensing authority.

Transfer of Liquid Sodium

When liquid sodium is transferred into or out of a system, it should be carried out at the lowest possible temperature and pressure.

Heating of a Systen

(a) Electrical. It is desirable to obtain the wattage required from high resistance, low current, elements as the arc from a failure of a heavy current resistor may burn through a sodium pipe before interruption of the supply.

(b) Steam. It is desirable that the steam be dry and condensate blown off before system is primed with liquid sodium. In case of a sodium pipe failure - the reaction with wet steam is not fully predictable, but can be dangerous - however, the dry steam reaction is safer.

(c) Flame. In the case of a burn through or tube failure from other causes in the fire box the liquid will flux the firebrick into a molten slag. The fire box should be designed to cope with this eventually.

Acknowledgements

Acknowledgements are made to:

Dr. S.G. Bauer and Mr. W.B. Woollen of Chemical Engineering Group for information and guidance on all major points, and to Mr. R.G. Davies for assistance in summarising the following references.

References

Reference has been made to the following publications:

(1) Liquid Metals Handbook - NAVEXUS p.733.

(2) Alkali Metals Area Safety Guide. Y-811.

(3) Guide to Liquid Metal Handling. AECU.1273.

(4) Notes of a visit to A.E.C. Northwick Works by Dr. S.G. Bauer.

(5) Notes on Fire Extinguishers for Sodium by W.B. Woollen. AERE CE/M 49.

## SECTION 6

## CODE OF PRACTICE FOR THE SAFE USE OF LIFTING MACHINES AND TACKLE

(A copy of these instructions is given to every slinger and to every Foreman, Assistant Foreman and Chargehand in charge of slingers or tackle stores and is posted up in all workshops, tackle stores and crane control cabins.)

1. Cranes, pulley blocks or other lifting machines must not be loaded above the safe working load marked on the machine.

2. When a block and tackle has to be used the lashing of the upper block must be of sufficient strength to sustain five times any load required to be lifted. If a hook is used with the lashing, it shall either be fitted with a safety latch or tied across the opening in order to prevent any possibility of the hook becoming detached.

3. Chains, ropes, hooks, shackles or other lifting tackle must not be loaded above their safe working loads as stamped on or marked by a standard tally. The loading of multiple chains and slings at different angles shall be reduced in accordance with the reduction factors shown on the tables posted up in all tackle stores.

4. No lifting tackle, sling or rope, shall be used unless it bears an identification number and safe working load.

5. Slingers and persons in charge of tackle stores are expected to make themselves familiar with the requirements of Section 23 of the Factories Act 1937 which is posted up in full in all tackle stores and an extract is given below:-

Section 23 (a) No chain, rope or lifting tackle shall be used unless it is of good construction, sound material, adequate strength and free from patent defect.

(e) No chain, rope or lifting tackle.....shall be taken into use in any factory for the first time in that factory unless it has been tested and thoroughly examined by a competent person and a certificate of such a testsand examination specifying the safe working load and signed by the person making the test and examination has been obtained and is kept available for inspection.

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6. The Safety Officer and his staff are very anxious to be of service to all concerned and if anyone using lifting tackle has the slightest doubt about the operations being carried out, the Safety Officer should be asked for an opinion before it is used.

WEIGHT IN LBS. PER CUBIC FOOT

| WATER | SAND | CONCRETE | STEEL | LEAD | URANIUM |
|---|---|---|---|---|---|
| 62.5 | 130 | 140/220 | 486 | 708 | 1150 |

## SECTION 7

## CODE OF PRACTICE FOR THE AVOIDANCE OF ELECTRICAL ACCIDENTS

[A copy of these instructions is given to every skilled man joining the department]

1. In order to ensure that all electrical apparatus and circuits shall be installed, operated and maintained by the department in a safe manner and condition the Electricity Regulations of the Factory Act, The Electricity Supply Regulations (1937) and the I.E.E. Regulations for the Electrical Equipment of Buildings shall be rigourously compiled with and no departure from these regulations will be made without the authority of the Electrical Maintenance Engineer.

2. Copies of the above 3 sets of regulations will be kept in the Electrical Foreman's Office and will be available for perusal by all members of the department.

   Electricians are expected to make themselves reasonably familiar with the scope and contents of the above sets of regulations and to refer to their immediate supervisors if in any doubt as to what constitutes good practice.

3. All men are expected to familiarise themselves with the notice detailing immediate action to be taken in the event of apparent death due to electric shock and all men will undergo practical

training in the application of artificial respiration.

4. No work of any description will be carried out upon 11 Kv. Sub-station apparatus or upon the 11 Kv cable network without a permit to work having first been obtained from an authorised person.

Applications for permits to work should normally be made through the electricians immediate supervisor.

Supervisory grades should apply to the Electrical Maintenance Engineer for permits or to such other authorised persons as may, from time to time, be designated.

5. No work of any description will be carried out upon the 400v switchgear in the Sub-station or upon the 400v cable network or upon the inconing switches of individual buildings without a permit to work having been first obtained from an authorised person as detailed in (4) above.

6. No work will, under any circumstances be carried out on a circuit or piece of apparatus which is alive at a pressure exceeding 650 volts.

7. No work will be carried out on a circuit which is alive at a pressure of 230 volts or above except when specificially authorised as detailed in paragraph (9) below.

8. Before carrying out any work on circuits the working voltage of which is 230 volts

or above, the electrician in charge of the work will switch off and isolate the supply.

In making a circuit dead it is not sufficient merely to trip a starter or circuit breaker, in addition the appropriate isolating switch should be opened or fuse links withdrawn and a danger notice affixed to the isolator or fuse-box to avoid accidental restoration of supply.

Before handling any part of a circuit the electrician will first prove that it is dead by use of a Neon Tube Tester, voltmeter or other safe method.

The use of a single 230 volt metal filament test lamp on a 415 volt, 3 phase circuit does not constitute a "safe method" on account of the danger of accidentally testing across phases and is therefore prohibited.

9. Should it be necessary to carry out work on a circuit which is alive at a pressure between 230 and 650 volts the electrician will, under no circumstances do so on his own initiative but will refer to his Assistant Foreman for permission.

The Assistant Foreman will ensure that the man is issued with rubber gloves and that he is provided with a mate for the period when he is handling live circuits.

