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ABSTRACT

This instructor's manual contains the materials required to conduct the competency-based workplace literacy program that was developed to help employees at a foundry that has evolved from a small, family-owned business into a major foundry group with several automated production systems. The workplace literacy program consists of 24 lessons in which information about the company and the tasks performed by its workers is used as the basis for helping workers develop the reading, writing, mathematics, problem-solving, and computer literacy skills required to work at the foundry. Each lesson contains some or all of the following: behavioral objectives; lesson plan containing instructor notes, lesson activities, a list of required materials, and estimates of the time required for each component of the lesson; one or more learning activities; vocabulary list; vocabulary definitions; reading material and accompanying questions; and answers to the learning activities and discussion questions. The following are among the unit topics: company history; International Standards Organization and company mission; problem solving; foundry process; coremaking I-II; grinding; pouring I-II; melting; general safety; material safety data sheets; safety--lockout/tagout and personal protective equipment; basic mathematics; statistical process control (SPC) history and principles; SPC math; form completion; job procedure; process cards; benefits; computers--introduction; computer applications; writing I-II; and bar coding. (MN)

Southern Ductile Training Manual

SOUTHERN DUCTILE

November 26, 1996

Dr. Bobby Dees
Alabama State Board of Education
Adult Education Program
50 North Ripley Street, Room 5343
Montgomery, AL 36130-3901

Subject: Alabama WorkPlace Literacy Program

Dear Dr. Dees:

In accordance with the grant for the subject program, this is your authorization to use the generic programs developed by Southern Ductile Casting Company for distribution to other facilities, as you deem appropriate.

Yours Truly,

David M. Ford
Human Resources Manager

DMF/sr

Copy: Mr. Randel Walker

Southern Ductile Training Manual

TABLE OF CONTENTS

Company History

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to company history.
- answer comprehension questions with 90% accuracy.
- explain changes that have taken place and how the changes have affected the company.

Instructor Notes	Activities	Materials	Time
	<u>Set Induction</u>		
	Have learners tell their name and two words that describe them, using their first and last initial. Start with yourself in order to give the learners time to think. When everyone has finished, have each group member try to remember the name of each person in the group and the two things they told about themselves.		5-10 Minutes
	<u>Guided Practice</u>		
	<u>Introduce Vocabulary</u>	Course Content	5-10 Minutes
	Explain the purpose of the program, the course content. Give the pre-test. Have learners read the company history.	Pre-test Workbook	20-30 Minutes
	<u>Applied practice</u>		
	Have learners answer questions about Southern Ductile.	Workbook	20 Minutes
	<u>Closure</u>		
	Allow learners to ask any questions they might have or to express any concerns they might have about the training.		5-10 Minutes

HISTORY AND FOUNDRY PROCESS

S	C	A	S	T	I	N	G	A	T	E	S	A	N	D	R	I	S	E	R	S
E	H	C	W	J	C	R	Y	R	U	P	H	N	V	W	X	M	J	B	K	N
J	A	O	E	G	A	C	S	M	A	T	E	C	H	N	O	L	O	G	Y	I
O	R	R	T	Y	Q	Q	U	C	A	P	R	O	M	D	P	V	J	K	S	M
B	G	E	I	B	F	L	X	P	R	O	H	E	L	E	Y	T	E	G	H	E
B	E	R	C	Q	L	I	W	G	O	A	H	I	A	L	L	O	Y	J	A	C
I	O	S	E	E	L	A	T	U	C	L	P	A	T	T	E	R	N	B	K	H
N	N	Y	R	C	U	X	S	N	X	R	A	B	E	E	M	K	G	R	E	A
G	K	S	H	V	J	E	B	T	Z	D	U	C	T	I	L	E	I	R	O	N
F	E	T	P	O	S	T	I	N	O	C	U	L	A	T	I	O	N	J	U	I
O	T	E	A	E	O	Y	R	F	I	C	P	Z	P	I	S	N	R	T	T	Z
U	L	M	T	J	C	I	G	J	O	Y	U	N	X	V	R	M	K	L	S	A
N	V	S	C	H	W	T	W	B	R	H	B	O	E	U	W	X	T	P	D	T
D	T	A	U	X	X	L	I	X	K	L	E	A	J	U	M	B	M	B	D	I
R	L	N	S	L	X	F	I	O	G	D	C	I	H	Y	C	H	F	I	Y	O
Y	W	D	R	V	L	L	F	D	N	I	X	Q	H	U	X	M	Q	K	H	N

Word List

POST-INOCULATION
JOBBING FOUNDRY
GATES AND RISERS
MECHANIZATION
DUCTILE IRON
INSPECTION
SYSTEM SAND
TECHNOLOGY
SHOTBLAST
TREATMENT
GRAY IRON
SHAKEOUT
GRAPHITE
CASTING
PATTERN
CHARGE
MULLER
CUPOLA
SCRAP
ALLOY
CORE
TAP

Vocabulary - Company History and Foundry Process

1. **Alloy** - A metal-like material added to molten iron to change one or more of its properties. Magnesium, ferrosilicon and copper are common alloys used at Southern Ductile.

2. **Casting** - A metal object produced by pouring molten metal into a mold.

3. **Charge** - The materials placed in a melting furnace. Two common charge materials for ductile iron production are steel and foundry returns.

4. **Core** - A sand structure placed into a mold to create a hole or internal cavity in a casting.

5. **Cupola** - Stack-type melting furnace in which metal is melted in direct contact with the fuel.

6. **Ductile Iron** - Cast iron that has a large amount of carbon in the form of balls or nodules. These nodules are produced by adding a small amount of magnesium to the molten iron.

7. **Gates and Risers** - The network of extra metal attached to a casting reflecting the path of the molten metal inside the mold that must be removed at gatebreaking.

8. **Graphite** - A soft, black form of carbon found in gray and ductile iron. It is also used to increase the carbon content of the furnace iron.

9. **Gray Iron** - Cast iron that has a large amount of carbon in the form of flake graphite.

10. **Inspection** - The various procedures used to check castings to determine if they meet customer requirements.

11. **Jobbing Foundry** - A foundry that contracts to make a relatively small number of many different castings to various customers. Southern Ductile is a jobbing foundry.

Vocabulary - Company History and Foundry Process

12. **Mechanization** - The process of introducing machines to replace human labor.

13. **Muller** - A machine used to prepare molding sand by mixing sand with water, clay and other additives.

14. **Pattern** - A form usually made of wood or metal around which sand is packed to make a mold.

15. **Post-inoculation** - The addition of an iron-silicon alloy, ferrosilicon, to the treated iron while it is transferred from the bull ladle to the pouring ladle. This process helps promote the formation of large numbers of graphite balls or nodules.

16. **Scrap** - A defective or unusable casting.

17. **Shakeout** - The process by which the casting is separated from the molding sand.

18. **Shotblast** - To blast metal shot against the surface of a casting in order to clean it.

19. **System Sand** - Recycled sand. During shakeout the sand that is removed from the casting is returned to the muller for reuse.

20. **Tap** - The removal of molten metal from the melting furnace.

21. **Technology** - Tools, machines, materials, methods and processes used to produce goods or provide services, or to perform other useful functions in our lives.

22. **Treatment** - The addition of a small amount of magnesium to low-sulfur liquid cast iron to produce ductile iron. The magnesium causes the carbon in the molten iron to form round ball-like structures called nodules as the casting cools.

The Challenge of Change - A Brief History of Southern Ductile Casting Company

Since its founding in 1937, Southern Ductile Casting Company (SDCC) has undergone many changes. These changes transformed a small family-owned business into a modern operation that is part of one of the largest foundry groupings in the nation. New technology produced dramatic changes in the workplace and in the way work was organized and performed. The story of how advancing technology created a changing workplace for Southern Ductile employees can be divided into three major periods.

SOUTHERN
DUCTILE

The Early Period (1937-1950)

Southern Ductile had a modest beginning as a small family-owned jobbing foundry. Five employees produced gray iron castings in a former horse stable in Bessemer, Alabama. This small foundry was named Jones Foundry after its founder and owner Gibb Jones. Work at Jones Foundry was physically demanding. Employees made molds on the floor using portable squeeze machines. They prepared and shoveled large amounts of sand to make molds. The same employees poured these molds after carrying hand-held crucibles filled with iron from the cupola furnaces to the molding area. Despite the strenuous work, these early employees were skilled craftsmen who took years to master their trade. In the coming years the skills and the physical requirements of jobs at Jones Foundry would change drastically with the introduction of more advanced technology.

The Middle Period (1950-1969)

By the early 1950s Gibb Jones' son, Jack, had begun to take over the operation of the foundry. Under his direction two major changes occurred. The first major change was the increased mechanization of the foundry process. This reduced much of the heavy labor involved in producing castings and increased productivity. The changes included the following:

- An overhead rail system to transfer iron from the cupolas to the molding area.
- A rail system to support movable pouring ladles, thus eliminating the hand-held crucibles.
- A system of conveyor pans and belts to transport castings and move large quantities of molding sand.
- New stationary jolt-squeeze molding machines with overhead sand storage bins along with pallet lines to transport the molds to pouring.

The second major change during these middle years was the shift to ductile iron production. Ductile iron contains carbon as round or ball-shaped graphite, giving this new alloy advantages over the older gray iron. This transition made Jones Foundry one of the first foundries in the Birmingham area to produce ductile iron. It also created two important changes in the production process.

1. **Treatment:** During treatment a magnesium alloy is added to the molten metal after tapping the iron from the furnace. This magnesium addition is responsible for changing the typical gray iron graphite flakes into round or ball-shaped structures characteristic of ductile iron.

2. **Post-inoculation:** Post-inoculation takes place when the magnesium-treated iron is transferred to the pouring ladles. At this point another alloy called ferrosilicon is added. This ferrosilicon addition helps the formation of large numbers of graphite nodules necessary for high quality ductile iron.

The Modern Period (1974-Present)

Jack Jones died in 1968 and shortly thereafter Jones Foundry fell upon hard times. In 1971 First National Bank foreclosed and ran the foundry until Morris Hackney purchased the company in 1975. This management transition ushered in a series of dramatic changes.

The old cupola furnaces were replaced with modern electric induction furnaces. The new furnaces increased both the speed and the degree of control of the melting process. They proved to be ideal for the production of high quality ductile iron. Other changes soon followed. Automated Hunter Molding Machines were installed. Shortly after changing its name to Southern Ductile Casting, the company began an ambitious modernization project. This $2.4 million project included:

- the building of a new coreroom and pattern storage building,
- the purchase of new cold box core blowers and two high speed mullers,
- the installation of the British Molding Machine (BMM) to replace the old manual cope and drag machines.

In the second half of the 1980s several other automated systems were installed.

- The old Hunter pallet lines were replaced with an automated Tru-Flow mold handling system.
- New vibrating conveyor systems were introduced to transport molds to the shake out and castings to the gatebreaking area.
- Two high output cold-box core machines, the Laempe and the B & P Coldbox, were installed.

The 1990s witnessed the installation of the new Hartley Sand Control Systems in the Hunter and BMM molding areas. These computerized systems automatically prepare sand for the molding machines.

Southern Ductile is part of Citation Corporation. Citation is one of the largest foundry groups in the nation. It now owns 18 foundries in 9 states, employing 5,000 people.

Changes in the foundry industry and the overall economy have created the need for increased training to prepare Southern Ductile employees for the challenges of a changing workplace as we approach the 21st century.

