Foundry work

Level-II

Learning Guide-31

Unit of Competence:	**Operate Non–electric Melting Furnace**
Module Title:	**Operating Non–electric Melting Furnace**
LG Code:	**IND FDW2 M9 LO1-LG-31**
TTLM Code:	**IND FDW2 TTLM 1019v1**

LO 1: Select materials

Instruction Sheet	Learning Guide 31

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Completing requisitions for materials.
- Analysing charge undertake accordance with standard operating procedures.
- Analysing the charge converted to furnace.
- Charging weighed according to standard operating procedures.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Complete requisitions for materials as required according to standard operating procedures.
- Undertake charge analysis in accordance with standard operating procedures.
- Convert the charge analysis to furnace charge weight using standard operating procedures.
- Weigh charge according to standard operating procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 and Sheet 4". In page 3, 9, 12 and 22.
4. Accomplish the "Self-check 1, Self-check 2,Self-check 3and Self-check 4" **in page 8, 11, 21 and 15**respectively.

Information Sheet-1	Completing requisitions for materials

1.1. Introduction

Melting Materials

- **Aluminum**

Aluminum (**aluminum** in American and Canadian English) is a chemical element with the symbol **Al** and atomic number 13. It is a silvery-white, soft, non-magnetic and ductilemetal in the boron group. By mass, aluminum makes up about 8% of the Earth's crust; it is the third most abundant element after oxygen and silicon and the most abundant metal in the crust, though it is less common in the mantle below. The chief ore of aluminum is bauxite. Aluminum metal is highly reactive, such that native specimens are rare and limited to extreme reducing environments. Instead, it is found combined in over 270 different minerals.

Aluminum is remarkable for its low density and its ability to resist corrosion through the phenomenon of passivation. Aluminum and its alloys are vital to the aerospace industry and important in transportation and building industries, such as building facades and window frames. The oxides and sulfates are the most useful compounds of aluminum.

Despite its prevalence in the environment, no known form of life uses aluminum saltsmetabolically, but aluminum is well tolerated by plants and animals.[10] Because of these salts' abundance, the potential for a biological role for them is of continuing interest, and studies continue.

Aluminum is the most widely used non-ferrous metal. The global production of aluminum in 2016 was 58.8 million metric tons. It exceeded that of any other metal except iron (1,231 million metric tons). Aluminum is almost always alloyed, which markedly improves its mechanical properties, especially when tempered. For example, the common aluminum foils and beverage cans are alloys of 92% to 99% aluminum.

The main alloyingagents are copper, zinc, magnesium, manganese, and silicon (e.g., duralumin) with the levels of other metals in a few percent by weight.

The major uses for aluminum metal are in:

- ✓ Transportation (automobiles, aircraft, trucks, railway cars, marine vessels, bicycles, spacecraft, etc.). Aluminum is used because of its low density;
- ✓ Packaging (cans, foil, frame etc.). Aluminum is used because it is non-toxic, non-adsorptive, and splinter-proof;
- ✓ Building and construction (windows, doors, siding, building wire, sheathing, roofing, etc.). Since steel is cheaper, aluminum is used when lightness, corrosion resistance, or engineering features are important;
- ✓ Electricity-related uses (conductor alloys, motors and generators, transformers, capacitors, etc.). Aluminum is used because it is relatively cheap, highly conductive, has adequate mechanical strength and low density, and resists corrosion;
- ✓ A wide range of household items, from cooking utensils to furniture. Low density, good appearance, ease of fabrication, and durability are the key factors of aluminum usage;
- ✓ Machinery and equipment (processing equipment, pipes, tools). Aluminum is used because of its corrosion resistance, non-pyrophoricity, and mechanical strength.

- **Brasses**

Brasses are the most commonly used copper alloys. The addition of zinc strengthens the material and incidentally changes the color to a yellow or gold effect. The ratio of copper and zinc can be varied for advantages and the addition of other elements gives still more variety of combinations of properties such as machinability, strength, hardness, ductility (hot or cold), conductivity and corrosion resistance as well as many others. Lead additions are used to improve machinability. The lead is insoluble in the solid brass and segregates as small globules that help the swarf to break up in to small pieces and may also help to lubricate the cutting tool action. The addition of lead does, however, affect cold ductility which may control both the way in which material is produced and the extent to which it can be post-formed after machining. Additions of manganese, iron, aluminum, silicon and other elements are used to increase strength and hardness while tin, aluminum and arsenic are used to further improve the good corrosion resistance of brasses, making them suitable for use in more aggressive environments.

The additions of lead for improved machinability have been made for many years. Such brasses are standard for the manufacture of water fittings and give years of satisfactory service in all closed-circuits such as central heating systems and in the majority of fresh water supplies.

Generally such fittings give no cause for concern when used for fresh water for drinking purposes but in certain well-known areas the supply water can be aggressive to brass and the use of a material that is immune to dezincification (such as cast gunmetal) or dezincification resistant (such as CZ132, CuZn36Pb2As) is recommended for service above ground and mandatory for underground fittings.

- **Bronzes**

Bronzes are alloys of copper and tin. In the UK they are generally deoxidized with phosphorus which improves strength and hardness and the alloys are then known as **phosphor bronzes**.

They are used for bearings and gears. In wire and strip form they have good elastic properties and are used for contacts. Lead is often added to improve machinability and to improve bearing properties. **Gunmetal** are alloys of copper, tin and zinc. They are readily cast and have good machinability and good corrosion resistance. They are used for pumps, bearings, valves and "bronze" statuary.

- **Magnesium alloys**

Magnesium alloys are mixtures of magnesium with other metals (called an alloy), often aluminum, zinc, manganese, silicon, copper, rare earths and zirconium. Magnesium is the lightest structural metal. Magnesium alloys have a hexagonal lattice structure, which affects the fundamental properties of these alloys. Plastic deformation of the hexagonal lattice is more complicated than in cubic latticed metals like aluminum, copper and steel; therefore, magnesium alloys are typically used as cast alloys, but research of wrought alloys has been more extensive since 2003. Cast magnesium alloys are used for many components of modern automobiles and have been used in some high-performance vehicles; die-cast magnesium is also used for camera bodies and components in lenses.

Metal	Melting point t_m °C	Mean specific heat 20–t_m °C c_p J/g deg C	Latent heat of fusion L J/g	Total heat requirements for melting $L + c_p(t_m - 20)$ For 1 kg kJ	For 1 litre kJ	For 1 lb BthU	For 1 in^3 BthU
Iron	1536	0.590	272	1168	9228	502	141
Nickel	1455	0.548	302	1084	9651	466	149
Copper	1085	0.440	205	674	6067	290	93
Aluminium	660	0.992	388	1022	2759	439	43
Magnesium	649	1.210	558	1122	1909	482	29
Zinc	420	0.423	110	285	2018	122	32
Lead	327	0.142	23.9	67	783	29	12
Tin	232	0.243	59.5	113	825	49	13

Table 1.1. Properties and heat requirements for metal melting

Apart from the type of alloy being produced, selection of equipment for melting and casting must depend upon economic factors. These include the balance between cost and quality requirements for particular classes of casting, and the nature of the demand for molten metal as determined by the pattern of production. This demand may vary widely: a regular flow of small quantities of metal may be needed to sustain a continuous production line, or much larger batches may be required for the intermittent production of heavy castings. Furnace capacities and melting rates must thus be related not simply to total output but to the whole pattern of production. Melting units and casting equipment range in capacity from a few kilograms to many tonnes, although the supply of metal to the casting floor is often regulated independently of the melting units themselves by the use of holding furnaces of suitable capacity. This practice gives an additional degree of freedom in the melting operations. A further factor in melting and casting practice is the availability of facilities for the bulk transport of certain molten alloys from outside sources in insulated containers.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. ________________is a silvery-white, soft, non-magnetic and ductile metal in the boron group.
   A. Copper C. aluminum
   B. Bronze D. all
2. The main alloying agents of aluminum
   A. Copper B. magnesium C.siliconD. All
3. Additions of manganese, iron, aluminum, silicon and other elements in the brass are used to increase strength and hardness
   A. True B. False
4. ______________ is used for bearings and gears.
   A. Magnesium B. Bronze C. lead D. Aluminum
5. ____________ alloys of copper, tin and zinc
   A. Magnesium alloy C. bronze
   B. Gunmetal D. brass
6. List the major uses of aluminum?

Note: **Satisfactory rating – 3 points Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________

Rating: _____________

Name: ____________________________ Date: ________________

Short Answer Questions

Information Sheet- 2	Analyzing charge undertake accordance with standard operating procedures.

Introduction to Charge

The furnace charge may consist of pre-alloyed pig or 'ingot', virgin metals and 'hardener' alloys, scrap from outside sources or from internal fettling and machine shops, or any mixture of these materials. Externally purchased pig, ingot and alloy additions are normally supplied to certified analysis, but certain materials, especially scrap, require sorting and analytical control for charges to be calculated with accuracy.

The task of melting depends on the state of division as well as the composition of the charge. Large pieces, for example pigs and heavy scrap, have a small surface area and are therefore least susceptible to melting losses and contamination. Finely divided bulky materials such as swarf or turnings are much less satisfactory: they are most readily absorbed by feeding directly into a liquid bath but this introduces dangers of gas contamination. It is nevertheless economically desirable that these materials be returned to the production cycle at the earliest stage, if necessary by pre melting and casting in denser form: this also assists in maintaining accurate control of composition, although double melting losses are then incurred.

The physical problem of swarf recovery in cast iron founding has been approached through various techniques of canning and briquetting.

Work has also been carried out with systems of injection of borings directly into the melting zone of the cupola. The value of induction furnaces for the direct recovery of cast iron borings has previously been mentioned.

The processing and refining of these more inconvenient returns may be uneconomic for the founder as compared with disposal to specialists for the production of secondary ingots of controlled composition. Where extensive refining is undertaken in the foundry, however, the opposite principle maybe adopted, the foundry not only processing its own returns but combing the scrap market for further sources of cheap raw material. The former practice is common in the non-ferrous foundry industry, particularly the light alloy industry, whilst ferrous alloy founders utilize a major proportion of returned scrap in crude form. Efficient materials utilization in furnace charges is facilitated by computerized control systems. These are designed to achieve minimum cost charges and the subsequent adjustment of bath composition to the required specification.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Certain materials, especially scrap, require sorting and analytical control for charges.
    A. True
    B. False
2. The task of melting doesn't depends on the state of division as well as the composition of the charge.
    A. True
    B. False
3. Efficient materials utilization in furnace charges is facilitated by computerized control systems
    A. True
    B. False

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-3	Analyzing the charge converted to furnace.

3.1. Introduction to furnace

A furnace is a device used for high-temperature heating. The name derives from Latin word fornax, which means oven. The heat energy to fuel a furnace may be supplied directly by fuel combustion, by electricity such as the electric arc furnace, or through induction heating in induction furnaces.

3.2. Melting furnaces

Much foundry melting is carried out on a batch basis from cold charges, the notable exception being the continuously melting cupola widely used in cast iron production. Intermediate between batch and continuous melting is the semi continuous practice in which a 'heel' or proportion of liquid metal is retained in the furnace to provide a bath for the absorption of the succeeding charge of solid materials. In certain cases duplex practice is used, involving separate furnaces for successive stages: the use of a holding furnace to provide a reservoir of molten metal at the pouring temperature is the most important example. Although melting furnaces must be designed for effective heat transfer to the charge, thermal efficiency is not the principal criterion in the choice of equipment and practice. The overall economics of melting operations depend upon many factors, including capital depreciation and degree of utilization; the operating costs themselves include maintenance and labour as well as fuel and power.

Metallurgical factors in the choice of melting facilities relate to the tendency of the charge to react with its surroundings, affecting compositional control, impurity level and metallic yield. Compositional effects must be judged in relation to casting quality requirements, whilst the economic importance of minimizing melting losses depends on the intrinsic value of the metals concerned: losses are, in general, more critical in the case of highly priced non-ferrous alloys.

To summarize, therefore, furnace selection is determined by cost, metal quality, production requirements and alloy type; flexibility for a wide range of conditions is itself an advantage for many types of production. It is not intended to describe the many individual types of melting unit which may be found in the literature. The principal types of unit used in the foundry industry are classified in Table 3.1.and some of the main operating characteristics will be summarized. It will be seen that the furnaces have been classified in two main groups, based on fuel combustion and electrical heating. Within each of these categories the principal distinction, apart from the special case of the cupola, is between hearth and crucible types. Important characteristics of these main design variations and heat sources will be separately considered.

Energy	*Basic type (see Figure 8.35)*		*Furnace*	*Usual means of heating*	*Main fields of application*
I. Fuel fired	Shaft		Cupola	Coke. Charge in direct contact with fuel. Continuous melting Gas; oil	Cast iron
	Hearth		Reverbatory (air)	Gas; oil	Non-ferrous alloys; cast irons,
			Rotary (rotating or rocking)	Gas; oil	Non-ferrous alloys; cast iron, esp. malleable and special. Duplex holding
	Crucible		Crucible		
			Lift out or pit type	Gas; oil	Most alloys, except steel
			Tilting	Gas; oil	
			Bale out	Gas; oil	Light castings, especially die castings
II. Electric	Hearth	Arc	Direct arc	Arc to charge	Steel; cast iron
		Arc	Indirect arc (rocking)	Radiant arc	Non-ferrous alloys; high alloy steel and special irons
	Crucible	Resistance	Resistor (static or rocking)	Radiant resistor rod	Steel; cast iron; copper alloys
		Resistance	Resistance	Elements (shroud or immersion)	Non-ferrous alloys, especially holding for die casting
		Induction	Coreless induction	Medium frequency induction	Steel, esp. alloy and small tonnage; cast irons; Ni base
	Melting channel	Induction	Cored induction	Mains frequency induction	Non-ferrous alloys; holding for die and light castings

Table 3.1. Foundry melting furnace

3.3. Types of furnaces

- **Oil fired furnace**

This furnace is mounted on two pedestals above the floor level. For pouring the molten metal, the furnace is rotated by the geared hand wheel. Oil and air are admitted with pressure through a nozzle. The crucible is placed in the heating chamber and is heated by the flame. The furnace can be stopped whenever needed and temperature can be controlled easily. They give lesser pollution. However, improvements in efficiencies have been brought about by methods such as pre heating of combustion air and other waste heat recovery systems. Oil-fired furnaces mostly use furnace oil, especially for reheating and heat treatment of materials. Light diesel oil is used in furnaces where sulphur is undesirable.

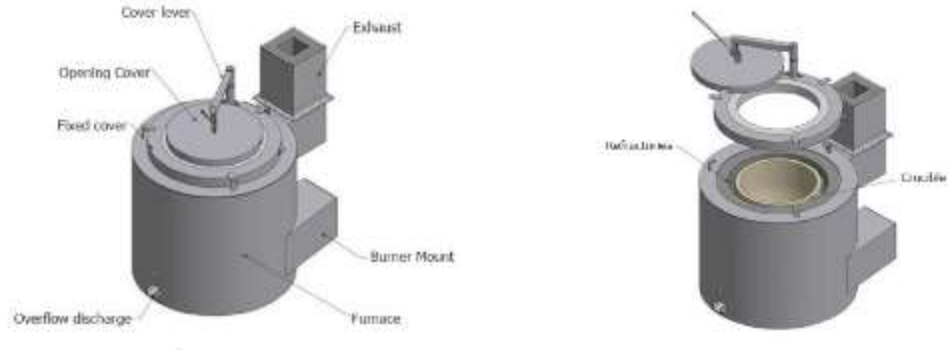


Fig. 3.1. Oil fired furnace

- **Oil-Fired Heating System Works**

  When a room thermostat is turned up or the room temperature drops below the thermostat setting, the unit signals the furnace or boiler that additional heat is needed. As a result of the signal, the burner motor activates the fuel oil pump, sending fuel oil to a nozzle at the end of an air tube. Under high-pressure, the fuel oil is pushed through the nozzle to form a fine mist. At the same time, the burner blower, also operated by the burner motor, blows room air into the same air tube. The two-the air and the fuel oil mist-combine to form a highly flammable vapor that is then ignited by a spark supplied by the ignition electrodes. Once started, the flames continue to burning the combustion chamber with additional fuel oil and room air supplied through the air tube/nozzle. In turn, the combustion gases from the flame flow through the flue passageways of the heat exchanger, heating it, and then continue to flow up and out the exhaust stack. In the meantime, heat is transferred from the flue gases through the heat exchanger walls to the heat distribution medium (either air or water) that flows through the supply system, distributing heat to various parts of the home.