In all except jobs of a simple nature on low power circuits the Assistant Foreman will inspect and ensure that all necessary safety measures are carried out. These

may include the use of rubber mats, temporary shielding of live parts and the use of insulated tools.

Should the work be of any difficulty or on a circuit of considerable power the Assistant Foreman will be present while the work is being carried out.

In all cases where the safety and practicability of carrying out the work alive is in doubt the Assistant Foreman will refer to the Foreman for guidance who will in turn refer to the Electrical Maintenance Engineer if uncertain as to the procedure to be followed.

10. Before carrying out any work on flameproof equipment in flameproof areas electricians will first obtain permission from the Assistant Foreman who will check with the Area Supervisor that such work may safely be undertaken.

Non flameproof hand lamps and portable electric tools will not be used in flameproof areas without the permission of the Area Supervisor.

11. Smoking in battery rooms and battery charging stations is prohibited and care should be taken to ensure good ventilation and to avoid causing sparks which may give rise to explosions.

12. It is the duty of Electrical Maintenance Department personnel to set an example to the rest of the Establishment in the observance of all electrical safety regulations and by the high standard of their workmanship.

## SECTION 8

## CODE OF PRACTICE FOR ENSURING THE SAFE USE OF LADDERS

NOTE:- Instructions (1) to (4) (inclusive) below do not apply to step ladders or to ladders less than 6 feet in length.

1. It is the responsibility of every man when using a ladder to ensure that it is securely fastened and that there is no possibility of the ladder slipping or falling.

2. Wherever possible the top end of the ladder will be lashed into position.

3. Where it is not possible to lash the top of the ladder the man will apply to his immediate superior for an assistant to foot the ladder.

4. It is expressly forbidden for work to be carried out from ladders except when the safety precautions detailed in (2) and (3) above have been compiled with.

5. It is forbidden to erect ladders so that they could accidentally come into contact with electric overhead wires or so that a man working from the ladder could reach the wires, without the wires first having been made dead and isolated from supply by a competent electrician and adequate steps taken to prevent the accidental restoration of

the supply. In all such cases application will be made by the intending user of the ladder to his immediate superior who will request the electrical maintenance foreman or assistant foreman to make the wires safe as detailed above.

6. Step ladders will not be used except with the legs in the fully open position and the use of step ladders with the legs folded as an ordinary ladder is forbidden.

7. It is the responsibility of the man using a step ladder to ensure that it is on a level and firm footing and the use of step ladders on footings of loose bricks or other loose packing is forbidden.

## SECTION 9

## CODE OF PRACTICE FOR THE INSTALLATION AND MAINTENANCE OF BURSTING DISCS

### 1. Introduction

Bursting discs are used in special cases as a means of relieving pressure in chemical plant and other pressure vessels.

A bursting disc consists of a thin sheet of a suitable material clamped in a holder mounted in a vent line from the vessel to be protected and so arranged that it will rupture and discharge the contents of the vessel if the pressure should ever rise dangerously near the pressure at which the vessel itself might fail.

In general, if sufficient care is taken in manufacture and use, a bursting disc can be guaranteed to fail within 10% of its rated bursting pressure. In some cases this margin will only be 5%.

The conditions which commonly dictate the use of a bursting disc are:-

(1) where a mechanical relief valve would be liable to corrosion which might cause premature failure or prevent the valve from opening at all;

(2) where a mechanical relief valve might be expected to develop a slow leak which would be undesirable;

(3) where the pressure rise in the vessel may be so rapid that the inertia of the parts of a mechanical valve would prevent it opening quickly enough to protect the vessel from damage. In this case the bursting disc becomes an explosion disc.

It should be remembered that adequate provision must be made for the safe discharge of the contents of the vessel down to atmospheric pressure when a disc fails. This is particularly important when the contents of the vessel are radioactive, toxic or inflammable.

2. Materials

The materials commonly used to make bursting discs are:-

Platinum
Silver
Nickel
Stainless Steel
Aluminium
Copper
Various types of rubber and rubber insertion

Materials such as tin and lead whose creep resistance is low are not normally suitable for making bursting discs, though in certain cases they are used as the inner layer in a composite disc, to protect from corrosion a second disc of a material which will have adequate strength. The same remarks apply to silver at temperatures above atmospheric.

3. Working Conditions

Bursting discs can be designed to provide protection to any vessel working at any pressure above atmospheric with one or two important limiting conditions:-

(a) the plant as a whole must be designed to provide suitable pressure and temperature conditions for the bursting disc;

(b) in the case of very small working pressures the thickness of the disc may become so small and its diameter so large as to be impracticable. In this case special measures can usually be applied to provide a solution, for example, lutes.

(c) in the case of a vessel whose pressure may occasionally fall below atmospheric, a bursting disc is preferably not used, as reverse pressure on the disc would cause premature failure.

The dimensions of a disc for a given application must be chosen to take account of the following considerations:-

(a) an adequate margin must be allowed between the working pressure in the vessel and the rated bursting pressure of the

disc under test conditions. The magnitude of this margin is conditioned by:-

(1) the physical nature of the material of the disc;

(2) the effect of corrosion on the thickness of the disc over its required life;

(3) the reduction in strength due to elevated temperature under working conditions;

(4) the seriousness of the consequences of failure of the disc;

(b) an adequate margin must be allowed between the rated bursting pressure of the disc under test conditions and the test pressure used to prove the mechanical strength of the vessel.

(c) the size of the clear opening after the disc has ruptured must be adequate to prevent any further rise of pressure in the vessel and in the case of an explosion disc the shape of the passages for the escaping material must be arranged to prevent excessive back pressure due to inertia.

## 4. Procurement and Issue of Bursting Discs for Use at Harwell

In view of the specialised and complex procedure required to produce reliable bursting discs, it is not proposed to manufacture them at Harwell at present. In general, they will be obtained from I.C.I. Limited.

### 4.1 Design and Inquiry

All questions of design and liaison with I.C.I. Ltd., will be handled by the Safety Group of the Engineering Division, Extn. 2950, to which any suggestion to use a bursting disc should be referred at any early stage as the design of the plant or pressure vessel is often affected by the decision to use a bursting disc, and a suitable carrier has to be provided.

### 4.2 Issue and Replacement

All bursting discs will be kept and issued by the Safety Group, which will keep comprehensive records of each one, every disc being numbered serially.