History Questions - Molders

Answer the following Questions. Look back at the history if necessary.

1. The foundry was named after founder and owner **Gibb Jones**.

2. In 1971 **First National Bank** foreclosed and ran the foundry until Morris Hackney purchased the company in 1975.

3. Two major changes occurred when Jack Jones took over the business in the early 1950s. What were the changes? **Increased mechanization and a shift to ductile iron production**.

4. The 1990s witnessed the installation of the **Hartley Sand Control Systems** in the Hunter and BMM molding areas.

5. The old Hunter pallet lines were replaced with an automated **Tru-Flow** mold handling system.

6. What changes have taken place that affected the way you perform your job? Were the changes good or bad? **Accept any reasonable answers.**

History Questions - Coremakers

Answer the following Questions. Look back at the history if necessary.

1. The foundry was named after founder and owner **Gibb Jones**.

2. In 1971 **First National Bank** foreclosed and ran the foundry until Morris Hackney purchased the company in 1975.

3. Two major changes occurred when Jack Jones took over the business in the early 1950s. What were the changes? **Increased mechanization and a shift to ductile iron production**.

4. The 1980s witnessed the installation of the **Laempe and the B & P cold box core machines** in the coremaking area.

5. The 2.4 million dollar project brought about many changes at Southern Ductile. What changes took place in the coreroom as a result of this project? **A new coreroom was built as a result of the 2.4 million dollar project and new cold box core blowers were purchased**.

6. What changes have taken place that affected the way you perform your job? Were the changes good or bad? **Accept any reasonable answers.**

History Questions - Grinders

Answer the following Questions. Look back at the history if necessary.

1. The foundry was named after founder and owner **Gibb Jones**.

2. In 1971 **First National Bank** foreclosed and ran the foundry until Morris Hackney purchased the company in 1975.

3. Two major changes occurred when Jack Jones took over the business in the early 1950s. What were the changes? **Increased mechanization and a shift to ductile iron production**.

4. Southern Ductile is part of a larger corporation. What is the name of that corporation? **Southern Ductile is owned by Citation Corporation.**

5. What changes have taken place that affected the way you perform your job? Were the changes good or bad? **Accept any reasonable answers.**

History Questions - Iron Pourers

Answer the following Questions. Look back at the history if necessary.

1. The foundry was named after founder and owner **Gibb Jones**.

2. In 1971 **First National Bank** foreclosed and ran the foundry until Morris Hackney purchased the company in 1975.

3. Two major changes occurred when Jack Jones took over the business in the early 1950s. What were the changes? **Increased mechanization and a shift to ductile iron production**.

4. What changes took place in Pouring in the 1950s? **An overhead rail system to transfer iron from the cupolas to the molding area.**
   A rail system to support movable pouring ladles, thus eliminating the hand-held crucibles.

5. What changes have taken place that affected the way you perform your job? Were the changes good or bad? **Accept any reasonable answers.**

History Questions - Melting

Answer the following Questions. Look back at the history if necessary.

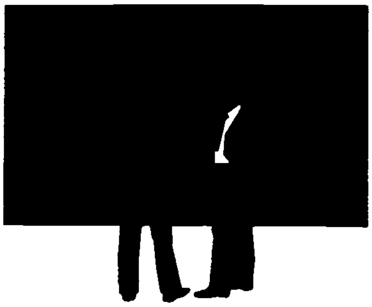
1. The foundry was named after founder and owner **Gibb Jones**.

2. In 1971 **First National Bank** foreclosed and ran the foundry until Morris Hackney purchased the company in 1975.

3. Two major changes occurred when Jack Jones took over the business in the early 1950s. What were the changes? **Increased mechanization and a shift to ductile iron production**.

4. During the modern period the old cupola furnaces were replaced with modern electric induction furnaces. How did the electric induction furnaces change things in the melting department? **The new furnaces increased both the speed and the degree of control of the melting process**

5. What changes have taken place that affected the way you perform your job? Were the changes good or bad? **Accept any reasonable answers.**



ISO and Mission Statement

Upon completion of this lesson the learner will be able to:

- define ISO and Mission Statement vocabulary words
- explain the mission statement
- explain the importance of the ISO certification
- explain the importance of customer satisfaction

Instructor Notes	Activities	Material	Time
	Set Induction Divide learners into two groups. Have the learners brainstorm and record information about the changes that have taken place since they started working for the company. After 5 minutes bring learners back together. Write the different changes on the markerboard and discuss each.	Paper Markerboard Kit	10 Minutes
	Guided Practice Introduce Vocabulary Read Indispensable? and explain that everyone at the company is a team member and that players on a team work together to accomplish goals. Each team member has a specific job that is an important part of the whole operation at the company. A big part of that job includes customer satisfaction.	Indispensable?	10 Minutes
	Applied Practice Have learners complete the exercise in their workbook.	Workbook	15-20 Minutes
	Closure Discuss the exercises.	Workbook	15-20 Minutes

Indispensable?

Sometime, when you're feeling important,
Sometime, when you're ego's in bloom,
Sometime, when you take it for granted
You're the best qualified in the room.
Sometime when you feel that your going
Would leave an unfillable hole,
Just follow this simple instruction
And see how it humbles your soul.
Take a bucket and fill it with water,
Put your hand in it up to the wrist,
Pull it out and the hole that's remaining
Is the measure of how you'll be missed.
You may splash all you please when you enter,
You can stir up the water galore,
But stop, and you'll find in a minute
That it looks quite the same as before.
The moral of this quaint example
Is to do just the best that you can,
Be proud of yourself, but remember,
There is no indispensable man (or woman).

-Anonymous
(Source Unknown)

ISO AND MISSION STATEMENT

V	M	A	R	K	E	T	I	N	G	G	D	C	T	R	P	Q
Y	H	N	M	J	K	H	X	Y	X	D	R	C	M	V	M	D
L	E	S	T	A	N	D	A	R	D	S	K	D	I	T	P	L
P	S	I	N	T	E	G	R	I	T	Y	T	I	F	O	R	P
M	S	P	R	O	D	U	C	T	S	O	L	U	T	I	O	N
O	R	I	J	V	I	S	V	Y	Q	Z	U	A	X	C	B	C
C	O	M	M	U	N	I	C	A	T	I	O	N	T	M	L	U
O	R	E	S	P	O	N	S	I	B	I	L	I	T	I	E	S
M	M	E	V	A	L	U	A	T	E	V	O	C	X	V	M	T
P	V	V	D	E	U	E	Y	D	H	I	N	V	E	W	J	O
E	T	G	M	I	J	D	M	P	I	L	C	B	Q	V	T	M
T	P	M	W	L	B	K	I	E	U	G	P	K	O	Y	R	E
I	P	W	L	D	B	I	S	T	N	Q	M	F	R	S	A	R
T	S	Y	P	I	E	X	L	G	O	T	G	G	L	R	D	E
I	W	Q	I	K	E	K	T	I	I	R	X	O	Y	Q	J	P
V	F	U	N	D	A	M	E	N	T	A	L	S	J	N	U	C
E	F	F	I	C	I	E	N	C	Y	Y	N	L	B	R	B	Y

Word List

RESPONSIBILITIES
COMMUNICATION
FUNDAMENTALS
COMPETITIVE
CREDIBILITY
EFFICIENCY
INTEGRITY
MARKETING
IMPLEMENT
STANDARDS
PRODUCTS
CUSTOMER
SOLUTION
EVALUATE
AUDITOR
PROBLEM
PROFIT
COMPLY
ANSI
ISO

Vocabulary - ISO, Mission Statement, and Problem Solving

1. **(ISO)** - International Standardization Organization

2. **(ANSI)** - American National Standards Institute

3. **Standards** - Rules or models to be followed.

4. **Responsibilities** - Duties or obligations

5. **Comply** - To obey rules or standards

6. **Fundamentals** - Basic principles

7. **Communication** - The exchange of information or opinions.

8. **Auditor** - One who examines.

9. **Efficiency** - ability to be productive.

10. **Profit** - What is left after all production costs are paid.

11. **Marketing** - The practice of selling goods.

12. **Competitive** - Able to compete with others in the marketplace.

13. **Products** - Something made or produced.

14. **Customer** - Those who buy from you.

15. **Credibility** - How trustworthy you are.

16. **Integrity** - Maintaining a code of values.

17. **Problem** - Something that needs consideration or a solution.

Vocabulary - ISO, Mission Statement, and Problem Solving

18. Solution - The answer to a problem

19. Implement - To carry out

20. Evaluate - Appraise

ISO 9000

The International Standardization Organization (ISO) was founded in 1946 with the American National Standards Institute (ANSI) representing the United States. The purpose of the ISO is to develop and encourage industrial standards of quality worldwide. More than 100 countries have adopted the ISO 9000 standards. Failure to implement ISO 9000 could result in lost business opportunities in the very near future.

The standards are general in nature in order that they may be adapted to the structure of any company. The standards deal with the design, manufacture, sales, and servicing of a product and are divided into three areas of responsibility. The three areas of responsibility to the customer are:

- management responsibilities
- companywide responsibilities
- department or individual responsibilities.

Customers Worldwide are demanding more from their suppliers, especially when it comes to quality assurance. Customers want high quality products and they want consistency of that high quality. ISO certification lets everyone know that you comply with high standards of quality. The fundamentals of ISO 9000 may be summed up as:

- Say what you do
- Do what you say
- Be able to prove it.

Changes will take place as the company moves toward the ISO 9000 certification. This means that you will be solving problems and making decisions on your own. ISO 9000 makes it necessary for employees to be able to:

- identify problems
- initiate action to correct problems
- follow-up to insure that the corrective action is effective
- take the necessary measures to prevent the problem from re-occurring.

The key factors in all this are communication and training. Communication is the way we exchange thoughts and ideas or give and receive information. To communicate well does not mean to agree with everything someone else says. It does mean you should try to understand the other person's point of view. Remember no two people in the world are exactly alike. We all have different personalities, thoughts, ideas, values, and experiences. We can share these experiences through open communication on the job and through training sessions.

Training is one of the points covered by the ISO 9000 standards. According to the standards, the company is responsible for identifying training needs and providing the training for all employees affecting quality. The employees need to be qualified for their job based on education, training and/or experience. Employees must be able to communicate to ISO auditors what they do and how they do it.

Compliance with ISO 9000 standards will improve the efficiency of the company, increase profit, and improve marketing. It will give the company a competitive advantage as customers learn of the certification. Job security will also increase as the word spreads throughout the marketplace.

Read the ISO 9000 information and answer the questions.

1. The acronym ISO stands for **International Standards Organization**.

2. Why is it important that Southern Ductile becomes ISO certified? **ISO certification tells customers that you meet the highest standards of quality**.

3. The basis of ISO can be summed up in three short sentences. What are they?
   1. Say what you do.
   2. Do what you say.
   3. Be able to prove it.

4. What does the ability of the company to remain competitive mean to you? **Accept any reasonable answer**.

Mission Statement

Mission

Southern Ductile's mission is to lead the world in customer service. Our mission is dedicated and predicated on reducing waste and on never-ending improvements through training of our most valuable resource, our people. It allows Southern Ductile to grow, develop, expand, and profit through humanitarian practices.

Values

We, at Southern Ductile, hold these values accountable to our success:

- **People** are our greatest resource.
- **Products** exceed our customer's expectations.
- **Profits** allow us to provide the best customer service available.