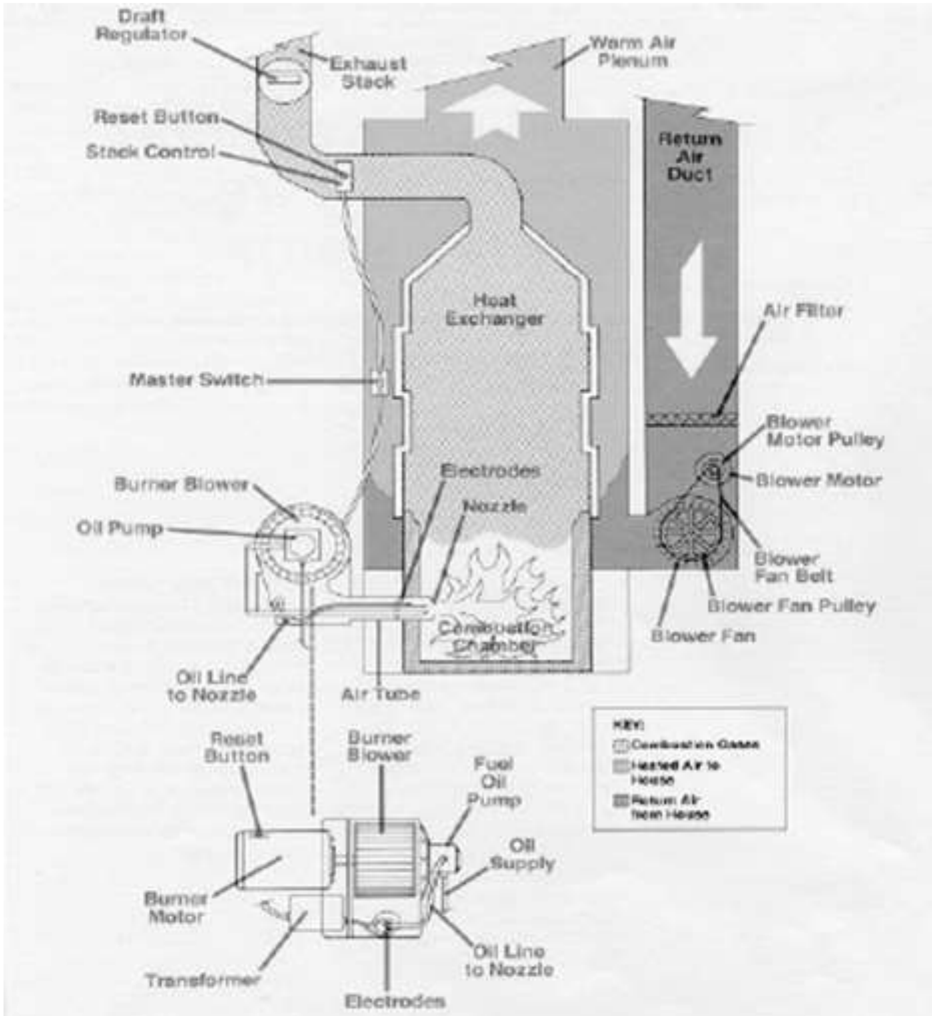


Fig. 3.2. Fuel oil forced air furnace

How a Typical Forced Air Distribution System Works

When the air temperature in the heat exchanger reaches predetermined temperature, which is controlled by a fan-and-limit control, the furnace blower begins pulling cool room air through their turn air registers and ducts. The air is passed through a filter to clean it of dust. It then passes through the heat exchanger, as described above, where it is warmed by the hot combustion gases passing through the heat exchanger on their way out of the house. The furnace blower then forces the warm supply air into a plenum and through the supply ducts, finally distributing it through supply registers in each room in the home.The two air supplies, the combustion air and the air distributed through the house system, should never come indirect contact with each other.

How a Hot Water Distribution System Works

When a house thermostat calls for heat from a hot water distribution system, the circulator pump is activated and supplies hot water held in reserve in the boiler throughout the distribution system-through the supply main, the supply branches and finally the baseboard units (i.e., radiators or convectors in some systems) in the various rooms. As cool room air passes over the warmed baseboard unit surfaces, the air absorbs heat and distributes it throughout the room. Individuals, furnishings and objects near the baseboard units are also warmed by heat given off by the units. The now cool water completes the cycle, flowing from the baseboard units through their turn branches and the return main back to the boiler. When the water in the boiler drops below a predetermined temperature, the aqua stat activates the burner. The heat given off by the burner warms the heat exchanger and rewarms the water in the boiler, which holds it in reserve until the circulator pump moves the water through the distribution system once again. This two-phase process enables the system to maintain an on-demand supply of hot water at all times. The homeowner does not have to wait for the water to be reheated and circulated through the system.

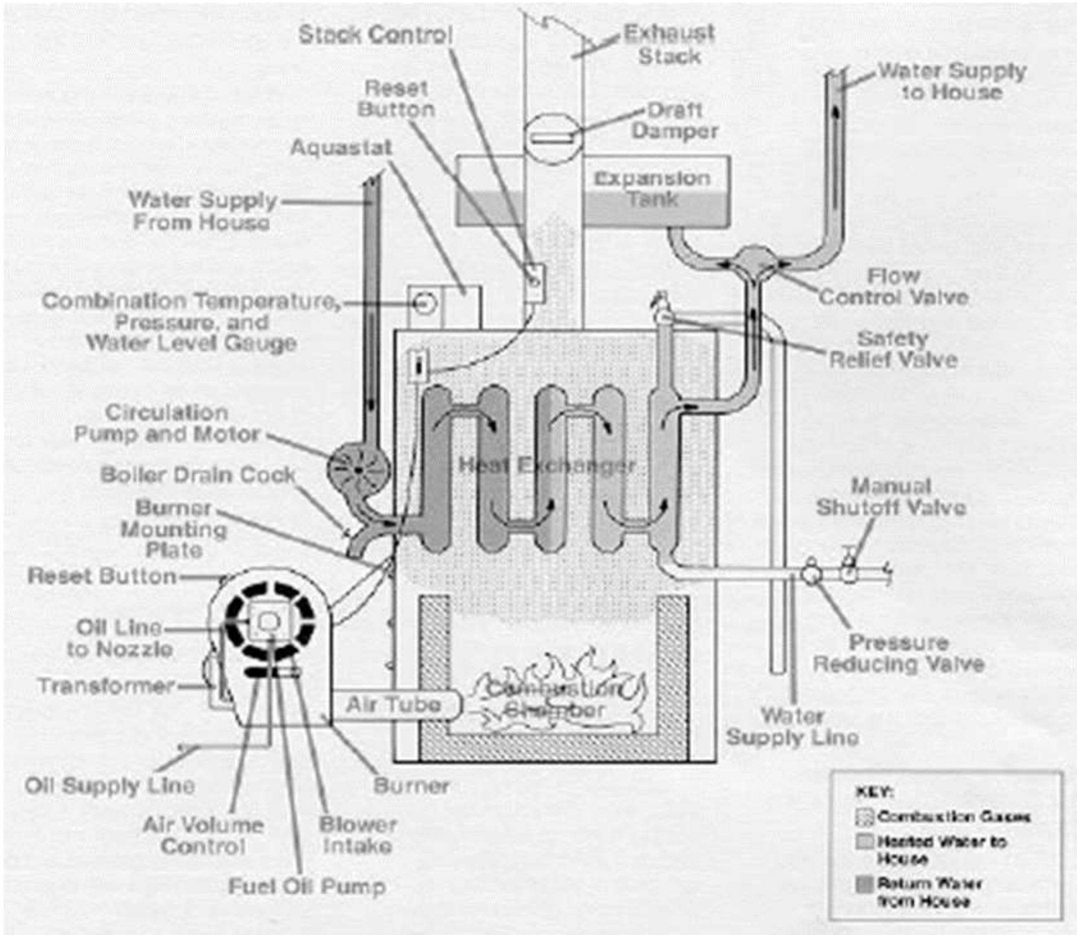


Fig. 3.3. Fuel oil forced hot water boiler

- **Single-stage**

A single-stage furnace has only one stage of operation, it is either on or off.This means that it is relatively noisy, always running at the highest speed, and always pumping out the hottest air at the highest velocity. One of the benefits to a single-stage furnace is typically the cost for installation. Single-stage furnaces are relatively inexpensive since the technology is rather simple.

- **Multi-fuel Boiler**

Hot-water boiler with independent combustion chambers (above) efficiently burns gas or oil on one side, coal or wood on the other. Chamber walls transfer heat to surrounding water, which is pumped to radiators as needed. If solid-fuel fire is allowed. To die down, oil (or gas) burner will kick in automatically. Electrical heat elements can also supplement solid fuel. In addition, tank less coil produces domestic hot water.

What they do; how they work

A multifuel heater is a furnace or boiler which will burn some combination of fossil and solid fuels. A typical unit will burn oil or gas, plus wood or coal. Some units can even operate on electricity, while others are restricted to wood, plus oil or gas.

The heat distribution system for multi-fuel units is the same as for conventional forced-air, hot-water and steam heaters. Installation is not complicated. Most units can be connected to existing house thermo- stats and Class A chimneys (tile- lined or insulated stainless steel)

barn," as one manufacturer of oil burners puts it, tends to promote greater stack loss of heat. Enno Toomsalu, associate managing engineer at Underwriters Laboratories, agrees and states further that two combustion chambers, sized specifically for the fuel to be burned in them, will tend to be more efficient than single-chamber units for burning oil or gas. Which are in good repair. Existing flues for gas-fired furnaces and boilers may not be adequate for multi- fuel units-check manufacturer's specifications and your local building code before you buy.

A multi-fuel heater is usually hand-fired with solid fuel. To do so, a homeowner must turn off the elec-tric current to his oil or gas burner and feed the combustion chamber in much the same way he would a coal or wood-burning stove. The solid fuel chamber of most units is equipped with an automatic draft set to keep the fire at an even tem-perature. If the fire gets too hot, the damper closes to reduce the air sup-ply and retard combustion. If it be-gins to cool, the damper opens to let in more air. In some units, the pri-mary air is supplied by a small ther-mostat-activated blower.

Multi-fuel heaters are set up so that when the solid-fuel fire cannot meet the demand because the fuel has dwindled, the automatic gas or oil burner switches on and takes over. Some units, usually those that have single combustion chambers for both solid- and fossil-fuel burn-ing, are designed primarily to burn solid fuel. The oil or gas burner on such units is a backup, to be used when you are away and can't feed-in solid fuel.

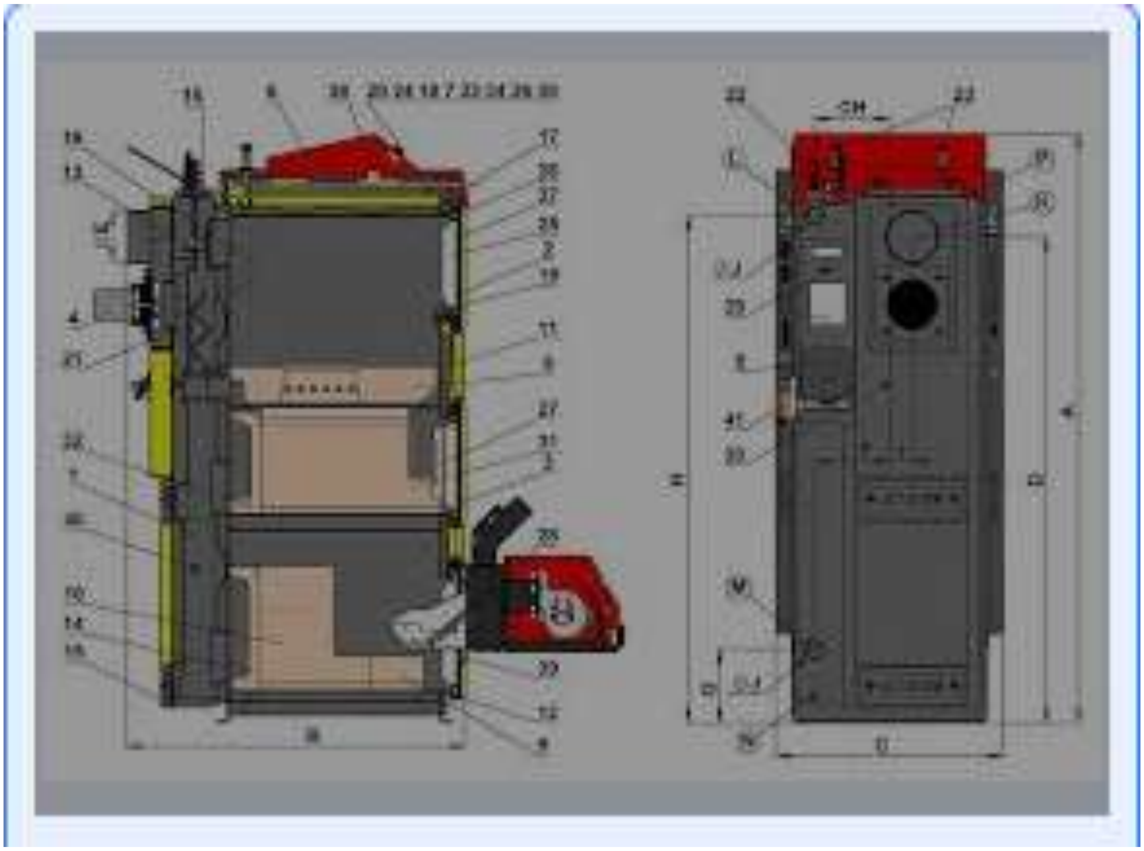


Fig.3.4. multi fuel furnace

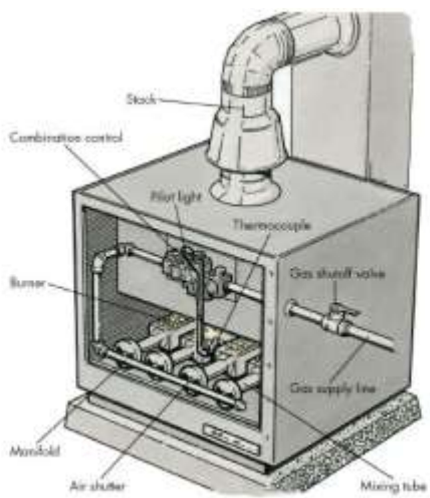
- **Gas fired furnace**

Gas fired forced air furnaces have a burner in the furnace fuelled by natural gas. A blower forces cold air through a heat exchanger and then through duct-work that distributes the hot air through the building. ... Simple types of gas-fired furnace lose significant amounts of energy in the hot waste gases.

Gas fired forced air furnaces have a burner in the furnace fuelled by natural gas. A blower forces cold air through a heat exchanger and then through duct-work that distributes the hot air through the building. [2] Each room will have an outlet from the duct system, often mounted in the floor or low on the wall - some rooms will also have an opening into the cold air return duct. Depending on the age of the system, forced air gas furnaces use either a pilot light or a solid state ignition system (spark or hot surface ignition) to light the natural gas burner.[3] The natural gas is fed to buildings from a main gas line. The duct work supplying the hot air (and sometimes cool air if an AC unit is tied into the system) may be insulated. A thermostat starts and stops the furnace to regulate temperature. Large homes or commercial buildings may have multiple thermostats and heating zones, controlled by powered dampers. A digital thermostat can be programmed to activate the gas furnace at certain times. For example, a resident may want the temperature in their dwelling to rise 15 minutes before returning from work.