When a bursting disc is issued the following information is required from the user to be entered on the record for the particular disc:-

(a) contents of the pressure vessel

(b) degree of corrosion

(c) working temperature and pressure

(d) probable daily operating time

(e) AERE Plant Reference number

Discs will be fitted to their respective carriers by the Safety Group, the approximate rupture pressure being etched on the carrier, the shape and radii of which should not be altered without reference to the Safety Group. The combined unit will be handed to the Maintenance Group for installation under the direct supervision of the Safety Officer or his representative.

Replacement discs will be issued on the return of the original disc, and in the event of a vessel becoming redundant the Safety Group should be informed prior to its disposal so that the disc and carrier may be recovered.

4.3 Inspection and Maintenance

In order to provide a safeguard against the failure of discs (with the consequent loss of time and material), due to ageing, corrosion and other effects not involving excess pressure, and also to obtain data on its operational life, the Safety Group will carry out a periodical examination and where necessary arrange the replacement of the disc.

Cleaning methods employing solvents that do not reduce the thickness of discs should be used, the application of a wire brush, abrasives or mechanical tools will damage the discs and should on no account be employed.

4.4 Installation

The Safety Officer will arrange for an examination of the installation and issue of a clearance certificate before the vessel is put into operation.

## SECTION 10

## CODE OF PRACTICE FOR ENTRY INTO CLOSED TANKS, VATS, PITS, PIPES FLUES, SEWERS, MANHOLES AND SIMILAR CONFINED SPACES

(A copy of these instructions shall be given to every person in the Division who may be called upon to enter any confined spaces described above.)

1. No person shall enter any such confined space until he has obtained a Safety Permit of the appropriate type, properly completed and signed by a responsible person, known as the authorising officer and appointed in writing by the Group Leader. Staff appointed to issue permits should be familiar with Sections 27 and 28 of the Factories Acts of 1937 and 1948 and with the Chemical Works Regulations (S.R.&O. 1922 No.731). Copies of these documents are available to all concerned.

2. The authorising officer will ensure that:-

(a) where necessary, all practical steps have been taken by flooding, steaming, neutralising or ventilation to remove any fumes which may be present and to prevent the ingress of fumes by blanking off or isolating. (It is not sufficient merely to close the valve, a stopper plate should be inserted, or, the pipeline broken).

(b) where a vessel is fitted with stirring gear or other movable parts inside, the transmission drive shall be disconnected or, the isolator for

the driving motor shall be locked in the "OFF" position. Alternatively, the fuses may be withdrawn by a competent officer, and kept by the authorising officer until the work is completed.

(c) a person entering a confined space such as a closed tank, vat, or deep manhole has a rope securely attached, the free end of the rope to be held by a standby man outside, who must remain on duty during the whole period in which the person is inside the confined space.

(d) an adequate supply of fresh air is provided by natural ventilation, by means of a blower or from a compressed air jet, or, a fresh air breathing set of the "Antipoys" type is worn and a second breathing set is also available at the place of working.

NOTE:- Canister type masks are not suitable for work in confined spaces (or anywhere where there is a shortage of oxygen) and must not be used.

3. The standby man must be trained and certified competent by the Safety Officer in rescue and resuscitation work including the use of Novita reviving apparatus. A Novita reviving set must be immediately available adjacent to the opening to the confined space.

4. No plant, tank or vessel which contains or has contained any explosive or inflammable substance shall be subject to any welding, brazing or soldering operation or to any cutting operation which involves the application of heat until all practicable steps have been taken to remove the substance and any fumes arising therefrom, or, to render them non-explosive or non-inflammable. The authorising officer is responsible that a check is made before the aforementioned operations are carried out, and the Industrial Chemistry Group will be glad to carry out some tests upon request.

5. No explosive or inflammable substance shall be placed in any plant, tank or vessel which has been subjected to any heating operation until the metal has cooled sufficiently to prevent any risk of igniting the substance.

6. No electrical lamp, torch, monitor or other equipment shall be taken into any plant, tank or vessel which has contained an explosive or inflammable substance until it has been proved by a test carried out either by or at the request of the authorising officer that the concentration of inflammable gases or vapours has been reduced to a value well below their lower inflammable limit.

Any electrical equipment then placed inside must be of an intrinsically safe or "approved" type, and must be so certified by the Safety Officer.

7. Precautions regarding Radioactivity - In the case of plant known to have been used with radioactive material and/or closed tanks, vats, pits, etc., contained within a restricted

area, the normal works permit shall be raised. This certificate must be signed by the Health Surveyor who will detail what precautions, if any, are necessary.

8. This Code of Practice may not cover every case of entry into confined spaces, and in such cases authorising officers shall seek advice of the Group Leader before operations are carried out.

9. Responsibilities of Authorising Officers - The wide variation in the types of tanks, vats, pipes, sewers, etc., of the establishment, necessitates consideration of degrees of responsibility for entering therein. Accordingly the degree of responsibility of each authorising officer is defined as follows:-

(a) in the case of closed process tanks, vats or closed chemical plant of any kind the responsibility for entry, and operations carried out therein is that of the following Officers of the Industrial Chemical Group:-

(1) Mr. R.H. Burns
(2) Mr. H.J. Blythe
(3) Mr. C.J.C. Nash
(4) Mr. H. Wells
(5) Mr. J.H. Clarke

(b) in the case of open chemical tanks and the like, entry is authorised by Foremen and A/Foremen.

(c) in the case of routine examination of drainage ducts, manholes and

similar confined spaces of the effluent system, the Leading Hand of the Duct Examination Party is the authorising officer.

(d) In the case of ventilating or other service ducts, including boiler flues and plant such as receivers, the engineer immediately in charge of the plant shall designate the authorising officer.

## SECTION 11

## CODE OF PRACTICE FOR THE INSTALLATION AND MAINTENANCE OF PRESSURE GAUGES

The Factories Act 1937, Sections 29, 30 and 31, gives specific requirements in respect of the proper installation and maintenance of pressure gauges, and in order that our practice at A.E.R.E. shall conform not only with the letter but with the spirit of the Factories Act, this code of practice has been drawn up and must be followed in all appropriate cases.

At A.E.R.E., pressure gauges are used in connection with steam boilers, pressure vessels, air receivers and experimental plant of a widely varying character. In addition, there are many hundreds of pressure gauges used in connection with reduced pressure supplies from high pressure gas cylinders, e.g. oxygen, hydrogen and nitrogen.

