CHAPTER III

GENERAL INFORMATION

3.1 Company Background

The selected company is a multi phase project to build and operate a three million tons per year steel plant in Thailand for production of hot rolled, flat carbon steel in coil form. The first phase will produce 1.8 million tons per years of world class quality hot rolled product made from raw materials to international steel product specifications for domestic and international markets.

The company is the dominant producer of hot rolled steel with a combined annual capacity of approximately 800,000 tons. It also owns one steel coil center with an annual capacity approximately 150,000 tons. The company has equity participation from a number of prominent Japanese companies and the project is strongly supported by the Japanese Government in the form of loan guarantees issued by the Ministry of International Trade and Industries (MITI)

3.2 Product

The products of the company are hot roll, flat carbon steel in coil form. The specification of these products can be categorized following the chemical composition (Steel grade) and the dimension.

<u>Steel Grades and Specifications</u>

The following steel grades and specifications are available

a) Plain Carbon Steels

- Low Carbon
- Peritectic
- Medium Carbon
- High Carbon

b) High Strength Low alloy (HSLA) Steels :

- Vanadium and/or Niobium (Columbium) bearing with Mn < 1.35%
- Intermediate Mn of up to 1.6 %

These steels offer higher mechanical properties than the plain carbon steels, or special characteristics such as corrosion resistance. Technically they do not qualify as an alloy steels and are priced from a carbon steel base.

Product Dimensions

Thickness and Width, the table below lists the possible limits:

Table3.1 Product dimensions

	Minimum	*Maximum*
Thickness (Guage)	1.0 mm	12.0 mm
Width	900 mm	1550 mm

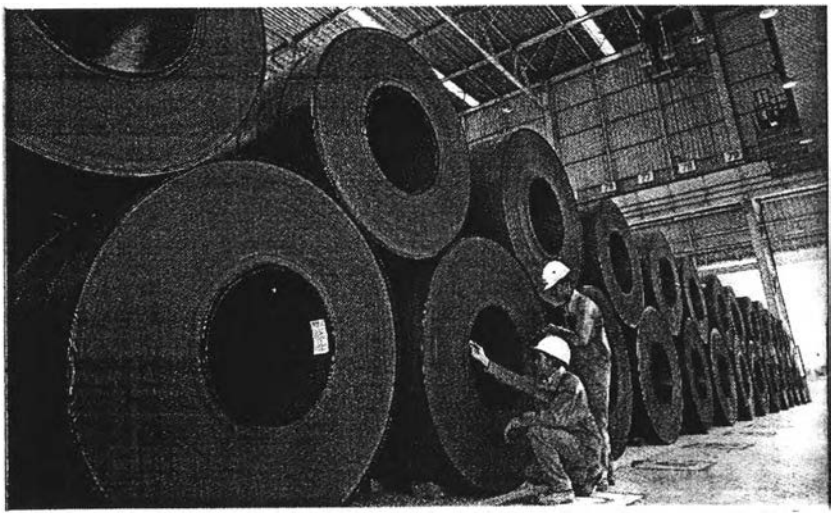


Figure 3.1 The hot rolled coil steel

3.3 The organization chart

The company organization is designed base on functional responsibility. Figure 3.2 and figure 3.3 show the top management organizational chart and the operations organizational chart.