Guiding Principles

We, at Southern Ductile, will do exactly what we say we will do, when we say we will do it. We will tell you well in advance if something changes so you will not be harmed by our actions.

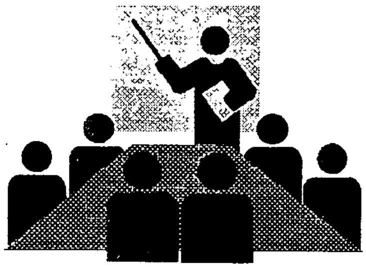
We, at Southern Ductile, believe our credibility and integrity must never be compromised.

Read the Southern Ductile Mission Statement and answer the questions.

1. Southern Ductile holds three values accountable for the success of the company. What are those three values?
   1. people
   2. products
   3. profits

2. What are the key points brought out in the mission section of the "Mission Statement"?
   Southern Ductile wants to: lead the world in customer service, reduce waste, and to continuously improve by training their employees.

3. At Southern Ductile we believe that two things should never be compromised. What are those two things?
   1. Southern Ductile credibility
   2. Southern Ductile integrity

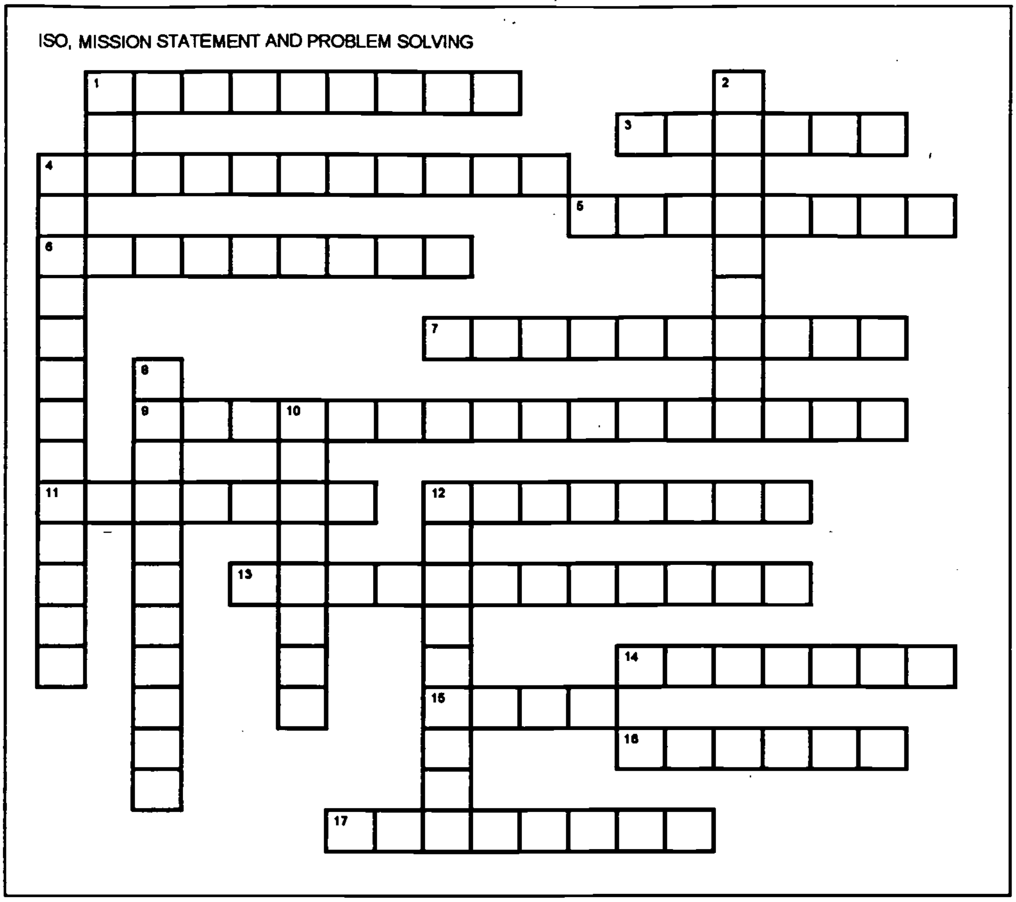


Problem Solving

Upon completion of this lesson the learner will be able to:

- list the four steps of problem solving
- practice problem solving techniques
- brainstorm to solve problems
- utilize problem solving on the job

Instructor Notes	Activities	Materials	Time
	<u>Set Induction</u> Read "What went Wrong?", and discuss how situations like this can be avoided.	Story "What Went Wrong?"	5 - 10 minutes
	<u>Guided Practice</u> Guide learners through the problem solving steps on the board. 1)What is the problem? 2)What are some possible solutions? What are the consequences of these solutions? 4) What is the best solution? Have learners read the "Truck Story" and help you answer the problem solving questions.	Markerboard Kit Workbook "Truck Story"	10 - 15 minutes
	<u>Applied Practice</u> Have the learners work in pairs to read the case studies and answer the problem solving questions. <u>Review Vocabulary</u>	Workbook	20 - 25 minutes
	<u>Closure</u> Discuss the answers as a whole group.		15 - 20 minutes



Across

1. Maintaining a code of values.
3. To obey rules or standards.
4. Able to compete with others in the marketplace.
5. Appraise
6. The practice of selling goods.
7. Ability to be productive.
9. Duties or obligations.
11. One who examines.
12. The answer to a problem.
13. BAsic principles.
14. Something that need consideration or a solution.
15. American National Standards Institute (acronym)
16. What is left after all production costs are paid.
17. Those who buy from you.

Down

1. International Standardization Organization (acronym)
2. To carry out.
4. The exchange of information or opinions.
8. How trustworthy you are.
10. Something made or produced.
12. Rules or models to be followed.

Word List

ANSI
AUDITOR
COMMUNICATION
COMPETITIVE
COMPLY
CREDIBILITY
CUSTOMER
EFFICIENCY
EVALUATE
FUNDAMENTALS
IMPLEMENT
INTEGRITY
ISO
MARKETING
PROBLEM
PRODUCTS
PROFIT
RESPONSIBILITIES
SOLUTION
STANDARDS

WHAT WENT WRONG?

This is a story of four people: Everybody, Somebody, Anybody and Nobody. There was an important job to be done and Everybody was sure that Somebody would do it. Anybody could have done it, but Nobody did it. Somebody got angry because it was Everybody's job. Everybody thought that Somebody would do it, but Nobody asked Anybody. It ended up that the job wasn't done and Everybody blamed Somebody when actually Nobody asked Anybody.

Author Unknown

(Source Unknown)

Problem Solving Steps

1. State the problem.
2. State the possible solutions.
3. Implement the most feasible solution.
4. Evaluate the effectiveness of the solution.

Truck Story

Greg is a driver for the Zig Zag Trucking Company. He has a delivery for Southern Ductile. The load must be delivered by 10:00 AM. He is traveling down the Interstate thinking he will not have any trouble making the delivery on time. As he approaches the exit he can see that traffic is backed-up. Greg continues on thinking it is just your typical bad traffic day. When he gets closer he can see that there has been an accident. He decides to take a street he has not been on before. He is not familiar with this part of town. As he approaches the train overpass he looks down at his watch. Greg realizes he has plenty of time to make the delivery. The cab goes under the overpass and Greg hears a loud scraping. He remembers that he does not have the rig he normally drives. The rig is stuck under the overpass.

1. What is the problem?

2. What are some possible solutions?

3. What do you think is the best solution and why?

4. How could this situation have been avoided?

Molders

Read the case studies that follow and answer the problem solving questions. Discuss the case studies with your partner. You may not agree on the answers, but that is expected.

Case Study # 1

You are doing your 9:30 AM cope up. You see that a lot of sand has fallen into the cavity. Sand has fallen into the cavity before and your supervisor told you to go ahead and run the molds. You decide to go ahead this time too. Several parts have to be scrapped.

1. What is the problem?

2. What are some possible solutions?

3. How could this problem have been avoided?

Molders

Case Study # 2

You are running molds for an order. The iron pourer informs you that there is sand in the sprue cup. You continue to run the molds without checking.

1. What is the problem?

2. What are some possible solutions?

3. How could this problem have been avoided?

Case Study # 3

You are running a job that you know required chaplets in the past. The set-up man did not bring you any chaplets. You go ahead and run the job without the chaplets. Your supervisor notices what you are running and stops you.

1. What is the problem?

2. What are some possible solutions?

3. How could this problem have been avoided?

Case Study # 4

Your supervisor gives you your paycheck. You look at it at break and notice that you did not get paid for all of the overtime you worked last week.

1. What is the problem?

2. How should this problem be handled?

3. What are the possible solutions?

Coremakers

Read the case studies that follow and answer the problem solving questions. Discuss the case studies with your partner. You may not agree on the answers, but that is expected.

Case Study # 1

The set-up man has your order ready to run. You run the cores and mark the boxes according to the core card. The cores get down to molding and they will not fit the mold. The box of cores is labeled for the correct order.

1. What is the problem?
   The lead put on the wrong core box.

2. What are some possible solutions?
   Check the core box number with the process sheet.

3. How could this problem have been avoided?
   Check the core box to make sure the lead man put the correct core box on the machine.

Coremakers

Case Study # 2

You are running a core order. You are using 65-500 sand, after all what does it matter, sand is sand. Right? The supervisor comes by and notices what you are doing. The cores have to be scrapped.

1. What is the problem?
   The cores were made using the wrong sand.

2. What are some possible solutions?
   Check the core card for the type of sand.

3. How could this problem have been avoided?
   Read the process card before making cores.

Case Study # 3

You are running a job that has two cavities per box. The order is for 250 pieces. You run the job until the counter says 250 because you have not had any bad cores.

1. What is the problem?
   The operator ran too many cores.

2. What are some possible solutions?
   Accept any reasonable answer.

3. How could this problem have been avoided?
   Check the process card for the number of boxes to be run.

Grinders

Read the case studies that follow and answer the problem solving questions. Discuss the case studies with your partner. You may not agree on the answers, but that is expected.

Case Study # 1

You are grinding a part that you have done several times before. You do not have the process sheet. You decide to go ahead and grind the part without the process sheet. The process sheet comes out after the part is finished. The instructions for special processing have changed. QC scraps the parts.

1. What is the problem?
   The part had to be scrapped because the process sheet was not followed.

2. What are some possible solutions?
   Process sheets should be ready on time. Check with the supervisor for instructions if you do not have a process sheet.

3. How could this problem have been avoided?
   Always have the process sheet before you start to grind. If the process sheet has not been run, check with the supervisor for instructions.

Grinders
Case Study # 2

You place some barrels in the furnace, at 8:00, for annealing. You clean up around the machine during the heat treating process. When you check the heat treating recorder at the end of the cycle you notice that the temperature reached 1100° at 8:15 and remained there for the rest of the cycle.

1. What is the problem?
   <u>The digital temperature setting was not checked to be sure the it was set at the correct temperature.</u>

2. What are some possible solutions?
   <u>Check the temperature setting and monitor periodically throughout the cycle.</u>

3. How could this problem have been avoided?
   <u>Always check heat treat process sheet to have correct temperature setting and keep a check on the furnace during the cycle.</u>

Grinders

Case Study # 3

You have to change the wheel on your machine. You remove the old wheel and go to get the new wheel. You drop the new wheel on the way to your machine. Nobody saw you drop it and it looks all right, so you put it on the machine. You think you might get in trouble for dropping the wheel, so you do not tell anyone.

