Draft Indian Standard

CODE OF PRACTICE FOR DESIGN, CONSTRUCTION, INSTALLATION AND OPERATION OF INDUSTRIAL GAS/OIL BURNING EQUIPMENT

(First Revision)

1 SCOPE

1.1 This standard sets out safety principles related to the design, installation and operation of industrial appliances that involve the combustion of gas, oil or other fuel in air suspension, or the generation of combustible vapours in such appliances.

1.2 Relationship with Regulations — The requirements of this code should be read in conjunction with any Statutory Regulations that may apply in any area.

1.3 New Designs, Innovations — Notwithstanding the specific requirements of this code, any new materials, designs, techniques, methods of assembly, etc. which give equivalent results to those specified may be considered for acceptability.

2. REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
IS 3043 : 2018	Code of practice for earthing (Second Revision)

3. DEFINITIONS

For the purpose of this code, the following definitions shall apply.

3.1 Appliance — Industrial-type equipment, irrespective of application or location, used to apply heat to objects or materials or to produce a special atmosphere.

3.2 Approval, Approved — With the approval of acceptable to, and meeting the prescribed standards of, the authority having jurisdiction.

3.3 Authority, Authority having Jurisdiction — The authority having statutory (legal) control of the subject installation.

3.4 Critical Energy — The maximum potential energy in the form of unignited fuel which may be introduced into an appliance before a potentially hazardous level is reached.

3.5 Critical Time — The time required to accumulate unignited fuel in such quantity and proportions that, if it were ignited, the pressure of the resultant explosion would constitute a hazard.

3.6 Dilution — The supply of fresh air or other suitable diluent, and its circulation, distribution and exhaust to outside atmosphere, with the purpose of diluting flammable vapours or dusts to concentrations that are below the lower explosive limit (LEL).

3.7 Duct — Taken to include:

a) any passage that leads gases from an external combustion chamber to the appliance;

b) any passage that introduces ventilating air;

c) any passage that recirculates air or gases, either external to or as an integral part of the appliances; and

d) any exhaust for process products, vapours or dusts.

3.8 Flame Simulation — A false signal indicating that the flame is present when in fact no flame is present.

3.9 Flue — A duct used to remove products of combustion lo the outside atmosphere after then-

purpose has been fulfilled.

3.10 Fresh Air — Air which, at the point of usage, is essentially free from solid particles, fibres, liquid droplets, or gaseous contaminants.

3.11 Installer — A person or organization who undertakes the responsibility of making the installation, and not an individual tradesman employed by the installer.

3.12 Interlock — A device which makes the operation of an item of equipment dependent of the fulfilment of predetermined conditions by any other item of equipment.

3.13 Lockout — A condition in which the device under consideration has been turned off and can be restarted only after an initial manual action.

3.14 Purging — The use of air or inert gas to remove and replace a potentially dangerous atmosphere.

4. AUTHORITY, RESPONSIBILITIES, GENERAL PRESCAUTION

4.1 Statutory Requirements — Appliances shall not, when installed, contravene the requirements of any Statutory Authority which may be applicable; for example, factory or machinery safety, electricity, gas, health, water supply, sewerage and drainage.

4.2 Qualifications of Staff — Installation, maintenance and operating staff shall be trained for their particular functions and shall be licensed, or other- wise authorized, under the terms of any Statutory regulation which may be applicable.

4.3 General Safety — The design, installation and operation of any appliance should be such as to permit compliance with the provisions of any applicable regulations.

4.4 Alternations, Extensions, Repairs — It shall be the responsibility of the owner to ensure that any alterations or repairs to any appliance or associated equipment do not render the installation hazardous or otherwise unacceptable to the Statutory Authority.

5. DESIGN AND CONSTRUCTION

5.1 General Design

5.1.1 *Expansion* — The appliance together with conveyors and other equipment shall incorporate where necessary provisions to prevent damage resulting from thermal expansion and contraction.

5.1.2 *Ladders or Steps* — Any ladder or step which may be needed to reach valves or other operating controls on the appliance should be an integral part of the appliance.

5.1.3 *Protection of Equipment* — Guard, rails, or equivalent protection shall be provided where necessary to protect controls and equipment from damage or Prom alternation of settings by traffic, mechanical equipment, and the like.

5.1.4 *Accumulations Within Cavity Walls* — Cavity walls in an appliance structure, whether or not they contain insulating material, shall be so designed that condensible products of combustion or flammable gases and vapours cannot accumulate within them.

5.1.5 *Support of Insulation* — Adequate supports shall be provided to prevent the settling of, or the occurrence of voids in, insulating materials.

5.1.6 *Electrostatic Earthing* — Where there is any danger that static electric changes may cause an explosion, provision shall be made for electrical bonding and earthing in accordance with IS : 3043-2018.

5.1.7 *Belt Drives* — Belt drives that are used in proximity of flammable fuel/air mixtures, vapours, or dusts should be of the antistatic type.

5.1.8 *Strength of Doors* — The strength of fasteners and mountings of doors and covers over access ports or opening shall be sufficient to ensure that explosion pressures will not cause them to open before explosion reliefs operate unless the doors or covers themselves form part of the designed explosion relief.

5.1.9 *Prevention of Accidental Fires* — An appliance shall be so designed, and in particular heating means shall be so located, that accumulations of combustible waste or similar material on a scale likely to cause accidental fires are prevented.

5.1.10 *Free Circulation* — Shelves, loading arrangements, and internal design generally shall be such that the circulation of dilution air, the exhaust of vapours, and purging, are not impaired.

5.1.11 *Adjusting Devices* — Any appliance adjusting device that affects the safety of the appliance shall be so designed that:

a) it may be readily and conveniently reset as required;

b) it is, if important to the safety of the equipment, protected against unauthorized interference;

c) it is not upset by temperature changes;

d) it is not susceptible to sticking or seizing under normal conditions of use; and

e) it incorporates locking or holding arrangements which are sufficiently positive to prevent subsequent movement through accident, vibration, or expansion; the tightening of any such locking devices shall not significantly alter any setting.