Top Management Organizational Chart

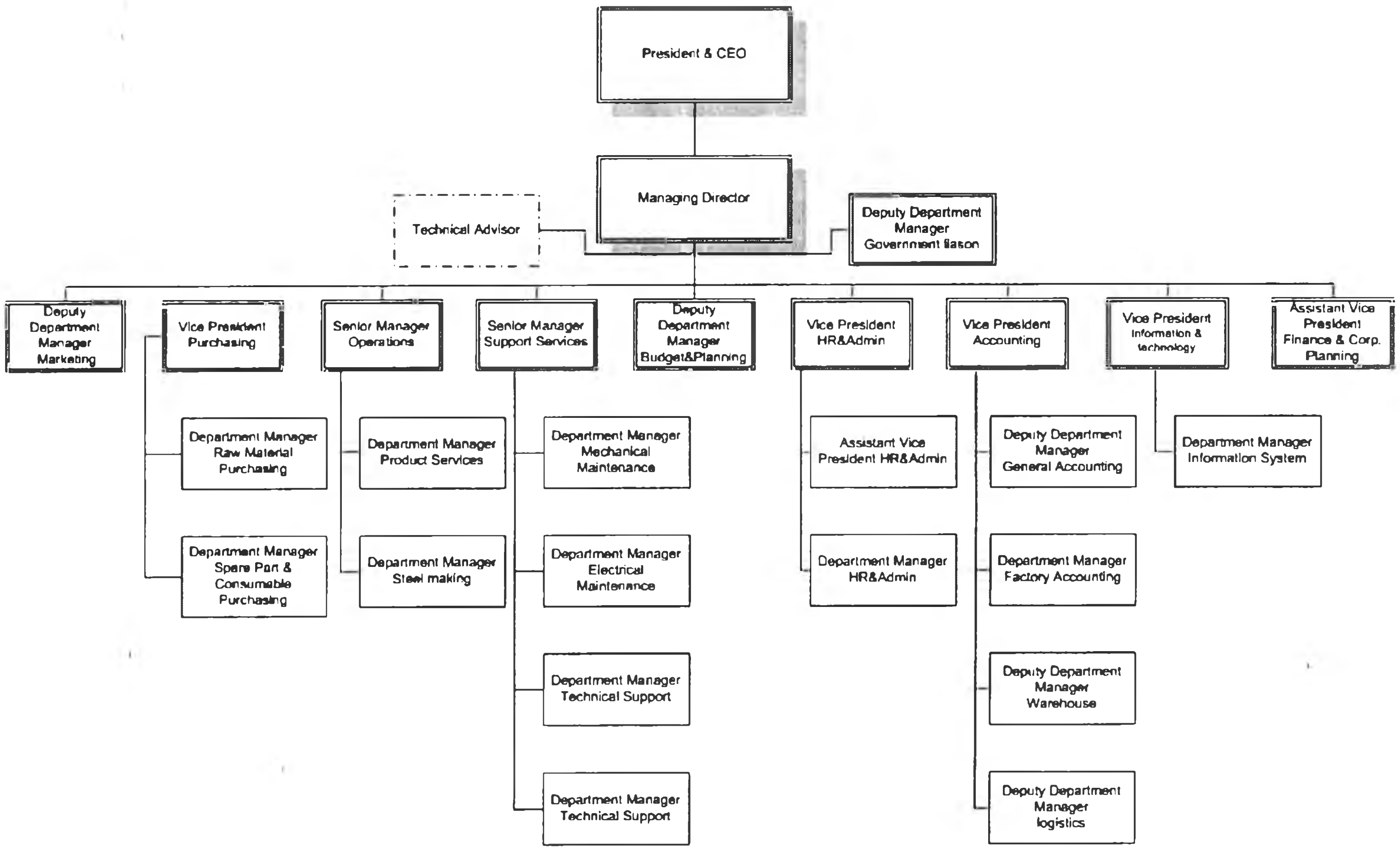


Figure 3.2 Top management organizational charts

Operations Organizational Chart

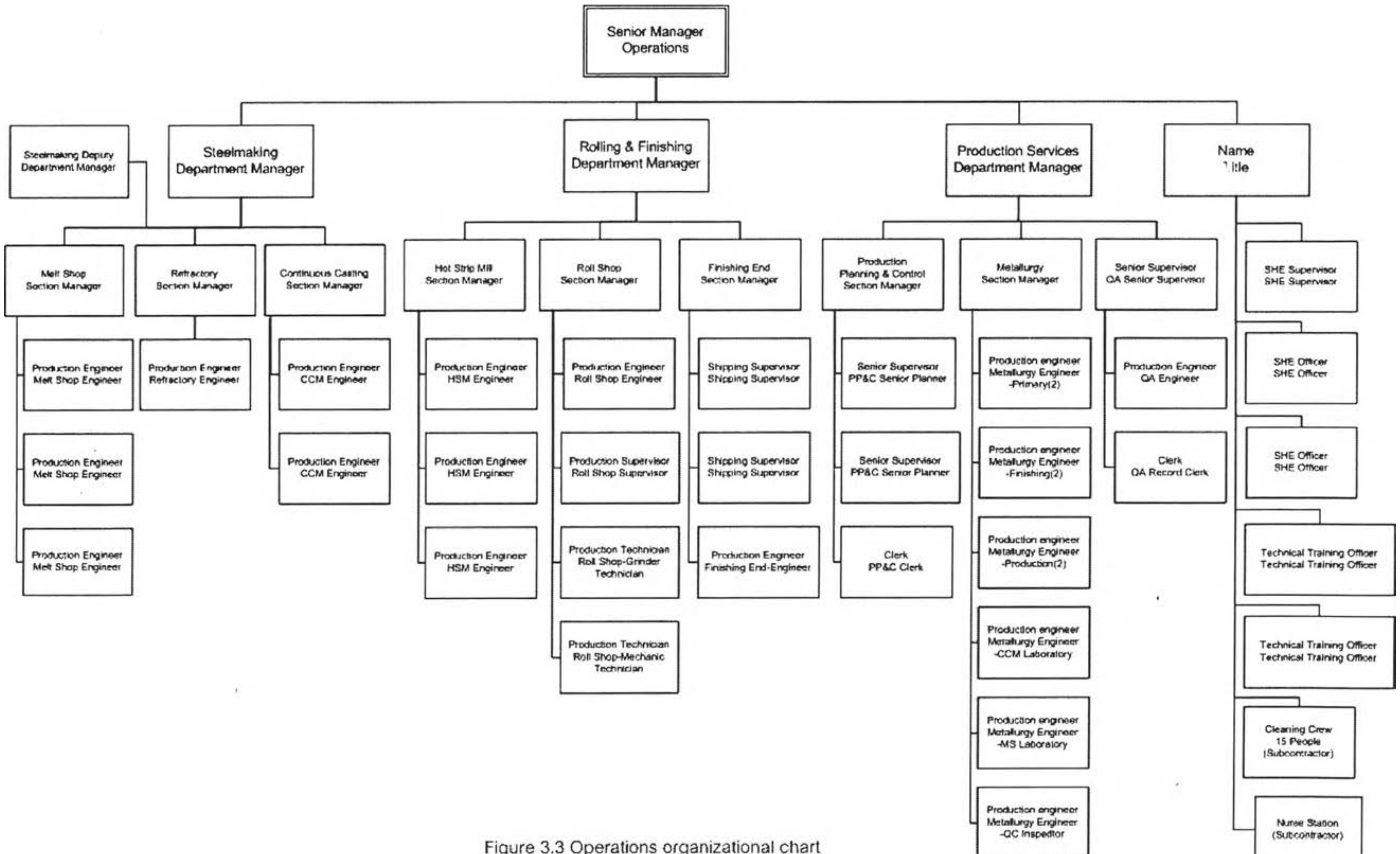


Figure 3.3 Operations organizational chart

3.4 Manufacturing Process

There are 3 main manufacturing processes of producing the roll steel coil. These processes are composes of Electric Arc Furnace Steelmaking, Continuous casting and Hot rolling as shown in figure 3.4