Simple types of gas-fired furnace lose significant amounts of energy in the hot waste gases. High-efficiency condensing furnaces condense the water vapor (one of the by-products of gas combustion) and extract the latent heat to pre-heat the incoming furnace airflow, using a second heat exchanger. [2] This increases the efficiency (energy delivered into the building vs. heating value of gas purchased) to over 90%. An incidental beneficial effect is that the exhaust flue is much smaller and can be made of plastic pipe since the exhaust gas is much cooler. As a result it can be more easily routed through walls or floors. However, the condensing furnace is more expensive initially because of the extra induced draft fan and condensate pump required, and the extra heat exchanger in the firebox.

The heat exchangers may be damaged by corrosion or metal fatigue from many heating and cooling cycles. A small leak of combustion gases into the heated air can be dangerous to the occupants of the heated space, because of possible carbon monoxide build up.



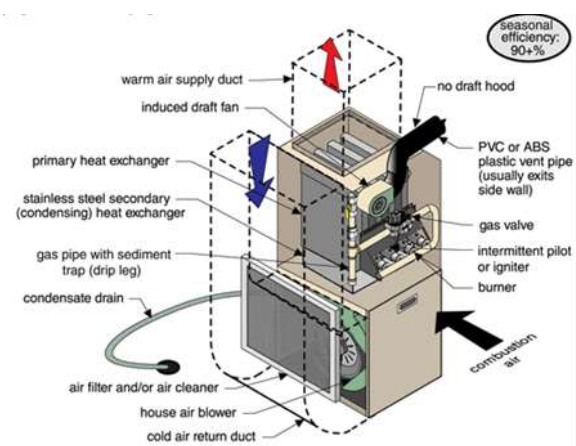


Fig. 3.5. gas fired furnace

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. furnace selection is determined by
   A. cost
   B. metal quality
   C. production requirements and alloy type
   D. All
2. Furnaces according to energy
   A. Gas fired and oil fired C. oil fired and electric
   B. Gas fired and electric D. Electric and Fuel fired
3. Once started, the flames continue to burning the combustion chamber with additional fuel oil and room air supplied through the____________
   A. Stack B. tube/nozzle C. chimney D. none

Note: **Satisfactory rating –2 points** **Unsatisfactory - below 2 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ______________

Information Sheet-4	Charging weighed according to standard operating procedures

4. Furnace Charging

4.1. Introduction

The first step in any tap-to- tap cycle is "charging" into the furnace. The roof and electrodes are raised and are swung to the side of the furnace to allow the scrap-charging crane to move a full bucket of scrap into place over the furnace. The bucket bottom is usually a clam shell design - i.e. the bucket opens up by retracting two segments on the bottom of the bucket. The scrap falls into the furnace and the scrap crane removes the scrap bucket. The roof and electrodes swing back into place over the furnace. The roof is lowered and then the electrodes are lowered to strike an arc on the scrap. This commences the melting portion of the cycle. The number of charge buckets of scrap required to produce a heat of steel is dependent primarily on the volume of the furnace and the scrap density. Most modern furnaces are designed to operate with a minimum of back-charges. This is advantageous because charging is a dead-time where the furnace does not have power on and therefore is not melting. Minimizing these dead-times helps to maximize the productivity of the furnace. In addition, energy is lost every time the furnace roof is opened. This can amount to 10 - 20 kWh/ton for each occurrence. Most operations aim for 2 to 3 buckets of scrap per heat and will attempt to blend their scrap to meet this requirement. Some operations achieve a single bucket charge. Continuous charging operations such as CONSTEEL and the Fuchs Shaft Furnace eliminate the charging cycle.

The scrap yard operator will prepare buckets of scrap according to the needs of the melter. Preparation of the charge bucket is an important operation, not only to ensure proper melt-in chemistry but also to ensure good melting conditions. The scrap must be layered in the bucket according to size and density to promote the rapid formation of a liquid pool of steel in the hearth while providing protection for the sidewalls and roof from electric arc radiation. Other considerations include minimization of scrap cave-ins which can break electrodes and ensuring that large heavy pieces of scrap do not lie directly in front of burner ports which would result in blow-back of the flame onto the water cooled panels. The charge can include lime, dolomitic lime, and carbon, or these can be injected into the furnace during the heat. Many operations add some lime and carbon in the scrap bucket and supplement this with injection.

4.2. Charging Techniques

The most efficient melting (in terms of heat transfer or efficient use of fuel) is achieved with faster melt times, and the highest metal quality is obtained when a heel of metal is used to start the melting. Here the heat travels easily from the flame through the crucible wall and into the metal. A crucible that contains only a solid charge provides little contact between the crucible wall and the metal to be melted. As a result, there is a considerable time lapse between charging and the initial melting of the charge. For efficient melting, a good heel size is roughly 25% of the crucible capacity.

A second point concerning charging is the need to keep a loose charge. When a cold charge is tightly jammed into the crucible, the expansion of this charge upon heating will often break or crack the crucible.

The third point concerns the need for gentle charging of all heavy or sharp-cornered material. Crucibles are fragile and easily broken. Many crucibles have been broken by rough and careless charging with heavy and/or sharp ingot or scrap.

4.3. Charging systems

Charging systems are required for the charging of the crucible furnaces. Smaller furnaces up to approx. 500 kg are as a rule charged by hand. Furnaces of up to approx. 3,000 kg are filled with the aid of hydraulically operated delivery chutes without a vibration drive. In the case of furnaces from approx. 5000 kg and crucible diameter is of greater than 800 mm, vibration chutes are used. From approx. 1,200 mm diameter, charging buckets with opening bottoms are also used for mains frequency induction furnaces. The most commonly used system is the vibration chute with various additional devices such as: impact protection for the crucible, a connection for an extraction hood, a complete housing for the purposes of noise protection and lateral swivel equipment for the operation of two furnaces from one rail system in a Y-arrangement. The charging troughs must be so designed that the available scrap can also be made up and conveyed in sufficient quantities. In the case of a high proportion of small particles, a separating device may have to be installed in the area 500 mm in front of the edge of the crucible

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. The first in the furnace operation is
   A. Charging B. Melting C. pouring D. preheating
2. The scrap falls into the furnace and the scrap crane does not removes the scrap bucket.
   A. True B. False
3. A crucible that contains only a solid charge provides little contact between the crucible wall and the metal to be melted.
   A. True B. False
4. Which of the following points are considers charging technique
   A. Time lapse between charging and the initial melting of the charge
   B. Need to keep a loose charge
   C. Need for gentle charging of all heavy or sharp-cornered material
   D. All

***Note:* Satisfactory rating –3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _____________

List of Reference Materials

1. Gromicko, Nick. "Gravity Furnace Inspection - InterNACHI". InterNACHI. Retrieved 2014-06-25.
2. Bill Johnson, Kevin Standiford, Practical Heating Technology, Nelson Education, 2008 ISBN 111180267X, pp.114-119
3. Gas Furnace Guides. Retrieved
4. http://www.furnaceprices.ca/#fuel-types

Foundry Work

Level II

Learning Guide-32

Unit of Competence: Operate Non–electric Melting Furnace

Module Title: Operating Non–electric Melting Furnace

LG Code: IND FDW2 M9LO2-LG-32

TTLM Code: IND FDW2 TTLM 1019v1

LO 2: Start-up furnace

Instruction Sheet	Learning Guide 32

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Inspecting furnace for any defects or damage.
- Undertaking routine operational maintenance of furnace.
- Starting-up furnace to standard operating procedures.
- Reporting faults according to standard operating procedures.

Selecting and positioning appropriate core making equipmentThis guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Inspect furnace for any defects or damage.
- Undertake routine operational maintenance of furnace to standard operating procedures.
- Start-up furnace to standard operating procedures.
- Report faults according to standard operating procedures.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3, and Sheet 4".in page 28, 31, 43 and 48
4. Accomplish the "Self-check 1, Self-check 2, Self-check 3, and Self-check 4. In page **24, 27, 30, 40, 46, and 52**respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation Sheet 2, Operation Sheet3 and Operation Sheet 4"**in page – 41,42 and 52** respectively.
6. Do the "LAP test" in page – 53 (if you are ready).

Information Sheet-1	Inspecting furnace for any defects or damage

1.1. Crucible furnaces

Are one of the oldest and simplest types of melting furnace unit used in the foundry. Thefurnaces uses a refractory crucible which contains the metal charge. The charge is heated via conduction of heat through the walls of the crucible.

The modern crucible process offers industry a great deal of flexibility and a wide variety of options with regard to metals, melt sizes, fuels, smelting, and processing techniques. Aluminum, brass, bronze, copper, ductile or gray iron, steel, magnesium, Monel, nickel, refractory alloys, steel, and other metals and alloys are produced using the crucible melting processes. Crucible capacity can vary from mere ounces for laboratory melts to 1.4 Mg (3000 lb) for the melting of aluminum alloys. Fuel choices include coal, coke, electricity, commercial gases (natural, propane, producer, and so on), and fuel oil. Crucible liners are often used for low- or high-frequency electric induction furnaces.

Foundry metal melting and handling operations that utilize crucible equipment include furnace melting, pouring ladle equipment (either separately heated or as a ladle liner), and liners for electric induction melting furnaces. Metal processing operations include in-line filtration, fluxing, and hydrogen gas content control. Crucible melting can also be used as a component of quality adjustment equipment between melter and casting furnaces to alter the chemistry and temperature of the melt for control of such factors as porosity content prior to casting. Crucible melting is a simple and flexible process. Crucible furnaces can generally be started or shut down at a moment's notice. Normally, there is non-stand by charge for labor costs between uses of this equipment.

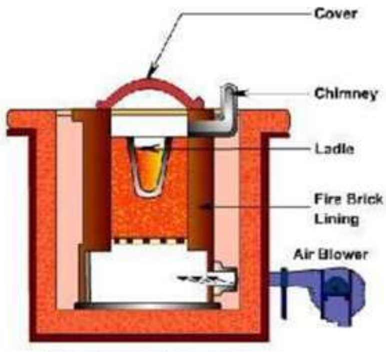


Fig.1.1. Coke Crucible Furnace

- **Please specify inspections performed and any corrective actions or adjustments made.**

  - ✓ Inspect Filters
  - ✓ Inspect duct work
  - ✓ Inspect flue and vent system
  - ✓ Inspect combustion air opening for blocks or restrictions
  - ✓ Inspect thermostat operation
  - ✓ Inspect blower assembly including housing, wheel, and motor
  - ✓ Inspect electrical outlet for proper voltage
  - ✓ Inspect and tighten electrical connections
  - ✓ Perform heat rise test
  - ✓ Inspect safety controls and heat exchanger
  - ✓ Inspect burner assembly
  - ✓ Inspect and clean flame sensor
  - ✓ Inspect inducer
  - ✓ Inspect Ignition system
  - ✓ Inspect for gas leaks in furnace
  - ✓ Inspect for carbon monoxide

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Why inspect furnace
   A. To increase life of furnace
   B. To eliminate possible defects
   C. To improve efficiency of the furnace
   D. All
2. List the basic inspection areas (min 6)

Note: **Satisfactory rating - 2 points   Unsatisfactory - below 2 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________
Rating: ______________

Name: ___________________________   Date: ________________

Short Answer Questions

2.1. Routine operational maintenance

- **Routine lubrication**

How to Properly Oil a Furnace Blower Motor

The **furnace blower motor** comes equipped with fans. If these fans become dirty or lacks lubrication, it starts squeaking. This can be easily fixed. Here's how you do the job.

Step 1 – Locating the Oil Ports - Most furnace blower motors come equipped with a self-oiling system, but if yours does not have this then you will have to manually lubricate it. Locate the oil ports in the motor. This is where the oil has to be applied.

Step 2 – Buying the Right Lubricant - Buy non-detergent oil that is exclusively made for the furnace blower motor. Do not use an all-purpose oil, as it is not apt for this procedure.

Step 3 – Oiling the Furnace Blower Motor - Lubricate the oil ports by applying a few drops on them. Two or three drops would suffice. Do not apply too much oil, as over lubrication can lead to other complications.

Step 4 – Blower Shaft - Blower shafts on the furnace blower motor could have additional oil ports. Locate them and lubricate the ports with the same quantity of oil. It is imperative to lubricate the furnace blower motor once in a year for smooth, hassle free operation.

- **Cleaning**

Cleaning your furnace is an important task to keep on your home maintenance schedule. A dirty furnace will burn higher amounts of electric and/or gas fuel as well as work less effectively than a clean furnace. There are 3 basic parts of your furnace that can be impacted by the presence of dirt: the filter system, the blower, and the heat exchanger. You must know how to clean a furnace effectively and do so regularly if you want to extend the life of your current furnace and prevent costly repairs.

PART ONE-Inspecting the Furnace Filter

- **Locate the access panel on the outside of the furnace.** This is below the return-air duct, between the blower system and the duct. Usually, the filter is found inside the front of the furnace. You may need to unscrew the front panel from the furnace or remove it from hooks that hold it in place in order to access the filter. Your furnace filter may also have its own access door.
- **Remove the filter by pulling it up and out of the tracks.** Generally, the filter should come out quite easily. To prevent damage to the filter and/or furnace, don't force the filter out. If it seems stuck, look carefully and see if anything (like dirt or debris) is blocking it
- **Inspect the filter for dirt or damage.** If the filter appears dirty, it needs to be cleaned or replaced, depending upon the filter type
  - ✓ If you are unsure whether your filter is dirty, hold it up to the light, and look through it. If you cannot see the light, the filter is dirty and needs to be replaced. A dirty filter will circulate dirt and dust through your home instead of usable, clean air and will force your furnace to work harder to push air through the grime.
  - ✓ If your filter is not disposable, it must be cleaned. First remove any dirt or loose particles. Generally, a mild soap and tap water can then be used to rinse and wash the filter.
  - ✓ Make sure to let the filter dry thoroughly before putting it back in the furnace.
  - ✓ Many furnaces use a disposable filter. If this applies to yours, take the old filter to a hardware or appliance store (or record the size and/or model number), and purchase a replacement filter of the same type or model.
- **Place the new or newly cleaned filter back into the furnace**. Slide the filter back into the furnace so that it fits securely. Then close the access door or reapply the furnace's front panel using the hooks or screws.

- ✓ If the filter doesn't seem to fit properly, make sure that no dirt or debris is blocking it. If you have a new filter that doesn't seem to fit right, double-check that you purchased the correct type or size.

- **Remember to inspect your filter regularly.** Furnace filters will need to be cleaned or replaced three or four times a year. Set reminders on your calendar to inspect yours regularly. For instance, you can check your filter on the first day of each season of the year.

PART TWO- Cleaning the Blower Assembly

- **Unplug your furnace.** Make sure that all power sources that run to your furnace unit, including battery backup systems or electrically generated power, are unplugged. Failure to turn off any source of power before cleaning the assembly may result in electrocution and/or serious bodily injury.
- **Remove the front panel of the furnace**. To clean the blower assembly, you will most likely have to remove the whole front panel, even if your furnace has an access door for cleaning the filter. To remove the panel, you may have to loosen the screws that hold the panel in place or take the panel off its supporting hinges.
- **Slide the fan unit out of the furnace.** Most fans are secured to the furnace by a track, which allows it to slide in and out easily. The fan may also be connected by wire connections. If so, make a note of where each wire connects to the fan before removing them. This will make it easier to reassemble the unit.
  - ✓ You can wrap a small piece of tape around each wire and label it, to make reassembly easier—just make sure to remove the tape labels before reattaching the wires to the blower fan.
  - ✓ Some fans are held in by screws or bolts; remove these with a screwdriver or ratchet in order to take the fan out. Keep the screws or bolts in a safe place so you won't lose them before you are ready to put the fan back.

- **Clean the blower assembly.** A mild soap, and water are usually sufficient for cleaning the blower, although a toothbrush may help you to clean the fan blades and the small spaces between them.
  - ✓ The blower assembly is the component that pulls air in through the back of the furnace, pushes it out of the front, and creates the heat. If the blower assembly is dirty, your furnace will push dust and dirt out through the vent system of your home. Thus, it is very important to clean the assembly well.