The code of practice for installation and maintenance of pressure gauges will, of course, vary with the type of service to which the gauges are to be subjected, and accordingly the following procedure will be adopted for the various kinds of service.

(1) Steam Boilers

The steam boilers at A.E.R.E. are insured with an Engineering Insurance Company, and it is their responsibility to see at working examinations that the gauges are inspected and tested on a standard gauge. No other tests will be carried out by the Establishment

save insofar that if a gauge is noted to be inaccurate or giving rise to trouble in service, the matter must be reported to the Group Leader, who will take the necessary steps to provide a new gauge pending the repair of the old one.

2. Steam Pressure Vessels

All shell type steam calorifiers are also insured with the Engineering Insurance Company, and where the pressure within the steam chest of the calorifier is different from that obtaining in the steam supply line to it, the reducing valve, safety valve and pressure gauge is fitted in accordance with the requirements of Section 30 of the Factories Act. These fittings are then inspected, and are under the regular inspection of the Insurance Company, and the Inspector is again responsible that at his examinations the pressure gauge in each case is reading correctly.

3. Air Receivers

Most of the air receivers at A.E.R.E. are also inspected by the Engineering Insurance Company who ensure by means of regular thorough examinations that the vessels and their fittings are maintained in good order and that the pressure gauges are reading correctly.

4. Laboratory Pressure Vessels

In addition to the pressure vessels described above, there is a number of steam jacketed vessels and special purpose chemical pressure vessels which for reasons of security, or, because they may be radioactive, are not examined by an outside inspecting body but are examined at prescribed

intervals by the Safety Group. In these cases arrangements will be made by the Safety Group for the pressure gauges to be tested when necessary. This will normally be once every two years, except in the case of corrosive conditions when the interval between inspections will depend upon each individual case.

5. Gas Cylinders

The periodical testing of gas cylinders is carried out by firms to whom the cylinders are sent for filling, but in general, the fillers do not have anything to do with the testing of the pressure regulating valves and pressure gauges.

A register of pressure gauges for use with gas cylinders is therefore to be kept and arrangements made for the routine testing of the gauges against a standard gauge once every year or more frequently if requested by the users or the Safety Officer.

6. Laboratory Services

Under this heading are included pipe lines for compressed air, oxygen, hydrogen and possibly other gases. Pressure gauges are fitted in the laboratories to give ready indication of the pressure at a particular point. These are, in the main, low pressure services at less than 30 P.S.I. and it is not considered necessary to register and carry out periodical tests on the pressure gauges because in almost all cases a gauge in one laboratory may be checked against the gauge in an adjoining laboratory.

Where, however, the operating conditions of a particular installation are deemed to warrant the routine testing of the pressure gauges the Safety Officer will inform the Pressure Gauge Test Department, who will register and carry out periodical tests at intervals to be agreed with the users.

7. Pilot Plants and Similar "Permanent" Laboratory Equipments

It is suggested that tests should be taken as required by the users but in any case tests should be taken at intervals not exceeding two years.

8. Pressure Gauges in Casual Use

Gauges which are used in connection with short term experimental work should be tested before issue and retesting will be carried out as required at the request of the user.

Gauges returned to store will be re-tested before being issued to another person and the test will be recorded in the register.

9. Pressure Pumps and Hydraulic Installations

It is not considered to be necessary that periodical tests be taken of pressure gauges used with water pumps or similar equipment. Testing will however be carried out at the request of the Maintenance Engineer or the users.

The Engineering Services and Operating Group - Instrument Section - will be responsible for the testing and the keeping of records of all pressure gauges covered by this Code of Practice.

## APPENDIX

(1) It is important that the right type of pressure gauge is used, due regard being given to the corrosive action of gases or liquids in the system.

(2) An isolating cock or valve should always be provided between the gauge and line in order that a faulty gauge can be removed without shutting down the whole system.

(3) Gauges for oxygen should be marked "Oxygen" and should not be tested with oil.

(4) Gauges for chlorine should not be tested with oil or with water.

## SECTION 12

## SOME NOTES ON THE FACTORIES ACTS

This section gives guidance about the safety regulations which are included in the Factories Acts.

It is taken from the H.M.S.O. Publication entitled "A Short Guide to the Factories Acts 1937 and 1948" with minor amendments and an additional note on the DUTIES OF PERSONS EMPLOYED has also been included.

### SAFETY

14. Fencing

Every dangerous part of machinery, and all parts of electric generators, motors, rotary converters, and flywheels directly connected to them, must be securely fenced unless in such a position or of such construction as to be as safe to every person employed or working on the premises as if securely fenced; and any part of a stock-bar which projects beyond the head-stock of a lathe must be securely fenced unless it is in such a position as to be as safe to every person as if securely fenced. A male person over 18 may, however, approach unfenced machinery in motion in certain strictly limited contingencies and subject to conditions specified in Regulations. (Sections 12 to 15).

15. Moving parts of other prime movers and flywheels directly connected to them, and the head and tail race of a water wheel or water turbine, must be securely fenced irrespective

of their position. (Section 12).

16. Fixed vessels, pits, etc., containing scalding, corrosive or poisonous liquids must, unless the edge is three feet above the adjoining ground or platform, be securely fenced to at least that height or be securely covered; where this is impracticable, other precautions, so far as practicable, must be taken. (Section 18).

17. All fencing must be of substantial construction and be maintained in an efficient state (Section 16).

18. Further requirements in connections with transmission machinery

Devices or appliances for promptly cutting off the power from the transmission machinery, must be provided in every room or place where work is carried on. Efficient mechanical appliances must be provided to move driving belts to and from fast and loose pulleys. Driving belts must not rest or ride on revolving shafts when the belt is not in use. (Section 13).

19. New Machines

New power-driven machines must not be sold, let on hire, or used unless certain parts are effectively guarded. (Section 17).

20. Cleaning Machinery

A woman or young person must not clean (a) a prime mover or transmission machinery while it is in motion or (b) any part of any machine if there is risk of injury from any moving part of that machine or of any adjacent machinery. (Section 20).

21. Training of Young Persons

A young person must not work at any machine specified by the Minister to be dangerous unless (i) he has been fully instructed as to the dangers and precautions and (ii) he has received sufficient training in the work or is under adequate supervision. (Section 21).