A few days later you come to work and everyone is talking about the injury Janice sustained when the wheel on the machine broke. You realize that Janice runs the same machine you do only on another shift. You act as though nothing has happened, thinking "That could have been worse and it could have been me".

1. What is the problem?
   The wheel broke because you failed to tell anyone you dropped it.

2. What are some possible solutions?
   Take care when handling the wheel. If the wheel is too heavy to handle alone ask for help.
   When something like this happens notify the supervisor.
   Have the wheel checked to be sure it can still be used.

3. How could this problem have been avoided?
   Have a good attitude about your work and be respectful of others who use the same machine.

Iron Pourers/Bull Pushers

Read the case studies that follow and answer the problem solving questions. Discuss the case studies with your partner. You may not agree on the answers, but that is expected.

Iron Pourers/Bull Pushers - Case Study # 1

You are pouring an "as cast" job. The next job is a "copper addition" job. You have not finished pouring the ladle when the molds for the copper job start. You go ahead and finish pouring out of that ladle until you use the iron. You add copper to the next ladle of iron and continue to pour the molds. The sample catcher does a check and then has to check even more molds for copper.

1. What is the problem?
   Some molds were poured without copper.

2. What are some possible solutions?
   Pigout the remainder of the iron that does not have copper and get another ladle of iron to add copper.

3. How could this problem have been avoided?
   Always add copper to jobs that should have copper.

Iron Pourers/Bull Pushers - Case Study # 2

You are pouring molds for an order. There is sand in the sprue cup. You continue to pour the molds without reporting the problem to your supervisor. When the castings reach inspection they are discarded.

1. What is the problem?
   Sand in the sprue cup made bad castings.

2. What are some possible solutions?
   Notify molding of the sand in the sprue cup.
   Report the problem to the supervisor before pouring the molds.

3. How could this problem have been avoided?
   Do not pour molds if there is sand in the sprue cup unless your supervisor has told you it is all right to pour the molds.

Iron Pourers/Bull Pushers - Case Study # 3

You signal the furnace for a tap out. You ask for 1300 pounds of iron. The furnace operator misunderstood you and taps out 1800 pounds.

1. What is the problem?
   The ladle has been overtapped

2. What are some possible solutions?
   Be certain that you speak loud enough to be heard up at the furnace.
   Develop a system for signaling the amount needed.
   Accept any reasonable solution.

3. How could this problem have been avoided?
   Speak loudly and clearly
   Listen carefully

Iron Pourers/Bull Pushers - Case Study # 4

Your supervisor gives you your paycheck. You look at it at break and notice that you did not get paid for all of the overtime you worked last week. You complain to the receptionist.

1. What is the problem?
   You did not get all your overtime pay.

2. How should this problem be handled?
   Report the problem to your supervisor. Your supervisor will check with payroll and get back to you with a solution.

3. What are the possible causes of the problem?
   Accept any reasonable answer.

Read the case studies that follow and answer the problem solving questions. Discuss the case studies with your partner. You may not agree on the answers, but that is expected.

Case Study # 1 - Melting

You have a full furnace at the beginning of the shift. The iron pourer calls for iron and you begin to tap out the furnace. You continue to tap out iron until your supervisor informs you that the iron is out of the metal specification range.

1. What is the problem?
   The iron is out of the metal specification range.

2. What are some possible solutions?
   The furnace should be pigged out in order to get 2500# of charge steel in the furnace so the problem can be corrected.

3. How could this problem have been avoided?
   Check the metal specifications before tapping the iron.

Case Study # 2 - Melting

You are having a bad day. The bull pusher signals you for a tap out. He needs 1300 pounds of iron. You think he said 1800 pounds so that is what you tap.

1. What is the problem?
   <u>The ladle has been overtapped</u>

2. What are some possible solutions?
   <u>Ask the bull pusher to speak loud enough to be heard up at the furnace.</u>
   <u>Develop a system for signaling the amount needed.</u>
   <u>Accept any reasonable solution.</u>

3. How could this problem have been avoided?
   <u>Speak loudly and clearly</u>
   <u>Listen carefully</u>

Case Study # 3 - Melting

Your supervisor gives you your paycheck. You look at it at break and notice that you did not get paid for all of the overtime you worked last week.

1. What is the problem?

2. How should this problem be handled?

3. What are the possible solutions?

Case Study # 4 - Melting

When you start to work you realize that someone is missing. You think that the person may be doing something for the supervisor that you do not know about. You continue to do your job.

After lunch your supervisor asks you to work over due to absences in your department. You tell him/her that you will work over. You go back to work and start thinking about the plans you have for that night. Your son has his first basketball game. You cannot work over and miss the first part of the game.

You try to find your supervisor when it is time for your regular shift to end. He/She is in a meeting so you ask someone on second shift to tell the supervisor that you had to leave at your regular time. That person gets busy and forgets to tell anyone why you left at the regular time.

Your supervisor writes you up the next day for an incomplete shift.

1. What is the problem?

2. What are some possible solutions?

3. How could this problem have been avoided?

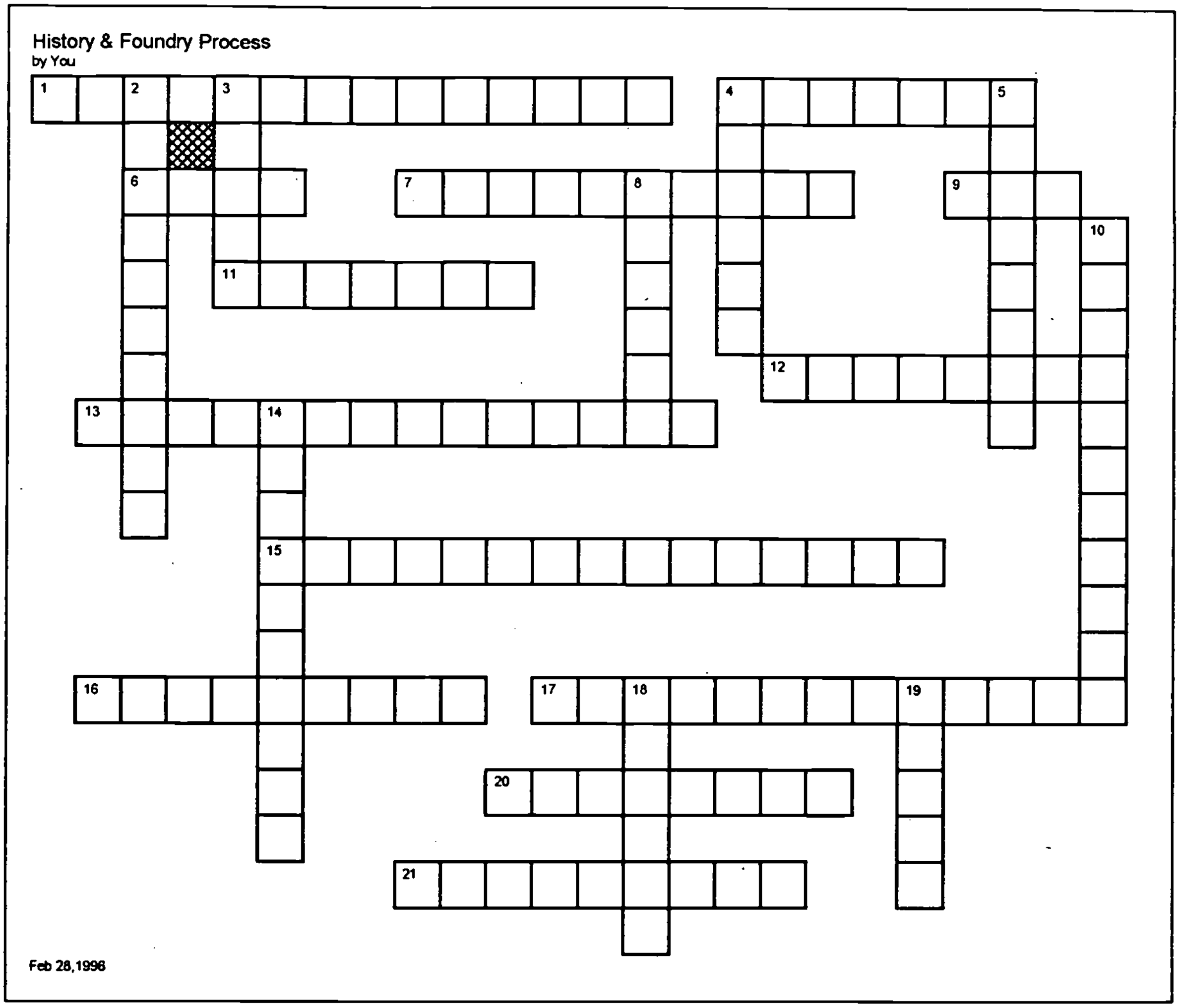
SOUTHERN
DUCTILE

Foundry Process

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to the foundry process
- sequence steps in the foundry process
- explain how their job fits into the foundry process

Instructor Notes	Activities	Materials	Time
	Set Induction Divide the class into two groups. Have each group sort the pictures in the correct order. Have volunteers from each group display the picture sequence on the cork board. Lead the class in a brief discussion of the differences in the two picture sequences.	2 Sets of Foundry Process Pictures Cork Board Pushpins	10-15 Minutes
	Guided Practice Explain that making ductile iron castings is like putting your child's bicycle together. You must perform a number of steps in a given order to achieve the desired result. Read "Steps in the Foundry Process". Ask if there are any questions.	Workbook	15-20 Minutes
	Applied Practice Have learners look at the "Diagram of the Foundry Process". Explain that the diagram is another way to describe the foundry process. Have learners study the diagram and then answer questions about the foundry process. Vocabulary Review	Workbook Transparency	20 Minutes
	Closure Ask learners if they have any questions about the foundry process.		5 Minutes



Across

1. Metal attached to a casting that is removed at gatebreaking. (3 wds.)
4. A metal object made by pouring molten metal into a mold.
6. A sand structure placed in a mold to create a cavity or hole.
7. Recycled sand. (2 wds.)
9. The removal of molten metal from the melting furnace.
11. A form around which sand is packed to make a mold.
12. The process of separating the casting from the molding sand.
13. Southern Ductile is a ____________. (2 wds.)
15. The addition of ferrosilicon to the iron as it is transferred from the bull ladle to the pouring ladle.
16. The addition of magnesium to low-sulfur liquid iron to produce ductile iron.
17. The process of introducing machines.
20. A soft, black form of carbon found in gray and ductile iron.
21. To blast metal shot against the surface of a a casting to clean it.

Down

2. Tools, machines, materials, methods and processes used to produce goods or provide services.
3. A defective or unusable casting.
4. The materials placed in a melting furnace.
5. Cast iron that contains a large amount of carbon in the form of flake graphite. (2 wds.)
8. A machine used to prepare molding sand by mixing sand with water, clay, and other additives.
10. Cast iron that has a large amount of carbon in the form of balls or nodules. (2 wds.)
14. Checking castings to determine if they meet customer requirements.
18. Stack-type melting furnace used in the past.
19. A metal-like material added to molten iron to change one or more of its properties.