- **Vacuum the assembly.** Running a handheld vacuum on low power over the fan blades and belts will help ensure that all dirt is removed. If you do not have a vacuum, you can also wipe any belts clean with a damp cloth.
- **Put the fan blower assembly back into the furnace.** Once the assembly is clean and thoroughly dry, slide it back onto its track so that it fits into the furnace again. If you had to disconnect any wires to remove the assembly, reattach them, making sure to connect them to the right location.

PART THREE- Cleaning the Heat Exchanger Block

- **Turn the furnace off: -** Unplug all power connections running to your furnace. If it is a gas furnace, you should also turn the gas off.
- **Clear any dirt off of the block: -** Use a brush to loosen the black build-up off of each chamber of the block. You can also use a damp cloth to remove this buildup.
- **Vacuum the block assembly: -** Using a narrow vacuum attachment, thoroughly clean all chambers of the heat exchanger block assembly. Using a vacuum will help ensure that all of the debris you loosened off of the assembly is removed.
  - ✓ Remember to plug your furnace back in and turn it on once you have finished cleaning and vacuuming the heat exchanger block.

Flame Sensor Cleaning

The flame sensor is a crucial safety feature on your gas heating equipment. It safeguards your furnace against the unsafe burning of fuel, and a dirty flame sensor may cause your furnace to function improperly.

Typically, the flame sensor comes in the form of a rod that can be found near the back of the furnace, right in the path of the burner.

How to Clean the Sensor:

Step 1: Turn off power to the furnace at the breaker box

Step 2: If possible, remove the sensor from the furnace

Step 3: Scrub the sensor gently to remove dust and other residues

Step 4: Reattach the sensor

Step 5: Resume power to the furnace

Over time, if the flame sensor is not cleaned appropriately, oxidation or carbon buildup can restrict the flame sensor's ability to work properly, which can cause the furnace to malfunction

- **Routine repair: -** The following items are to be maintained on a regular basis:

Combustion air blowers

Blow dirt out of the fan wheels with an air hose monthly. If dirt builds up on the fan blades, first scrape clean, then blow air out.

Flame sensors

Safety switch with thermocouple sensor – replace thermocouple annually.

Electronic safety with flame rod – Clean rod with emery cloth monthly; replace if it is badly burned.

Electronic safety with ultraviolet sensors – Clean UV scanner lens monthly; replace sensor annually.

Oil burners

Check and clean burner nozzles every six months.

If system is equipped with a fuel filter, the filter cartridge should be replaced after the first two weeks of operations, and every six months following that.

The burner internals should be checked at the same time the nozzles are inspected, to be sure the spark electrodes and wires are in good condition and are not corroded. The internals should be cleaned and checked for leaks at that time. This would also be a good time to clean the blower.

The oil pump on the burner is direct driven by the blower motor through a flexible coupling. The coupling is a vital part of the oil system, and should be periodically inspected for wear, damage and loose components.

- **Repairing of refractory lining**

The most important part of the furnace is perfect refractory work. Its material, quality & chemical composition decide the furnace life which is very important. We undertake all types of oil fired furnace refractory lining work and furnace cell designing and fabrication works. Air and oil pipe line fabrication works, chimney fabrication and erection works and furnace pollution control scrubber fabrication and erection works. As we have skilled & experienced group of people to fulfill the technical requirement of lining work.

Maintenanceof Gas Furnace

External Air Filters

Filters used with this furnace must be installed external to the furnace casing. DO NOT attempt to install filters inside the furnace cabinet. Some installations may have the air filter in a rack attached to the casing of the furnace or placed in the return air duct. If the filter location or replacement process is not obvious, contact your installer or service technician for assistance.

Every time the external air filters are changed, the following items should be visually inspected:

- ✓ Check combustion air and vent pipe for blockage or leakage;
- ✓ Check all components to be sure they are in good condition and that there are no obvious signs of deterioration;
- ✓ Check the drain lines to make sure there are no cracks or leaks;
- ✓ Check for dirt or lint on any surfaces or on components.

Do not try to clean any of the surfaces or components. Cleaning of the furnace and its components must be done by a qualified service professional.

If during the inspection of your furnace, you find any of the following conditions:

- ✓ Excessive amounts of dust and lint on components;
- ✓ Damaged or deteriorated components or surfaces;
- ✓ Leaks or blockage in the vent pipe passages;
- ✓ Water on any surface inside or outside of the furnace.

Do not operate the furnace, call a certified dealer or servicing contractor to check or clean your furnace, or for more information if you have questions about the operation of your furnace. If all components appear to be in good operating condition, replace the furnace access panels/doors. Turn ON the gas and electrical power supplies to the furnace, and set thermostat to the desired temperature.

Blower Care

Even with good filters properly in place, blower wheels and motors will become dust laden after months of operation. The entire blower assembly should be inspected annually. This service must be performed by a qualified service agency.

NOTE: The spring-loaded safety cut-off switch, mounted at the blower deck will automatically cut off the electrical power supply to the furnace when the furnace blower access panel/door is removed. As a safety precaution, all electrical power and the gas supply to the furnace should be turned off before servicing.

The Furnace/Boiler

- ✓ Change the fuel oil filter periodically.The fuel filter cleans the fuel of any impurities (e.g., dirt and water) that may affect the efficient supply, ignition and burning of the fuel. Consult the owner's manual for the correct procedure.
- ✓ Clean and lubricate the burner motor. Dust and oil buildup will shorten the life of theburner motor. Vacuum away any loose dust and wipe away any oil

buildup or greasy dirt. Lubricate the burner motor according to your owner's manual.

- ✓ Inspect the burner mounting plate for evidence of leaks. They can alter the fuel/air mixture and allow smoke to escape into the room. If smudges are present around the plate, call your heating contractor to correct the situation.
- ✓ Inspect the furnaces/ boilers electrical system. Electrical problems affect the performance of a unit and also present a safety hazard. Badconnections, bare wires, blown fuses, tripped circuit breakers and tripped reset buttons (the reset button automatically disconnects the electricity to an overloaded electrical motor) indicate that an electrical problem is present.
- ✓ Inspect the exhaust stack forbad connections and damaged or corroded pipes. Replace if damage is evident.
- ✓ Clean the draft regulator the mechanism controlling the rate at which combustion gases are pulled up and out the exhaust stack. Soot and dust buildup can interfere with the draft regulator's efficient operation. Vacuum any loose dust and wipe off any greasy soot. Also clean the back side of the hinged plate. Any modifications or changes in the draft regulator setting should be done by a qualified service person.
- ✓ Inspect the fuel storage tank for leaks. Clues include oil stains or puddles and/or a strong odor in the vicinity of the tank. Call a heating contractor to replace the unit.
- ✓ Clean the furnace room periodically. Dirt and lint from areas surrounding the unit can be pulled into the burner along with combustion air. Eventually they will slow the movement of combustion air to the unit, causing it to burn inefficiently and give off soot.
- ✓ Clean and adjust the room thermostats. Dust buildup interferes with efficient thermostat operation. Remove the cover and wipe away dust with a soft brush, such as a watercolor paint brush. Work carefully- thermostats are fragile.
- ✓ Observe the color of smoke leaving the chimney. Black smoke is a sign of poor combustion. Call a heating contractor to make needed adjustments.

- ✓ Inspect any visible sections of the chimney and the chimney top. If they are worn or damaged, consult your heating contractor.
- ✓ Most oil furnaces are equipped with a reset button located on either the stack control or the primary control-the safety devices that shut the burner off if a flameless condition exists. Stack controls are found on older units, while primary controls are found on newer ones. If the reset button trips the burner off, a fuel supply or ignition problem has occurred. Push the reset button once to restart the burner. If the reset button trips the burner off again, contact your heating contractor.
- ✓ Safety note oil-fired furnaces and boilers require an adequate supply of air to ensure proper and safe burning of the fuel. In addition, adequate clearances are necessary between combustibles such as walls, doors and framing members and the furnace/boiler, the vent stack and the chimney never enclose a unit unless you check with a heating contractor about the unit's combustion air needs. Never store combustible materials near the unit.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. dirty furnace will burn higher amounts of electric and/or gas fuel
   A. True B. False
2. One of the following items should be visually inspected
   A. Check combustion air and vent pipe for blockage or leakage;
   B. Check all components to be sure they are in good condition and that there are no obvious signs of deterioration;
   C. Check the drain lines to make sure there are no cracks or leaks;
   D. Check for dirt or lint on any surfaces or on components.
   E. All
3. If during the inspection of your furnace, by whichconditions do not operate furnace.
   A. Excessive amounts of dust and lint on components
   B. Damaged or deteriorated components or surfaces
   C. Leaks or blockage in the vent pipe passages
   D. Water on any surface inside or outside of the furnace
   E. All
4. Repairing of refractory lining includes
   A. Chimney B. Air and oil pipe line C. All D. None
5. Oil-fired furnaces and boilers require an adequate supply of air to ensure proper and safe burning of the fuel
   A. True B. False

***Note:* Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Operation Sheet 1	Techniques of Cleaning the Blower Assembly

- **Cleaning the Blower Assembly**

Step 1. Unplug your furnace

Step 2. Remove the front panel of the furnace

Step 3. Slide the fan unit out of the furnace

Step 4. Clean the blower assembly

Step 5. Vacuum the assembly

Step 6. Put the fan blower assembly back into the furnace

Operation Sheet 2	Techniques of Inspecting the Furnace Filter

- **Inspecting the Furnace Filter**

Step 1. Locate the access panel on the outside of the furnace

Step 2. Remove the filter by pulling it up and out of the tracks

Step 3. Inspect the filter for dirt or damage

Step 4. Place the new or newly cleaned filter back into the furnace

Step 5. Remember to inspect your filter regularly

Operation Sheet 3	Techniques of Cleaning the Heat Exchanger Block

- **Cleaning the Heat Exchanger Block**

Step 1. Turn the furnace off

Step 2. Clear any dirt off of the block

Step 3. Vacuum the block assembly

Information Sheet-3	Starting-up furnace to standard operating procedures

Start-Up Procedures

WARNING

Never purge a gas line into a combustion chamber. Never use matches, candles, flame, or other sources of ignition for the purpose of checking leakage. Use a soap-and-water solution to check for leakage. Failure to follow this warning can cause fire, explosion, personal injury, or death.

- ✓ Purge gas lines after all connections have been made.
- ✓ Check gas lines for leaks.

WARNING

Blower access door switch opens 115-v power to control. No component operation can occur unless switch is closed. Caution must be taken when manually closing this switch for service purposes. Failure to follow this warning could result in electrical shock, personal injury, or death.

- ✓ To Begin Component Self-Test: Disconnect the thermostat R lead from furnace control board. Manually close the blower door switch. Briefly short the TEST/TWIN terminal to the COM 24V terminal until LED goes out. Remove jumper from terminals.
- ✓ Operate furnace per instruction on door.
- ✓ Verify furnace shut down by lowering thermostat setting below room temperature.
- ✓ Verify furnace restarts by raising thermostat setting above room temperature.

Unit Start-up pre-startup checklist

- ✓ Electrical supply status.
- ✓ Fuel supply off.
- ✓ Perform safety inspection of area – remove tripping hazards.
- ✓ Visually inspect furnace.
- ✓ Check fuel level in fuel tank(s).
- ✓ Ensure there is no standing water in unit, ingot holders, or in/on scrap metal.
- ✓ Sort metal avoiding metal with magnesium, zinc, or lead and use only dry metal

Start-up

- ✓ Turn power supply on
- ✓ Turn blower switch(s) "on" and ensure they are operating correctly
- ✓ Open fuel valves to primary/holding chamber(s) and afterburner
- ✓ Turn ignition switch on to start burners
- ✓ If there is moisture in the primary chamber, run an hour before smelting to dry it out
- ✓ Set to manufacturer's recommended temperature for primary/holding chambers
- ✓ Set afterburner temperature to $1600^{o}F$; afterburner must be started up before charging with scrap
- ✓ After temperatures have stabilized, move charging table in place
- ✓ Deposit aluminum onto table

Control of the fuel gas flow at startup

It is largely agreed that controlling the fuel gas pressure at light-off is an important safety requirement. In the past, the norm was to ignite burners manually. The operator procedure would specify to open the burner manual valve slowly to ensure a smooth ignition. More recent burner ignition methods with the operator at a safe location have shown that when the fuel gas control valve lacks the required turndown to light the first few burners, the first burners will need to be ignited at a higher pressure to prevent tripping on low fuel gas pressure. A startup override to defeat the high pressure trip is then required until enough burners can be ignited for the control valve to be within control range. Thus, the correct selection and sizing of the fuel gas control valve is a critical design issue. Unfortunately, the process data on valve specification sheets is typically provided for all burners in service and rarely identify the turndown requirements to light the first few burners of a multiple burner system. If a heater is equipped with six burners and if burner ignition is to be performed at ¼ of the burner capacity, the required turndown of the control valve should be a very minimum of 24. This widely exceeds the 1 to 10 turn-down of a globe valve.
A preferable, inherently safer practice is to properly size the control valve or install a startup regulator to assist the operator, is lighting the burners at lower pressure. When the control valve lacks sufficient startup turndown to light the first burner, the common best practices to maintain the desired light-off pressure are to install a small bypass line with a startup

regulator or to select a Vee-ball with improved startup turndown (estimated at 300:1 or better). The benefit of a startup regulator is that it requires no action by the operator to hold light-off pressure. In contrast, the controller output to the Vee-ball will have to be manually adjusted (from burner curve calculations) until the valve is within control range for automatic pressure control.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Checking of leakage done by
   A. Matches B. candles C. flame D. Soap and water
2. It is possible to purge a gas line into a combustion chamber
   A. True B. False
3. List the basic start-up procedures of furnace. (5 pt.).

***Note:* Satisfactory rating –4 points Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: ____________

Operation Sheet 4	Techniques of starting up Furnace

Procedures of starting up furnace

Step 1. Turn power supply on

Step 2. Turn blower switch(s) "on" and ensure they are operating correctly

Step 3. Open fuel valves to primary/holding chamber(s) and afterburner

Step 4. Turn ignition switch on to start burners

Step 5. If there is moisture in the primary chamber, run an hour before smelting to dry it out

Step 6. Set to manufacturer's recommended temperature for primary/holding chambers

Step 7. Set afterburner temperature to 1600^{o}F; afterburner must be started up before charging with scrap

Step 8. After temperatures have stabilized, move charging table in place

Step 9. Deposit aluminum onto table

Information Sheet-4	Reporting faults according to standard operating procedures

1.1. Operational Problem Reporting

Where external users of the NM operational services encounter problems, a number of possible reporting methods are available, depending on the type of problem and the service concerned.

This procedure is divided into three parts:

- **Real Time Operational Problem reporting**

The first part gives detailed instructions for external users of the NM operational services who encounter operational problems which require immediate action.

- **Post Event Operational Problem Reporting**

The second part provides reporting instructions for external users of the NM operational services in post event mode, where either an operational problem has occurred or apparent anomalous behavior has been identified.

- **Technical Problem Reporting**

Part three indicates the actions required for external users of the NM operational services who encounter technical difficulties.

1.2. Faults

- **Damage crucible**

Improper charging practices are crucible killers. Physical damage caused by dropping heavy charge materials into an empty crucible will not simply reduce crucible service life, it also can cause sudden crucible failure. When charging an empty crucible, small scrap materials and returns first should be carefully placed in the bottom of the crucible to protect that interior surface. Then ingots can be carefully added. If only ingots are being charged, they should be slowly lowered vertically into the furnace, using tongs if the furnace is deep. Do not pack metal tightly, allow room for the metal to expand and to reduce the likelihood of bridging. Some crucible materials are more resistant to physical damage than others. Know how resistant your crucible is to physical damage and respect its limitations.

