

SAFETY

HEALTH

WELFARE



A GUIDE TO THE SAFE USE OF MOLTEN SALT BATHS



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1. INTRODUCTION

The use in industry of molten salt baths for the heat treatment of metals is an important process with a number of unique advantages. Depending on the nature of the salt used, the bath may be simply a heat transfer medium (e.g. nitrate tempering treatments, chloride austenitizing baths) or a high temperature chemical processing system (cyanide treatments) where reactions within the bath and at the surface of the treated part result in fundamental structural changes in the part with, in particular, enhancement of surface hardness and wear resistance.

The main types of salt baths may be summarized as follows:

- 1.1 Baths containing molten alkali metal nitrates or a mixture of these with their nitrites are often used where temperatures in the range 320°F - 1022°F are desired, e.g. in the austempering, martempering or normal tempering of carbon and alloy steels and in the heat treatment of a range of aluminum alloys. Nitrate salt baths have also found application in the vulcanization of rubber, and in burning off polymer residues from extrusion dies in synthetic fibre manufacture. It is important that the temperature of molten nitrate salts should not be permitted to exceed 1022°F since, at temperatures not far above this point, nitrates will decompose with liberation of oxygen, and this reaction may occur with extreme explosive violence.
- 1.2 Molten cyanide baths are used for producing a hard surface case on parts subject to wear. The composition of these baths and their operating temperature (in the range 1472°F - 1742°F) are the two factors which determine the depth and nature of the case.
- 1.2 Baths containing molten chloride salts are used in various tempering processes or as neutral rinse baths to remove adhering cyanide or nitrate salts while maintaining the work at high temperatures. Typical operating temperatures are 1292°F - 2012°F.

Factors such as even and rapid heating of the work piece and protection from atmospheric oxidization and sealing both during and after treatment, molten salt baths have unique advantages over other processes.

1.4 Scope of the Code

This Code lays down the safety rules to be observed in any process in which ferrous or non-ferrous metals and sometimes other materials such as rubber, are heat treated in baths which contain molten salts. The most common form of accident involving salt baths results from spattering of molten salt when moisture enters the bath in some manner. In addition, the use of cyanides involves an obvious toxicity hazard and violent explosions due to overheating and decomposition of nitrate salts have also occurred.

While the Code is primarily concerned with the prevention of accidents due to the above three hazards, it also establishes requirements for bath construction, maintenance, location and heating and sets out safety rules to be observed by persons engaged in the process and precautions necessary for the safe handling, storage and disposal of the various types of salts. Modern first aid treatment of cyanide poisoning is also discussed.

1.5 Hazards Involved in Salt Bath Heat Treatment Processes

The potential hazards connected with the use of salt bath are:

- 1.5.1 Explosive generation of steam due to water or moisture being inadvertently introduced into the molten salt.
- 1.5.2 Overheating and eventual explosive decomposition of nitrate salts at temperatures above 1,112°F.
- 1.5.3 Explosive reactions between molten nitrates and aluminum or magnesium alloys under certain conditions.
- 1.5.4 Molten nitrates and cyanides may decompose explosively if mixed together.
- 1.5.5 Production of highly toxic hydrogen cyanide gas from reaction of acids or water (under certain conditions), with cyanide salts.
- 1.5.6 Fires caused through the hot molten salts coming into contact with combustible materials.
- 1.5.7 Burns resulting from contact with the molten salt. These are especially hazardous when caused by molten cyanide since absorption via body tissues can lead to fatal poisoning.
- 1.5.8 Accidental ingestion of cyanide salts.
- 1.5.9 Gassing caused by inhalation of fumes given off in the heat treatment process.
- 1.5.10 Salt flows as a result of leakage or bath failure. These hazards are discussed more fully in Section 8.

2. DEFINITIONS

2.1 Salt Bath

The receptacle containing the salts (or mixtures of salts) which when heated melt to form a liquid medium for heat treatment processes.

2.2 Catch Pit

A pit or other receptacle placed beneath the salt bath and capable of containing the total salt contents if bath failure should occur.