Word List

ALLOY	MULLER
PATTERN	CHARGE
POST-INOCULATION	CASTING
TECHNOLOGY	CUPOLA
SCRAP	CORE
SHAKEOUT	SYSTEM SAND
SHOTBLAST	TAP
DUCTILE IRON	GATES AND RISERS
GRAPHITE	GRAY IRON
INSPECTION	JOBBING FOUNDRY
MECHANIZATION	TREATMENT

Steps in the Foundry Process

Melting

Weigh charge of steel and returns.
Load charge into pre-heater.
Dump charge into charging bucket.
Drop charge into furnace.
Monitor chemistry and temperature of molten iron, if necessary:

- Add graphite (C) and/or silicon carbide (SiC) to adjust iron chemistry.
- Make temperature adjustments.

Tap molten iron from furnace into transfer ladle containing magnesium/ferrosilicon alloy.

Molten Metal Transfer

Transport treated iron to slagging station.
Skim off iron from iron surface.
Transport treated iron to pouring station.

While metal is being melted and prepared two other processes are going on, molding and coremaking.

Molding

Prepare or modify pattern.
Add system sand and new sand into muller.
Mix sand with water and premix (clay and other additives).
Distribute prepared sand to overhead hoppers that supply molding machines.
Make green sand molds by squeezing sand around patterns.
Remove pattern from sand.
If necessary, set cores in the drag half of molds.
Close the mold.
Transport mold to pouring station.

Coremaking

Prepare or modify corebox.
Add sand mixed with binders to core box mounted on machine.
Compact sand in metal core box to form cores.
Remove cores from corebox.
Store cores until needed in molding process.
Transport cores to molding area.

Pouring and Cooling

Transfer molten iron to pouring ladles.
Add ferrosilicon to the stream of molten metal.
If necessary, add other alloys, usually copper.
Check the iron temperature.

- If too hot, add chill iron and recheck temperature.
- If too cold, pig it.

Pour iron into waiting molds.
Transport iron-filled molds around Tru-Flo mold handling system. The molten iron within molds cools and solidifies into castings.

Shakeout

Punch out molds onto vibrating conveyor pan.
Transport molds by conveyor pans to vibrating shaker screen.

- Sand falls onto conveyor belt and is returned to storage silo.
- Castings are carried on conveyor pans to gatebreaking station.

Gatebreaking (Breakoff/Sorting)

Remove the gates and risers from castings.
Throw gates and risers into hoppers. The scrap is thrown into a separate hopper and then carried to the furnace for remelting.
Sort castings and throw into containers.
Transport castings to cleaning department.

Grinding/Inspection/Shipping

Load castings into shot blasting machines to remove sand and scale.
Inspect castings.
If necessary, heat treat castings.
Transport castings to grinding stations.
Remove excess metal (gates and fins) through grinding, reaming, chipping, etc.
Inspect castings.
Transport castings to QC for final inspection.
Ship castings to customer.

Write the letter for the definition on the line next to the corresponding vocabulary word.

Charge __J__

Core __G__

Gates and Risers __C__

Graphite (C) __K__

Inspection __D__

Pattern __A__

Scrap __B__

Shakeout __F__

Shotblast __E__

System Sand __H__

Tap __I__

A. A form usually made of wood or metal around which sand is squeezed to make a mold.

B. A defective casting.

C. The extra metal attached to a casting that must be removed at gatebreaking.

D. The various procedures used to check castings to determine if they meet customer requirements.

E. To blast metal shot against the surface of a casting in order to clean it.

F. The process of separating the metal casting from the molding sand.

G. A sand object placed in a mold to create a hole or internal cavity.

H. Recycled sand.

I. To remove molten metal from the melting furnace.

J. The materials placed in a melting furnace.

K. A soft, black form of carbon found in gray and ductile iron. It is also used to increase the carbon content of the furnace iron.

Number the following steps according to the order in which they occur in the production process. Refer to the "Steps in the Foundry Process" and the "Diagram of Foundry Process" if necessary.

__3__ Pour iron into molds

__7__ Ship castings to customer

__4__ Shakeout molds

__6__ Grind Castings

__1__ Load charge into pre-heater

__2__ Add ferrosilicon to stream of molten metal

__5__ Remove the gates and risers from castings

SOUTHERN
DUCTILE

Coremaking - An Overview I

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to the coremaking process
- list the stages of the shell core and cold box coremaking processes
- explain advantages and disadvantages of each coremaking process
- list the factors necessary for the production of good cores

Instructor Notes	Activities	Materials	Time
	Set Induction Have learners grab a handful of sand and squeeze it together. What happens when you open your hand? To make cores we must find a way to make the sand stick together. Ask learners to share their ideas about how this can be done.	Container of Dry Core Sand	5 Minutes
	Guided Practice Introduce Vocabulary Have learners follow along in their workbook as you read the "Core Room Overview". Display the following transparencies in sequence and explain: 1) Basic Components of Coremaking, 2) Steps in the Shell Process, 3) Steps in the Cold Box Process and 4) Comparison of the Shell and Cold Box Processes.	Workbook Overhead Projector Transparencies	25-30 Minutes
	Applied practice Have learners work in pairs to complete the exercises in their workbook. Circulate around the room and assist learners if necessary.	Workbook	15-20 minutes
	Closure Discuss the answers to the exercises. Ask if there are any questions.		5-10 minutes

CORE ROOM

C	O	M	P	O	N	E	N	T	W	M	N	G	C	F	P	P	A
O	J	E	K	T	R	I	E	T	H	Y	L	A	M	I	N	E	V
L	S	T	I	C	K	P	O	I	N	T	V	H	K	N	V	N	G
D	C	H	K	L	T	P	A	R	T	I	N	G	L	I	N	E	O
B	R	Y	I	J	D	D	M	V	C	L	L	N	S	S	O	T	Z
O	A	L	K	F	T	X	V	G	I	H	U	K	W	H	P	R	E
X	T	F	W	E	T	B	G	L	G	Q	G	I	D	Q	J	A	U
P	C	O	N	T	I	N	U	O	U	S	M	I	X	E	R	T	L
R	H	R	R	E	D	N	I	B	A	T	C	H	M	I	X	E	R
O	H	M	I	Q	A	K	D	C	U	R	E	H	M	N	Y	E	O
C	A	A	N	W	V	K	H	O	A	S	Z	U	E	N	E	V	F
E	R	T	S	N	Z	G	O	R	W	T	H	R	Q	X	Y	I	L
S	D	E	P	U	J	V	Z	E	E	E	A	I	S	E	B	T	E
S	N	V	E	J	E	C	T	O	R	S	L	L	N	J	A	I	L
N	E	Q	C	N	E	F	T	X	Z	D	I	P	Y	G	D	D	Q
J	S	P	T	G	V	E	I	N	I	N	G	N	I	S	V	D	R
K	S	S	H	E	L	F	L	I	F	E	N	R	B	N	T	A	K

Word List

ADDITIVE
ALIGN
BATCH MIXER
BINDER
BUSHING
CATALYST
COLD BOX PROCESS
COMPONENT
CONTINUOUS MIXER
CORE
CORE WASH
CURE
DOWEL PIN
EJECTORS
FINISH
INSPECT
METHYL FORMATE
PARTING LINE
PENETRATE
RESIN
SCRATCH HARDNESS
SHELF LIFE
SHIFT
SOLIDIFY
STICK POINT
TRIETHYLAMINE
VEINING
VENTS

Vocabulary - The Core Room

1. **Additive** - A material added to a sand-binder mixture for a specific purpose.

2. **Align** - To adjust the parts of a machine so that they are in the proper relation to each other. To arrange in a straight line.

3. **Batch Mixer** - A device that mixes a measured quantity of sand and additives at one time .

4. **Binder** - A material other than water that is used to hold sand grains ogether in a core.

5. **Bushing** - A fixed or removable metal lining that serves as a guide for a locator pin.

6. **Catalyst** - A substance or agent that speeds up a chemical reaction.

7. **Cold Box Process** - A coremaking process that uses gas chemicals as a catalyst to cure resin-coated sand while it is inside a room temperature corebox.

8. **Component** - A part of something.

9. **Continuous Mixer** - A device that mixes a continuous flow of sand and additives.

10. **Core** - A rigid sand object placed in a mold to form the internal shape of a casting. Cores can also be used to form external parts of a mold that would be difficult or impossible to otherwise make with a mold alone.

11. **Core wash** - A liquid material used to coat the surface of a core.

12. **Cure** - The hardening process that a core undergoes as the binder causes the sand grains to form a strong, rigid object as a result of chemical or thermal reactions.

Vocabulary - The Core Room

13. **Dowel Pin** - A rounded pin that fits in a bushing for the purpose of aligning the parts of a core box or pattern.

14. **Ejectors** - Pins used to push the core from the corebox cavity so that it can be removed.

15. **Finish** - The final steps in producing or completing a product.

16. **Inspect** - To examine closely.

17. **Methyl Formate** - A gas catalyst used to cure cores on the Beta cold box core machine.

18. **Parting line** - The line along which a core box or pattern is divided.

19. **Penetrate** - To enter into.

20. **Resin** - A particular type of binder used to coat the grains of core sand.

21. **Shift** - A core or casting defect in which the two parts of the core or casting do not match up.

22. **Solidify** - The process by which a substance changes from a liquid to a solid.

23. **Stick Point** - The temperature at which the resin coating begins to soften or melt. Also called the melt point.

24. **Scratch hardness** - A measure of the ability of a core to resist being worn down.

25. **Shelf Life** - The length of time a core can be stored without losing its strength.

Vocabulary - The Core Room

26. **Shell Core Process** - A coremaking process in which resin-coated sand forms a hardened shell while inside a heated corebox.

27. **Triethylamine** - A gas catalyst used to cure cores made on the Laempe cold box core machine. It is also called T-gas.

28. **Veining** - A casting defect caused when molten iron weakens and runs into small cracks in a core.

29. **Vents** - Openings in the corebox that allow air or gas to pass out of the corebox. These vents also control the flow of the sand in the cavity ensuring that it completely fills the corebox cavity.

Core Room Overview

Coremaking is an important part of the foundry process. Without cores foundries could only produce simple, mostly solid castings. With the use of cores, foundries are able to make specialized castings with complex internal cavities.

Cores give the foundry industry an important competitive advantage. Cores make it possible for foundries to make complex castings with internal cavities in a single casting operation. In other metalworking industries internal cavities have to be cut out after the part has already been made.

The basic principle of coremaking is simple. A specially prepared sand mixture is blown into a corebox. The sand takes the shape of the corebox cavity. After a short curing period during which it hardens, the core is removed from the corebox.

In these next two lessons we will take a closer look at Southern Ductile's coremaking practices. We will look at:

- The basic components of core making
- The various methods, machines and materials used to make cores at Southern Ductile
- The processes of inspecting, cleaning and boxing of cores
- The most important characteristics of a good core

The Basic Components of Coremaking

To produce good cores, you need a:

1. **Coremaker** - The most important element in making good, quality cores is you, your skills, knowledge and experience as a coremaker.

2. **Corebox** - Cores are made in metal coreboxes with cavities that shape the core.

3. **Core Machine** - Coreboxes are mounted on machines. We use three main types of coremaking machines:

   - Five B & P and three Redford shell core machines
   - One Laempe cold box machine
   - One Beta cold box machine

4. **Core Sand Mixture** - Core sand has three main ingredients:

   - **Sand** - Sand makes up about 98 percent of a core sand mixture. Two of the most important things about sand are the size and shape of its grains. They affect the amount of binder required for core sand. They also affect the permeability of the core sand. Round sand grains, for example, need less binder than other shapes. A small increase in the amount of fine sand grains will dramatically increase the amount of binder needed to coat their surfaces. Too many fine sand grains reduce the ability of the core to let the gases created during pouring to pass through the core and out of the mold.