22. Protection of Eyes

Goggles or effective screens must be provided in processes specified by the Minister. (Section 49). These processes are specified in The Protection of Eyes Regulations S.R.&O No. 654 and include:-

1. Dry grinding of metals or articles of metal applied by hand to a revolving wheel or disc driven by mechanical power.

2. Turning (external or internal) of non-ferrous metals, or of cast iron, or of articles of such metals or such iron, where the work is done dry, other than precision turning, where the use of goggles of a screen would seriously interfere with the work, or turning by means of hand tools.

3. Welding or cutting of metals by means of an electrical, oxy-acetylene or similar process.

4. The following processes when carried on by means of hand tools or other portable tools:

(a) Fettling of metal castings involving the removal of metal.

(b) Cutting out or cutting off (not including drilling or punching back) of cold rivets or bolts from boilers or other plant or from ships.

(c) Chipping and scaling of boilers or ship's plates.

(d) Breaking or dressing of stone, concrete or slag.

Quite apart from the legal aspect of eye protection, it is obvious that we must do all possible to safeguard our eyes and to this end, every craftsman on the establishment who is likely to use grinding wheels or other appliances giving rise to possible risk is given a personal issue of a pair of approved goggles. If any other person is carrying out work where goggles should be worn they can be obtained from the Foreman or Assistant Foreman-in-charge who has a stock for issue as required.

This personal issue of goggles is an expensive matter and it is made as an earnest of our anxiety about eye injuries. We do urge everyone to co-operate to reduce the number of eye injuries to the minimum.

23. Hoists or Lifts

Every hoist or lift must be of good mechanical construction, sound material and adequate strength and be properly maintained. It must be thoroughly examined every six months by a competent person whose report must be entered in or attached to the

General Register.

Every hoistway must be efficiently protected by a substantial enclosure and landing gates, with efficient interlocking or other devices. The safe working load must be marked conspicuously on each hoist. Additional safeguards (e.g. interlocking gates for cages) must be provided on hoists used for carrying persons, whether with goods or otherwise. The requirements are somewhat less stringent in the case of hoists constructed before the passing of the Act, hoists not connected with mechanical power, and continuous hoists.

Every teagle opening or similar doorway used for hoisting or lowering goods must be fenced (except when the hoisting or lowering is going on at that opening) and be provided with a hand-hold on each side of the opening. (Section 22, Section 11, 1948).

24. Chains and Ropes and Lifting Tackle
(Also see pages 6.1-6.2 of this Handbook)

No chain, rope or lifting tackle used for raising or lowering persons or goods may be used unless it is of good construction, sound material and adequate strength and free from patent defect. Tables of safe working loads must be posted in the stores and elsewhere but need not cover any lifting tackle the safe working load of which is marked on the tackle itself. Chains, ropes and lifting tackle in use must be thoroughly examined by a competent person every six months and must not (excepting fibre ropes and fibre rope slings) be taken into use for the first

time in the factory unless they have been tested and certified.

Periodic annealing is required except in the case of ropes and rope slings and other tackle exempted by the Chief Inspector.

A register of all chains, etc. and also the certificates of tests, must be kept. (Section 23).

25. Cranes, etc.

All parts and working gear (including anchoring appliances) of cranes and other lifting machines must be of good construction, sound materials and adequate strength and must be properly maintained. A thorough examination of all such parts by a competent person must be made every fourteen months. A lifting machine must not be taken into use for the first time in the factory unless it has been tested and certified. A register of examinations and tests must be kept. The safe working load or loads must be shown on every lifting machine; in the case of cranes with a derricking jib an automatic indicator or a Table of safe working loads must be attached to the crane.

Rails and tracks of travelling cranes and transporters must be of proper size and construction. If any person is working near the wheel-track of an overhead travelling crane steps must be taken to ensure that the crane does not approach within 20 feet. (Section 24).

26. Construction of Floors, etc.

Floors, passages, gangways, steps, stairs and ladders must be soundly constructed and

properly maintained and handrails must be provided for stairs. (Section 25).

27. Precautions against falls

So far as is reasonably practicable, there must be provided (i) safe means of access to every place at which any person has at any time to work, and (ii) fencing or other means for ensuring the safety of any person who is to work at a place from which he would be liable to fall more than ten feet and which does not afford secure foothold and, where necessary, secure hand-hold. (Section 26).

28. Precautions against Gassing

(Also see pages 10.1-10.5 of this Handbook).

Special precautions are laid down for work in confined spaces where men are liable to be overcome by dangerous fumes. (Section 27, Section 11 (2) [1948]).

29. Explosions of Inflammable Dust or Gas

(Also see pages 10.1-10.5 of this Handbook).

Precautions against explosion are laid down for certain processes and for welding or soldering on containers which have held any explosive or inflammable substance. (Section 28. Section 11 (4) [1948]).

30. Steam Boilers, Steam Receivers, etc.

Every part of every steam boiler and steam receiver must be of good construction, sound material, adequate strength and free from

patent defect. Detailed requirements are laid down as to the valves and other fittings. The outlet of every steam container must at all times be kept open and free from obstruction.

Steam boilers and steam receivers and their fittings must be properly maintained and must be throughly examined by a competent person. In the case of boilers every fourteen months and after extensive repairs, and in the case of steam receivers every 26 months. A report of each examination must be attached to the General Register. New or second-hand boilers must be certified or examined before being taken into use. (Sections 29, 30 and 32).

31. Air Receivers

Every air receiver and its fittings must be of sound construction and properly maintained. Detailed requirements are laid down as to the fittings.

Air receivers must be thoroughly cleaned and be examined or tested by a competent person, every 26 months and a report entered in or attached to the General Register. In some cases a longer period is allowed. (Sections 31 and 32).

32. Notification of Accidents and Dangerous Occurrences

Accidents causing loss of life or disabling a worker for more than three days from earning full wages at the work at which he was employed must be reported forthwith to the District Inspector and entered in the General Register. Certain dangerous occurrences must also be reported whether disablement is caused or not,

e.g., the bursting of a revolving vessel, wheel or grindstone moved by mechanical power, the collapse or failure of a crane, hoist or other lifting appliance, or any part thereof (except the breakage of chain or rope slings), or the overturning of a crane; and explosions or fires in certain circumstances. (Sections 64 and 65).