5.1.12 *Inlet Guards* - Any inlet outside the appliance shall be protected by a screen, and shall be so guarded or so located that it is not likely to be obstructed.

5.2 Appliance Heating and Fuel Systems

5.2.1 *Fuel Shut-off* — A means for quickly shutting-off the flow of fuel shall be fitted adjacent to each burner, and shall be so located that it is readily accessible at all times. If access may be prevented in the event of fire, explosion, or other emergency, another shut-off shall be provided in a safe location.

NOTE — Any arrangement that shuts-off the internal valves of a burner would comply with this requirement.

5.2.2 *Manual Ignition Equipment* — Any manually inserted gas torch shall be connected by means of approved flexible tubing which shall be of the minimum length for the purpose. Where extended distances occur between burners, two or more lighting torches shall be used. Torches of the oil soaked type shall be of a metal rod, with provision for securing the absorbent material to the rod and a safe quenching pot shall be provided.

5.2.3 *Gas Piping and Components* — Gas piping, fittings and components that form part of the appliance shall comply with the requirements of the Authority.

5.2.4 *Fuel Supply* — Fuel supply installations shall comply with the Authority's requirements.

5.2.5 *Solid Fuel Systems* — Systems for handling, preparation and supply of powdered or pulverized solid fuel shall be so designed that the possibility of uncontrolled ignition or explosion of the fuel within the supply system is minimized.

NOTE — The hazards resulting from residual fuel contained within the fuel-handling system after shut-down require particularly close attention, and procedures to clear out this residual fuel, or render it inert, or prevent the generation of volatiles in stationary fuel in hot bunkers and handling equipment, must be arranged and enforced.

5.2.6 *Hot Fluid Heating Systems* — Elements, radiators, etc, containing heated fluids shall be designed to withstand the maximum temperatures and pressures to which they are likely to be subjected.

5.3 Materials

5.3.1 *Specifications* — Material used in the construction of an appliance shall comply with the relevant Indian Standard, or an appropriate acceptable standard if no Indian standard exists. Alternative materials or components shall not be used without specific approval.

5.3.2 *Suitability* — Material used in the construction and installation of an appliance shall be suitable for the conditions of use. In particular:

a) material used to convey fuel shall be compatible with the particular fuel,

b) insulating material shall be suitable for the temperature and other conditions of the particular application, and

c) material shall be subject to heat or corrosion to ensure acceptable equipment life.

5.3.3 *Combustibility* — Materials used in the construction of an appliance should be essentially non-combustible. Where the use of combustible materials is unavoidable, they shall not be used in applications in which their temperature could exceed 70°C. In any case, ladders, steps, walkways, handrails and the like shall be of non-combustible material.

5.4 Ducts

5.4.1 *Construction* — Ducts shall be of adequate strength and rigidity, sufficiently braced and supported, and adequately protected from mechanical damage to meet the normal conditions of operation.

5.4.2 *Joints* — Where leakage from or air induction into a duct is unacceptable, for example, where a duct is carrying volatile or toxic materials, the joint shall be sealed in a manner and with materials suitable to the conditions of the applications. The assembly of a lap joint in relation to the direction of flow should ensure induction into, in preference to leakage from, the duct. No part of the duct system shall depend on soft solder for mechanical strength.

NOTE — Where condensation may occur in a vertical or sloped duct, the direction of the lap of the joint and the sealing should be so arranged that leakage is prevented.

5.4.3 *Cleaning* — Duct used to convey materials in suspension that may settle or form deposits shall incorporate provision for cleaning.

5.4.4 *Condensation Provisions* — The design of any duct shall be such that any vapours that condense in it, do not drip back into an area where they could create a hazard. Means shall be provided to collect any deposit in a trap which can be periodically cleaned.

5.4.5 *Dampers* — Duct dampers that affect the volume of fresh air admitted to and the volume of vapours or gases exhausted from an appliance shall be so designed or so interlocked with the heat

input system that unsafe accumulations of volatiles cannot occur, and heating cannot be initiated unless the dampers are in a safe operating position.

5.5 Safety of Personnel

5.5.1 *Working Inside Appliances* — Where any operator is required to enter a potentially hazardous location in the normal course of his duties, means under the sole control of that operator shall he provided to prevent the hazard from causing injury to the operator, and provision shall be made for the purging of any potentially hazardous atmosphere before entry of personnel.

5.5.2 *Door Handles* — Any door which may be used as an entry for personnel shall be so designed that it may be opened from both inside and outside.

5.5.3 *Burns Injury* — The method of ignition and the location of burner controls shall not render the operator liable to injury or burns while carrying out the lighting procedure. Door handles or knobs shall be designed to obviate accidental contact with hot surfaces. Handles, removable parts of components, shelves, racks, and the like, shall have no sharp points or edges of a nature likely to cause injury. Inspection ports shall be designed to avoid injury.

5.5.4 *Projections* — Appliances shall be so designed that projection of a nature likely to cause injury to personnel are adequately guarded.

5.5.5 *Explosion Reliefs* — Any explosion relief, vent or closure shall be designed and located on the appliance so as to facilitate compliance with **8.3.5.**

5.6 Operating and Maintenance Provisions

5.6.1 *Control Equipment* — Controls and indicating devices shall be sufficient to provide complete control of the appliance, and those that require frequent observation or manipulation should be in convenient locations. In particular,

a) gauges and meters should be at a convenient viewing level, well illuminated and free from glare or reflections;

b) where direct access to controls from floor level is not possible, remote control devices should be provided in preference to steps;

c) method of operation and direction of motion of manual controls should comply with accepted practice and with any applicable standards or regulations; and

d) controls should be located and arranged to facilitate operation in an orderly sequence.

5.6.2 *Manual Ignition* — An appliance requiring manual ignition shall be so arranged that the operator can simultaneously operate the fuel valve, initiate ignition, and observe the flame.