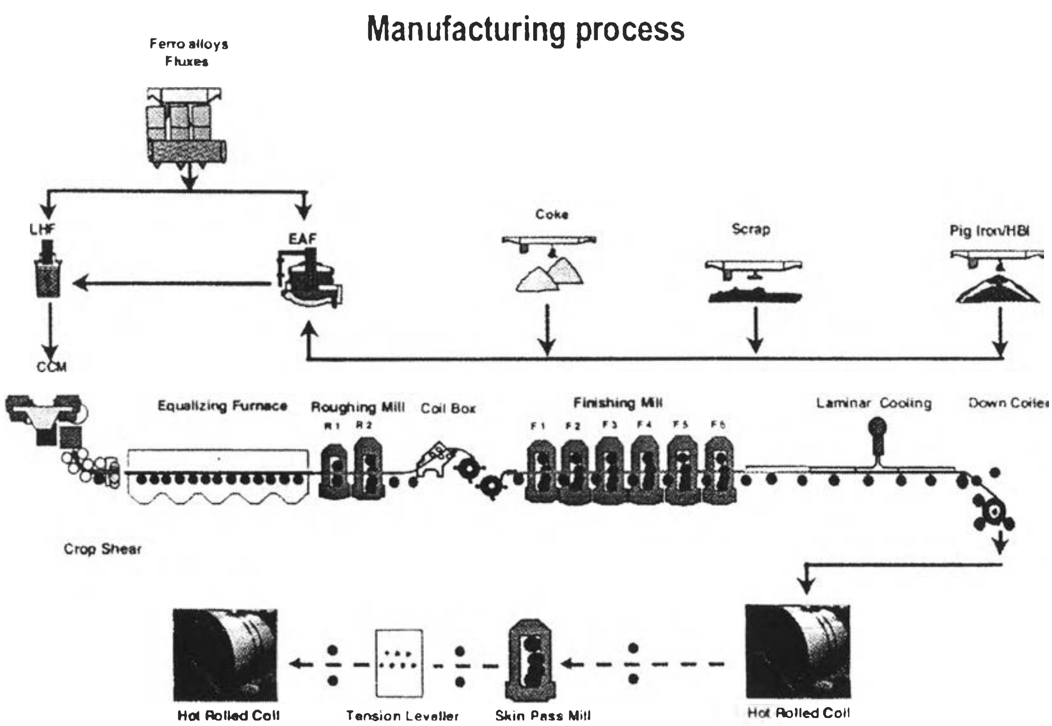
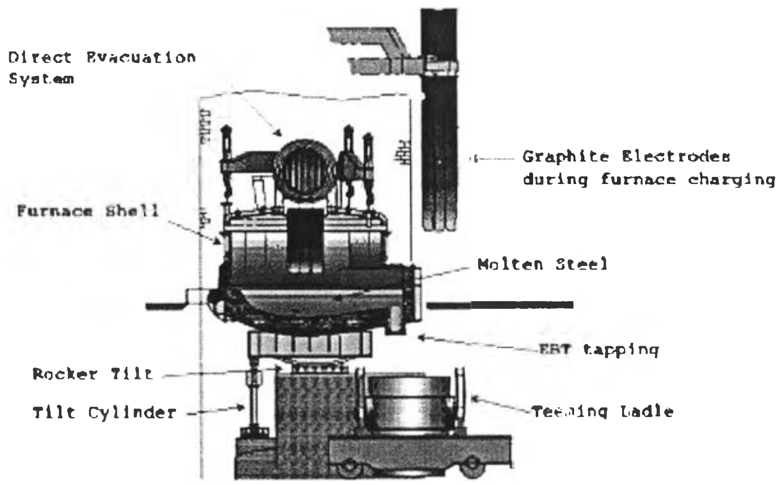
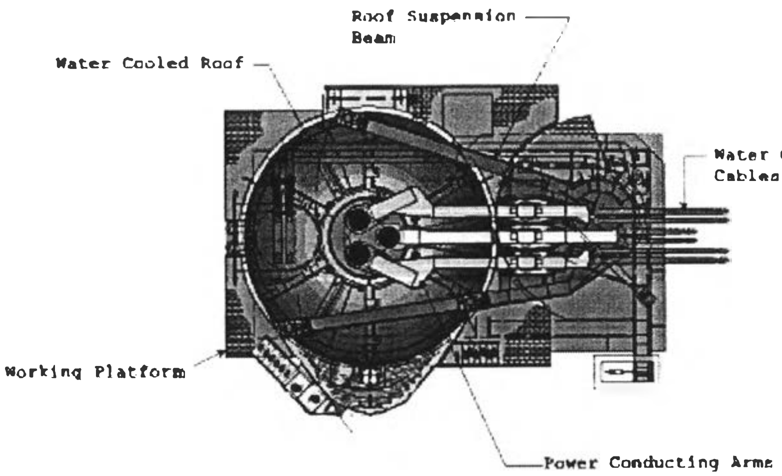


Figure3.4 Manufacturing Process

3.4.1 Electric Arc Furnace Steelmaking process

Furnace Operation





Courtesy of Mannesmann Demag Corp.

Figure 3.5 Electric Arc Furnaces

The electric arc furnace operates as a batch melting process producing batches of molten steel known "heats". The electric arc furnace operating cycle is called the tap-to-tap cycle and is made up of the following operations:

- Furnace charging
- Melting
- Refining

- De-slagging
- Tapping
- Furnace turn-around

Furnace Charging

The first step in the production of any heat is to select the grade of steel to be made. Usually a schedule is developed prior to each production shift. Thus the melter will know in advance the schedule for his shift. 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 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.

Melting

The melting period is the heart of EAF operations. The EAF has evolved into a highly efficient melting apparatus and modern designs are focused on maximizing the melting capacity of the EAF. Melting is accomplished by supplying energy to the furnace interior. This energy can be electrical or chemical. Electrical energy is supplied via the graphite electrodes and is usually the largest contributor in melting operations. Initially, an intermediate voltage tap is selected until the electrodes bore into the scrap. Usually, light scrap is placed on top of the charge to accelerate bore-in. Approximately 15 % of the scrap is melted during the initial bore-in period. After a few minutes, the electrodes will have penetrated the scrap sufficiently so that a long arc (high voltage) tap can be used without fear of radiation damage to the roof. The long arc maximizes the transfer of power to the scrap and a liquid pool of metal will form in the furnace hearth At the start of melting the arc is erratic and unstable. Wide swings in current are observed accompanied by rapid movement of the electrodes. As the furnace atmosphere heats up the arc stabilizes and once the molten pool is formed, the arc becomes quite stable and the average power input increases.

Chemical energy is being supplied via several sources including oxy-fuel burners and oxygen lances. Oxy-fuel burners burn natural gas using oxygen or a blend of oxygen and air. Heat is transferred to the scrap by flame radiation and convection by the hot products of combustion. Heat is transferred within the scrap by conduction. Large pieces of scrap take longer to melt into the bath than smaller pieces. In some operations, oxygen is injected via a consumable pipe lance to "cut" the scrap. The oxygen reacts with the hot scrap and burns iron to produce intense heat for cutting the scrap. Once a molten pool of steel is generated in the furnace, oxygen can be lanced directly into the bath.

Once enough scrap has been melted to accommodate the second charge, the charging process is repeated. Once the final scrap charge is fully melted, flat bath conditions are reached. At this point, a bath temperature and sample will be taken. The analysis of the bath chemistry will allow the melter to determine the amount of oxygen to be blown during refining. At this point, the melter can also start to arrange for the bulk tap alloy additions to be made. These quantities are finalized after the refining period.

Refining

Refining operations in the electric arc furnace have traditionally involved the removal of phosphorus, sulfur, aluminum, silicon, manganese and carbon from the steel. In recent times, dissolved gases, especially hydrogen and nitrogen, been recognized as a concern. Traditionally, refining operations were carried out following meltdown i.e. once a flat bath was achieved. These refining reactions are all dependent on the availability of oxygen. Oxygen was lanced at the end of meltdown to lower the bath carbon content to the desired level for tapping. Most of the compounds which are to be removed during refining have a higher affinity for oxygen that the carbon. Thus the oxygen will preferentially react with these elements to form oxides which float out of the steel and into the slag.

At the end of refining, a bath temperature measurement and a bath sample are taken. If the temperature is too low, power may be applied to the bath. This is not a big concern in modern meltshops where temperature adjustment is carried out in the ladle furnace.

De-Slagging

De-slagging operations are carried out to remove impurities from the furnace. During melting and refining operations, some of the undesirable materials within the bath are oxidized and enter the slag phase.