2.3 Heat Treatment Terms

- 2.3.1 Case-hardening: The production of a thin file-hard case on steel surfaces heated in molten cyanide salts and subsequently quenched. The case is formed by the absorption of both carbon and nitrogen from the salt. The chemical composition of the bath determines whether the bath is predominantly carburizing or nitriding with respect to the steel surface.
 - 2.3.1.1 Carburizing is the impregnation of steel surfaces with carbon and small amounts of nitrogen to improve strength and resistance to wear.
 - 2.3.1.1.1 Nitriding is an analogous impregnation with nitrogen and very small amounts of carbon to improve strength, wear resistance and anti-galling properties.
- 2.3.2 Austenitizing: A process in which steel is heated to a temperature above that at which the austenite crystal structure of iron begins to form and held at the temperature until this formation is complete. If the process is carried out in a salt bath, a neutral chloride bath is used at temperatures in the range of 1,292°F ó 1,652°F.
- 2.3.3 Tempering: The heating of previously hardened steel to a temperature below the austenite transformation range and cooling at a suitable rate, primarily to increase ductility and toughness.
- 2.3.4 Austempering: A process involving the heating of an alloy steel above the austenitizing temperature followed by quenching at a constant temperature between 500°F ó 716°F and cooling to room temperature in air.
- 2.3.5 Martempering: The process involves quenching in a nitrate salt bath from the austenitizing temperature to a temperature in the upper part of the range for the formation of the martensitic crystal structure of steel (464°F ó 698°F depending on the type of steel) and holding in the molten salt medium until the temperature throughout the part is uniform. The work is then cooled slowly in the air.

3. STORAGE OF SALTS

3.1 General Provisions

The room in which the salts are stored should be kept dry and clean. No smoking shall be permitted in any such storage area and a suitable sign should be displayed to indicate this.

3.2 Containers

All Salts should be stored in appropriately labeled containers which are moisture-proof.

3.3 Placement of Nitrates in Storage

Nitrates should be stored in places remote from easily oxidizable materials and away from steam pipes, radiators or other sources of direct heat.

3.4 Special Provisions for Nitrate Containers

Where practicable, all containers used for storing nitrate salts shall be constructed of non-combustible material.

3.5 Placement of Cyanides in Storage

Cyanides should not be stored together with nitrates and acids or acidic materials **MUST NOT** be allowed to come into contact with cyanide salts. The cyanide store shall be locked and in the charge of a responsible person.

3.6 Handling and Transferring of Cyanides

Cyanide containers should be opened only in the room in which the salt is to be used. Dry gloves should be worn whenever cyanide salts are handled and a scoop is recommended for transference of the salts.

4. PROVISIONS RELATING TO PREMISES

4.1 Location and Isolation of Salt Baths

Salt baths shall preferably be located at ground-floor level. If on an upper level, a bath should be placed on a suitable strengthened concrete floor. Where practicable, the section containing the salt baths shall be separated from other sections of the workplace by means of fire-resisting walls, ceilings and doors, and shall be reserved exclusively for the heat treatment process.

4.2 Accidental Entry of Water

Provision shall be made to ensure that water cannot accidentally enter a salt bath from water pipes, steam pipes, leaky roofs, or as a result of condensation from overhead or from other sources. Fire sprinkler systems shall not be fitted in heat treatment areas containing salt baths.

4.3 Flooring

The floor area under and around every salt bath shall be constructed of concrete or other suitable non-combustible material and shall be kept free of any obstruction likely to cause tripping or slipping hazards.

4.4 Adequate Working Space

In rooms where one or more salt baths are situated, the baths shall be so placed as to provide adequate working space in the vicinity of each bath for every person working in that part of the premises.

4.6 Nitrate Salt Spillages

The surface of the floor shall be kept clean and any spillages or splashes of molten nitrate salts shall, when cold, be removed promptly by sweeping or other suitable means.

5. CONSTRUCTION OF BATHS AND ACCESSORIES

5.1 General Requirements

Every heat treatment bath for use with molten salts shall be of sound construction and without obvious points of weakness in design. In particular, it is recommended that integral joints and corners be rounded off so as to limit the possibility of local heating at right-angled edges. Where heating is by means of gas or oil firing, the combustion chamber of the bath shall be lined with a suitable refractory.