33. Duties of Persons Employed

Section 119 of Factories Acts 1937 and 1948

(1) No persons employed in a factory or in any other place to which any provisions of this Act apply shall wilfully interfere with or misuse any means, appliance, convenience or other thing provided in pursuance of this Act for securing the health, safety or welfare of the persons employed in the factory or place, and where any means or appliance for securing health or safety is provided for the use of any such person under this Act, he shall use the means or appliance.

(2) No person employed in a factory or in any other place to which any provisions of this Act apply shall wilfully and without reasonable cause do anything likely to endanger himself or others.

In addition to Section 119, there are some 50 codes of regulations published As Statutory Rules and Orders which set out safety requirements for particular processes and also include duties of employees so far as they concern, for example, the use of protective equipment and clothing provided; no smoking and no naked

lights in areas where the fire or explosion risk renders this necessary; access to certain areas not allowed except to authorised persons e.g. switchboards having bare electrical conductors etc.

Any person in doubt about any particular aspect or safety precaution necessary should see his Supervisory Officer who will, if necessary, get into touch with the Safety Officer to ensure that a safe system of work is established.

ILLUSTRATION NO.1 - PORTON FULL FACE MASK FITTED WITH D/8/41 FILTER

SUITABLE FOR:- Poisonous and active dusts such as Beryllia, Uranium Oxide and dusts associated with Fission Products.

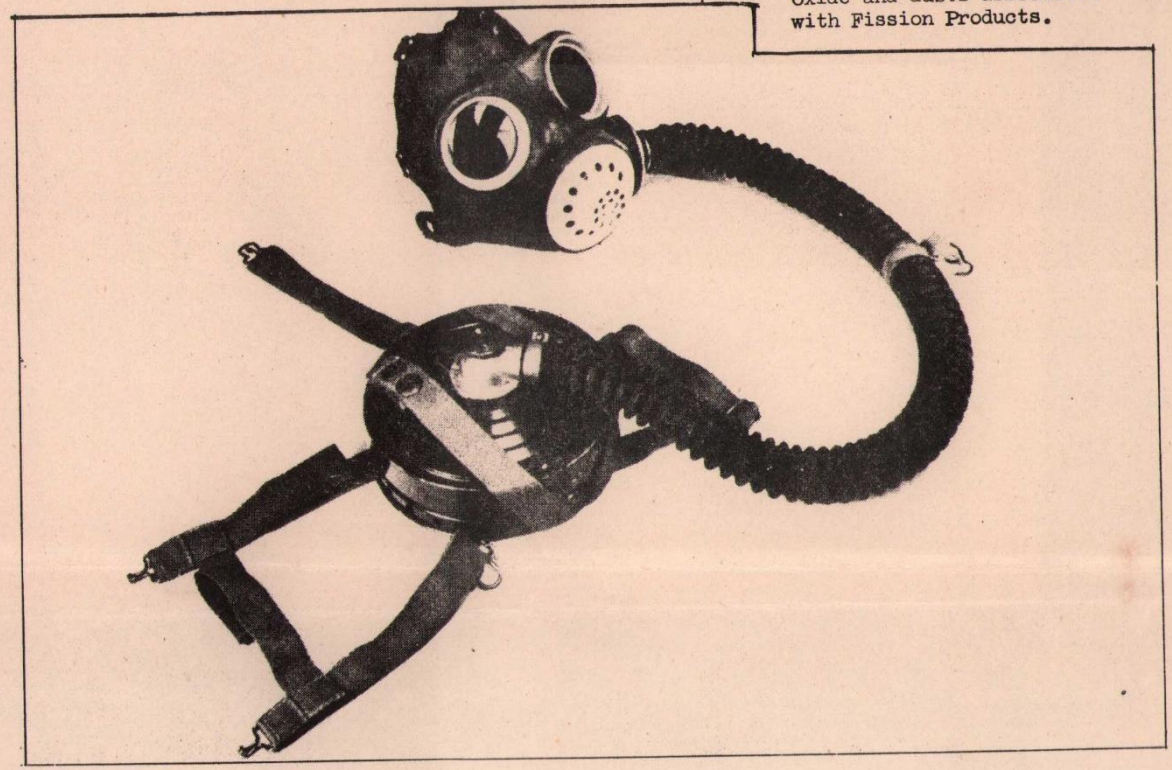

ILLUSTRATION NO.2 - MARK IV AND PYRENE DUST RESPIRATORS.

SUITABLE FOR:- Nuisance dusts only such as coal or cement dusts etc.

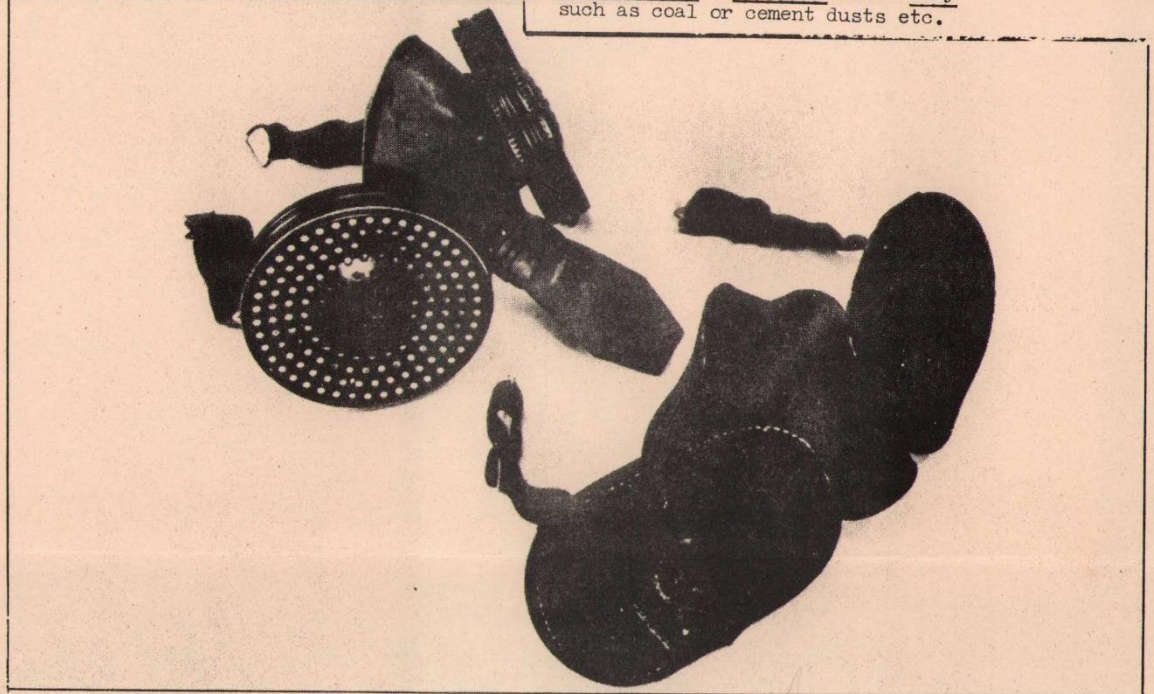

ILLUSTRATION NO.3 - PAINT SPRAY RESPIRATORS

SUITABLE FOR:- Vapours and fumes associated with the spraying of cellulose and other paints.