Fig. 4.1. The impact of charge material dropped into the crucible produced this damage

Every crucible has a maximum temperature limit. You must know that limit and operate below it. Exceeding that limit will damage the crucible, reduce its service life and can lead to crucible failure. The best defense against crucible overheating is to follow a practice of taking frequent temperature readings of the molten bath with a portable or fixed pyrometer. Remove from service any crucible that has been subjected to temperatures above its maximum limit.

Protecting Your Crucible From Chemical Attack – If your melting or holding application requires the heavy use of fluxes or produces large amounts of slag or dross, you must use a crucible type that provides resistance to chemical attack and erosion. But you can help any crucible type resist chemical attack and slag and dross accumulation by using the minimum quantity of flux required and only adding flux after the metal is fully molten. It is also important to carefully clean your crucible every day while it is still in a red hot condition. Dross has a high expansion rate and causes internal pressure that can damage the crucible. It also accelerates chemical attack.

The common causes of heater and boiler explosions are:

- Inadequate purge during start-up sequence, mostly because of leaking, damaged or obstructed single safety shutoff valves. A partial list of accident causes include the following:
  - ✓ Insufficient purge flow rate
  - ✓ Insufficient purge time
- Inadequate or improperly followed start-up procedure. A partial list of accident causes include the following:

- ✓ Repeated attempts to light pilot without intermediate purging
- ✓ Burner ignition attempt with excessive gas flow or for a too long trial-for-ignition period, allowing fuel toreach the explosive limit
- ✓ Insufficient time between successive ignition attempts, allowing fuel to accumulate in the combustionchamber and reach the explosion limit
- ✓ Safety shutoff valves bypassed

- Delayed ignition at start-up, with gas not ignited as soon as it enters the furnace but instead collected in an unburned cloud before being ignition. A partial list of accident causes include the following:
  - ✓ Improper use of hand torch
  - ✓ Pilot too small, improperly positioned or unreliable
  - ✓ Poor mechanical condition of the pilot or burner
  - ✓ Improper fuel flow control at low load
- Improper fuel-air ratio, causing the burners to flame out. A partial list of accident causes include the following:
  - ✓ Erroneous operation of air registers, leading to operate some burners with only part of the required combustion air
  - ✓ Failure of the control system allowing the overall air/fuel mixture to become sub-stoichiometric
  - ✓ Excessive draft causing a high level of tramp air ingress and operation of burners with a sub-stoichiometric air/fuel ratio
  - ✓ Unstable fuel supply due to changes in the fuel gas composition
- Presence of liquid condensates or inserts in the fuel gas system, caused by flaws in the fuel gas network design.
- Tube failure, causing a large and sudden release of hydrocarbon in the combustion chamber. A partial list of accident causes include the following:
  - ✓ Over firing the tubes above their metallurgical limit
  - ✓ Operation with significant tramp air, leading to flame impingement on tubes and hot spots.
  - ✓ Uneven distribution of heat release, leading to flame impingement on tubes and local hot spots

- Insufficient maintenance of the equipment, causing difficulties to ignite the pilots or burners. A partial list of accident causes include the following:
  - ✓ Fouling of the fuel gas supply to the pilots or burners
  - ✓ Damage to the pilots, pilot igniters or burners
  - ✓ Damage to the stack damper or fan dampers

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

4. __________ is caused by dropping heavy charge materials into an empty crucible will not simply reduce crucible service life, it also can cause sudden crucible failure.
   A. improper charging
   B. overheated
   C. under heated
   D. none
5. Every crucible has a maximum temperature limit
   A. True
   B. False
6. Tube failure, causing a large and sudden release of hydrocarbon in the combustion chamber.
   A. True
   B. False
7. The stack damper or fan dampers are damaged when
   A. Insufficient maintenance of the equipment
   B. causing difficulties to ignite the pilots
   C. All
8. Foundry metal melting and handling operations that utilize crucible equipment include
   A. furnace melting
   B. pouring ladle equipment
   C. liners for electric induction melting furnaces
   D. All

***Note:* Satisfactory rating –3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

LAP Test	Practical Demonstration

Name: _______________________________ Date: _________________

Time started: __________________________ Time finished: _________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 4 hours.

Task 1. Cleaning the heat exchanger and blower of the furnace.

Task 2. Inspecting filters of the furnace

List of Reference Materials

1. www.morganmms.com
2. Foundry Work For The Amateur By TERRY ASPINE
3. http://www.eurocontrol.int/publications/nm-operational-problem-report-form-ms-word-format
4. Gromicko, Nick. "Gravity Furnace Inspection - InterNACHI". InterNACHI. Retrieved 2014-06-25.
5. Bill Johnson, Kevin Standiford, Practical Heating Technology, Nelson Education, 2008 ISBN 111180267X, pp.114-119
6. Gas Furnace Guides. Retrieved
7. http://www.furnaceprices.ca/#fuel-types

FOUNDRY WORK

Level II

Learning Guide -33

Unit of Competence: -	**Operate Non–electric Melting Furnace**
Module Title: -	**Operating Non–electric Melting Furnace**
LG Code:	**IND FDW2 M9 LO3-LG-33**
TTLM Code:	**IND FDW2 TTLM 1019v1**

LO3 : Charge furnace

Instruction Sheet	Learning Guide #33

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Identifying emergency/safety procedures..
- Pre-heating materials if required.
- Charging materials into furnace using.
- Identifying suitable areas for emergency unloading of molten metal

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Identify and follow Emergency/safety procedures as necessary.
- Pre-heat Materials if required according to standard operating procedures.
- Charge Materials into furnace using standard operating procedures.
- identify and keep available Suitable areas for emergency unloading of molten metal

Learning Instructions:

5. Read the specific objectives of this Learning Guide.
6. Follow the instructions described below 3 to 6.
7. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 and Sheet 4".
8. Accomplish the "Self-check 1, Self-check t 2, Self-check 3 and Self-check 4" **in page -6, 9, 12 and 14** respectively.
9. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 " **in page -15.**
10. Do the "LAP test" **in page – 16** (if you are ready).

Information Sheet-1	Identifying emergency/safety procedures.

3.1. **Identifying emergency/safety procedures.**

- Charge materials must be dry and free of combustible materials and liquids. If submerged under a molten bath, can vaporize and cause a possible boil-over or explosion.
- Care should be exercised when adding low melting point materials that have low vaporization Temperatures into high temperature baths. If such materials become submerged before they Melt, they can vaporize and cause a possible boil-over or explosion.
- Built equipment is designed for safe, efficient and reliable operation with maintenance ease. If Some simple rules of operation are observed. Several safety features are built into Magnalenz equipment to provide operator protection. DO NOT OVER LOOKED THESE SAFETY FEATURES.
- Keep all cabinet doors locked and make keys available only to those who require access to the Enclosure.
- Keep shields, covers and other protective devices in place at all times. An open enclosure is a Peril to personnel

WHEN CHARGING A FURNACE…

- Use only dry charge material.
- Be sure bundled or baled scrap is dry before adding to melt.
- Do not allow closed or partially closed containers that may contain liquids (beverage can Sheared tubing, etc.) to be mixed with the furnace charge. Liquids or pieces of combustible material can vaporize instantly upon contacting the melt and scatter molten metal.
- The above precautions are especially important with aluminum because scattered molten Particles can combine with oxygen which can result in a secondary explosion.

ELIMINATING WET SCRAP

In foundries where most of the charge originates as scrap, wet charge materials pose the greatest Cause for concern. Some foundries reduce the possibility of water/metal explosions by storing Scrap undercover for a least one day and then carefully inspecting bales and containers for any Residual moisture. But a more reliable solution being used by an increasing number of foundries today is to use remote charging systems with charge dryers or pre heaters. Remote charging systems permit the operators to be safely back from the furnace or behind Protective screens during charging. Dryers and pre heaters maximize the removal of water and Moisture before the scrap enters the bath.

Information Sheet-2	Pre-heating materials if required.

3.2. Pre-heating materials if required.

Scrape pre-heating

First initiated during the the fifties to prevent explosion during melting from moisture and ice (more scrape drying)

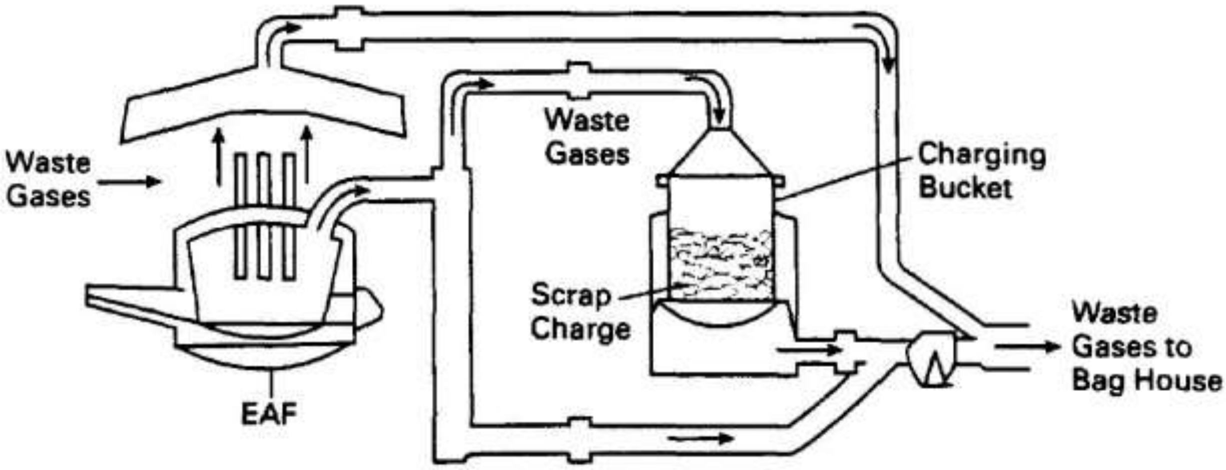
- Early scrap pre-heating systems used independent heat sources
- Separated scrap preheating
  - ✓ Mostly for increased productivity, not for decreased energy consumption
  - ✓ Possible energy savings
    - ➢ Better utilisation of organic components in the scrap
    - ➢ Lower energy losses because of lower tap to tap time
- Normal charging of cold scrap possible
- Efficiency
  - ✓ 35 % direct flow
  - ✓ 65 % recirculated flow
- **Utilizing energy in off-gas**
- Off-gas approximately 25% of energy from the process
- Development towards
  - Continuous preheating
  - Higher pre-heating temperatures ~1000 oC possible
- Pre-heating closely related to scrape charging

3.3. **Charging materials into furnace using.**

Charging and pre-heating concepts

- Several different concepts are available today from different suppliers
- Establish concepts
- Bucket charging with pre-heating
  - ✓ With EAF off-gas or conventional burners
  - ✓ Drying / preheating up to 200 °C possible without need for dioxine treatment
  - ✓ Short power-on time is a problem
  - ✓ Possible for all furnaces
  - ✓ Energy savings 35 kWh/ton

Bucket charging with pre-heating



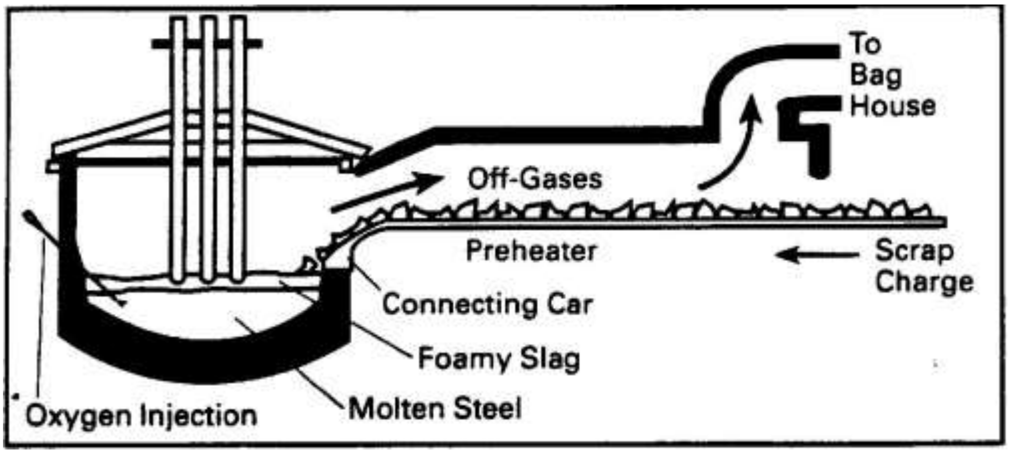
charging and pre-heating concepts

- Establish concepts with continuous or semi continuous charging
- **Consteel**
  - ✓ Develop by Intersteel Technology Inc i Charlotte, North Carolina (since 1994 a part of Techint, Tenova S.p.A.)
  - ✓ 45 installations 18 countries (Norway 2008, Celsa armeringstål, Mo i Rana)

- ✓ Continuous scrap charging into flat bath

- **Finger Shaft Furnace, FSF**
  - ✓ Developed by Fuchs
  - ✓ Many installations ~30 since first installation at DDS Denmark 1988 (This installation was replaced by a conventional EAF 1992)
  - ✓ Semi continuous scrap charging into flat bath
- **Several additional solutions are available**

- **Consteel consept**



Consteel consept - Advantages

•Electrical energy savings

•Lower power requirement for the same level of production reduces kWh unit cost

•Decreased problems with flicker and other disturbances on the grid

•Lower electrode consumption and electrode breakage

•Cost reductions for logistics, manpower, maintenance and waste product management

•Lower use of oxygen and no burner fuel consumption in the furnace

•1 - 2% increase in scrap yield

•Less dust is evacuated to the baghouse

Information Sheet-4	Identifying suitable areas for emergency unloading of molten metal

3.4. **Identifying suitable areas for emergency unloading of molten metal**

Materials Handling in Foundries

- General safe working recommendations
  - Instruct workers in the safe methods of manual and mechanical materials handling.
  - Provide PPE such as eye protection, safety hats, face shields, and gloves.
  - Plan the sequence and method of handling materials to eliminate unnecessary handling.
  - Safeguard mechanical devices and set up inspection procedures to ensure proper maintenance.
  - Keep good order at storage piles and bins, and pile materials properly.
  - Keep ground and floor surfaces level.
  - Install side stakes or sideboards on tramway or railroad cars to prevent materials from falling off.
  - Chock railroad cars and flag tracks.

- Sand, coal, and coke
  - Prevent falls through hoppers while unloading bottom-dump railroad cars with fall protection.
    - Be sure observers are on the scene and prepared to summon help in emergencies.
  - Use safety ratchet wrenches for hopper doors to keep the doors from swinging and striking workers.
  - Prevent hand and foot injuries by using safety car movers instead of ordinary pinch bars to spot cars by hand.
  - To reduce cave-ins of loose material, prohibit the undermining of piles and avoid overhangs.
  - Prevent electric shock by grounding portable belt-conveyor loaders.

- To keep dump cars under repair from being moved, use locking switches and car chocks.

Materials Handling in Foundries

- Ladles
  - Provide a manually operated safety lock and suitable covers for portable ladles.
  - Thoroughly dry out and heat ladles before use.
  - Provide LEV to control vapors and fumes.
  - Ensure that the ladle is suited for its intended operation and make necessary adjustments.

Figure 25–3. This tilting ladle is equipped with a manually operated antitilt level. *(Courtesy American Foundrymen's Society, Inc.)*

- Hoists and cranes
    - Require preventive maintenance program.
    - Gear the program to ensure that the operation is much safer than simply to comply with minimal regulations.
    - Conduct inspections on a weekly basis by trained specialists.
    - Nondestructive testing (ultrasonic) may be required to locate cracks and other issues.

- Conveyors
    - Conveyors are used to carry sand to and from the mixing room.
    - An endless conveyor is used to handle molds.
    - When installing a system, guard shear points, crush points, and moving parts.
    - Where conveyor systems run over passageways and working areas, protect employees beneath them with screens, grating, or guards.
    - Guarding should be strong enough to resist the impact of the heaviest piece handled.

- Charging
    - Dangers are principally confined to handling material.
    - Never unevenly load or overload barrows or buggies.
    - Break open scrap cylinders, tanks, and drums before charging to prevent an explosion.
    - Install railings or other safeguards underneath the elevators, machines, hoists, and cranes.