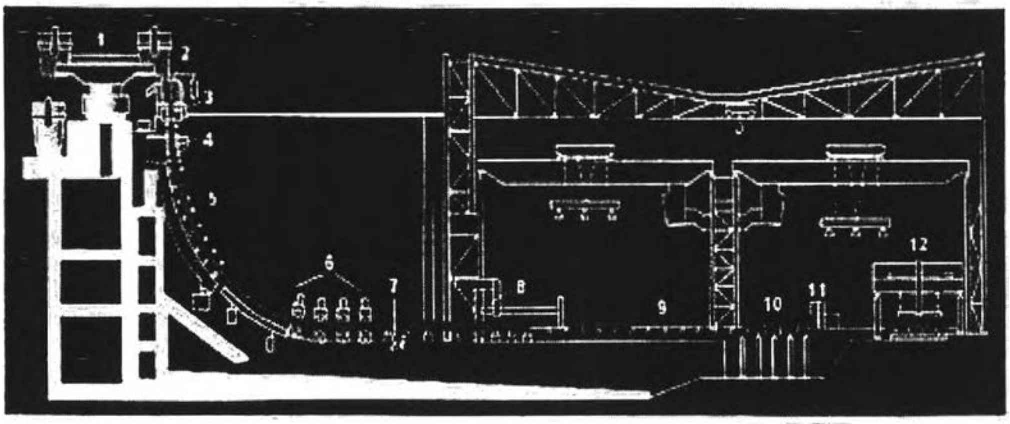
Tapping

Once the desired steel composition and temperature are achieved in the furnace, the tap-hole is opened, the furnace is tilted, and the steel pours into a ladle for transfer to the next batch operation (usually a ladle furnace or ladle station). During the tapping process bulk alloy additions are made based on the bath analysis and the desired steel grade

Furnace Turn-around

Furnace turn-around is the period following completion of tapping until the furnace is recharged for the next heat. During this period, the electrodes and roof are raised and the furnace lining is inspected for refractory damage. If necessary, repairs are made to the hearth, slag-line, tap-hole and spout. In the case of a bottom-tapping furnace, the taphole is filled with sand. Repairs to the furnace are made using gunned refractories or mud slingers.

3.4.2 Continuous Casting Process



1:Ladle Turret, 2:Tundish/Tundish Car, 3:Mold, 4:First Zone (Secondary Cooling), 5:Strand Guide (plus Secondary Cooling), 6:Straightener Withdrawal Units, 7:Dummy Bar Disconnect Roll, 8:Torch Cut-Off Unit, 9:Dummy Bar Storage Area, 10:Cross Transfer Table, 11:Product Identification System, 12:Product Discharge System

Figure 3.6 - General Bloom/Beam Blank Machine Configuration

Continuous Casting is the process whereby molten steel is solidified into a "semifinished" billet, bloom, or slab for subsequent rolling in the finishing mills.

Steel from the electric or basic oxygen furnace is tapped into a ladle and taken to the continuous casting machine. The ladle is raised onto a turret that rotates the ladle into the casting position above the tundish. Referring to Figure 3.6, liquid steel flows out of the ladle (1) into the tundish (2), and then into a water-cooled copper mold (3). Solidification begins in the mold, and continues through the First Zone (4) and Strand Guide (5). In this configuration, the strand is straightened (6), torch-cut (8), then discharged (12) for intermediate storage or hot charged for finished rolling.

3.4.3 Hot Rolling Mill

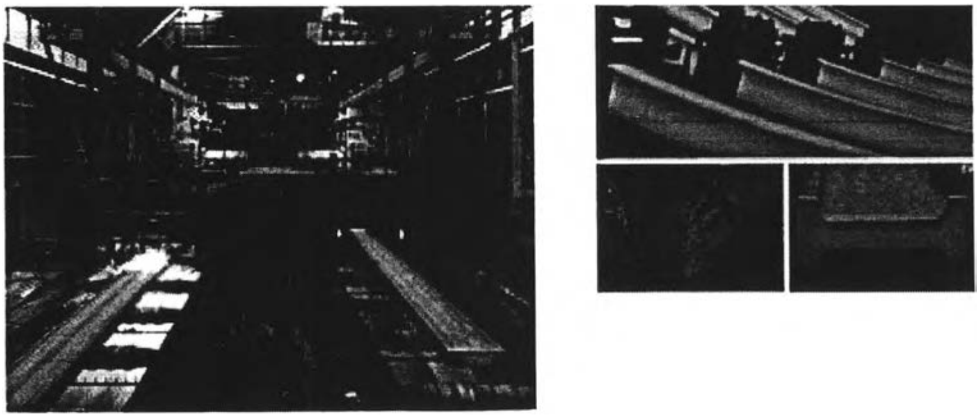


Figure 3.7 Hot Rolling Mill

Semi-finished products called blooms, billets and slabs are transported from the steelmaking plant to the rolling mills. In many plants steelmaking and rolling are both carried out on the same site.

Steel products can be classified into two basic types according to their shape: **flat products and long products**. Slabs are used to roll flat products, while blooms and billets are mostly used to roll long products. Billets are smaller than blooms, and therefore are used for the smaller type of long product.

Semi-finished products are first heated in a re-heat furnace until they are red hot (around 1200 degrees C). On all types of mill the semi-finished products go first to a roughing stand. A stand is a collection of steel rolls (or drums) on which pressure can be applied to squeeze the hot steel passing through them, and arranged so as to form the steel into the required shape. The roughing stand is the first part of the rolling mill. The large semi-finished product is often passed backwards and forwards through it several times. Each pass gradually changes the shape and dimension of the steel closer to that of the required finished product.

Strip mills.

Slabs are also used to make steel strip, normally called hot rolled coil. After leaving the roughing stand, the slab passes continuously through a series of finishing stands which progressively squeeze the steel to make it thinner. As the steel becomes thinner, it also of course becomes longer, and starts moving faster. And because the single piece of steel will be a whole range of different thicknesses along its length as each section of it passes through a different stand, different parts of the same piece of steel are traveling at different speeds. This requires very close control of the speeds at which each individual stand rolls; and the entire process is controlled by computer. By the time it reaches the end of the mill, the steel is traveling at about 40 miles per hour. Finally the long strip of steel is coiled and allowed to cool.

Hot rolled strip is a flat product which has been coiled to make storage and handling easier. It is a lot thinner than plate, typically a few millimetres thick, although it can be as thin as 1mm. Its width can vary from 150mm to nearly 2 metres. It frequently goes through further stages of processing such as cold rolling and is also used to make tubes (smaller tubes than those made from plate). It is also frequently sold through service centres (stockholders) who will cut the coil into individual sheets or into other shapes thereby reducing the amount of processing that the customer needs to perform on the steel.