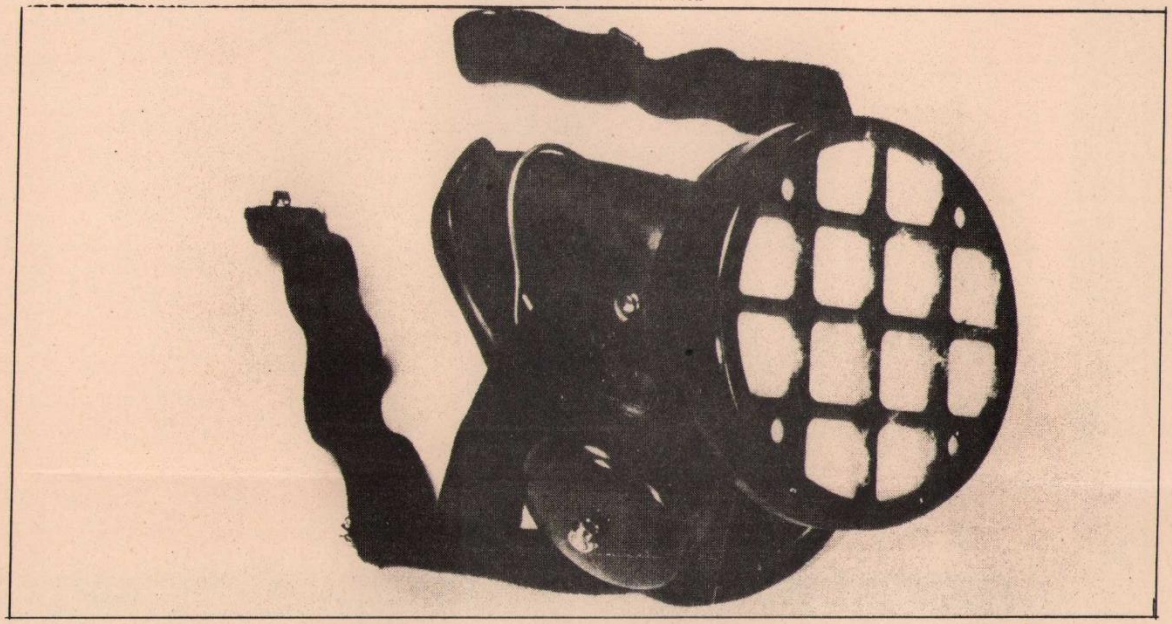

ILLUSTRATION NO.4 - GAS (CANISTER TYPE) RESPIRATORS

SUITABLE FOR:- Wide variety of gases, fumes and vapours providing the appropriate canister is fitted.

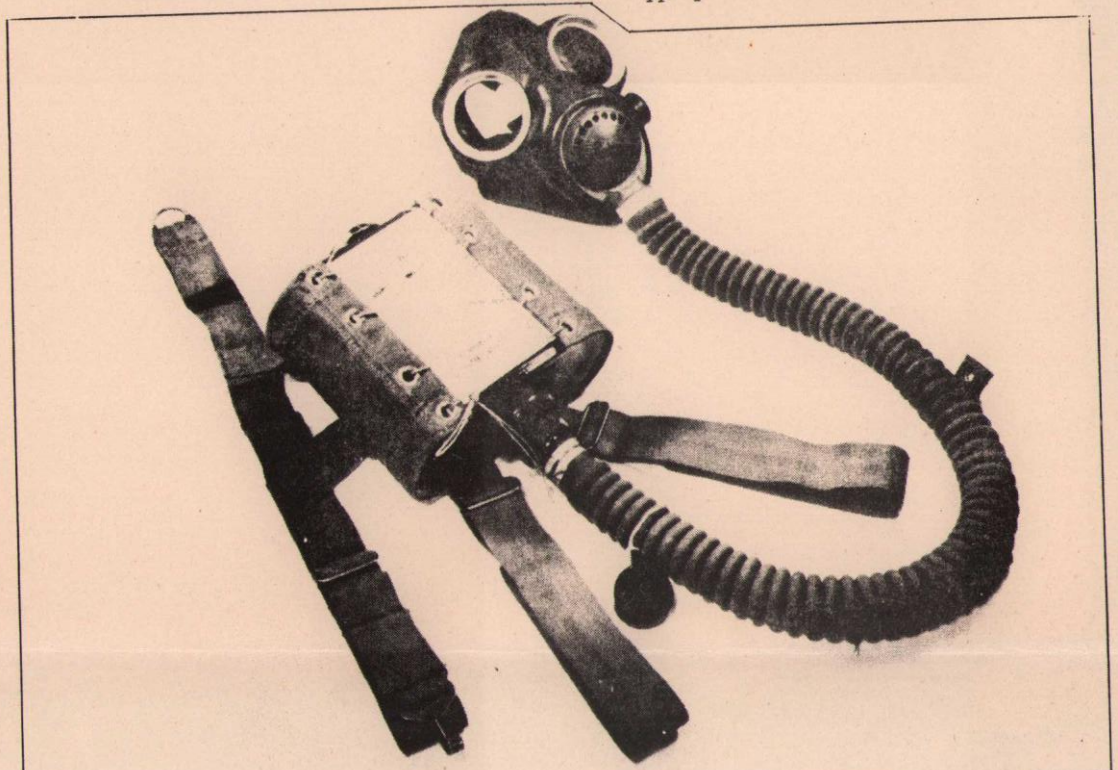

ILLUSTRATION NO.5 - SELF CONTAINED (OXYGEN) BREATHING APPARATUS

SUITABLE FOR:- Emergency repair or rescue work where the canister type of respirator cannot be used, such as in enclosed spaces, tanks etc. or where an unusually high concentration of gas, or lack of oxygen is involved.