5.2 Bath Covers

- 5.2.1 For new baths, the provision of suitable sliding or hinged and counter-balance covers shall be included in the general bath design. These covers shall be of non-combustible material and should be fitted into guides provided with stops to ensure that they cannot inadvertently be removed from the guides and allowed to fall into the bath. The covers should be in place whenever the bath is not in use, and in particular during the heating up and melting of solid salts. It is recognized that for existing baths the provision of lids may not be practicable, but if at all possible they should be provided.
- 5.2.2 If a bath containing molten salts has its edge less than 1 metre above the adjoining floor or platform, it is mandatory to provide a lid or otherwise enclose the area so as to prevent any person from falling into the bath.

5.3 Catch Pits

- 5.3.1 It is recommended that salt baths be provided with catch pits capable of containing the contents of the bath in the event of any leakage occurring. If molten salts can be contained within the furnace structure without coming into direct contact with the heat source or with any combustible material, then the provision of a catch pit would not be necessary. For large baths it will normally be impractical to provide a catch pit; for this situation provision should be made to channel leaking salts to a safe area free of combustible material where they can solidify.

- 5.3.2 If a catch pit is common to a series of baths containing different salts, then the pit must be divided by non-permeable and non-combustible rigid material to stop the possible mixing of molten nitrates and cyanides.
- 5.3.3 An adequate amount of dry sand or other suitable material should be available for restricting the flow of escaping molten salts.

5.4 Quench Baths

- 5.4.1 Every quench bath which forms part of a heat treatment process shall, where practicable, be located at a safe working distance (at least 24 inches) from any salt bath.
- 5.4.2 The level of the top of every quench bath shall be lower than that of the nearest salt bath so as to reduce the risk of splashes from the quench bath reaching the molten salts.
- 5.4.3 If either or both of provisions 5.4.1 and 5.4.2 above cannot be met, the provision of a suitable relocatable baffle or screen to eliminate the entry of quench bath water splashes into any nearby molten salt bath will be mandatory.
- 5.4.4 Flexible hoses shall not be used for filling or replenishing water in quench baths.
- 5.4.5 Provision shall be made for the safe discharge of quench bath water to a suitable drain. If the water is contaminated with cyanide salts it must be rendered harmless by chemical treatment before being discharged.

5.5 Identification

Every bath shall be clearly and indelibly marked on the outside or above it with a *sign* indicating whether nitrate or cyanide salts are present within.

6. MEANS OF HEATING

6.1 General Requirements

- 6.1.1 There shall be provided a safe means of heating every salt bath. The application of heat to the bath shall be gradual so as to ensure, as far as practicable, that excessive local temperature rises do not occur in any part of the bath which is in contact with the salt. In this regard furnace brickwork must be such that heat application to the bath is even and local hot spots do not arise.
- 6.1.2 For nitrate salt baths, the design of the heating system shall be such as to prevent accidental contact of incandescent carbon and salt within the bath.
- 6.1.3 Where heating is by means of gas or oil firing, flues shall be kept clean and free of soot and burners kept properly adjusted and maintained in serviced condition. Flue gases from furnace burners should be exhausted outside the factory well clear of air intakes.

6.2 Temperature Control and Alarm Devices

The following four provisions should be taken as applying to all types of salt baths; however only nitrate baths present an explosion hazard with respect to overheating and hence the provisions must be applied most rigorously in this case. Overheating of other baths may result in bath failure, the production of dangerous fumes, undesirable case depths in case-hardening work, and generally poor economy of operation.