5.6.3 *Visual Flame Checking Provisions* — Facilities for visually checking the flame shall be provided as follows:

a) It shall be possible for an operator to ensure visually, safely, and at any time that a burner or pilot is alight. Reflected glare would be considered to be adequate for this purpose.

b) It shall be possible for maintenance or adjusting personnel to view a flame, either by direct sight or by means of a remote viewing device equivalent to direct sight. The removal of a panel or part to facilitate viewing is permissible provided that there is no hazard involved.

5.6.4 *Test Facilities* — Any equipment that incorporates sequential start up shall be so designed that with the main heat system locked out, all operations prior to the initiation of main heat or main flame can be initiated for the purpose of checking.

5.6.5 *Removable Components* — Designs that require the removal or dismentling of panels or components during routine operation should be avoided. Where unavoidable, their design should be such that replacement does not require undue force, and incorrect replacement is either impossible or completely obvious.

5.6.6 *Special Tools* — The use of special tools for operating or maintaining equipment should be avoided. Where unavoidable, the special tool shall be provided by the manufacturer.

5.6.7 *Cleaning* — Interior surfaces and auxiliary equipment, such as, conveyors, racks, shelves, baskets, and hangers should be finished, smooth and designed to facilitate cleaning.

5.6.8 *Maintenance Safety and Convenience* — Each appliance should be so designed and constructed that its maintenance may be carried out safely and conveniently and without undue risk of damage or incorrect replacement of component parts. Particular attention should be paid to the following:

a) Isolation of fuel and power sources;

b) The safety of such maintenance operations as may need to be made when the equipment is operating;

c) The design of access panels for control equipment, so that their opening or removal cannot cause wiring or piping connections to be stretched, kinked, or otherwise damaged; and

d) The design or marking of handles, pointers, knobs, or spindles, such that incorrect re-assembly after dismentling is prevented.

5.7 Explosion Relief and Damage Protection

5.7.1 *General* — Explosion reliefs complying with the requirements of this standard shall be provided in accordance with the conditions specified in **6.2.4** or **7.1.3**, and where required by the Authority.

5.7.2 *Operation* — The design of an explosion relief, its effective vent, area, closure and location shall be such that under the worst attainable conditions of explosion, the products of combustion of the explosion can be so relieved through the explosion vent that the pressure within the appliance is below the level which will cause damage sufficient to endanger personnel.

5.7.3 *Relief Location* — The location on an appliance of any explosion relief should be chosen to ensure its optimum effectiveness; for example, it should be:

a) as close as practicable to any potential source of ignition;

b) facing the; direction of flow of products of combustion;

c) so located that shelves, racks of similar obstructions do not impair the flow of explosion products and

d) so located on the appliance as to' facilitate compliance with **8.3.4.**

5.8 Temperature Hazards

5.8.1 Components Floors, Walls — The temperatures given in Table 1 shall not be exceeded when the appliance has been operated at maximum thermal input rate in such conditions and for a sufficient time as to allow surrounding materials to reach equilibrium temperature.

TABLE 1 MAXIMUM TEMPERATURES OF SURFACE AND COMPONENTS

Sl No.	*Surface or Component*	*Temperature C°*
(1)	(2)	(3)
i)	Adjacent combustible materials, floors, walls and the like	50
ii)	Surfaces intended to be handled, that is, handles, knobs and the like	50
iii)	When made of Metals, materials with similar high conductivity (*see* Note)	50
iv)	Procelain, vitreous enamel of similar medium conductivity surfaces	60
v)	Plastics, wood, rubber or similar low conductivity surfaces	70
vi)	Surfaces likely to be accidentally touched except those obviously hot (*see* Note)	120
vii)	Bodies of valves, cocks, and the like (unless specifically designed for higher temperature)	120
viii)	Controls and components containing non-metallic bellows, diaphragms and the like (unless specifically designed for higher temperature).	165
ix)	Copper main and pilot fuel lines	120

NOTE — The limits specified above for knobs, handles, surfaces, etc, are intended to provide a degree of personnel protection. It is recognized that equivalent protection may be achieved by the provision of such measures as special protective clothing, gloves, guards, and the like. In any such case, the appliance would be exempt from the relevant rule.

5.8.2 *Power Failure* — Appliances that incorporate power-assisted heat transfer, such as, air circulating fan of a furnace or the pump of a circulating boiler, shall be so designed of shall be fitted with such protective devices as to be capable of complying with the requirements of **5.8.1** with the pump or fan inoperative.

5.9 Instructions

5.9.1 The manufacturer of the appliance or his representative shall provide 'instructions that ate sufficient to permit safe and satisfactory installation, maintenance and operation. Regular testing of safety devices and procedures is given at Appendix A. The nature and extent of instructions shall be determined by agreement between the purchaser and the supplier, and shall meet all the requirements of the Authority. Instructions shall include a programmed schedule of checks of safety equipment.

5.9.2 *Additional Information* — Where an appliance has been specially designed to Operate in particular conditions, or to handle a particular material so that any subsequent alteration to operating procedures, type of work handled, or other factors could possibly result in unsafe operating conditions, sufficient additional information and instructions shall be supplied to ensure that the limits of safe operation for which the equipment was designed are clearly understood. This information may be marked on the equipment or supplied separately. A typical form for the recording of such information is set out in Appendix B.

5.10 Marking

5.10.1 *General*— The appliance shall be legibly and indelibly marked with the following information:

a) Name or registered trade-mark of the manufacturer;

b) Serial number and/or catalogue number;

c) Rated heat input (W, kW, etc):

d) Marking required by any Statutory Authority (for example, electrical data plates); and

e) Type, grade or class of fuel.

5.10.2 *Indicators, Gauges, and Controls* — Dials, gauges and indicators, shall be indelibly marked with the appropriate scale and unit, and the function should be identified. Wherever practicable, the function of operating controls should be identified and direction of operation indicated.

5.10.3 *Emergency Stops* — Emergency shutdown devices shall be clearly indicated, together with sufficient instructions to ensure that their method of operations is clear.