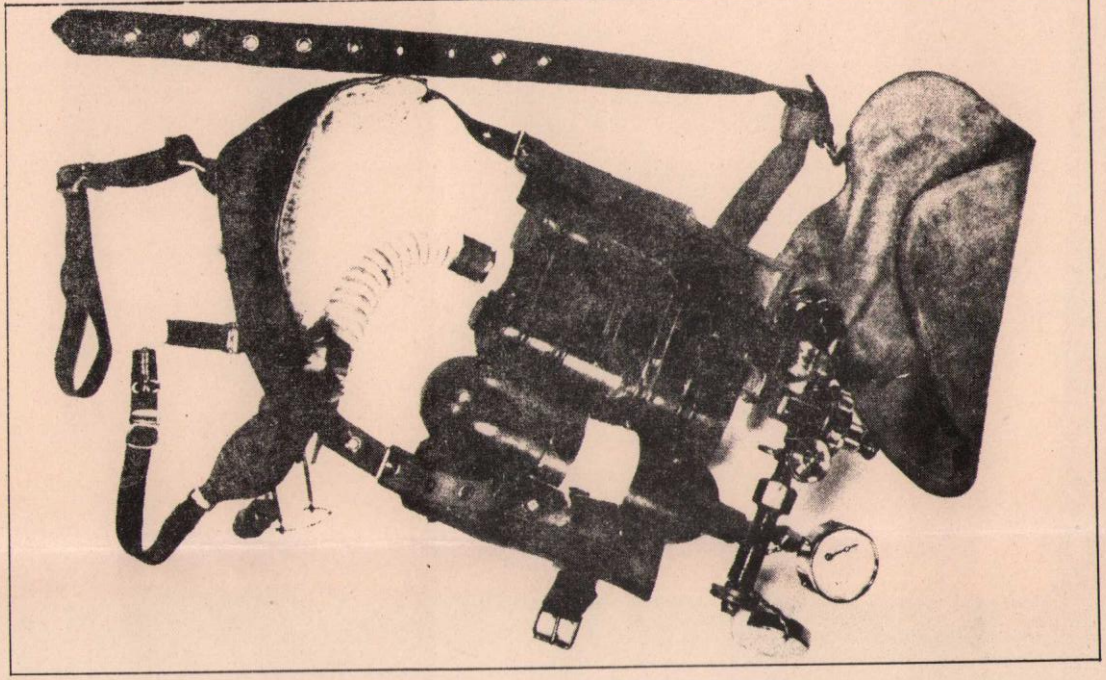

ILLUSTRATION NO.6 - COMPRESSED AIR BREATHING APPARATUS

SUITABLE FOR:- All conditions where a compressed air supply is available. Should be used in preference to all other types.

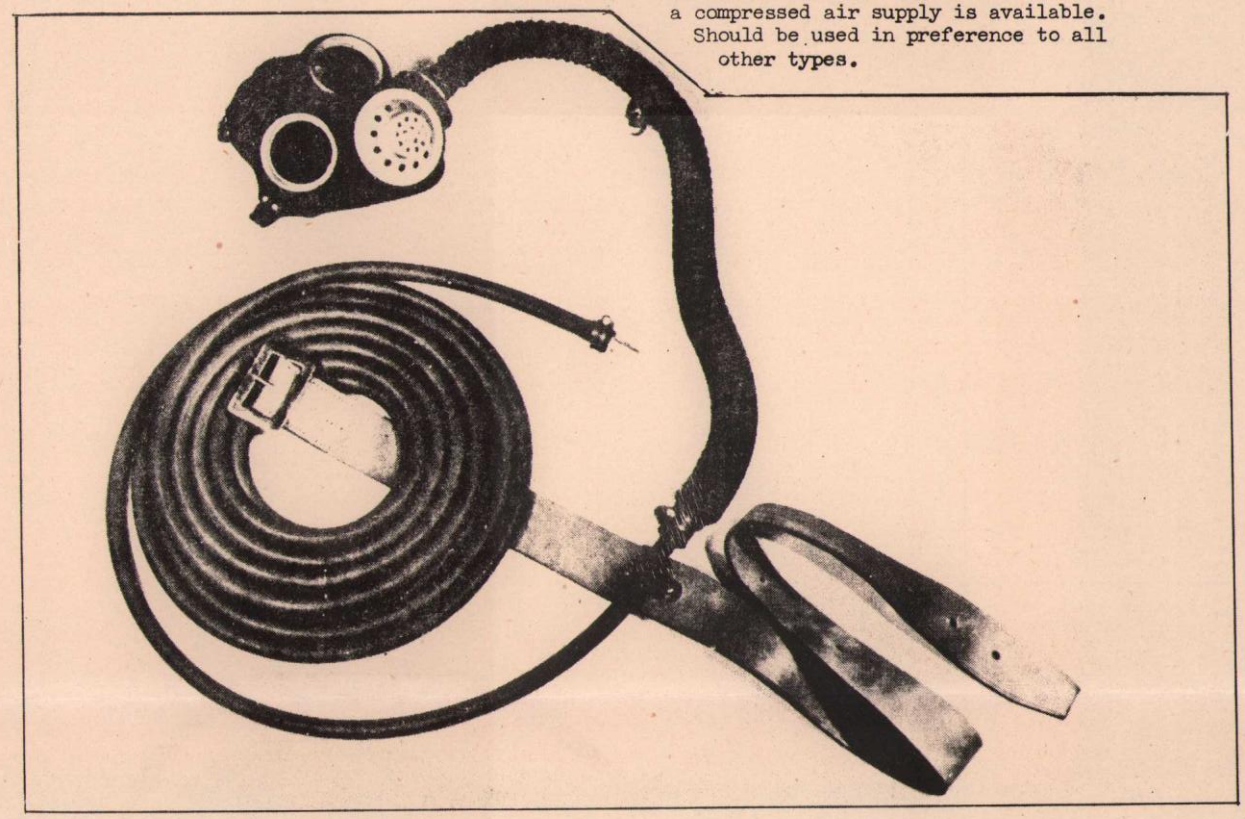

ILLUSTRATION NO. 7 HARWELL AIR HOOD

ILLUSTRATION NO. 8 HARWELL AIR HOOD