- 6.2.1 Every salt bath shall be equipped with at least one efficient device by which the temperature of the molten salt is kept within safe working limits. Any such control shall operate as a thermostat or otherwise serve to cut off the heat source automatically before the upper limit of the safe working temperature is reached (see Section 1.1). All such temperature control devices shall be constructed so that they fail to safety. It is recommended, however, that the practice of installing two independent systems of temperature control in each bath should be followed; one operating as an overriding cut-out if the main control system fails. The overriding cut-out safety device should be adjustable if the bath has to be operated at more than one specified temperature and the setting of the device should always be closely related to the particular temperature at which heat treatment is to be carried out.
- 6.2.2 Where the heat control circuit fails or is interrupted, it shall remain off until the control is reset by hand. For gas or oil heated baths, a manual reset valve shall be provided.
- 6.2.3 All heat control devices shall be tested regularly to ensure that the cut-out operates effectively in the event of an emergency arising; such tests should be at monthly intervals for baths in regular use. The results of the tests shall be entered in a register which shall contain the following details: date of test, description of device tested, remarks and signature of the person conducting the test.
- 6.2.4 Every salt bath shall be equipped with an efficient audible and visual alarm device capable of giving a clear warning in the event of the temperature of the salt exceeding a safe predetermined level.

6.3 Temperature Measurement Gauge

Every salt bath shall have a suitable temperature indicator fitted in a prominent position clearly visible to the operator.

6.4 Additional Electric Heating Safeguards

Where the heating is by medium of electric current the following additional safeguards shall apply:

- 6.4.1 Each individual heating unit shall be provided with automatic excess current protection which shall operate at the smallest practicable differential. Circuit breakers are preferable to fuses as they can be selected to provide closer protection tolerance.

- 6.4.2 Electrode heating elements shall be provided with guards to protect them against accidental short circuits and the guards shall be designed so as to interfere as little as possible with the circulation and even heating of the salt.
- 6.4.3 Immersion heaters shall be capable of being easily removed for inspection and cleaning. Each immersion heater shall be fitted with a guard to prevent mechanical damage to it. All electric heaters shall be capable of being controlled to generate heat at a reduced rate during the melting period of the salts.
- 6.4.4 Every electrically heated bath shall be provided with an earth leakage indicator and earth leakage trip mechanism shall be installed so as to cut off the electrically supply when any leakage exceeds a predetermined value.
- 6.4.5 The following measurements shall be taken regularly and at least once a month while the heaters are hot and the results of the test shall be entered in a register and signed by the person conducting the examination: (a) the insulation resistance of each unit of the heaters; and (b) the ohmic resistance of each unit of the heaters.

7. GENERAL PRECAUTIONS

7.1 Instruction and Supervision of Workers

- 7.1.1 Every person required to work at or in the vicinity of, any salt bath shall be properly instructed as to the hazards connected with the process and the precautions to be taken.

Adequate supervision by a competent person shall be maintained during all stages of the heat treatment process.

- 7.1.2 In particular, where cyanide baths are in operation, all personnel involved in working with cyanides shall be thoroughly instructed in first aid for treatment of cyanide poisoning.

7.2 Cautionary Notices

A cautionary notice setting out the principal safety requirements of this Code shall be posted in a prominent place near each salt bath. A second notice detailing the procedure to be followed in the treatment of cyanide poisoning must also be displayed where cyanide salt baths are located.

7.3 Instruction of Nightwatchman

If a salt bath is set to idle overnight, nightwatchmen, if employed, shall be instructed in the supervision of the plant, in instrument reading and also in what to do in case of emergency.

7.4 Fire Hazards to be Notified

- 7.4.1 The occupier of every factory in which salt baths are installed shall notify the local Fire Authorities of their existence and location.
- 7.4.2 A precautionary warning notice ó òChemical Bath ó Introduce No Water or other Foreign Matter ó Explosion Dangerö should be displayed in prominent locations inside and outside the bath area to prevent mistakes.

7.5 Fire Fighting Equipment

- 7.5.1 A sufficient supply of dry sand shall be stored in suitable containers near salt baths to be used for fire fighting purposes.
- 7.5.2 No vaporizing liquid such as carbon tetrachloride, water, foam or aqueous extinguishing agent shall be used for fighting fires near molten salt baths
- 7.5.3 The area containing salt baths shall not be equipped with a water sprinkling system for fire fighting.
- 7.5.4 For fires at nitrate salt baths, a sufficient number of carbon dioxide or approved dry powder fire extinguishers shall be provided in the vicinity of the bath for Fire fighting purposes besides dry sand as discussed in 7.5.1 above.
- 7.5.5 For fires at cyanide salt baths, no extinguisher containing either carbon dioxide or material likely to produce carbon dioxide on heating (e.g. sodium bicarbonate dry powder) shall be used for fire fighting. Dry sand or dry powder extinguishers containing approved material shall be used.