List of Reference Materials

- www.morganmms.com
- Foundry Work For The Amateur By TERRY ASPINE
- http://www.eurocontrol.int/publications/nm-operational-problem-report-form-ms-word-format
- Gromicko, Nick. "Gravity Furnace Inspection - InterNACHI". InterNACHI. Retrieved 2014-06-25.
- Bill Johnson, Kevin Standiford, Practical Heating Technology, Nelson Education, 2008 ISBN 111180267X, pp.114-119
- Gas Furnace Guides. Retrieved
- http://www.furnaceprices.ca/#fuel-types

Foundry Works

L-II

Learning guide 34

Unit of Competence: **Operate Non–electric Melting Furnace**

Module Title: **Operating Non–electric Melting Furnace**

LG Code: **IND FDW2 M09 LO 1 – LG-34**

TTLM Code: **IND FDW2 TTLM 1019V1**

LO4 : Monitor furnace

Instruction Sheet	Learning Guide #34

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Maintaining furnace at optimum.
- Analysing sample for chemical taken and remedial action.
- Removing dross or slag from furnace.
- If necessary, metal in the furnace is de-gassed to standard operating procedures.
- Checking temperature of metal and adjustment made.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Maintain Furnace at optimum operating condition to standard operating procedures.
- Take Sample for chemical analysis and apply remedial action as required to correct composition using standard operating procedures.
- Remove Dross or slag from furnace per standard operating procedures.
- If necessary, de-gas metal in the furnace to standard operating procedures
- check and make adjustment Temperature of metal if necessary according to operating

Learning Instructions:

11. Read the specific objectives of this Learning Guide.
12. Follow the instructions described below 3 to 6.
13. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 and Sheet 4".
14. Accomplish the "Self-check 1, Self-check t 2, Self-check 3 and Self-check 4" **in page -6, 9, 12 and 14** respectively.
15. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 " **in page -15.**
16. Do the "LAP test" **in page – 16** (if you are ready).

Information Sheet-1	Maintaining furnace at optimum

4.1. Maintaining furnace at optimum.

FOR MAINTENANCE PEOPLE

- Study the Maintenance Manual.
- Become familiar with the unit an its dangerous areas before attempting maintenance of any Kind.
- Always use independent methods to support a tilted furnace whenever working on or near.
- Never enter the high risk zone like running crucible/ ON-SOLID state generator. Always work on electrical section of furnace with main Breaker off and keep fuses With while working.

Information Sheet-2	Analysing sample for chemical taken and remedial action.

4.2. Analysing sample for chemical taken and remedial action.

Introduction

THIS SECTION is intended to provide fundamental information on presolidification phenomena. Because much of the information is in the realm of physical chemistry, the first article provides a theoretical introduction to the subject. The next two articles provide pertinent thermochemical data for ferrous and nonferrous

(aluminum and copper) casting alloys.

The last three articles deal with important presolidification phenomena, composition control (alloy addition and impurity removal), and casting defects with origins in the liquid state (gas defects and inclusions).

TWO SUBJECTS that underlie all foundry processes, from melting to heat treatment, are chemical thermodynamics and chemical kinetics. Relationships derived from the disciplines are extremely useful in providing a quantitative framework for explaining and predicting chemical behavior. This includes all the chemical processes involved in preparing liquid metal for casting (going back to the winning of ores, if desired), the chemical processes involved in making molds and cores, the casting and solidification processes, the microstructural development of alloys, and the phase changes that occur after casting (for example, by heat treatment).

Thermodynamics defines the most stable chemical system (equilibrium system) that can be produced, given a set of starting conditions (compositions, temperature, pressure, and so on). An examples is the phase diagram. It gives the stable phases that coexist at equilibrium, given the composition, temperature, and pressure.

While chemical thermodynamics is only concerned with the initial and final states of a system, chemical kinetics is concerned with how and at what rate the system is transformed from the initial to the final state. The practical importance of chemical kinetics implies that systems often fail to reach the most stable condition and that the path taken plays a major role in determining the speed of the reaction. In general, kinetics assumes its greatest importance when atomic movement is restricted, such as at low temperatures or in solids. Thermodynamics most often applies when atoms have high mobility, as in gases and liquids and at high temperatures. Another factor that determines the relative applicability of thermodynamics and kinetics is time. The less time available for a process, the more likely that kinetic processes will govern the chemical state of the system.

Chemical Thermodynamics

There are three thermodynamic laws that provide the basis for the relationships that describe chemical systems. These laws hold that perpetual motion and absolute zero temperature can never be achieved. The relationship between the thermodynamic laws and, for example, phase diagrams is not immediately apparent. However, the connection exists and is testimony to a great deal of brilliant theoretical work carried out over the last 100 years.

For metallurgical systems, the most important thermodynamic variables are enthalpy and Gibbs free energy. The former governs the disposition of heat, and the latter governs chemical equilibrium.

Information Sheet-3	Removing dross or slag from furnace

4.3. Removing dross or slag from furnace.

MANAGING SLAG OR DROSS:

Slag or dross is an unavoidable by product of melting metal. Slag forms when rust, dirt and sand from the charge and refractory material eroded from the furnace lining, separate from the melt and rise to the top of the bath. Dross is created when oxides form during the melting of nonferrous metals such as aluminum. Chemical reactions between the slag or dross and the melt increase the rate at which the lining erodes.

A highly abrasive material, slag or dross will erode away refractory material near the level of the molten metal. It is not uncommon for this part of the furnace to be patched between scheduled relining. In extreme circumstances. This erosion may expose the induction coils, creating the risk of a water/metal explosion. Refractory linings in this condition should be removed from service immediately.

Although unavoidable, the effects of slag attack can be minimized by limiting the amount of rusty scrap in the charge shot blasting foundry returns and avoiding excessively high temperatures. Dross formation can be controlled through careful regulation of stirring, metal level and temperature.

Information Sheet-4	If necessary, metal in the furnace is de-gassed to standard operating procedures

4.4. If necessary, de-gas metal in the furnace to standard operating procedures.

Information Sheet-5	Checking temperature of metal and adjustment made.

4.5. Checking temperature of metal and adjustment made.

Introduction

Temperature measurement in today's industrial environment encompasses a wide variety of needs and applications. To meet this wide array of needs the process controls industry has developed a large number of sensors and devices to handle this demand. In this experiment you will have an opportunity to understand the concepts and uses of many of the common transducers, and actually run an experiment using a selection of these devices. Temperature is a very critical and widely measured variable for most mechanical engineers. Many processes must have either a monitored or controlled temperature. This can range from the simple monitoring of the water temperature of an engine or load device, or as complex as the temperature of a weld in a laser welding application. More difficult measurements such as the temperature of smoke stack gas from a power generating station or blast furnace or the exhaust gas of a rocket may be need to be monitored. Much more common are the temperatures of fluids in processes or process support applications, or the temperature of solid objects such as metal plates, bearings and shafts in a piece of machinery.

A corrected melting point can be obtained by using a reference substance with a known melting point. If one measures the melting point of this reference compound on any apparatus available (remember the melting point is known, let it be y) one will obtain a certain melting point x. If x=y no correction has to be done.

FOUNDRY WORK

Level II

Learning Guide -35

Unit of Competence: -	**Operate Non–electric Melting Furnace**
Module Title: -	**Operating Non–electric Melting Furnace**
LG Code:	**IND FDW2 M10 LO5-LG-35**
TTLM Code:	**IND FDW2 TTLM 1019v1**

LO 5: Tap or unload the furnace

Instruction Sheet	**Learning Guide 35**

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

This guide will also assist you to attain the learning outcome stated in the cover page.

This guide will also assist you to attain the learning outcome stated in the cover page.

- Quantity of the required metal is identified.
- Carrying out tap rate.
- Tapping or unloading undertaken and completed safely

This guide will also assist you to attain the learning outcome stated in the cover page.operating procedures.

Specifically, upon completion of this Learning Guide, you will be able to –

- Identify quantity of the required metal
- Carry tap rate out to standard operating procedures.
- Undertake and complete tapping or unloading safely according to standard operating

Learning Instructions:

17. Read the specific objectives of this Learning Guide.
18. Follow the instructions described in number 3 to 20.
19. Read the information written in the "Information Sheets 1". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
20. Accomplish the "Self-check 1" in page 5.
21. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).

22. If you earned a satisfactory evaluation proceed to "Information Sheet 2". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
23. Submit your accomplished Self-check. This will form part of your training portfolio.
24. Read the information written in the "Information Sheet 2". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
25. Accomplish the "Self-check 2" in page 7.
26. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 2).
27. Read the information written in the "Information Sheets 3 . Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
28. Accomplish the "Self-check 3" in page 11.
29. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 3).
30. If you earned a satisfactory evaluation proceed to "Operation Sheet 1" in page 12. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
31. Read the "Operation Sheet 1" and try to understand the procedures discussed.
32. If you earned a satisfactory evaluation proceed to "Operation Sheet 2" in page 13. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
33. Read the "Operation Sheet 2" and try to understand the procedures discussed.
34. If you earned a satisfactory evaluation proceed to "Operation Sheet 3" in page 14. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
35. Read the "Operation Sheet 3" and try to understand the procedures discussed.

36. Do the “LAP test” in page 15 (if you are ready). Request your teacher to evaluate your performance and outputs. Your teacher will give you feedback and the evaluation will be either satisfactory or unsatisfactory. If unsatisfactory, your teacher shall advice you on additional work

Information Sheet-1	Identify Quantity of the required metal

1. **Introduction to Identify Quantity of the required metal**

   Many different kind of metals are used for casting in industry. The most common metals used are brass, bronze, magnesium, aluminium, grey iron, steel, and malleable iron. In school shops it is necessary to use metals that have low melting temperatures.

- Before pouring into the mould, the metal to be casted has to be in the molten or liquid state. Furnace is used for carrying out not only the basic ore refining process but mainly utilized to melt the metal also. A blast furnace performs basic melting (of iron ore) operation to get pig iron, cupola furnace is used for getting cast iron and an electric arc furnace is used for re-melting steel. Different furnaces are employed for melting and re-melting ferrous and nonferrous materials

1.1. The following are the factors which are responsible for the selection of furnace materials.

- Considerations of initial cost and cost of its operation
- Relative average cost of repair and maintenance
- Availability and relative cost of various fuels in the particular locality
- Melting efficiency, in particular speed of melting
- Composition and melting temperature of the metal
- Degree of quality control required in respect of metal purification of refining,

- Cleanliness and noise level in operation
- Personnel choice or sales influence Heat in a melting furnace is created by combustion of fuel, electric arc, electric resistance, etc. A furnace contains a high temperature zone or region surrounded by a refractory wall structure which withstands high temperatures and being insulating minimizes heat losses to the surroundings.
- For refining and melting the ferrous and non-ferrous materials, various furnaces are used.

1.2. Component that required for Melting

- Raw material (charge)
  - ✓ Scrap, alloying materials
- Atmosphere
  - ✓ Air (oxygen), vacuum, inert gas(argon)
- Heating
  - ✓ External – electric, gas, oil
  - ✓ Internal –induction, mix fuel with charge
- Furnace materials
  - ✓ Refractory ceramics

Advantages of gas and fuel furnaces:-

- There is no wastage of fuel;
- the output in a given times is greater due to higher efficiency;
- Better temperature control can be maintained;
- Less contamination of metal takes place;
- Saving in floor space is achieved;
- Labor cost is reduced.

1.3. Some of the commonly used furnaces in foundries are discussed as below

1. CRUCIBLE FURNACES

Crucible furnaces are small capacity typically used for small melting applications. Crucible furnace is suitable for the batch type foundries where the metal requirement is intermittent. The metal is placed in a crucible which is made of clay and graphite. The energy is applied indirectly to the metal by heating the crucible by coke, oil or gas.

Crucible

The heating of crucible is done by coke, oil or gas

1.1. Coke-Fired Furnace

- Primarily used for non-ferrous metals
- Furnace is of a cylindrical shape
- Also known as pit furnace
- Preparation involves: first to make a deep bed of coke in the furnace
- Burn the coke till it attains the state of maximum combustion
- Insert the crucible in the coke bed
- Remove the crucible when the melt reaches to desired temperature

1.2. Oil-Fired Furnace.

- Primarily used for non-ferrous metals

- Furnace is of a cylindrical shape
- Advantages include: no wastage of fuel
- Less contamination of the metal
- Absorption of water vapor is least as the metal melts inside the closed metallic furnace

1.3. PIT FURNACE

- Is a type of a crucible furnace bath which is installed in the form of a pit and is used for melting small quantities of ferrous and nonferrous metals for production of castings? It is provided with refractory inside and chimney at the top. Generally coke is used as fuel. It is provided with refractory lining inside and chimney at the top. Natural and artificial draught can be used for increasing the capability towards smooth operation of the furnace.

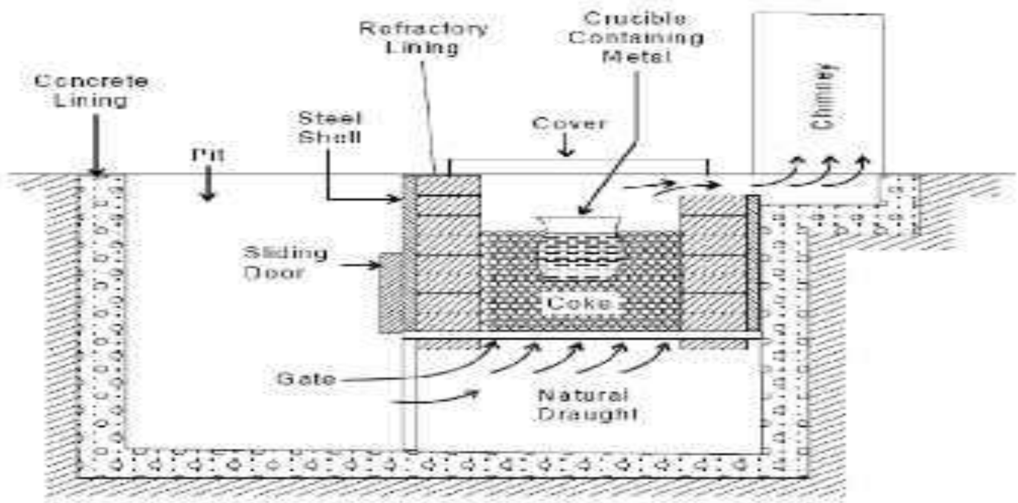


Fig. 2.1 Pit furnace

2. Open Hearth Furnace:

- In open hearth furnace, pig iron, steel scrap etc. are melted to obtain steel. This furnace is widely used in American foundries for steel production.

- The hearth is surrounded by roof and walls of refractory bricks as shown in Fig. 2.2. The charge is fed through a charging door and is heated to 1650°C mainly by radiation of heat from the burning of gaseous fuels above it.
- This heat is obtained by the burning of sufficiently pre-heated air and gas. Such pre-heated air of gas is obtained by passing them though arc shaped hot regenerators at a lower level.
- This contains fire bricks which are arranged to extract heat from exhaust gases. In the furnace air and fuel are passed through a honeycomb of hot firebrick, called checkers.
- It preheats the air and fuel so that they are ready for combustion when they enter the hearth. The products of combustion at the same time pass through the checkers at the other end of the furnace.
- The hot gases heat the checkers. The process then reverses itself, and the newly heated checkers now are used to heat the air and the fuel. It is said as a regenerative process.