3.5 The process related to the problem of the company

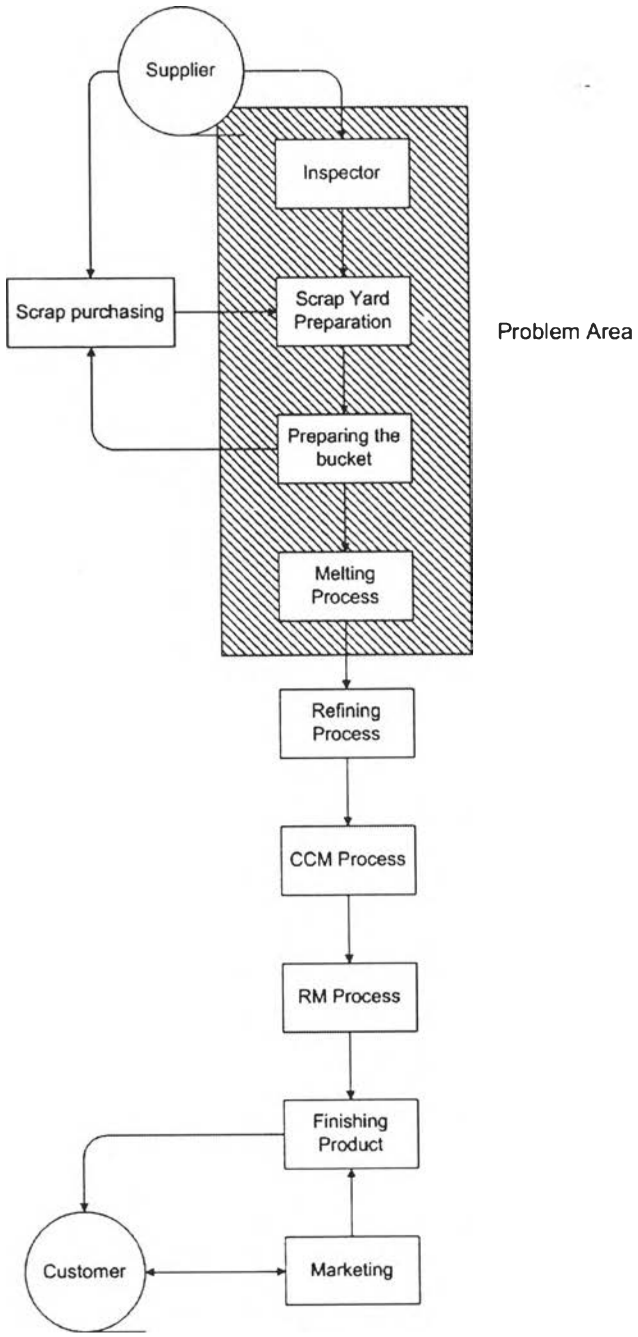


Figure 3.8 Overall process of the company

3.6 Scrap Yard Preparation Section

3.6.1 Type of Scrap

Scrap definition is Recovered plain carbon steels, processed to defined sizes, containing Mn no more than 1.65%. Limitations are also defined for elements such as Pb, Cu, Cr, Ni, Mo and Sn, and non-metallics. The scrap may be purchased or recycled from the production line as Home' scrap.

According to the overall process of production, Scrap Yard Preparation Section has to inspect the scraps from the suppliers and then sent them to the open scrap yard. So the inspector of this section is necessary to know the specification of each scrap type to sorting the type of the scrap.

In the Scrap Preparation Section, there are many types of scraps. They can be categorized the scrap into 5 types following by density and then % chemical component. These are shown in Table 3.2

Table3.2 Type of Scrap categorizing by density and Chemistry composition

Type of Scrap	Density	Chemistry Composition				
	t/m^3	%C	%P	%S	%Mn	%Si
Po(ex)	0.85	0.2	0.035	0.035	1	0.35
Po	0.7	0.2	0.025	0.025	0.9	0.25
A	0.6	0.18	0.02	0.02	0.8	0.25
B	0.45	0.15	0.02	0.02	0.5	0.25
I (Pig Iron)	3.3	4.5	0.16	0.08	1	1.25

3.6.2 Scrap Yard Layout

Scrap Yard Region of the company has about 10 rais. There are two mains areas. the first location in the left hand side is Open Scrap Yard and the second one is Scrap storage yard.

Open Scrap Yard is the location for loading the scrap from the suppliers. It provide into the U shape as you can see in the Figure 3.9 and there are the road around the Open Scrap Yard for the truck of suppliers to load the scrap. In the U shape, there are providing the scrap into 5 piles categorizing according to the type of scrap. In the middle of the U shape, there are magnetic truck clans to take the scrap in the open scrap yard to the truck for transporting them to the Scrap Storage Yard.

In Scrap Storage yard, there are providing the scraps into small 5 piles like the open scrap yard and there are the tower cranes in the middle. There is the fence between each pile of the scraps and the tower cranes (like the concrete mix station). The crane in the tower has the function to take the scraps in each pile to the bucket in the truck by Scale and sent it to the Electric Furnace Arc. In taking the Scrap to the bucket, the worker consider the quantity of weight and volume of each scrap according to the pattern of managing the scrap as you can see the next section.