6. IGNITION AND COMBUSTION CONTROL OF FULL

6.1 General

6.1.1 Appliance Supervision, Control, and Safe Procedures — Appliances supervision, operating procedures and control equipment shall be such that unsafe conditions are prevented from occurring. Whether operation, supervision and control are manual or automatic, they shall be such that:

a) each action or response is carried out in the correct relative order or sequence;

b) pre-starting checks and procedures are carried out;

c) fuel supply is available, adequate, and correctly treated, prepared and presented;

d) any necessary services, such as electricity, compressed air, steam or hydraulic power are available and ready for operation;

e) any residual flammable gases, vapours, or airborne dusts are removed from the combustion chamber or are safely diluted or rendered inert before ignition is initiated;

f) fuel is not admitted into the combustion chamber before any necessary combustion or atomizing airflow has been established;

g) fuel is not admitted into the combustion chamber before the means of ignition has been energized;

h) ignition is accomplished within a safe time;

j) fuel supply is shut off promptly if a stable flame is not established;

k) fuel supply is shut off promptly in the event of main flame failure after a period of stable operation;

m) no attempt at re-ignition is made until it has been established that it is safe to do so; and

n) the appliance is rendered safe if any essential auxiliary should fail.

NOTE — Combustion control systems may be operated in one of the following ways:

a) Fully manual in which the fuel is lit manually and the fuel flow is controlled manually under the observation of an operator.

b) Fully automatic, in which are incorporated self-lighting provisions, supervision of the main flame and/or pilot, and purging facilities if necessary to the process. Automatic firing systems usually operate in repeated cycles of purge, ignite, prove, on, off, purge, re-ignite, etc, unless shut down and locked out by a safety device. They may incorporate intermediate checking functions between stages, alarm systems, and may even incorporate duplicated safety features if this is considered necessary to achieve a higher degree of reliability.

c) Semi-automatic which may combine a number of manual and automatic operations, such as, initial lighting of a pilot or main flame may be manual, followed by temperature-controlled operation, with the possible addition of some degree of flame-failure protection as determined by the degree of risk and the quality of operator supervision.

The extent to which manual or automatic controls are used should be determined with due regard for the quality of operator supervision, the relative ability of operators or automatic control devices to respond quickly and reliably, and the degree of risk that would arise from any failure to respond. In many instances, the Authority will specify that particular controls be used in particular circumstances.

6.1.2 *Automatic Control* — Automatic control equipment shall be so designed that essential safety features cannot be bypassed or otherwise rendered inoperative except in the case of closely supervised maintenance or checking procedures. The control equipment shall be so designed that in the event of fault or breakdown, the appliance is placed in a safe condition.

6.1.3 *Manual Control* — Where important operating procedures are under manual control by an operator, the operator shall receive sufficient training to permit him to carry out his tasks in a safe and reliable manner; adequate notices, indicators, and other procedural aids shall be supplied, and it is the appliance owner's responsibility to ensure that the operator continues to carry out correct procedures.

6.1.4 *Interlocking Controls* — Safe operating conditions or correct sequences and procedures as required in **6.1.1** above should be ensured by providing interlocks wherever possible. Where an interlock is provided, a means should be incorporated, wherever practicable, to identify the function that caused the interlock to operate.

6.1.5 *Electricity Supply Faults* — Any electricity supply interruptions or variations that could cause malfunction shall result in lockout unless it can be shown that an automatic restart on restitution of supply can be carried out safely.

6.1.6 *Shutdown, Breakdown, Lockout, Restart* —Any shutdown that is caused by breakdown, that is, a system or component failure that is not self- correcting, shall result in lockout. When the shut-down is the result of a circumstance other than breakdown, automatic restart is permissible provided that the condition that caused the shutdown has corrected itself, and the provision of automatic restarting is not unsafe in the circumstances. When lockout has occurred, the restarting procedure shall ensure that means of ignition cannot be introduced before safe conditions have been established.

6.1.7 *Combustion and Flame Stability* — Flame shall be stable over the whole operating range and deposits detrimental to the combustion process should be kept to a minimum. A pilot flame shall be stable under any conditions that may be present when a pilot may be required to be active.

6.1.8 *Moveable or Swing-out Burners* — When the operating procedure may require the removal of a burner or part thereof from its intended operating position, the following rules shall apply:

a) The method of mounting and locating the burner shall be sufficient to prevent inadvertent movement from the intended operating position;

b) If the fuel supply is disconnected, a means for preventing significant leakage of fuel shall be provided, and

c) If automatic ignition is incorporated, a means shall be provided to prevent inadvertent start-up when in the other intended operating position.

NOTE — This requirement is not intended to apply to mobile hand burners, such as, hand torches, lighting torches and the like.

6.2 Starting and Ignition

6.2.1 *Ignition Procedure* — The starting and ignition procedure shall be such that the requirements of **6.1.1** are met. (*see* Appendix C for a typical starting and ignition procedure).

6.2.2 *Time to Ignite* — On carrying out the normal ignition procedure, a burner shall ignite completely and quietly and the flame shall stabilize. The time from first flow of fuel to the establishment of a completely ignited and stable flame shall be less than the critical time for the particular appliance.

6.2.3 *Ignition Fault Protection* — If the burner (either pilot or main) fails to ignite, the fuel shall be shut-off as quickly as practicable. Where ignition is initiated by an automatic device rather than by an operator, the shut-off function shall be provided by automatic sensing and control equipment which shall lock out in the event of ignition failure.

6.2.4 *Ignition Failure Response Time* — The time from first flow of fuel to fuel shut-off following ignition failure should, wherever possible, be less than the critical time. Where the response time of the supervisory system equals or exceeds the critical time for:

a) the pilot rate where a proven pilot is fitted; or

b) the start rate of the main burner plus the pilot rate where an unproven pilot is fitted; or

c) the start fuel rate of the main burner where no pilot is fitted, explosion reliefs in accordance with **5.7** shall be fitted unless:

1) it can be proved that the appliance is sufficiently strong to contain the maximum explosion pressure of the fuel without suffering damage which could endanger personnel: or

2) It is not possible to carry out the igniting procedure unless doors of sufficient area to constitute an explosion relief remain open during the igniting period; or

3) exemption has been obtained from the Authority,

6.2.5 *Attempted Re-ignition* — When an ignition attempt has failed, no further attempt to ignite shall be made until it has been established that it is safe to do so.