   - **Binders** - To form cores, sand must be mixed with other materials. Materials called binders or resin binders are mixed with the sand. Mixing coats the sand grains with the binders. Cores are formed when these binders harden and hold the sand grains together.

   - **Special Additives** - Some core jobs require other materials be added to the sand-resin mixture. These additives are used for special purposes. Iron oxide, for example, is an additive. It is used to strengthen cores and prevent them from cracking when they come in contact with molten iron.

Steps in the Shell Process

The B&P and Redford shell core machines use the shell process. This process forms a hardened shell when a resin-coated sand is blown into a heated corebox. When the resin-coated sand comes in contact with the hot corebox, the resin melts and binds the sand grains together. The shell core process has five steps: blow, invest, drain, cure, and strip.

1. During the **blow** stage, resin-coated sand is blown into a heated core box. This sand should completely fill the corebox cavity.

2. The **invest** stage begins when the sand comes into contact with the heated core box. The sand heats up and forms an outside shell of hardened sand that builds up until it reaches the desired thickness.

3. The **drain** stage involves the dumping out of the excess or loose sand from the inside of the core. The machine may invert or roll over to help remove the loose, unbonded sand from the core. This sand is collected for reuse.

4. During the **cure** stage (sometimes called the dwell stage) the shell core remains in the heated core box. As a result of chemical changes in the resin binder the core becomes hard and rigid. If this stage is too long, the core begins to weaken. This is known as overcuring.

5. In the **strip** stage the core is removed from the core box. Vibrators, ejector pins, and release agents help to unstick the core from the core box so that it can be easily removed.

Steps in the Cold Box Process

The Laempe and Beta cold box machines use the cold box process. Unlike the shell core process, the cold box process uses no heat to cure the core This coremaking process uses a gas catalyst to cure resin-coated sand while inside a room temperature corebox. The cold box process has four steps: blow, gas, invest and strip.

- During the **blow** stage, sand is blown into an unheated corebox. This sand should completely fill the corebox cavity.

- In the **gas** stage gas is blown into the corebox. The gas passes through the sand and acts as a catalyst to quickly harden the core. On the B & P coldbox machine the gas must come in contact with every part of the core or the core will have soft spots. The Laempe machine requires only that the gas comes anywhere in the vicinity of the sand.

- During the **purge** stage dry air is blown into the core box. This air purge forces the gas through the core and out of the corebox.

- The **strip** stage involves removing the core from the core box. Vibrators, ejector pins and release agents help to unstick the core from the core box so that it can be removed.

A Comparison of Shell and Cold Box Processes

	Shell Process		Cold Box Process	
Machine	B&P	Redford	Beta	Laempe
Sand Preparation	Premixed resin-coated sand		Continuous Mixer	Batch Mixer
Binder(s)	Phenolic resin and Hexamethylenetetramine		Part 1 resin	Part 1 resin Part 2 resin
Catalyst	Heat-activated		Methyl Formate	Triethylamine
Cycle Steps	Blow Invest Drain Cure Strip		Blow Gas Purge Strip	
Critical Factors	Core box temperature Blow pressure		Sand feed rate Binder and Catalyst flow rate	
Advantages	Sand is dry and free flowing • produces higher density cores and good casting finish • requires lower blow pressure Sand can be stored for long periods Shell cores can be made hollow. • easier to handle and place in the mold. • natural vent for gases		Less wear and tear on the corebox. High speed production process due to short curing cycle. No size limitation on cores.	
Disadvantages	Wear and tear on corebox due to heat Added cost of pre-coated sand Relatively long cycle time		Cores have a limited shelf life; High humidity causes cores to weaken and break down. The gas catalyst used on the Laempe must be sent through a scrubber before being released into the air.	

Answer the following questions about the coreroom. Refer to the lesson if necessary.

1. List the four factors needed to produce cores at Southern Ductile.
   The coremaker, the core box, the core machine, and the core sand mixture.

2. Name the two core making processes used at Southern Ductile and describe each process.
   The shell core process is a coremaking process in which resin-coated sand forms a hardened shell while inside a heated corebox.

   The cold box process is a coremaking process that uses gas chemicals as a catalyst to cure resin-coated sand while it is inside a room temperature corebox.

3. List the five stages of the shell core production cycle.
   Blow, invest, drain, cure, and strip.

4. List the four stages of the cold box coremaking process.
   Blow, gas, cure, and strip.

5. Name two advantages of the shell core process.
- **Shell cores are hollow.**
- **Shell cores can be stored for long periods.**
- **Shell cores sand can be used indefinitely.**
- **Shell core sand is dry and free flowing.**

6. Name one disadvantage of the cold box process.
- **Cold box cores have a limited shelf life.**
- **High humidity causes cold box cores to weaken and break down.**
- **The gas catalyst used on the Laempe must be sent through a scrubber before being released into the air.**

SOUTHERN
DUCTILE

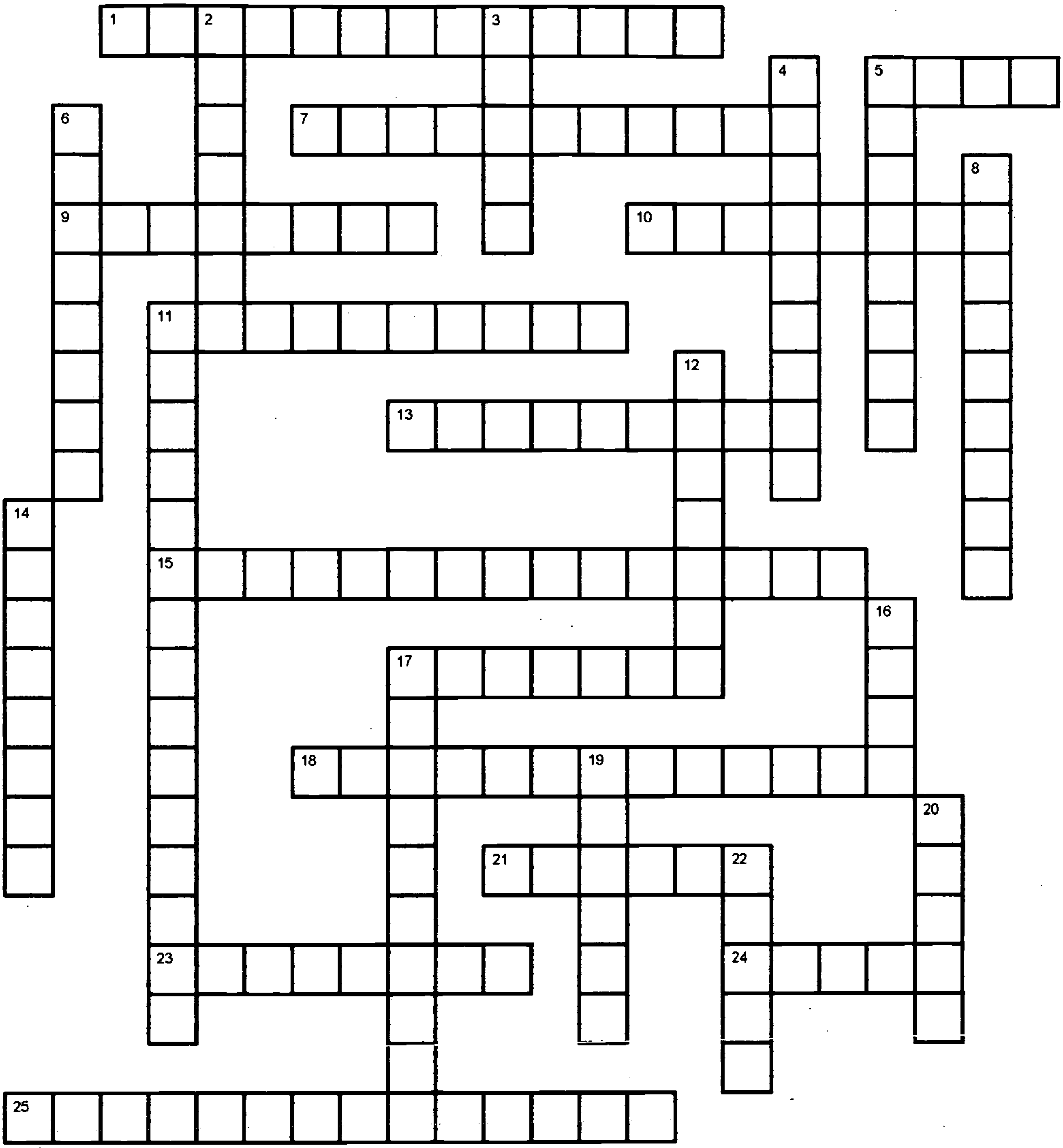
Coremaking - An Overview II

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to the coremaking process
- list the characteristics of a good core
- name and explain the finishing operations performed on cores
- list the things you look for when inspecting cores

Instructor Notes	Activities	Materials	Time
	Set Induction Have learners read a sentence from the markerboard that has a few key words missing. What is the main idea of this sentence? Point out the importance of context in interpreting words. We can also understand our job better if we see it in a larger context.	Markerboard Kit	5 Minutes
	Guided Practice Have learners follow along in their workbook as you read the lesson outline. Display the following transparencies and have learners assist you in discussing each: 1) Inspecting Cores, 2) Finishing and Packing Cores and 3) Characteristics of a Good Core.	Overhead Projector Transparencies Workbook	20-30 Minutes
	Applied practice Have learners complete the exercises in their workbook. Circulate around the room and assist if necessary.	Workbook	20 Minutes
	Closure Lead a discussion of the importance of the core room in the process of making a good, quality casting.		5-10 minutes

CORE ROOM



Across

1. The correct name for T-gas.
5. A rigid sand object used to form the internal cavity of a casting.
7. The line along which a core box or pattern is divided.
9. A rounded pin that fits in a bushing.
10. A liquid material used to coat the surface of a core.
11. The temperature at which the resin coating begins to soften or melt.
13. A part of something.
15. A device that mixes a continuous flow of asand and additives.
17. A fixed or removable metal lining that serves as a guide for a locator pin.
18. A gas catalyst used to cure cores on the Beta cold box.
21. A material other than water that is used to hold sand grains together in a core.
23. The process by which a substance changes from a liquid to a solid.
24. A core or casting defect in which the two parts of the core or casting do not match up.
25. A coremaking process that uses gas chemicals as a catalyst.

Down

2. To examine closely.
3. To arrange in a straight line.
4. To enter into.
5. A substance or agent that speeds up a chemical reaction.
6. A material added to a sand-binder mixture for a specific purpose.
8. The length of time a core can be stored without losing its strength.
11. A measure of the ability of a core to resist being worn down.
12. A casting defect caused when molten iron weakens and runs into small cracks in a core.
14. Pins used to push the core from the corebox cavity so it can be removed.
16. The hardening process that a core undergoes.
17. A device that mixes a measured quantity of sand and additives at one time.
19. The final steps in producing or completing a product.
20. Openings in the corebox that allow air or gas to pass out of the corebox.
22. A particular type of binder used to coat the grains of core sand.