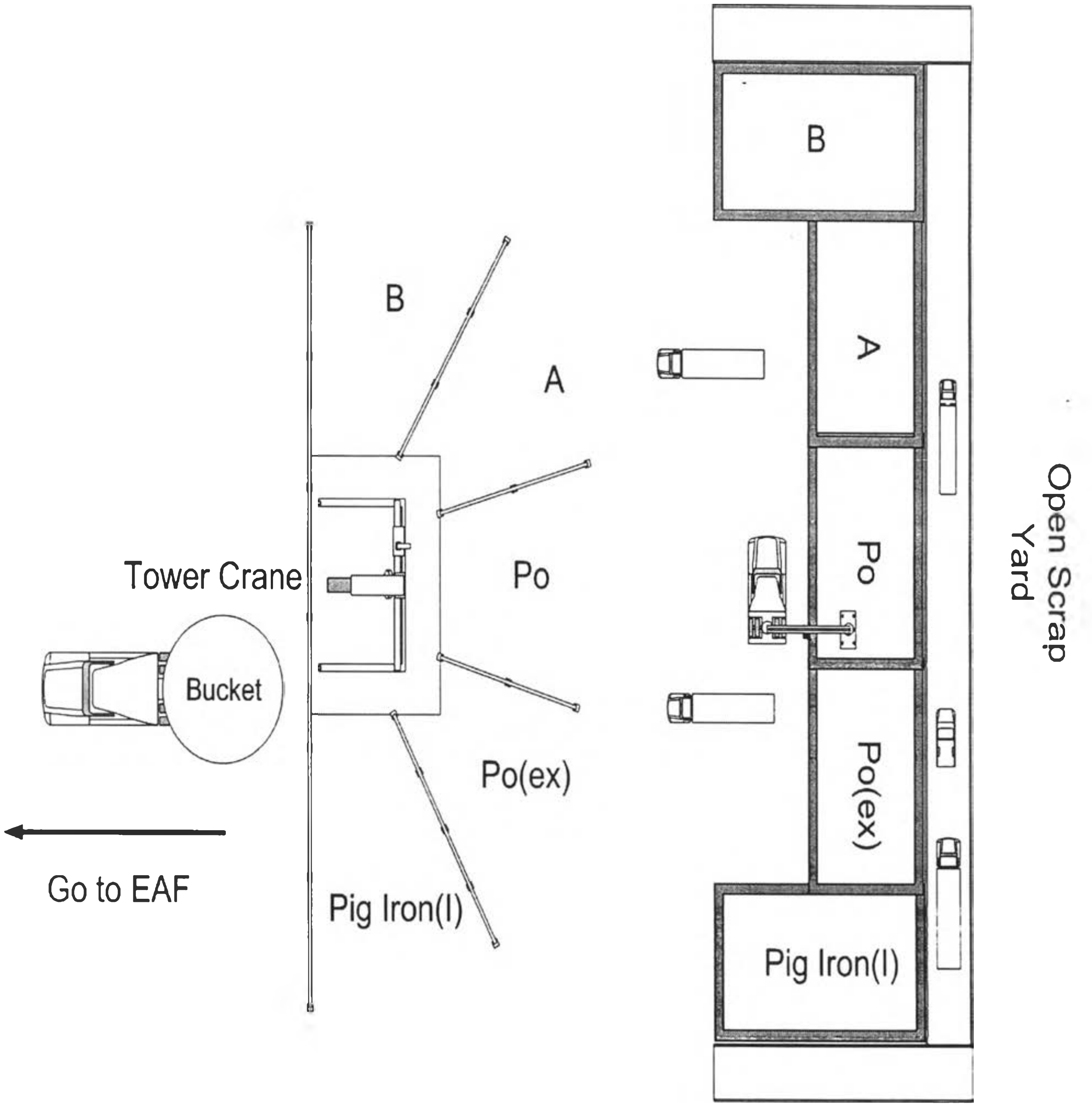


Figure 3.9 Scrap Yard Layout

3.7 Procedure of the production process related

3.7.1 Melting Process

Operation of Procedure

The following cycle of steps is followed for each batch of EAF production and is indicated in the flow chart form at the end of this document.

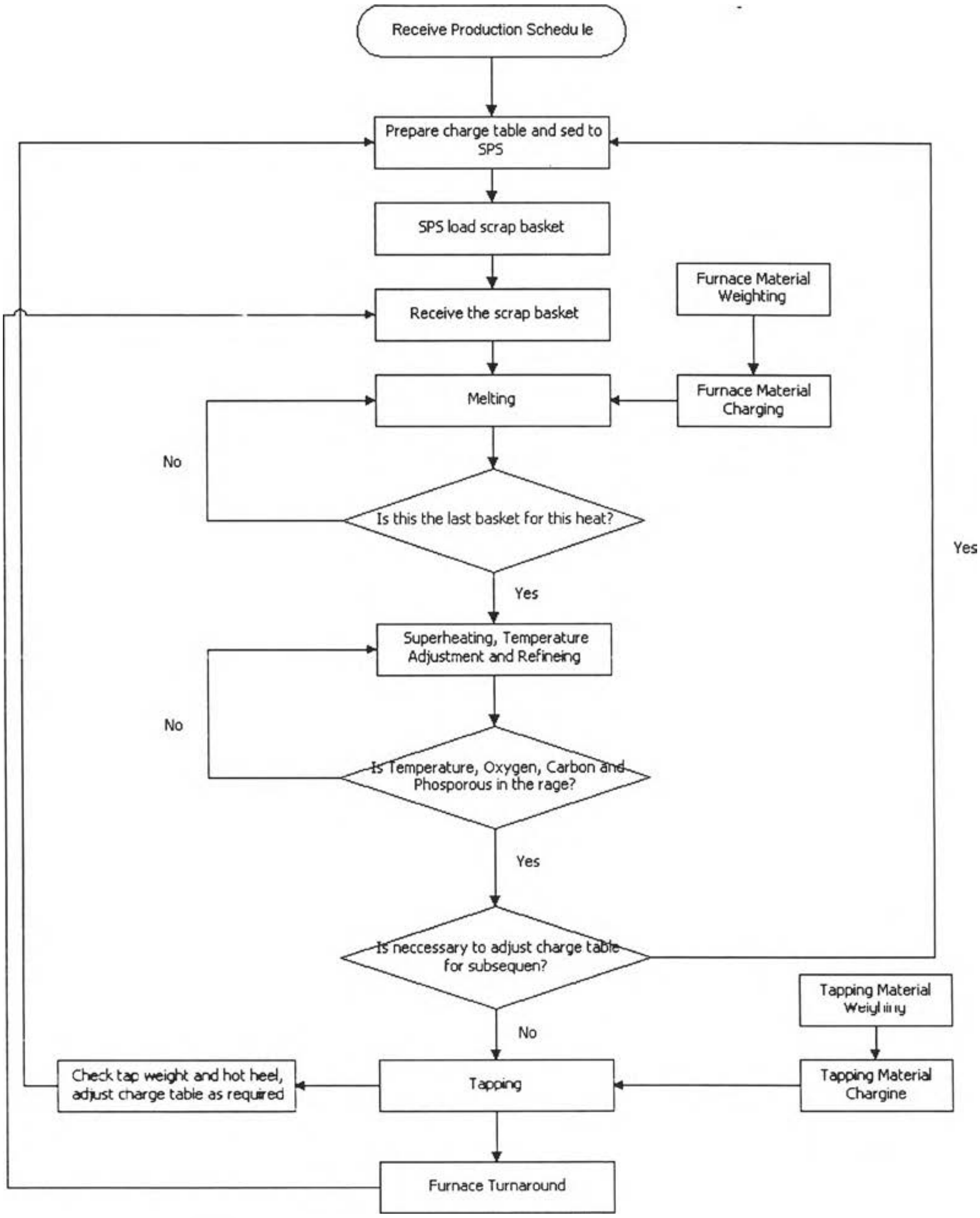


Figure 3.10 The flow chart of Melting process

➢ RECEIVE PRODUCTION SCHEDULE

The production schedule is delivered electronically from production planning to the Meltshop. Under the menu step 'Meltshop Planning', the production schedule lists the MS Grade Code, and corresponding MS Grade Name, for each Production Order Number.

The MS Grade Name includes 8 digits AA-BB-CC-DD. The CC digits are either:

LR – Low Residual

MR – Medium Residual

HR – High Residual, and indicate to MeltShop Production Engineers what general level is specified for residual elements. The MS Grade Code indicates, and references in the computer database; the type of steel, the major process setups, Charge Table, and the precise chemistry (including residual elements).