7.6 Melting and Solidifying of Salts

- 7.6.1 If a bath is fitted with a lid, then this should be in place during melting or solidifying of salts.
- 7.6.2 When re-melting a solidified mass of salt, it is recommended that vent holes be made in the salt as it solidifies after each period of use. This can be done with steel pipes or wedges which are set in place at the time of solidification and which must not be removed until the salt is fully frozen. If an immersed electrode system is used for heating, the use of venting wedges would not be necessary.

8. OPERATING RULES

8.1 General Rules

- 8.1.1 Explosive Generation of Steam: Water must not be allowed to come into contact with molten salt of any kind. An exception to this may occur in the martempering or austempering of steel in which small quantities (ca. 1%) of water may be added to

hasten the cooling process. Vigorous agitation of the salt at the point of addition must be maintained to reduce spattering and the temperature of the molten salt bath would normally be low.

- 8.1.2 Pre-heating: No article which is moist shall be immersed in a salt bath until the article has been thoroughly dried. This applies to both the work itself and to work handling devices such as tongs and baskets. It is important to pre-heat work in a furnace before salt bath treatment since this ensures both that the articles are dry and that the work reaches the salt temperature more rapidly.
- 8.1.3 Care with Hollow Workpieces: Work-containers or tools to be used in a salt bath heat treatment process shall be made of solid materials. No container or tool made of tubular or hollow parts likely to trap air or water shall be inserted into molten salt. Work shall be immersed in the bath in such a manner that entrapped air can escape without causing danger.
- 8.1.4 Precautions in Heating Up from Cold: The person in charge of any salt bath shall, throughout the whole of the preliminary heating stages, ensure that the heat is applied gradually so that over-heating of any part of the bath does not occur. In the event of overheating, which is likely to cause damage, a thorough inspection of the bath shall be made as soon as possible thereafter.
- 8.1.5 Combustible Material Prohibited: Carbonaceous or other combustible materials, in particular wooden duckboards, shall not be permitted in the vicinity of any salt bath while it is in operation.
- 8.1.6 Condition of Salts to be Added: When it becomes necessary to replenish the supply of salt while the bath is in a -heatedøstate, the salts to be added shall be thoroughly dry and free from deleterious impurities.
- 8.1.7 Salt Residues to be Dried Out Before Re-melting: Salt impregnating the ceramic lining in certain furnaces will pick up moisture on standing. If such a furnace has stood for more than 24 hours, the lining should be dried out since moisture in the lining may cause a salt spurt. Drying out can be conveniently done with a small electric heater until the brick lining is thoroughly warmed.
- 8.1.8 Explosion Hazard from Molten Nitrate-Cyanide Mixtures: No cyanide or compound containing cyanide shall be added to a nitrate salt bath (or vice versa), either as bulk-salt or as the adhering crust on work pieces removed from a previous salt bath. To avoid unnecessary cooling of work, removal of cyanide or nitrate salts can be carried out by rinsing in a neutral chloride salt bath maintained near the appropriate temperature before transference to the next bath in the salt bath cycle.

8.2 Rules Pertaining to Nitrate Baths

8.2.1 Explosion Hazards When Heat Treating Aluminum

Aluminum and its alloys, either in bulk or in the form of chips or sludge, will react violently with nitrate salts at temperatures above 1,076°F. Furthermore, iron oxide mixed with aluminum

sludge may combine in a thermite-type reaction which will further accelerate the oxidation of the aluminum by the nitrate. Thus loose oxide scale, sludge and small metal parts should not be allowed to accumulate at the bottom of a salt bath and the temperature of the bath must be maintained below 1,022°F.