6.2.6 *Pilot Ignition* — Any pilot burner shall be so located that it will safely and reliably ignite the main burner. Where a pilot-flame detector is fitted, the arrangement of the pilot and its detector shall be such that the detector cannot indicate the presence of a pilot flame unless that flame is in the correct position and of the correct size and shape to cause ignition.

6.2.7 Ignition during Purging — No means of ignition shall be introduced during a purge period.

6.2.8 *Multiple Main Burner Appliances* — Multiple main burners should, wherever practicable, be ignited in sequence rather than simultaneously. In either case, the following requirements shall apply:

a) The start sequence of a multiple main burner appliance shall require that the fuel shut-off valve be proved to be closed before initiating start;

b) Design of the ignition system or the ignition procedure shall provide for the smooth, safe and reliable ignition of each individual burner.

c) Any flame failure safeguard system for a single burner shall respond to the pilot or main flame of that burner only,

d) Multiple burner appliances should operate in either the 'high-low' or modulating modes rather than in the 'on-off' mode.

6.2.9 *Sequential Ignition of Multiple Main Burners* — Where each main burner of a multiple main burner arrangement is ignited sequentially, the following requirements shall apply;

a) Each burner and its associated ignition system shall comply with all other requirements for ignition in **6.2.1** to **6.2.8**,

b) The operator or the control equipment shall ensure that each single burner is alight and stable before initiating the ignition of the next burner to be lit.

c) Any preferred or essential lighting sequence should either be specified in operating instructions or marked on the appliance. Where ignition of the main burners is initialed automatically, the sequence shall be controlled automatically.

6.2.10 *Simultaneous Ignition of Multiple Main Burners* — Where the main burners of a multiple burner arrangement are ignited simultaneously, the following requirements shall apply:

a) The group of burners shall be taken as being a single burner for the purpose of this standard and particularly when calculating the critical time.

b) Each burner shall be supervised by an ignition failure protection system which shall be individual to the burner unless it can be shown that a common ignition protection system will cause lockout of all the burners in the group being ignited should any one or more of the burners fail to ignite, or unless exemption has been obtained from the Authority.

c) The occurrence of flame failure on any one burner shall cause shut-down with lockout of the failed burner where each burner is individually supervised, or of all burners in the group when a common supervision system is used.

d) The occurrence of flame simulation on any single burner of the group of burners during a start-up check shall lead to the lockout of all the burners in the group unless each burner is provided with its own ignition and flame safeguard system.

6.3 Flame Failure and Re-ignition.

6.3.1 *Flame Supervision and Failure Protection* — Every burner snail be so supervised when operating that if the flame is extinguished the fuel supply is shut-off as quickly as practicable. Where a burner is not under constant operator's supervision, the flame failure protection shall be provided by means of automatic devices.

6.3.2 *Flame Failure Response Time* — Fuel shut-off after flame failure should occur within the critical time.

6.3.3 *Relighting after Flame Failure* — Where automatic control equipment is provided, no attempt to automatically relight after flame failure shall be made. The appliance shall shut-down to a condition that requires a manual reset followed by the complete procedure for initiating ignition.

6.3.4 *Extraneous Ignition Sources* — No attempt shall be made to light a burner by means of hot brick-work, nearby burners, or other hot bodies unless the specific case can be shown to be safe to the satisfaction of the Autority.

6.4 Multi-Fuel Firing

6.4.1 *Application* — This clause applies to firing system using:

a) two or more separate fuels but never more than one in use at a time,

b) two or more separate fuels with two or more firing simultaneously:

1) through separate burners, and

2) through the same burner.

In each of these cases, one fuel may fire at a constant rate with the other(s) varying to adjust for load fluctuations or all fuel rates may fluctuate simultaneously.

NOTE — A burner that uses different fuels for pilot and main flame would not be considered to be a multi-fuel application.

6.4.2 *Alternative Firing* — Where two or more fuels are available but never used more than one at a time, each fuel system shall comply with all the requirements of this code applicable to that particular fuel. An interlocking system shall be provided, sufficient to ensure that more than one fuel cannot be supplied simultaneously, and that the shut-down procedure for one fuel is completed before the start-up procedure for the other fuel is initiated. This does not preclude the use of common components, such as, air supply fans provided that the component fully meets all the needs of each fuel system and sufficient interlocks are provided to eliminate all possibility of non-compliance with requirements.

6.4.3 *Simultaneous Firing* — Where two or more fuels are fired simultaneously:

a) operating procedures and safety systems for all fuels should be similar to minimize the possibility of operator confusion;

b) if only one fuel is used through any burner each such burner shall operate as a complete system;

c) if more than one fuel is used through any burner simultaneously, the system shall include:

1) a means of ensuring that an adequate air supply is always available to cope with the total fuel (regardless of type or differing air/fuel ratios) being admitted through the burner;

2) an ability to control all the firing rates of all the fuels to ensure stable and complete combustion at safe levels at all time;

3) an ability to control the rate of change from one fuel to the other within safe bounds; and

4) a control which can function safely and satisfactorily if the supply of any of the fuels temporarily fails or is shut off for any reason whatsoever.

6.5 Normal Shut-down Procedures

6.5.1 *Safety* — Shut-down procedures whether manual or automatic, shall be such as to leave the appliance, its contents and component parts in a safe condition ready for the next operation, cycle or batch.

6.5.2 *Shut-down Sequence* — Closing down shall be done in the following sequence:

a) Shut-off fuel supply;

b) Operate the post-purge system, if provided; and

c) Close down all systems and controls on completion of purging,

NOTES

1 Particular care should be taken to minimize the effects of residual heat which may cause a local temperature rise after shutdown.

2 It is important to ensure that an adequate supply of combustion air is maintained while the last of the fuel is being cleared from the burner.