➢ PREPARING AND LINKING THE CHARGE TABLE TO MS GRADE CODE

- Each MS Grade code data details set contains a Charge Table field into charge table number must be entered as a linkage between the MS Grade Code to be produced and the raw materials used.

  The Charge Table contains the type and quantity of each furnace material to be charged to the EAF. Each Charge Table is designed to meet a residual element requirement, maximize basket density, maintain consistent tap weight, control liquid heel levels, and manage scrap yard inventories.

  The Charge table is maintained in the MeltShop Level 2 database by the MeltShop Production engineers but can subsequently be modified by the Shift Manager or MeltShop Shift Supervisor according to actual plant conditions.

- Transmission of Charge Table and destination EAF to SPS (Scrap Preparation Section)

Three modes of chare table transfer to HMT are provided:

a) **Auto**:

On sending/re-sending of the Production Schedule from the Production Planning Level 2.1 computer, the MeltShop Level 2 automatically attaches the linked Charge Tables and electronically transmits these on to the SPS Scrap Handling Service computer.

b) **Manual**:

Should a change have been made to the Charge Table already linked to a Production Order Number (PON), electronic transmission of this change to SPS can be 'triggered' manual on the MeltShop Level 2 computer. A pre-condition however, is that loading of the first scrap basket of that PON has not commenced.

> Note: Manual changes to charge tables of an individual PON are to be made via the 'Basket Details' function in the 'Meltshop Planning' screen of Level 2. Such changes do not alter the Charge Table database and are thus only effective for that particular PON

c) Verbal: In case of an emergency, where there is insufficient time to alter a charge table or where scrap basket loading has already commenced, verbal communication from the Meltshop Shift Supervisor or Shift Manager to SPS staff is permitted. HMT staff may manually override the charge table in their computer to reflect the requested change.

➢ SPS LOAD SCRAP BAST

SPS load the scrap baskets for each PON in the sequence indicated in the production schedule. After loading each scrap basket, confirmation of the actual raw materials charged is sent electronically back to the Meltshop Level 2 computer and printed on the Level 2 EAF Heat report. In this way a precise record of actual charge is retained. Precise adherence to the charge table is not necessary because of the inconsistent nature of scrap. Of more importance is to control the total charge weight for each tap.

➢ RECEIVE THE SCRAP BASKET

After loading each scrap basket is placed at the EAF indicated by the Meltshop Level 2 computer. This is indicated in the function 'Route' selected in the 'Meltshop Planning' screen that mean the scrap basket is received by Meltshop.

➢ SCRAP CHARGING

The EAF crane charges the raw materials (i.e. Scrap, pig iron, HBI, carbon and fluxes) from the scrap basket to the furnace.

➢ MELTING

The process of converting the furnace materials (i.e. Scrap, Pig Iron, HBI, carbon and fluxes) to liquid by electrical and chemical energy. The process steps for melting are controlled by the MeltShop level 1 system and updated by MeltShop production engineers.

➢ SUPERHEATING, TEMPERATURE ADJUSTMENT AND REFINING

The process of removing impurities from the steel, and to bring temperature and oxygen content to required tapping conditions.

➢ TAPPING

The process to pour the liquid steel from the furnace to the ladle. The company aim total tapping weight is normally 133 MT (liquid steel weight ~132MT) but can be changed according to furnace conditions.

➢ FURNACE TURNAROUND

The process to prepare the furnace for melting the next heat.

3.7.2 Refining Process

Operation of Procedure

➢ RECEIVE HEAT FROM EAF

The ladle full of liquid steel is transferred from the Ladle transfer car to the LHF by overhead crane. If any slag carry-over has been observed at the EAF, this is poured off into CCM slag pot.

The LHF operator visually identifies the ladle number and from this is able to confirm on the Level 2 system which heat has arrived.

The level 2 computer retains the full process history record of the heat at the EAF and this allows the LHF to verify the current actual chemistry against the MS Grade Code requirements.

➢ REFINING AND TEMPERATURE ADJUSTMENT

- The heat at LHF must be refined to meet the requirements of the MS Grade Code and subsequent process steps. Specifically, steel chemistry, temperature and gases content are adjusted and controlled to ensure suitability for casting.

- The LHF 1st Melter directs the LHF 2nd Melter in the operation of the ladle furnace accordance with the MS Grade Code.

- The process steps for grade groupings are contained, as flow chart, in the "Ladle Furnace Metallurgical Practices"

  Residual elements cannot be adjusted in the LHF. If a heat's residual elements are out of specification the appropriate authority as defined in Management Responsibility verbally approve the disposition of the heat. The approval is noted on the "Level 2 LHF Heat Report"

- The Melt Shop Crane Operator in the ladle bay operates under the LHF 1st Melter's instruction to handle ladles for the LHF

➢ DELIVERY HEAT TO CASTER

After the heat meets the chemistry, de-oxidation and temperature requirements of the Caster, the heat must be delivered to Caster at the time requested. If the heat deviates from the MS Grade Code requirement or the requirement for the Caster, the appropriate authority person as defined in Management Responsibility verbally approves the heat for further processing. The approval is noted on the 'Level 2 LHF Heat Report".

In the case of Caster or subsequent process has some abnormal condition and the Heat at Caster must be returned to LHF, Melt Shop Shift Supervisor and Shift Manager have to decide how to process that heat.

3.7.3 Continuous Casting Process

Operation of Procedure

Continuous casting may be defined as teeming of liquid metal in a mold with a false bottom through which partially solidified slab is continuously withdrawn at the same rate at which metal is poured into the mold. Steel is poured in the mould via a tundish, and as soon as the mold is full to a certain level, withdrawal of the plug begins. Uninterrupted pouring and simultaneous withdrawal gives rise to the whole cast being poured in the form of one piece which is cut into smaller pieces as per the requirement.

- TUNDISH SET UP

The casting procedures may be considered to begin right from setting up a fresh tundish on a tundish car at casting area. A fresh tundish is delivered by the Refractory Section in a "ready to Pre-heat" condition to caster. A tundish is placed onto either of the two tundish cars located at the casting floor on east – west direction of the plant. Before a tundish is placed on a tundish car, the later must be parked in its pre-heating position.

- PRE-CAST PREPARATION

After a tundish is placed on a tundish car, it is preheated by the Continuous Casting Operation crew. The Ladle Operator is responsible for preheating a tundish. Tundish preheating is done at least 4 hours before cast start time. The following are other activities performed by the caster crew while the tundish is undergoing preheating. These activities are considered collectively as " Pre-Cast Preparation" tasks.