Word List

ADDITIVE
ALIGN
BATCH MIXER
BINDER
BUSHING
CATALYST
COLD BOX PROCESS
COMPONENT
CONTINUOUS MIXER
CORE
CORE WASH
CURE
DOWEL PIN
EJECTORS
FINISH
INSPECT
METHYL FORMATE
PARTING LINE
PENETRATE
RESIN
SCRATCH HARDNESS
SHELF LIFE
SHIFT
SOLIDIFY
STICK POINT
TRIETHYLAMINE
VEINING
VENTS

The Coreroom

In this lesson we consider two questions:

- What work is done on cores after they are removed from the core box?
- What happens to cores after they leave the core room?

1. The job is not finished when you remove the cores from the core box. Once the cores are removed from the core box, they must be:

- inspected
- cleaned
- and packed in boxes.

2. Some cores may be temporarily stored in the core room. Sooner or later, however, all cores are sent to the foundry to be used. To be useful in creating a good, quality casting cores must:

- be strong
- be collapsible
- have a smooth surface
- and produce as little gas as possible.

Inspecting Cores

Look for the following when inspecting cores:

- **Soft Cores** - Soft cores have low density. Density is how tightly the sand grains are packed together to form the core. If a core is not blown up tight it will be soft. The Beta cold box process will produce soft cores if the methyl formate catalyst does not pass through every part of the core.

- **Core Shift** - Core boxes are split in half. If the core box halves are not properly aligned the core will be shifted. This means that the two parts of the core made by the core box will not match. Shift is a result of the core box is not being properly set up on the machine. Core box problems such as worn dowel pins and bushings will also cause core shift.

- **Core Color** - The color of the core surface tells how much a shell core has cured. The longer a shell core is heated, the more it will cure. A properly cured core is honey brown. If a core is heated too long it will turn dark brown or even black. This overcuring will weaken the core and may cause casting defects if used.

- **Core Surface** - Defects on the surface of the core will create defects inside the casting. There are two types of surface defects. The first type is where you have an excess of sand on the core surface. Examples of this core defect include fins and bumps resulting from low ejector pins or low vents. The second defect type is a lack of sand where there should be sand. If the sand is not filling up the core box cavity the first place to look for voids is at the parting line. High ejector pins or high vents will also cause holes or voids in the core.

- **Core Wall Thickness** - Many shell cores are made hollow. The invest time for these cores have to be set to get the desired wall thickness. Hollow shell cores should sometimes be cut in order to measure their wall thickness.

- **Core weight** - Hollow shell cores should also be weighted hourly and recorded on the proper form. If the actual weight falls outside of the weight range called for on the process card a problem may exist.

Cleaning and Packing Cores

After cores are inspected they are cleaned and then packed in boxes.
Three types of finishing work are performed on cores:

- **Filing** - Excess sand such as fins or bumps must be removed from the surface of the core. Filing involves rubbing a file over the surface of a core to remove extra sand. This is necessary to produce a smooth casting or prevent a casting defect.

- **Mudding** - The inside of castings must be smooth. Moist graphite mud is sometimes applied to cores to fill in any voids or smooth over rough spots on the core.

- **Coating** - Some cores are coated with a protective covering of core wash. This covering is applied by dipping the core in a water-based graphite wash. The core wash fills the voids between the sand grains and forms a thin coating over the core. This coating serves many purposes. First, it makes the core surface smoother. Second, it helps prevent molten iron from penetrating the core during pouring. Finally, it acts as an insulator between the hot iron and the core. This helps to keep the core sand from sticking to the casting.

Finally, after cores have been inspected and cleaned they should be properly packed to prevent them from cracking or breaking. Cores are usually placed in wooden boxes. They are packed in layers separated by cardboard or rubber cushions. The Laempe and Beta cores are usually wrapped with rubber cushions so they do not touch.

Characteristics of a Good Core

A good core plays an important part in producing a good, quality casting. A good core must:

- be strong and hard - A core must be strong enough to withstand handling and transportation without breaking. It must also be strong enough to hold its shape as molten iron flows along or over its surface. It must be hard enough to prevent molten iron from penetrating its surface. If the core is not used immediately it must keep its strength until it is actually placed in the mold.

- be collapsible - After the casting has solidified the core should break up or fall apart. If the core does not fall apart it may tear and crack the casting. A collapsible core will also be easier to remove from the casting during shakeout.

- produce as little gas as possible - Gas is created when the binders in the core come in contact with the hot molten iron. Gas holes may form in the casting if more gas is produced than can escape from the mold.

- be smooth - A core must have a smooth surface so that it will form a casting with a smooth inside surface.

Answer the following questions. Refer back to the lesson if necessary.

1. What are three of the things you look for when inspecting cores?
- **Color**
- **weight**
- **wall thickness**
- **shift**
- **surface**
- **hardness**

2. Name the three types of finishing operations performed on cores.
- **Filing**
- **Coating**
- **Mudding**

3. List the characteristics of a good core.
- **Good cores are smooth, strong, collapsible and produce a limited amount of gas.**

4. What are two causes of core shift?
- **Improper core box setup**
- **Worn core box pins and bushings**

Grinding Overview

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to the grinding process
- explain the effects of carbon, silicon, sulfur and copper on ductile iron
- list the three main tests of ductile iron performed in the Southern Ductile QC lab
- define the term "degenerate graphite" and explain why it is undesirable in ductile iron.

Instructor Notes	Activities	Materials	Time
	<u>Set Induction</u> Have learners examine the two castings. What operations are required to transform a rough casting into a finished casting? List learners' responses on the markerboard.	2 castings of the same part - one "rough" casting; one that has undergone all required cleaning operations Markerboard kit.	10 Minutes
	<u>Guided Practice</u> Have learners follow along in their workbook as you read the "The Cleaning Room - An Overview." Display the "Basic Cleaning Room Operations" transparency. Describe each operation. Have learners compare these operations with the list on the markerboard.	Workbook Transparency Overhead Projector	20 Minutes
	<u>Applied Practice</u> Have learners complete the exercises in their workbook	Workbook	15 Minutes
	<u>Closure</u> Discuss the answers to the exercises.	Workbook	5 Minutes

GRINDING

F	T	N	W	A	R	P	A	G	E	V	I	S	A	R	B	A
E	N	I	L	G	N	I	T	R	A	P	A	V	D	S	N	U
I	O	S	H	O	T	B	L	A	S	T	I	N	G	N	M	J
L	I	P	E	T	U	M	Q	D	J	T	E	J	E	Z	X	S
E	T	E	A	B	R	I	N	E	L	L	V	A	P	Z	B	T
R	C	C	T	S	G	Q	X	L	R	V	L	L	B	U	W	F
S	E	I	T	I	N	F	S	J	X	I	T	B	M	J	N	E
S	P	F	R	S	N	I	F	I	N	I	S	H	K	W	G	K
E	S	I	E	U	X	T	D	G	V	D	E	A	I	P	I	B
R	N	C	A	S	C	A	S	T	C	A	S	T	I	N	G	S
T	I	A	T	S	C	X	F	T	W	I	D	Z	L	Z	E	W
S	U	T	M	C	S	Y	S	H	P	F	M	T	Y	V	S	S
C	E	I	E	H	P	T	E	G	F	V	X	J	A	G	G	R
A	C	O	N	C	W	U	Z	Q	N	B	G	M	O	R	Z	F
L	U	N	T	C	V	A	K	E	B	H	G	Y	W	G	J	Z
E	G	F	R	U	P	S	F	D	F	K	C	A	G	N	G	F

Word List

AS-CAST CASTINGS
HEAT TREATMENT
SPECIFICATION
SHOT BLASTING
STRESS RELIEF
PARTING LINE
INSPECTION
ANNEALING
ABRASIVE
BRINELL
WARPAGE
FINISH
GRADE
SCALE
GATE
FINS

Vocabulary - The Cleaning Room: An Overview

1. **Abrasive** - A substance used for removing material by grinding. Abrasive materials such as silicon carbide and aluminum oxide are used in the cleaning room for removing unwanted metal from castings by grinding or cutting.

2. **Annealing** - A heat treating process used to make castings softer and easier to machine.

3. **As-Cast Castings** - Castings that are produced without a heat treatment.

4. **Brinell hardness test** - A test to measure the hardness of a casting. A brinell hardness value is based on the size of the impression made by a machine that presses a ball against the casting surface.

5. **Finish** - Sometimes called surface finish. Finish refers to the appearance of the casting surface. (Ex. smooth or rough)

6. **Fins** - A thin piece of extra metal on the surface of a casting. Fins are often located at the parting line of a casting.

7. **Gate** - The part of the casting where the molten iron flows into the mold cavity. After the gates and risers are removed from the casting there is usually extra iron left in the gate area that must be removed.

8. **Grade** - A particular strength of ductile iron. The three most common grades of ductile iron produced at Southern Ductile are 60-40-18, 65-45-12 and 80-55-06. The 60-40-18 grade is the softest of the grades. It is usually annealed. The 65-45-12 grade is an intermediate or middle grade. It is harder and stronger than the 60-40-18 grade. It is usually produced as-cast, that is, without being heat treated. Finally, the 80-55-06 grade is the hardest, strongest and toughest of the three common grades of ductile iron. It is as-cast, but a copper alloy is added to the pouring ladle to produce this grade.

9. **Heat treatment** - The controlled heating and cooling of castings to produce useful properties in these castings. Iron castings may be heat treated to relieve internal stresses, soften and improve machinability or increase strength and wear resistance.

10. **Inspection** - The process by which castings are checked or examined for defects.

11. **Parting line** - The part of the mold or casting made where the two halves of the mold come together. There is often extra iron at the parting line area of the casting that must be removed by grinding.

12. **Scale** - A flaky oxide film that sometimes forms on the metal as a result of the casting process.

13. **Shot blasting** - The process by which metallic shot is blown or thrown against a casting to remove sand and scale from its surface.

14. **Specification** - A standard written description of exactly what the customer wants in a product. It usually contains a list of product characteristics and their tolerances.

15. **Stress relief** - A heat treating process used to remove or reduce internal stresses in castings which may cause warpage.

16. **Warpage** - An undesired change in the shape of a casting. Warpage may occur when castings are heat treated or during machining as a result of internal stresses within the castings.

The Cleaning Room - An Overview

The cleaning room (also called the grinding room or the finishing department) plays an important role in the production of ductile iron castings. The cleaning room is the end-of-the-line in the production process. It transforms a rough casting into a finished product ready to be used by the customer.

The work of the cleaning room adds value to the castings made in the foundry. Each casting must be cleaned, ground and inspected. Some castings also require heat treating or special processing operations in order to satisfy the customer's specifications. The work in the cleaning room is not complete until the casting is loaded onto the right truck to be shipped to the customer. The cleaning room plays a major role in making sure that customers receive good, quality castings when they need them.

Basic Cleaning Room Operations

Employees in the cleaning room perform the following basic operations:

1. **Shotblasting** - Two shotblast machines, the Blastec and the Wheelabrator, are used to clean the castings. Shotblasting removes sand, scale or other foreign material that may be stuck to the surface of the castings. It also improves the surface finish of the casting.

2. **Heat treating** - Three furnaces are used to heat treat castings. The two main heat treat operations are annealing and stress relieving.