3 It is common practice to use an intended shut-down as a convenient opportunity to check the action of safety devices.

6.6 Purging

6.6.1 *When to Purge* — Purging of the combustion chamber or, where necessary, any associated recirculation ducts, compartments or flue-ways, shall be carried out in the following circumstances:

a) Immediately before a source of ignition is introduced into or energized within the appliance at the commencement of every firing cycle, and immediately before any attempt to relight after ignition failure of flame failure (purging after shut-down is optional).

b) Immediately before the entry of any personnel into the appliance.

Note — in a multiple-burner installation incorporating sequential ignition, after the first burner has been ignited, further purging before igniting additional burners is not required.

6.6.2 *Method of Purging* — Purging shall be provided by mechanical means for:

a) direct fired appliances where combustible vapours or dusts other than unburnt fuel may be present; and

b) appliances in which the combustion chamber or any associated recirculation duct, compartments or flue-ways operate under forced or induced drought.

Natural convection purging may be used only with the approval of the Authority.

6.6.3 *Completeness of Purging* — Purging shall be continued for a sufficient time to ensure that the concentration of potentially hazardous mixtures has been reduced to a safe level. In particular.

a) the volume of purging medium used shall at least be equal to fi\e times the volume of the combustion chamber plus associated recirculation ducts, compartments, or appliance flue-ways unless it is shown to the satisfaction of the Authority that a lesser amount is safe; and

b) the purging medium shall be so circulated that its distribution is adequated and no zone in the appliance remains unpurged.

NOTE — Where a combustion chamber connects into an additional space in an appliance, the volume of purging medium will need to take account of the purging requirements of that additional space.

6.6.4 *Manually Controlled Purging* — Where the duration and extent of a purge period is under the control of an operator as in the case of a manually- lit manually-operated appliance, the operating instructions shall specify the purging technique and its duration. When purging is carried out by means of combustion air fans, the operating instructions shall require that the fuel supply be manually shut-off.

7. CONTROL OF EXPLOSIONS FROM NON-FUEL SOURCES

7.1 Prevention or Relief of Explosions

7.1.1 *Explosion Prevention* — Atmospheres that contain combustible vapours or dusts shall be prevented from exploding by one of, or a combination of, the following:

a) Ensuring that any such atmosphere will not contact any hot surface, flame zones, or heated gases whose temperature is higher than the auto-ignition temperature of the combustible material minus 100°C except in specifically designed incineration zones;

b) Maintaining the concentration of the combustible gas, vapour or dust at a safe level by diluting with air and/or products of combustion; and

c) Maintaining the oxygen concentration below 50 percent of the lowest oxygen percentage necessary to sustain combustion, for example, by introducing inert gases, by retaining or recirculating products of combustion and the like.

NOTE — When (c) alone is used, particular care to prevent air infiltration is essential.

7.1.2 *High Concentration of Volatiles* — The operating procedures of appliances whose atmospheres contain high concentrations of combustible, materials shall be such as will avoid the simultaneous occurrence within the appliance of mixtures with air which are within the combustible range and temperatures that are likely to cause ignition. Particular care should be taken to control the operation of any doors, hatches or other, entries that may admit air during any period of potential hazard.

7.1.3 *Explosion Relief* — Every oven, furnace, combustion chamber or duct in which airborne combustible vapours or dusts are present as the result of the process, shall incorporate provisions for relieving an explosion unless it can be proved that the appliance is sufficiently strong to contain the maximum cause injury to personnel.

7.1.4 *Incineration* — An atmosphere that contains any combustible vapour or dust in a concentration greater than 25 percent of the LEL shall riot be passed through a flame zone except in the case of intentional incineration of the combustible. In that case,

a) the velocity of such an atmosphere as it approaches the incinerating zone shall be not less than twice the flame speed of the materials, and, in any case, not less than 5 m/s;

b) percautions shall be taken to ensure that an atmosphere which is within the combustible range and is moving at a velocity lower than the flame speed cannot occur during normal start-up or shutdown operations; and

c) in the event of an emergency shutdown, the incinerating flame shall be turned off and any possible source of ignition shall be isolated from such an atmosphere,

7.2 Air Dilution, Exhausting, Circulation, Purging

7.2.1 *Method of Providing, Dilution Air* — Any air for dilution that may be provided as in **7.1.1** (b) shall be supplied by a mechanical system unless specific approval has been given for the provision of dilution air by natural convection.

7.2.2 *Distribution of Dilution Air* — Air supplied to the appliance shall be so circulated that its distribution is substantially even, and no dead pockets occur.

NOTE — It is recommended that airflow tests be conducted under operating: conditions after installation, whenever internal furniture or loading has been changed, and at regular intervals thereafter.

7.2.3 *Purging* — An appliance in which combustible vapours or dust are generated shall be so designed as to provide for purging the appliance before initial start-up, after an accidental or intentional shut-down, and before restarting after shutdown. The volume of purging medium circulated during the purge period shall be at least five times the internal volume of the appliance.

NOTES

1 The dilution air fan may be used to provide the purging medium in this ease.

2 Particular care should be taken to allow for residual heat after shut-down which may cause rising temperatures or a continued generation of vapours.

7.2.4 *Vapour and Dust Removal* — The design of the equipment and its installation shall be such that any process products which may be flammable, noxious or toxic are removed effectively to an out- side atmosphere or are effectively destroyed. Where it is intended to discharge to atmosphere, any applicable requirements of health and clean air authorities shall be met.

NOTE —Where air containing combustible materials recirculates and does not exhaust directly to atmosphere, it is not uncommon to limit the concentration of combustibles by passing the circulating air through the flame zone to achieve a degree of incineration. In such cases, the requirements for incineration will apply.

7.2.5 *Leakage of Hazardous Materials* — Any air- circulation system shall be so designed that it does not cause leakage of flammable or toxic materials into surrounding areas-

8. INSTALLATION

8.1 Installer's Responsibility

8.1.1 *Licences, Approvals* — The installer shall ensure that any necessary licences, approvals, or other forms of authorization required under **1.3** have been obtained at the approximate time from any authority having jurisdiction.