8.2.2 Precautions for Aluminum alloys Containing Magnesium

Aluminum alloys which contain more than 3% of magnesium shall not be heat treated in a nitrate salt bath at a temperature which exceeds 932°F.

8.2.1 Carbon Deposits on Work: Carbon deposits on work after carbonitriding in a cyanide salt bath should be removed before tempering in a nitrate salt bath since very toxic nitrous fumes will otherwise be produced. Rinsing in a molten chloride salt bath would resolve this problem by removing both the offending carbon deposit and also any adhering cyanide salt which might otherwise present an explosion hazard on entry into a nitrate salt bath (see Section 8.1.8).

8.2.2 Nitrous Fumes: In the event of carbonaceous material falling into a nitrate salt bath while the salts are molten, precautions shall be taken by all persons in the vicinity of the bath to avoid breathing the very toxic nitrous fumes which arise in such circumstances. Such precautions shall include the provision and operation of suitable exhaust ventilation hoods above baths. In situations where the provision of such hoods is impractical, respiratory protective equipment shall be made available; for this purpose canister respirators suitable for use against nitrous fumes may be adequate but it must be realized that both the life and the capacity to absorb fumes of such canisters is limited.

8.3 Rules Pertaining to Cyanide Baths

8.3.1 Possible Production of Hydrogen Cyanide in Case-Hardening Processes: Acids will react with cyanide salts to produce the lethal gas hydrogen cyanide. Therefore, where a heat treatment process involving cyanide salts is included in a production line for which acid pickling or similar treatment also forms part of the process, then the following precautions must be taken:

8.3.1.1 If the acid treatment occurs prior to immersion in a cyanide bath, then any acid on the work must be thoroughly removed by washing in clean water followed by drying and pre-heating.

8.3.1.2 If the acid treatment occurs after cyanide heat treatment, care must be taken to ensure removal of as much residual cyanide salt as possible from the work before immersion in acid. Since it is probably impractical to remove all salt from work containing blind holes or internally threaded surfaces, some hydrogen cyanide will be produced on acid treatment and hence all pickling baths must be fitted with efficient exhaust ventilation hoods to remove both hydrogen cyanide and acid fumes.

- 8.3.2 Decomposition of Cyanides: Cyanides will decompose at high temperatures with the production of carbonate fumes which are irritating to the nasal passages. Some hydrogen cyanide may also be produced and therefore, mechanical exhaust ventilation systems shall be fitted where practicable. If the lifting of large work parts rules out ventilation hoods, then efficient lip ventilation at the sides of the bath shall be provided.
- 8.3.3 Cyanide Burns: Burns caused by contact with hot cyanide salts should immediately be treated by washing the affected area with copious amounts of cold water to remove excess salt. This is necessary since cyanides are absorbed rapidly through exposed tissues.

9. MAINTENANCE OF SALT BATHS

9.1 Sludging

Salt baths that are in continuous use shall be sludged frequently and baths that are only used intermittently shall be sludged at regular intervals as required. Perforated metal scoops or other suitable appliances should be used.

9.2 Examination

Every salt bath which is used regularly during each working week shall be emptied, cleaned and thoroughly examined at least once in every period of six months; provided, however, that in the case of internally heated baths using immersion heaters, the examination need only be carried out at twelve-monthly intervals. The examination should include supporting and furnace brickwork. The date of examination shall be recorded along with any faults found, maintenance work done and the name of the person carrying out the inspection.

9.3 Salt Removal in Solid State

Special care shall be taken when removing used salt which has solidified in the bath to ensure that no damage is done to any part of the receptacle, heating appliances or to any other part of the bath.

9.4 Salt Removal in Molten State

If the salt mixture is in a molten state when the bath is being emptied, the following additional precautions shall be taken:

- 9.4.11 All emptying devices, receptacles and containers used for this purpose shall be made of suitable material and be of adequate strength to retain the molten salt.
- 9.4.2 Appliances which are used for emptying the bath shall be thoroughly cleaned and dried before use. All emptying devices shall be used at a safe distance from any person working in the vicinity of the bath.
- 9.4.3 No combustible materials shall be allowed to remain in the immediate vicinity while a molten mixture is being removed from the salt bath.