- Dummy bar head preparation:

  The strand Operators prepare the dummy bar head as per the schedule slab width to be casted in the forthcoming sequence. The dummy bar head size is determined with respect to mold bottom width MBW). The MBW required for casting the scheduled slab width is calculated by the Level – 2 computer system and is available in Level 2 computer at caster pulpit for the operators to prepare the dummy bar head.

- SEN set-up and preheating:

  The Submerged Entry Nozzle (SEN) is set-up to the tundish bottom (undergoing preheating) and is then preheated at least 45 minutes before cast start time. SEN set-up and preheating is normally done by Ladle and/ or strand Operators.

- Mold Calibration and Set-up:

  The Strand Operators are responsible for calibrating the mold. The mold set-up is done to set the mold to the targeted MBW in order to produce slab width as per production schedule delivered to caster from production planning. While setting up the mold width, the strand Operators need to do measurements of the mold top width and mold taper to achieve the targeted MBW. Local control panel (OP-MO) and mold taper gauge measuring tool are used while performing the mold calibration and set-up.

- Sealing the mold:

  The mold is sealed with the dummy bar head inside it. As such, this process is done after preparing the dummy bar head and setting the mold to the correct MBW. The sealing of mold is done by Strand Operators. Before start sealing, the Strand Operators make sure that the dummy bar with its head attached to it is inserted and the head is lying inside the mold at the bottom. Then, the annulus between the mold walls and the dummy bar head is sealed with sealing materials to achieve a perfect seal.

- Mold powder selection:

  The type of mold powder to be used during casting depends on the grade of steel to be cast. Accordingly, as per the received production schedule steel grade, the Strand Operators select the powder type and prepare the powder for casting. The mold powder is stored in 10 kg bags. Some of the bags are kept near the mold for manual feeding while bulk quantity of the powder is stored inside the mold powder feeding machine hopper(s).

  The type and quantity of mold powder consumed during casting is recorded for every sequence in the CCM Operation Sequence Report by the Pulpit Operator and in the Consumable Log Book by the CCM Shift Supervisor.

➢ LADDLE ON TURRET

After the Pre – Cast Preparations are completed, and the tundish preheating is sufficient enough, the caster is ready to receive molten steel to start cast. As such, the LJF delivers the ladle containing molten steel to caster with prior information about its delivery time, molten steel weight, ladle number, ladle tare weight, gross ladle weight, and molten steel temperature at delivery time. The Pulpit Operator records such information and also performs the checks of all interlocks at OIS 1 and OIS 2.

- LADLE SHROUD SETTING/LADLE SLIDE GATE CYLINDER SETTING

After a ladle is mounted onto the caster ladle turret, the Ladle Operators stopped preheating the tundish and prepare the tundish to move to the casting position. After the tundish car with the hot tundish arrives at the casting position, the Strand Operators perform the SEN alignment and other cast starts functions of Level 1 control system to achieve ready condition to start cast. In the meantime, the Ladle Operators fit the ladle shroud into the ladle nozzle and fit the ladle slide gate cylinder to the ladle slide gate mechanism. After the Strand Operators signified ready status, the ladle is then opened by the Ladle Operators upon confirmation from the Pulpit Operator.

- OPENING A LADLE

Normally when the ladle is opened, the molten steel inside it teems out on its own. This phenomenon is called ladle Free Opening. If however, a ladle does not open freely, the Ladle Operators oxygen lance the ladle nozzle to make the molten steel teems out.

- CASTING START / MOLD POWDER ADDITION

Once the ladle is opened (freely or lanced), the steel first flows into the tundish and then finally flows into the mold. Almost immediately after the steel flows inside the mold, casting starts. At this time, mold powder is added to the steel surface in the mold. Also tundish powder is added to the liquid steel in tundish during casting from time to time judging steel condition.

- CAST SPEED CONDITIONS

After casting starts and reached a steady condition, then this casting process continues under a set of conditions necessary to keep the casting process under control and steady conditions all throughout the sequence. The Caster Operators follow these conditions according to actual casting process behavior continuously.

- MENISCUS FREEZE CHECK / SLAG ROPE REMOVAL

During casting, the Strand Operators attend to the mold continuously and perform a set of functions like meniscus freezing checks and slag rope removal. These functions are necessary to avoid any abnormal events like steel freezing on liquid steel surface, blockage of mold powder infiltration into the gap between the mold copper plate and the solidifying steel shell.

- STEEL CHEMICAL COMPOSITION SAMPLING

Likewise the Ladle Operators periodically takes molten steel samples from the tundish. The samples collected are sent to the Melt Shop Laboratory for steel chemical composition analysis. The result of such chemical analysis is sent electronically from the Melt Shop Laboratory to caster Level 2 computer.

- LADLE EXCHANGE FOR SEQUENCE CASTING

If the production schedule (sent from production planning) shows more than one ladle (heat) of the same steel grade group to be casted, the, casting continues after the completion of first ladle (heat). Then, the successive ladle(s) are opened and casted one after another until the scheduled campaign is completed. Such an operation is referred to as ladle exchange for sequence casting.

- REACTING TO BPS RAMP DOWN

This casting machine is equipped with computerized process control technology at all critical control points. This also provides continuous monitoring of actual process values against setup values to ensure continued compliance to targeted quality of the cast slabs as per customer requirements. One of such critical and vital monitoring is temperature mapping inside the mold, due to heat exchange, during the process of steel solidification. The software or computer system monitoring this function is called Breakout Prediction System (BPS). Whenever this system predicts a potential breakout (sticker type only), the casting speed is automatically ramped down, to slow down the casting withdrawal process, thereby avoiding a breakout. If there occurs a casting speed ramped down due to BPS, the Caster Operators react to such an event to take precautionary measures like monitoring the mold surface (called meniscus), visual inspection of slab surface, etc.

- RESPONDING TO SLAG IN TUNDISH

  During sequence casting, the Ladle Operators or the CCM shift Supervisor monitors the tundish slag. This manual monitoring is important, as entrapment of slag into steel in tundish will eventually cause unwanted abnormalities, while casting that steel inside the mold, like boiling or breakout. As such, especially while casting a campaign of large number of ladles (heats), the Ladle Operators measure the tundish slag depth and take necessary actions based on measured result.

- END CAST

  The casting operation comes near to an end when the last ladle of a sequence reaches near empty and it's slide gate is closed by the Ladle Operators. After that the remaining steel in the tundish is casted and then finally the casting ends by closing the stopper rod (located inside the tundish), thereby plugging the bore for steel stream to flow into the mold. The steel inside the mold is casted and the final slab inside the machine is withdraw out to the downstream process,

- MOLD CHECKS AND CLEANING

  After the casting is finished, the Strand Operators clean the mold. Also, they do visual checks in the mold to ensure that the mold condition is good and that there is no sign of any damage or steel adhering to the walls or the rolls.