8.1.2 *Instruction* — The installer shall ensure that the installation instructions required under **5.9.1** have been complied with and that all equipment installed by him is left either in safe working order, or in a safe inoperative condition. Any testing or operator training which may have been agreed between the manufacturer, installer and the purchaser shall be completed. Any required operating instructions shall be permanently and prominently displayed near the appliance.

8.1.3 *Faulty Equipment* — If the equipment does not operate correctly due to defects either in the equipment itself or in the fuel supply, the installer shall not attempt rectification unless specifically authorized to do so. The equipment shall be shut down and protected against unauthorized or inadvertent attempts at operation, and the person or party responsible shall be advised.

8.1.4 *Suitability for Fuel and Electricity* — The installer shall ensure that the appliance is suitable for, and, where necessary, approved for the type of fuel and/or electricity supply with which it will be supplied. If the appliance is found to be unsuitable for the fuel or electricity supply available, it shall not be connected but the purchaser shall be notified.

8.2 Standards for Workmanship and Good Practice

8.2.1 *Materials* — Any material used in the installation of an appliance shall comply with the requirements listed in **5.3**.

8.2.2 *Finish* — Sharp corners or edges, projections and the like which could cause injury to personnel, should be removed or guarded before the completion of the installation.

8.2.3 *Building Structures* — The appliance should be separate from the building in which it is installed and from all building members. It should not support, include or incorporate any such member but where this is unavoidable, proper action should be taken to ensure that the strength of such a member, building or appliance is not impaired, and that it is not subject to overheating.

8.2.4 *Connection of Services* — The connection of an appliance to services, such as, fuel, water, air, electricity and sewerage shall be made in accordance with the requirements of the relevant Authority and standards.

8.3 Location and Access

8.3.1 *Building Safety* — An appliance should be located so as to minimize building damage or personal injury resulting from any fire, explosion, escape of fuel, escape of flue gases, or escape of deleterious process products.

8.3.2 *Safety and Convenience* — An appliance shall be located:

a) so as to facilitate safe working;

b) so that the passage of persons or goods along any passageway or through any exit is not hindered; and

c) so that the traffic is not likely to cause damage to or malfunction of the appliance or its components (*see* also **5.1.3**).

8.3.3 *Combustible Materials* — An appliance shall be located so as to permit compliance with **5.8**.

8.3.4 *Clearance for Explosion Relief* — The distance between the vent of an explosion relief and any nearby wail, ceiling, or other solid construction shall be sufficient to ensure that the flow of products of an explosion is not restricted, and shall be not less than following:

a) Clearance, in metres, from one wall or ceiling

$= 0.4\ (\frac{V}{3})^{\frac{1}{3}}$ with a minimum of 0.4 m.

b) Clearance, in metres, from two walls at right angles, or from one wall and a ceiling

$= 0.6\ (\frac{V}{3})^{\frac{1}{3}}$ with a minimum of 0.6 m.

where V = volume of the space being vented.

NOTE — It should be recognized that if an explosion relief discharges into a confined space may be subjected to an increase of internal pressure.

8.3.5 *Explosion Relief Protection* — An appliance shall be so located or so protected or guarded that when installed and operating, explosion reliefs, vents or closures cannot cause injury to personnel from moving parts or ejected flame. Where an appliance does not incorporate sufficient protection or guarding to permit compliance with this requirement, such protection or guarding shall be provided by the installer,

8.4 Fresh Air Supply

8.4.1 *Air Supply* — The area in which the appliance is located shall be sufficiently vented to provide adequate fresh air for dilution purposes, for the combustion of the fuel and for the comfort and protection of personnel.

8.4.2 *Air Intakes* — Any opening that functions as an intake for the fresh air required in **8.4.1** shall be so designed that it cannot be closed unless it is appropriately interlocked and shall be so arranged or protected that the materials or articles cannot be stacked so as to restrict the entry of the required amount of fresh air.

8.4.3 *Fan Failure* — Where fans or blowers are used to supply fresh air, appropriate interlocks or warning devices shall be provided to ensure safe conditions in the event of air supply failure.

8.5 Flues, Ducts and Exhaust Systems

8.5.1 *Provision of Flues* — Where products of combustion are of such a nature, or occur in such volumes, that they, may cause unacceptable discomfort to personnel, health hazards, spoilage or deterioration of products, structures, and the like, they shall be removed effectively to outside atmosphere. Each individual appliance should be provided with an individual flue.

NOTE— A common flue serving more than one appliance requires special design to ensure that it does not constitute an explosion hazard.

8.5.2 *Separate Flues and Exhausts* — Products of combustion of indirect fired appliances shall be discharged separately from any process products, except that, and provided that approval has been obtained, the flue may be connected to the exhaust system on condition that the temperature of the products of combustion at this point is always at least 100°C below the ignition temperature of the process products.

8.5.3 *Common Exhaust* — A common exhaust system may be used to remove process vapours or dust from a number of appliances or from a number of internal appliance compartments provided that the mixing of the various exhaust products is not hazardous.

8.5.4 *Hot Flues and Ducts* — Flues and ducts shall be installed to comply with the requirements of **5.8** (temperature hazards).

8.5.5 *Terminals for Exhaust Ducts and Flues* —Exhaust ducts and flues that terminate outside a building shall discharge away from doors, windows, of other possible air intakes in such a manner as to preclude the re-entry of vapours, hot air, exhaust products, and the like, into the building. The terminal shall comply with the requirements of the Authority, and shall be clear of any building or other construction that may impede free discharge from the terminal.

NOTE — Care should be exercised to prevent any exhaust gases that contain volatile materials, particularly those being discharged during purging, from being directed towards hot stacks or /ones where ignition may take place.

ANNEX A

(Clause 5.9.1)

REGULAR TESTING OF SAFETY DEVICES AND PROCEDURES

A-l. REGULAR TESTING

A-1.1 Systematic and thorough inspection and maintenance are essential and should be arranged on a properly established regular basis.

A-1.1.1 The frequency of testing should be determined by the reliability of the device, the environmental conditions and the back-up protection afforded by other devices or procedures.

A-2. METHOD OF TEST

A-2.1 At least one complete cycle of operation should be performed prior to and immediately following every test and at least two complete cycles where any adjustment has been made or any part replaced.