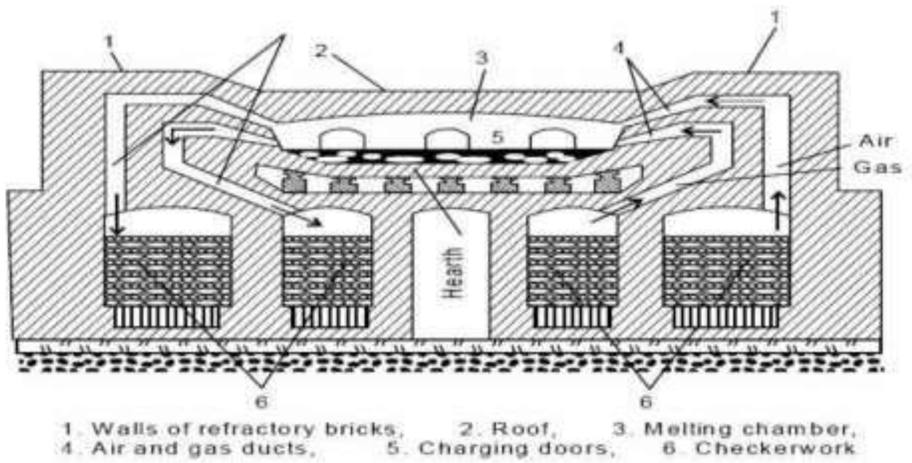


Fig. 2.2 Open hearth furnace

3. AIR FURNACE:

This furnace is also known as paddling or reverberator furnace. It is used for making wrought iron. Fig. 2.3 shows the construction of this type of furnace. A furnace or kiln in which the material under treatment is heated indirectly by means of a flame deflected downward from the roof. Reverberator furnaces are used in copper, tin, and nickel production, in the production of certain concretes and cements, and in aluminum. Reverberator furnaces heat the metal to melting temperatures with direct fired wall-mounted burners. The primary mode of heat transfer is through radiation from the refractory brick walls to the metal, but convective heat transfer also provides additional heating from the burner to the metal

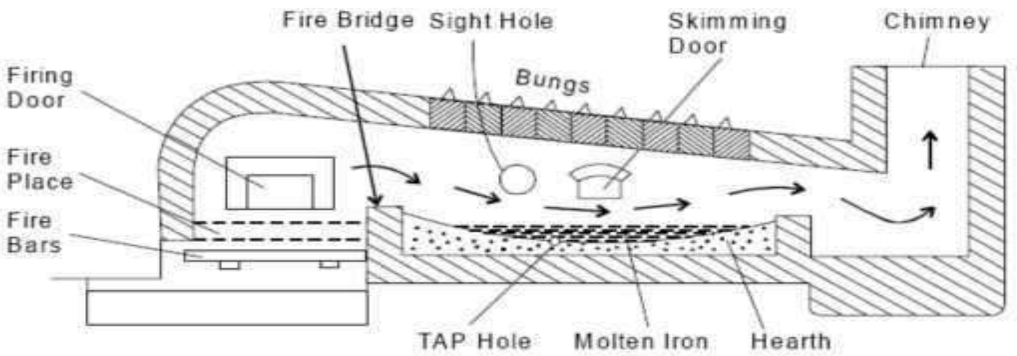


Fig. 2.3 Air Furnace

Advantages provided by reverberator melter:

- High volume processing rate
- Low operating
- Maintenance costs

Disadvantages of the reverberator melter:

- High metal oxidation rates
- Low efficiencies
- Large floor space requirements

4. CUPOLA FURNACE

- A cupola is a vertical cylindrical furnace equipped with a tapping spout near its base.

- Cupolas are used only for melting cast irons, and although other furnaces are also used, the largest tonnage of cast iron is melted in cupolas. General construction and operating features of the cupola are illustrated in Fig.
- It consists of a large shell of steel plate lined with refractory.
- The „„charge,"" consisting of iron, coke, flux, and possible alloying elements, is loaded through a charging door located less than halfway up the height of the cupola. The iron is usually a mixture of pig iron and scrap (including risers, runners, and spurs left over from previous castings).
- Coke is the fuel used to heat the furnace. Forced air is introduced through openings near the bottom of the shell for combustion of the coke.
- The flux is a basic compound such as limestone that reacts with coke ash and other impurities to form slag.
- The slag serves to cover the melt, protecting it from reaction with the environment inside the cupola and reducing heat loss.
- As the mixture is heated and melting of the iron occurs, the furnace is periodically tapped to provide liquid metal for the pour.

4.1. Description of Cupola

- The cupola consists of a vertical cylindrical steel sheet and lined inside with acid refractory bricks. The lining is generally thicker in the lower portion of the cupola as the temperature are higher than in upper portion□
- There is a charging door through which coke, pig iron, steel scrap and flux is charged
- The blast is blown through the tuyeres
- These tuyeres are arranged in one or more row around the periphery of cupola
- Hot gases which ascends from the bottom (combustion zone) preheats the iron in the preheating zone
- Cupolas are provided with a drop bottom door through which debris, consisting of coke, slag etc. can be discharged at the end of the melt

- A slag hole is provided to remove the slag from the melt
- Through the tap hole molten metal is poured into the ladle
- At the top conical cap called the spark arrest is provided to prevent the spark emerging to outside.

4.2. Operation of Cupola

- The cupola is charged with wood at the bottom. On the top of the wood a bed of coke is built. Alternating layers of metal and ferrous alloys, coke, and limestone are fed into the furnace from the top. The purpose of adding flux is to eliminate the impurities and to protect the metal from oxidation.
- Air blast is opened for the complete combustion of coke. When sufficient metal has been melted that slag hole is first opened to remove the slag. Tap hole is then opened to collect the metal in the ladle.

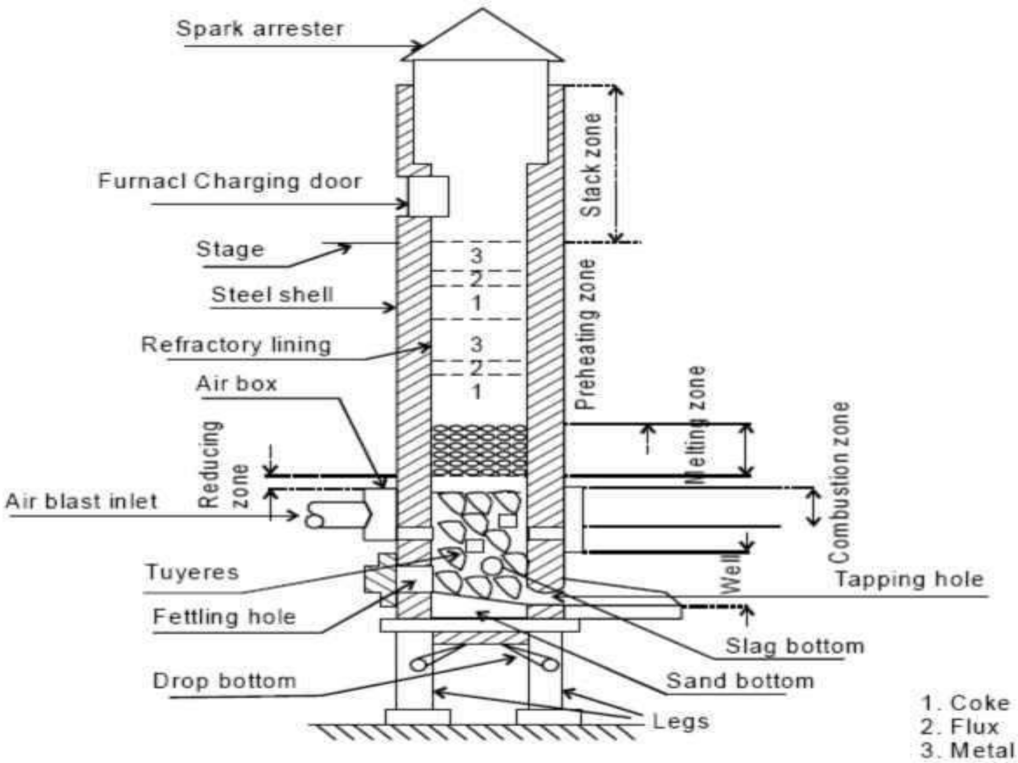


Fig. 2.4 Cupola Furnace

4.3. Pouring melted Metals

The organization of pouring might be regarded as the crucial step in founding, since it is possible to nullify (invalidate) by a single error the accumulated results of all the earlier work. In foundry work a ladle is a container used to transport and pour out molten metal. It needs to be:

- Strong enough to contain a heavy load of metal;
- Heat-resistant like a furnace;
- Heat-insulated as much as can be managed, to avoid losing heat and overheating its surroundings;
- Pouring temperature control is required;
  - For heavy works crane supported (lip pouring, teapot, bottom pouring)is required and should be pre heated to avoid moisture and contaminations of metal with water or other contaminants;
  - For small castings crucible tongs and shanks of various size and shapes are required;
  - Care should be taken not spill hot metal to body of the operator- safety clothing is essential;
- All types of ladles for in sizes ranging from 50kg to 10,000kg. They are straight or tapered shell as per IS - Specifications.

Figure; types of ladles

Mold Filling Phenomenon

- Two major characteristics of molten metal related to mould filling –
  - ✓ Fluidity and

✓ Turbulence or vibration, are related to flow related defect

1. **Fluidity** indicates the

- ability of liquid metal to flow through a given mold passage – even as it is solidifying
- fill the cavity to reproduce the design details;
- It is quantified in terms of the solidifiedlength of a standard spiral casting;
- The casting fluidity is driven by metallostatic pressureand hindered by:
    - viscosity and surface tension of molten metal,
    - heat diffusivity of mould,
    - back pressure of air in mould cavity and
    - friction between the metal-mold pair.

Metallostatic head: The metallostatic pressure is given by $\rho\ g\ h$ where ρ is the metaldensity and h is the height of liquid metal column above the filling point;

- A highermetallostatic pressure gives higher velocity of molten metal, and thereby higher fluidity.

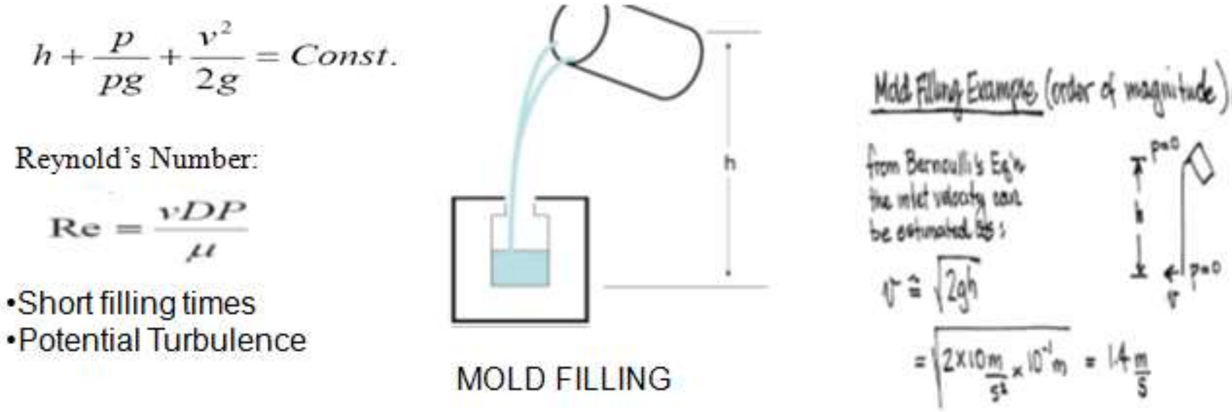
2. **Turbulence** implies irregular, fluctuating flow with disturbances; It is observed when:
    1. Inertia forces (which make the fluid continue in the same direction), are much higherthan the drag forces (which tend to stop the fluid motion), and
    2. There are obstructionsin the path of flow, such as a sharp corner or a change of section thickness.
    3. The drag forces include those caused by viscosity and surface tension. The viscous forcesmainly operate in the bulk of the liquid metal, whereas surface tension forces operatenear the mould wall.

Thus we have two types of turbulence: **bulk** and **surface**.;

- **Bulk turbulence** is quantified by Reynolds number *Re*, which is the ratio of inertia toviscous pressure in a fluid. It is given by $\rho\ V\ d\ /\ \mu$ where ρ is the density, μ is the viscosityand V is the velocity of the liquid; d is a characteristic dimension of the flow path; If *Re* ismore than 2000, then the flow is usually turbulent.
- **Surface turbulence**

- is quantified by the Weber number *We*, which is the ratio of inertiato surface tension pressure in a fluid;B It is given by $\rho V^2 r / \gamma$ where *r* is the radius ofcurvature of the free liquid ; For *We* is less than 1, surface turbulence is absent;.
  - When it is 100 or more, surface turbulence is prominent, leading to violent mixing of
  - surface layers with the bulk of the molten metal;
  - The path of molten metal during casting process comprises mainly four parts:
  - 1. Pouring of molten metal from ladle to the cup in the mould
  - 2. Flow within the gating channels, from pouring basin to ingate

Bernouli's Equation:



- **Viscosity:** Viscosity depends on the metal family, composition and the instantaneous temperature;
- **For most metals**, the viscosity at the pouring temperature is close to that of water (1 centistoke); aluminum: 1.2 and iron: 0.9 centistokes.
- **Surface tension:** For a flat plate of thickness t, the relation between head, thickness and surface tension is given by: $\rho g h = \gamma / t$, where γ is the surface tension;
- **At the pouring temperature**, the surface tension of aluminum and iron is 0.5 and 0.9 N/m respectively similar to mercury at room temperature (0.46 N/m), but higher than water (0.07 N/m).

Heat diffusivity: Moulds with high heat diffusivity transfer heat faster from the moltenmetal, causing it to freeze earlier and stop flowing;

Two Categories of Casting Process

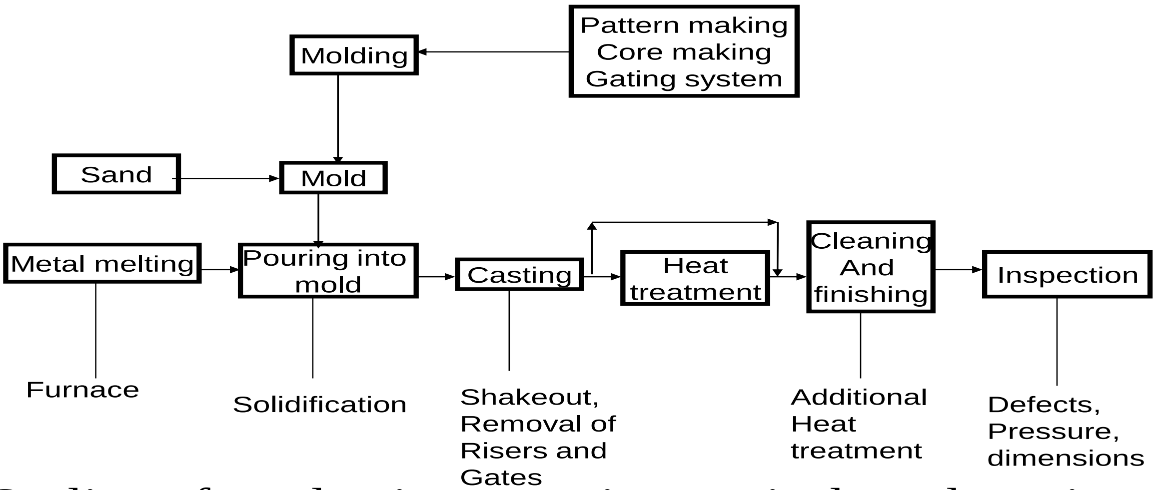
1. **Expendable mold processes**

   Uses an expendable mold which must be destroyed to remove casting

   Mold materials: sand, plaster, and similar materials, plus binders

2. **Permanent mold processes**:

   Uses a permanent mold which can be used many times to produce many castings Made of metal (or, less commonly, a ceramic refractory material



Outline of production steps in a typical sand-casting operation.