- 9.4.4 All persons engaged in the emptying shall wear suitable protective clothing (as specified in Section 11) while such operations continue and shall remain at a safe distance from the bath when handling molten salts.

10. DISPOSAL OF USED SALTS

10.1 Disposal of Used Nitrate Salts

- 10.1.1 Nitrate salts shall be disposed of in a safe manner after having been used. Burial of waste salt in a refuse dump may be contemplated but the area should be chosen only after consultation with the relevant local body and always with regard for the provisions of 10.1.2 below.
- 10.1.2 Used nitrate salts shall not at any stage of their disposal, be allowed to come into contact with carbonaceous or other materials under conditions where a fire or an explosion may result.

10.2 Disposal of Used Cyanide Salts

- 10.2.1 Cyanide wastes in the form of used salt from baths or contaminated quench water must be chemically decomposed before they are disposed.
- 10.2.2 Decomposition is accomplished by treating the cyanide salt in aqueous solution with an oxidizing agent, e.g. sodium hypochlorite or calcium hypochlorite (bleaching powder).
- 10.2.2 Discharge of untreated cyanide waste must be strictly avoided since, besides the obvious danger of first-degree pollution, there is also a considerable hazard in industrial areas that a nearby factory may discharge acidic waste at the same time, with the possible resulting formation of lethal hydrogen cyanide gas in sewers and drains.
- 10.2.3 Industrial waste treatment firms are the preferred agents for disposal.
- 10.2.4 Liaison with the relevant local authorities is strongly recommended with respect to the whole question of cyanide waste disposal.

11. PROTECTIVE CLOTHING AND EQUIPMENT

11.1 Provision to be made

- 11.1.1 The occupier of every factory in which a salt bath is operated shall provide each person working at the process with suitable protective clothing. Such clothing shall include an apron and a pair of gloves or gauntlets capable of covering the hands and forearms. General clothing should not be excessively bulky or such as to restrict ease of work-handling. Aluminized or heavy duty leather are suitable materials for aprons and gloves. A suitable face visor shall be provided for each worker engaged in the process; a visor of tinted glass may be preferred to shield the eyes against bright light from very hot salt of metal.

- 11.1.2 Carbonaceous or hygroscopic materials such as asbestos mill-board shall not be used as portable heat shields.

11.2 Laundry and Cleaning

The employer shall make suitable provision for the washing and cleaning of overalls and other protective clothing if such equipment becomes contaminated with salt splashes. In particular, nitrate salts should be washed out of clothing with water at regular intervals (not dry-cleaned), since if material becomes impregnated with the salts, any subsequent molten splashes which cause clothing to ignite will be made more serious by the oxidizing nature of the nitrate already present.

Splashes of cyanide salts on clothing should be washed off carefully by personnel aware of the toxicity hazards.

12. RESPONSIBILITIES OF PERSONNEL

12.1 Obligations of Employers

The employer shall ensure the following:

- 12.1.1 That the provisions of Section 7.1.1 and 7.1.2, viz. thorough instruction on process hazards and training of all personnel involved in working with cyanides in first aid for treatment of cyanide poisoning, shall be complied with.
- 12.1.2 That the first aid kit is always fully supplied with cyanide antidote and that it stays within easy reach of the heat treatment area.
- 12.1.3 That the exact chemical composition of salts supplied under a trade name only is obtained from the supplying agent.
- 12.1.4 That the registers required by Section 6.2.3 (heating cut-outs), Section 6.4.5 (electrical resistance measurements) and Section 9.2 (physical inspection)) be made available at any time to representatives of the Department of Labour, Electrical Supply Authority or other inspecting authority as the case may be.

12.2 Obligation of Workers

- 12.2.1 ALL PERSONS WHO WORK AT A MOLTEN SALT HEAT TREATMENT PROCESS SHALL WEAR THE PROTECTIVE CLOTHING AND EQUIPMENT PROVIDED FOR THEIR USE AT ALL TIMES WHILE THEY ARE WORKING IN THE VICINITY OF A SALT BATH.

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