A rigorous inspection should be made during and after the initial operating cycle and should include the following:

a) All appropriate inspection covers should be removed to expose any levers, contacts or other working parts.

b) The various safety devices should be operated in turn to check the proper performance of each one.

c) Close visual inspection of all mechanical and electrical components of the safety devices should be made. This includes all timers, relays, contactors, limit switches, etc. Particular notice should be taken of broken or bent parts, unusual or stickly action improper contact appearance or lack of contact pressure, effects of excessive heating, vibration, the presence of metallic particles and the intrusion of moisture or dust.

d) A proper check should be made of the surfaces and engagement of any clutches or timing gears and the position of connecting lever, wires, cables or pipes to be sure that mechanical interference cannot occur.

e) Timing mechanisms and devices need to be checked several times before satisfactory performance can be assumed.

ANNEX B

(*Clause* 5.9.2*)*

OPERATING DATA, SPECIAL PURPOSE FURNACES

Identification of Manufacturer…….
Manufacturer's Serial No…….
Name of Owner……
Location……...
This appliance is designed for use under the conditions specified below. Any deviation from these conditions may create hazards.
Type or purpose of appliance: ……
for example, paking, paint, enamel japan, metal heat treatment— exothermic atmosphere
Kind of Material Handled : ……
for example, wood, paper, textiles, metals, minerals

Dilution air volume…..…….m^3/min at 20°C
Design Solvent: Type……1/h
Purging Period:……..
Give complete details when more than one purging provision is Incorporated
Baking Time (batch oven):…….
Type of heating system: ……..
for example, convection, radiation
Heat Medium: …….
for example, oil direct, gas indirect
Oven or furnace temperature:…….°C
Internal dimensions:……..…Volume…….m^3

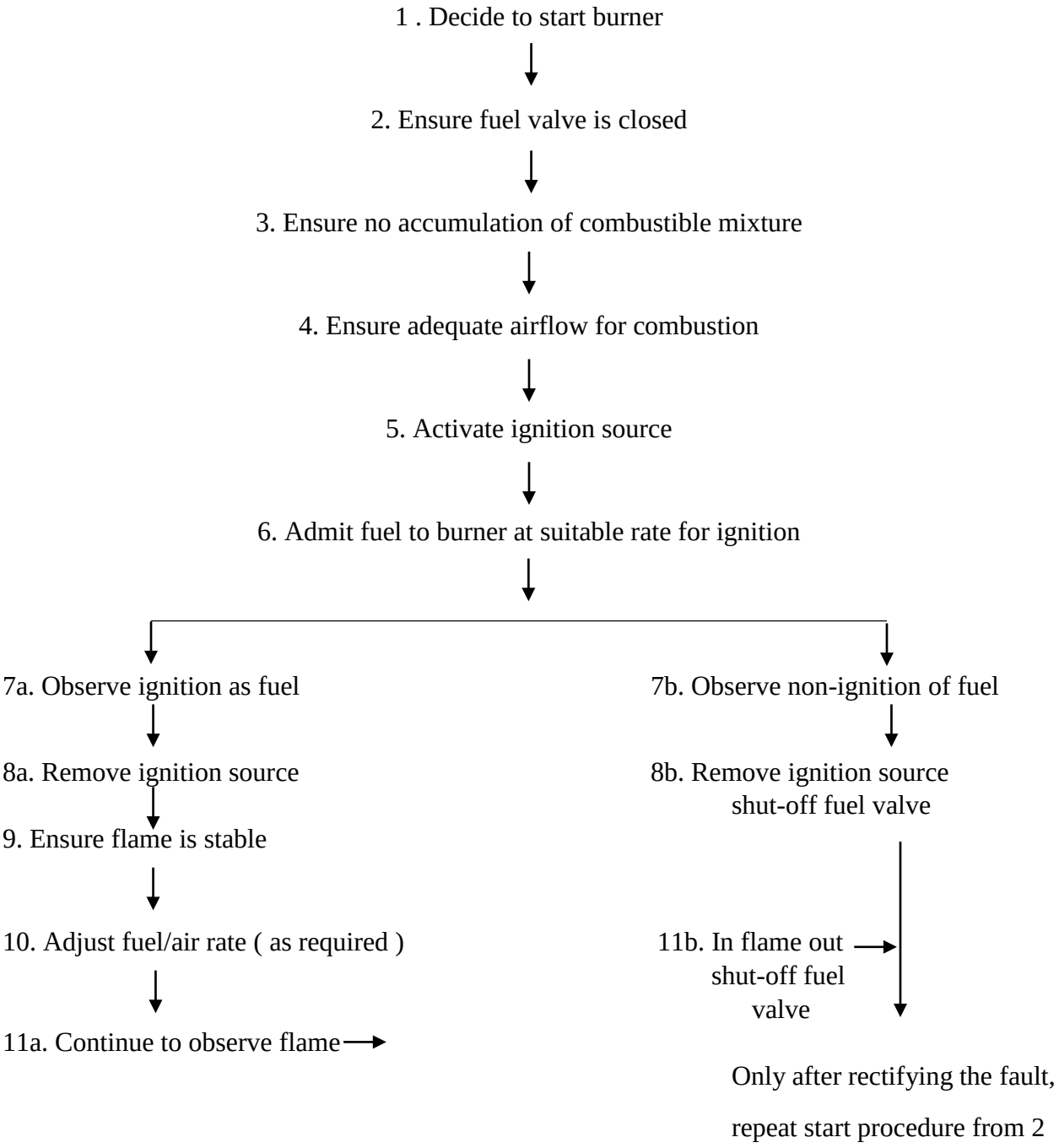
THIS FURNACE IS NOT INTENDED FOR USE IN HAZARDOUS LOCATIONS

ANNEX C

(Clause 6.2.1)

TYPICAL IGNITION PROCEDURES

C-1. IGNITION OF A BURNER WITHOUT THE USE OF A PILOT BURNER (Manual or Automatic System)



C-2. IGNITION USING A PILOT (Manual or Automatic System)