Steps in Sand Casting

Self-Check -1	Written Test

Directions: Write the best answer

1. List the Component required for Melting? **(5points)**
2. List two Categories of Casting Process? **(5points)**
3. List the two major characteristics of molten metal related to mould filling? **(5points)**
4. List the heating of crucible done by coke, oil or gas? **(5points)**
5. List advantages and dis-advantage by reverberator melter? **(5points)**

Note: **Satisfactory rating - 25 points** **Unsatisfactory - below 20 points**

Answer Sheet

Score = ____________
Rating: _____________

Name: ________________________ **Date:** ________________

Short Answer Questions

1.____

FOUNDRY WORK

Level II

Learning Guide -36

Unit of Competence	**Operate Sand Moulding and Core Making Machines**
Module Title:	**Operating Sand Moulding and Core Making Machines**
LG Code:	**IND FDW2 M10 LO6-LG-36**

TTLM Code: IND FDW2 TTLM 1019v1

LO 6: Shut down furnace

Instruction Sheet	Learning Guide 36

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Completing shut-down of furnace to standard operating procedures.
- Undertaking routine operational maintenance of furnace
- Observing and Applying OHS procedures and measures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
    - Complete Shut-down of furnace to standard operating procedures.
    - Undertake Routine operational maintenance of furnace to standard operating procedures.
    - Observe and apply OHS procedures and measures are throughout the process.
2. Follow the instructions described in number 3 to 20.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.

4. Accomplish the “Self-check 1” in page 5.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.
8. Read the information written in the “Information Sheet 2”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
9. Accomplish the “Self-check 2” in page 7.
10. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 2).
11. Read the information written in the “Information Sheets 3 . Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
12. Accomplish the “Self-check 3” in page 11.
13. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 3).
14. If you earned a satisfactory evaluation proceed to “Operation Sheet 1” in page 12. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
15. Read the “Operation Sheet 1” and try to understand the procedures discussed.
16. If you earned a satisfactory evaluation proceed to “Operation Sheet 2” in page 13. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
17. Read the “Operation Sheet 2” and try to understand the procedures discussed.

18. If you earned a satisfactory evaluation proceed to “Operation Sheet 3” in page 14. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
19. Read the “Operation Sheet 3” and try to understand the procedures discussed.
20. Do the “LAP test” in page 15 (if you are ready). Request your teacher to evaluate your performance and outputs. Your teacher will give you feedback and the evaluation.

Information Sheet 1	**Completing shut-down of furnace to standard operating procedures**

1.1. Concepts Completing shut-down of furnace to standard operating

Should you need to shut down your furnace for service or maintenance, you will need to turn the furnace off. The following procedures must be followed:

1. Set your room thermostat to the lowest temperature setting and set the “MODE” to “OFF.” See Fig. 16.

Fig. 16 – Lowest Temperature Setting

2. Close the external manual gas valve. See Fig. 17.

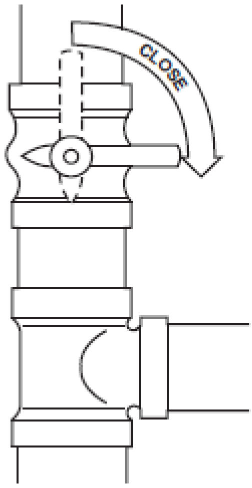


Fig. 17 − Close the External Manual Valve

3. Turn off electrical supply to the furnace. See Fig. 18.

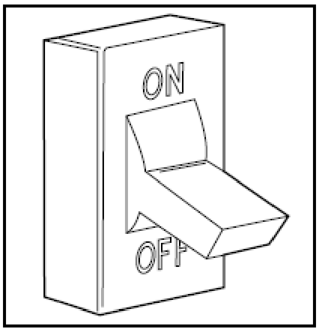


Fig. 18 − Turn Off Electrical Supply

1.2. Emergency Shutdown Procedure

The emergency shutdown will bring the incinerator line to a safe status. The Main objectives of the emergency shutdown procedure are as follows:

- To shut down the plant safely, avoiding injury to staff or damage to equipment
- To minimize emissions
- To protect equipment from damage caused by temperatures which are toohigh.

The experience of the operators of Indaver's plants in Meath/Belgium is that an

Emergency shutdown is not a frequent occurrence. In case of failure of electrical power supply, the plant will switch over to island mode and power itself through the turbine. The plant will reduce in load and remain in a stable condition. If the turbine trips in this condition then the motors and equipment required for the emergency shutdown will be powered by the emergency generator.

1.3. Two steps emergency Shutdown Procedure

Step 1

- Is the waste burn out? As soon as the emergency shutdown commences all waste supply will be stopped immediately. The ID-fan will be stopped. The water supply to the cooling section will be stopped. An emergency supply may be provided for use in the cooling section, if the temperature of the flue gases exceeds 250ºC. This option will be decided at detailed design stag

Step 2

- Is the cooling step. Once there is no more waste in the furnace, the ID fan will continue to pull air through the furnace boiler for a controlled cool down to protect the refractory and boiler from to rapid a cool down which could lead to mechanical failure. The ID fan can then be stopped once the plant is below 60°
- During any emergency shutdown, while there is waste in the furnace all the flue gases pass through the gas cleaning system and are emitted through the stack. As stated above, the ID Fan is kept operating during the shutdown by means of an auxiliary motor and an emergency generator

1.4. Turn Off Electrical Supply

- A dirty filter will cause excessive stress on the furnace, heat exchanger, and blower motor, and can cause it to overheat and automatically shut down.
- The furnace filter should be checked every four weeks and be cleaned or replaced if necessary. If installed with factory−specified disposable media filter, check or replace filter before each heating and cooling season. Replace disposable media filter at least once a year.

- If your furnace filter needs replacing, be sure to use the same size and type of filter that was originally specified. The air filter for the furnace may be located an external filter cabinet attached to the side or bottom of the furnace casing.
- If the air filter has been installed in another location, contact your dealer for instructions.
- To inspect, clean and/or replace the air filter(s), follow these steps:
  - ✓ Turn off electrical supply to the furnace.
  - ✓ Remove air filter from the filter cabinet.

    a. Remove filter cabinet door.

    It may be necessary to remove one thumbscrew.

    b. Slide air filter out of furnace. Keep dirty side up (if dirty) to avoid spilling dirt.
  - ✓ Inspect the filter. If torn replace it.

    NOTE: If a washable filter was supplied with the furnace and has been replaced by: Disposable media filter do not clean. If dirty, replace only with media filter having the same part number and size. Install with airflow direction arrow pointing towards blower. Electronic Air Cleaner (EAC), refer to the EAC Owner's Manual for maintenance information. If washable filter, wash filter (if dirty) in a sink, bathtub, or Outside with a garden hose. Always use cold tap water.
- Mild liquid detergent may be used if necessary. Spray water
  - ✓ Remove main furnace door.
  - ✓ Turn control switch on the gas control to "OFF" position.
  - ✓ Replace main furnace door.
  - ✓ If the furnace is being shut down because of a malfunction, call your dealer as soon as possible

FILTERING OUT TROUBLE

The manufacturer has specified filters which will enable your furnace to provide lasting comfort and efficiency throughout its life. Contact your dealer to help you choose filters for your furnace that both collect dirt before it enters your furnace, as well as provide a low resistance to circulating air. Avoid filters that report high cleaning efficiencies, but do not allow air to pass easily through them.

UNIT PERFORMANCE HAZARD

Failure to follow this caution may result in unit component damage. Never operate your furnace without a filter in place. Doing so may damage the furnace blower motor. An Accumulation of dust and lint on internal parts of your furnace can cause a loss of efficient

Self-Check -1	**Written Test**

Directions: List the best answer

1. List process of shut-down furnace? **(4points)**
2. List main objectives of the emergency shut down? **(4points)**
3. List two steps of emergency Shutdown Procedure? **(4points)**

Note: **Satisfactory rating - 12 points** **Unsatisfactory – below 10 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ **Date:** ________________

Short Answer Questions

1.____

Information Sheet 2	Undertaking routine operational maintenance of furnace

2. Introduction to Undertaking routine operational maintenance of furnace

2.1. PERFORMING ROUTINE MAINTENANCE

Modern furnaces especially high efficiency models are more complicated than models from decades ago. The efficiency gains are due in large part to the careful balancing of fuel, combustion air, and exhaust gasses. The management of these systems is accomplished through electronic controls, which need periodic

Adjustment and cleaning for optimum performance. An annual clean and tune of the

Furnace will keep the systems properly adjusted, and potentially reduce costly future repairs.

A qualified technician should:

- Check igniter and flame sensor
- Pull and clean burners

- Inspect heat exchanger for excess rust or cracks
- Blow out condensate line (90%+ models)
- Check system static pressure
- Do a combustion analysis
- Check gas pressure
- Check for gas or venting leaks
- Inspect and lubricate blower motor
- The qualified installer or agency must use only factory−authorized replacement parts, kits, and accessories when modifying this product. Installing and servicing of heating equipment can be hazardous due to gas and electrical components. Only trained and qualified personnel should install, repair, or service heating equipment?
  - Untrained personnel can perform basic maintenance functions such as cleaning and replacing air filters. All other operations must be performed by trained service personnel.
  - Observe safety precautions in this manual, on tags, and on labels attached to the furnace and other safety precautions that may apply.With proper maintenance and care, your furnace will operate economically and dependably.
  - Instructions for basic maintenance are found on this and the following pages. However, before beginning maintenance, follow these safety precautions

2.2. A CHECK−UP CHECKLIST

- Your furnace represents an important investment in your family's comfort and your home's value.
- To keep it performing properly and to prevent future problems, have a trained service specialist give your furnace a professional check−up annually.
- The following checklist can be used as a guideline to proper service:
- Inspect all flue gas passages, burners, heat exchangers, coupling box, and inducer assembly.
- Inspect all combustion−air and vent piping inside structure and pipe terminations outside the structure.

- Check gas pipes leading to and inside of your furnace for leaks.
- Inspect and clean the blower motor and wheel.
- The inducer and blower motors are pre−lubricated and require no additional lubrication. These motors can be identified by the absence of oil ports on each end of the motor.
- Inspect and change or clean air filter(s) if necessary.
- Inspect all supply− and return−air ducts for obstructions, air leaks, and insulation. Remedy any problem when necessary.
- Inspect the return−air duct connection(s) at the furnace to ensure
- it is physically sound, sealed to the furnace casing, and terminates outside the space containing the furnace
- Inspect electrical wiring, connections, and components for loose connections.
- Perform an operational checkout to determine whether your furnace is working properly and if it requires adjustments.
- Inspect all condensate drain tubes and condensate trap assembly for leaks. The condensate removal system should be cleaned annually by a qualified service agency. Refer to the Service and Maintenance Instructions Guide for further information.
- Examine the physical support of the furnace. Support should be sound with no cracks, sagging, gaps, etc. around the base.
- Check furnace for any obvious signs of deterioration.
- Ask your servicing dealer for further details about an economical service contract that covers seasonal inspections.
- If your furnace is not operating or not performing properly,
- you may save the expense of a service call by checking a few
- things yourself before calling for service

NOTE TO EQUIPMENT OWNER:

For your convenience, please record the model and serial numbers of your new equipment in the spaces provided. This information, along with the installation data and dealer contact information will be helpful should your system require maintenance or service.

FURNACE

Model # ______________________________

Serial # ______________________________

AIR CONDITIONER OR HEAT PUMP

Model # ______________________________

Serial # ______________________________

INDOOR COIL (Furnace Coil or Fan Coil)

Model # ______________________________

Serial # ______________________________

INSTALLATION INFORMATION:

Date Installed ______________________________

DEALERSHIP CONTACT INFORMATION:

Company Name______________________________

Address______________________________

____

Phone Number ______________________________

Technician Name ______________________________

____

____

NOTE TO INSTALLER:

This manual must be left with the equipment owner.

Self-Check -2	**Written Test**

Directions: Write the best answer

1. List check−up checklist in maintenance of furnace? **(5 points)**
2. List a qualified technician needs in maintenance? **(5 points)**

Note: **Satisfactory rating - 10 points** **Unsatisfactory – below 10 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ **Date:** _______________

Short Answer Questions

1.____

Information Sheet -3	**Observe and apply OHS procedures are throughout the process**

1. **introduction Observe and apply OHS procedures are throughout the process**

1.1. Casting bronze:

Is an inherently dangerous process that can result in serious injury or death?

2. Safety measures will be discussed and shown in class and it will be mandatory that they are followed.

3. Any student not complying with these safety measures or who is not using Common sense will be barred from the foundry.

It is everybody's responsibility to keep an eye out for dangerous situations or behavior, and point them out to the instructor or TA (whoever is closest) immediately.

General Safety for Foundries

Safety is YOUR Responsibility!

The methods and materials involved in any form of metal casting operation are VERY hazardous. Educate yourself on the proper safety precautions before attempting any metal casting. We will go over proper safety precautions, things to keep in mind are:

1. Even trace amounts of MOISTURE and MOLTEN METAL don't mix!!!

Steam explosions are the #1 cause of death in foundries.

- NEVER put water on a metal fire. This can cause a HUGE EXPLOSION
- Have a DRY pile of sand and a shovel ready to put out fires or to control metal spills.
- Have a sand bed under all areas. The sand bed should be at least 3 inches thick.
- This will help in containing metal spills and will help protect flooring.
- Never pour over wet ground. Remember, even TRACE AMOUNTS of MOISTURE can cause EXPLOSIONS.
- Molten metal spilled on concrete will cause the concrete to explode. Use a thick sand bed over concrete.
- Always use clean metal as feedstock. Combustion residues from some lubricantsand paints can be very toxic
- Always operate in a well-ventilated area. Fumes and dusts from combustion and other foundry chemicals, processes and metals can be toxic.
- Use a NIOSH rated dusk mask. Dusts from sand, parting dusts and chemicals can be hazardous or cancer causing. Protect your lungs!
- Always use safety glasses. Even minor mishaps can cause blindness.
- Never use a crucible that has been damaged or dropped. It's just not worth the risk. Imagine what would happen if a white-hot crucible of brass crumbled as you were carrying it!
- Always charge crucibles when cold. Adding metal to a hot crucible is really dangerous. If there is moisture on the metal, even just a haze, the metal can cause the entire contents of the crucible to explode.
- Spilled molten metal can travel for a great distance. Operate in a clear work area.

- *Think about what you are doing at all times. Focus on the job at hand and the next step. Have all moves planned and rehearsed prior to any operation.*
- Educate yourself beforehand and always be careful of your own and bystander safety.

Rules in Our Foundry

All students *must* follow these rules. These rules are made not only with your safety in mind, but also with the safety of those around you in mind. **Not followingthese rules could cause the injury or death of you or someone else.**

1. Read, understand and follow the General Safety rules for the foundry listed above.

2. Wear safety gear!! This includes, but is not limited to:

a. This includes, but is not limited to

- Leather shoes
- Fireproof apron
- Foot and leg protection
- Proper gloves, wire mesh face shield
- Safety glasses
- Cotton baseball hat. A leather foundry hat is the best choice.
  These hats look like a sailor's hat, with the brim turned down to cover your ears. Even wearing a baseball hat with the brim towards the back will help prevent metal from getting down your back.
- Don't laugh; ever had a weld splatter get into your shirt? Imagine what a tablespoon of molten metal would do!
- A long sleeve cotton shirt.

b. Clothes and shoes should be made from cotton or natural fibers.

- Synthetics melt and stick to the skin.

C. Wear safety glasses as well as the mesh face shield.

3. During a pour no one but the pouring crew is permitted in the foundry area.

- Do not distract anybody during a pour.

- Do not look into the furnace or kilns without a wire mesh shield or appropriate eye safety gear for splattering and infrared radiation.

4. Only 1 pour will take place at a time, the large furnace has priority

5. Do not participate or go near pours if you

- Have been taking medication that may impair your coordination, judgment, or reflexes.
- Have been using drugs or alcohol in the last 24 hours.
- Are very tired of feel in any way impaired (for example you feel like you are getting sick).
- unless you have planned and rehearsed the moves
- Feel that you do not understand in any way your part in the pour.

6. No running of goofing around in the foundry.

Self-Check -3	**Written Test**

Directions: Write the best answer

1. List wear safety in furnace? **(5 points)**
2. List and write Rules in our foundry work? **(5 points)**
3. List the responsibility of students in foundry work? **(5 points)**

Note: **Satisfactory rating - 15 points Unsatisfactory - below 15 points**

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ **Date:** _________________

Short Answer Questions

1.____

The teachers (who develop learning guides)

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