   - **Annealing**: Annealing creates soft castings that are easy to machine. The annealing process involves three steps. (1) The castings are heated to and held at 1550° F for 2 hours. Very small or thin castings are held at 1450° F for 2 1/2 hours. (2) The castings are cooled to 1000° F. (3) The furnace hood is removed and the castings continue to cool to room temperature.
   - **Stress Relieving**: Some castings made for Haglin Dennison and Lee Brothers are stress relieved The purpose of stress relieving castings is to reduce stresses within the casting that may cause casting to break or warp during machining. The stress relief cycle has three steps. (1) The castings are heated to and held at 1100° F for two hours. (2) The castings are cooled to 600°F. (3) The furnace hood is removed and the castings are cooled to room temperature.

3. **Grinding** - Several stationary grinders are used to remove excess metal from the surface of the castings. The grinding wheels remove relatively large amounts of iron from the gates and the parting line areas of castings.

4. **Special processing** - After grinding some castings require additional work. This work is called special processing. Air files are used to remove burrs from castings. Cut-off blades are used to clean out slots. Many Volvo and Fruehauf parts must have the holes reamed.

5. **Inspecting** - Every casting is inspected for defects such as shifts or coldruns.. Visual inspection takes place at three distinct stages in the cleaning process:

- after castings are shotblasted
- before castings are ground
- before castings are placed into a shipping container.

Some parts must also be gauged to make sure they meet the customer requirements. Castings found to be unusable are thrown into scrap hoppers. Good castings are placced in shipping containers and transported to the Q.C. inspection area for a final audit.

6. **Shipping** - Once the castings are released by Q.C., the shipping inspector weighs each container of castings and prints the shipping ticket. The containers are then staged in groups until a forklift driver loads them on the right truck to be shipped to the customer.

Answer the following questions.

1. What is the major role of the cleaning room?
   The major role of the cleaning room is to transform a rough casting into a finished product ready to be shipped to the customer.

2. When is the work of the cleaning room complete?
   The work of the cleaning room is not complete until the right casting is loaded onto a truck that will ship it to the customer.

3. What are the two major types of heat treating operations performed at Southern Ductile?
   Annealing
   Stress Relieving

4. List and briefly describe the six major operations performed in the cleaning room.

- **Shotblasting: A cleaning operation that removes sand and scale from the casting surface and also improves the casting finish.**

- **Heat treating: The controlled heating and cooling of castings in order to produce desired properties in these castings.**

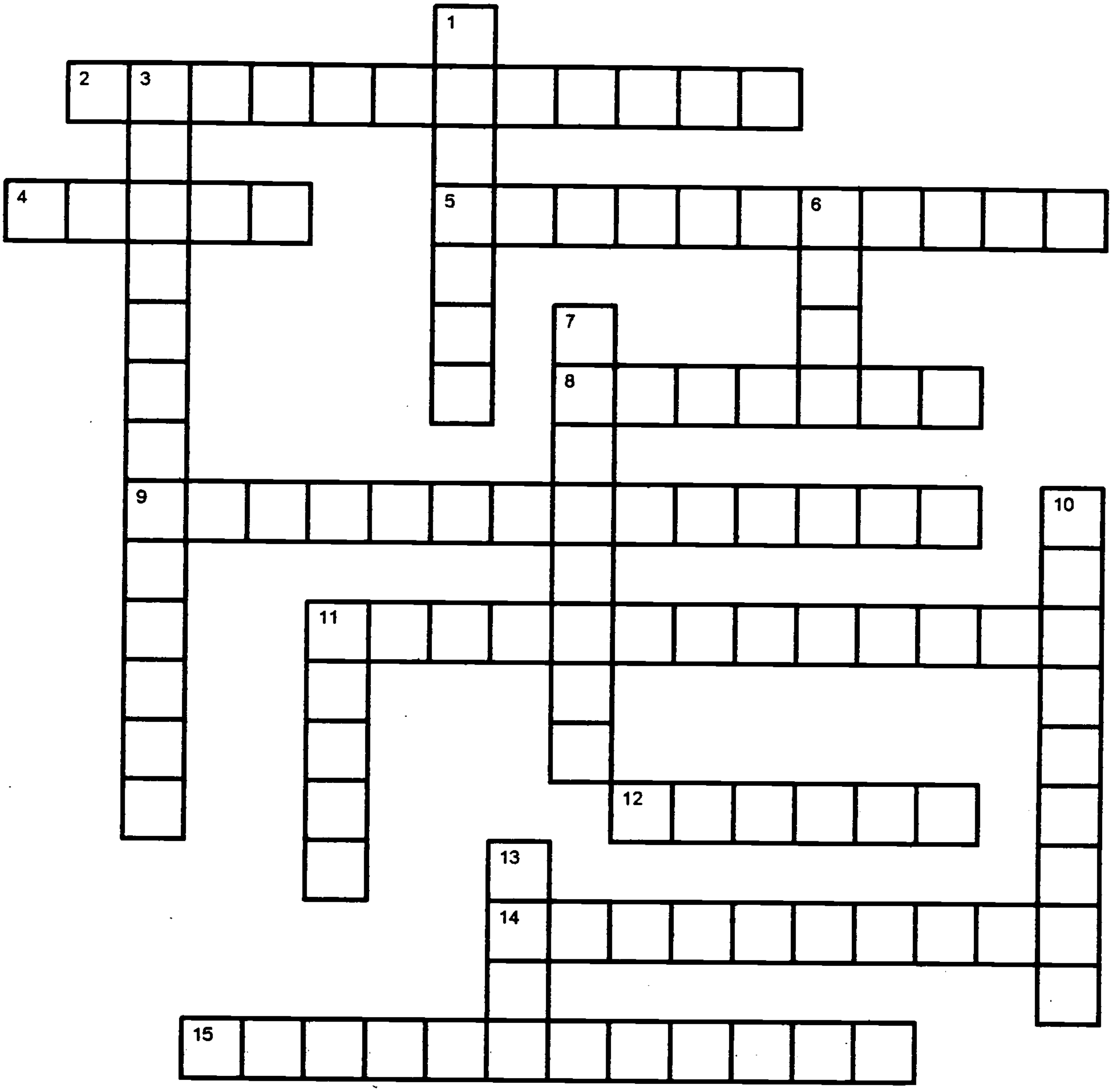
- **Grinding: The removal of relatively large amounts of iron from the gate and parting line areas of the casting.**

- **Special processing: Any added operation that must be performed on a casting once it has been ground.**

- **Inspecting: Every casting must be examined for defects that may cause to be it unusable or unacceptable to the customer.**

- **Shipping: After being inspected, castings must be placed in the appropriate container, weighed up and loaded on the right truck to be shipped to the customer.**

Grinding



Across

2. The process by which metallic shot is blown or thrown against a casting to remove sand and scale from its surface.
4. A particular strength of ductile iron.
5. The part of the casting made where the two halves of the mold come together.
8. A test to measure the hardness of a casting.
9. Castings that are produced without a heat treatment.
11. A standard written description of exactly what the customer wants in a product.
12. The appearance of the casting surface.
14. The process by which castings are checked or examined for defects.
15. A heat treating process used to remove or reduce internal stresses in castings which may cause warpage.

Down

1. An undesired change in the shape of a casting.
3. The controlled heating and cooling of castings to produce useful properties in these castings.
6. The part of the casting where the molten iron flows in the mold cavity.
7. A substance used for removing material by grinding.
10. A heat treating process used to make castings softer and easier to machine.
11. A flaky oxide film that sometimes forms on the metal as a result of the casting process.
13. A thin piece of extra metal on the surface of a casting.

Word List

ABRASIVE
ANNEALING
AS-CAST CASTINGS
BRINELL
FINISH
FINS
GATE
GRADE
HEAT TREATMENT
INSPECTION
PARTING LINE
SCALE
SHOT BLASTING
SPECIFICATION
STRESS RELIEF
WARPAGE

Pouring - Overview I

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to the pouring process
- correctly sequence the main steps in the production of ductile iron
- list three critical variables in the pouring process and explain the procedures used to control each of these variables

Instructor Notes	Activities	Materials	Time
	<u>Set Induction</u> Display the transparency of the foundry process. Have learners refer to page in their workbook. What steps in the foundry process are performed by pouring department employees? Discuss how the steps fit into the overall foundry process.	Workbook, Overhead Projector "The Foundry Process" flow chart transparency.	5-10 Minutes
	<u>Guided Practice</u> Ask for a volunteer to read the "Pouring Department Overview" passage. Have learners complete the flow chart exercise. Ask learners to list the main steps in producing ductile iron. Write the responses on the board. Show the first transparency. How closely do the steps on the transparency match those listed on the board? Show the second transparency. Use the transparency questions to test learners' knowledge of pouring department control procedures. Show and discuss the third transparency.	Workbook, Overhead Projector Transparencies	20-30 Minutes
	<u>Applied practice</u> Have learners complete the exercises in their workbook. Circulate around the room and assist if necessary.	Workbook	20 Minutes
	<u>Closure</u> Go over the answers to the exercises. Ask if there are any questions.		5-10 Minutes

pouring

P	O	S	T	I	N	O	C	U	L	A	T	I	O	N	M	U	Z	K	X	B
R	F	P	Y	V	C	L	A	V	N	W	U	O	N	T	C	I	P	R	B	M
O	E	E	H	K	H	O	M	O	G	E	N	E	O	U	S	M	J	C	Y	M
P	R	C	R	L	Z	D	N	O	D	U	L	A	R	I	T	Y	X	P	K	R
E	R	T	O	D	N	O	D	U	L	E	C	O	U	N	T	V	J	V	V	N
R	O	R	W	V	W	G	K	U	M	T	K	G	Y	R	K	T	F	A	M	O
T	S	O	O	I	E	Q	Y	E	O	P	W	O	Z	I	C	L	R	S	A	I
I	I	S	J	T	O	R	N	I	V	M	V	D	H	T	D	I	I	C	G	T
E	L	A	Z	J	V	T	Y	Q	R	E	P	P	O	C	A	R	B	O	N	A
S	I	M	O	D	I	F	I	E	D	K	E	E	L	B	L	O	C	K	E	C
P	C	P	R	Y	Q	U	W	D	U	C	T	I	L	I	T	Y	I	L	S	I
E	O	L	V	U	T	C	M	E	R	R	U	E	Y	K	S	I	T	C	I	F
C	N	E	O	L	F	R	O	L	B	K	B	R	T	L	T	F	G	Z	U	I
T	H	G	J	B	U	L	N	Y	N	Y	G	R	U	L	L	A	T	E	M	D
R	M	E	D	R	I	Y	U	H	V	C	E	H	C	U	C	S	U	Z	A	I
O	R	O	M	I	C	R	O	S	T	R	U	C	T	U	R	E	S	K	T	L
M	J	I	T	I	F	S	Y	L	C	R	K	F	O	H	W	F	R	Y	R	O
E	E	S	B	A	S	E	I	R	O	N	A	F	R	N	O	C	I	L	I	S
T	M	G	D	U	C	T	I	L	E	I	R	O	N	L	L	D	U	Q	X	L
E	M	E	L	M	I	C	R	O	S	A	M	L	P	L	E	Y	O	L	L	A
R	V	Q	I	Q	M	H	N	Y	W	S	D	D	O	I	K	D	N	V	V	G

Word List

MODIFIED KEEL BLOCK
POST-INOCULATION
MICROSTRUCTURE
SOLIDIFICATION
SPECTRO SAMPLE
SPECTROMETER
MICRO SAMLPLE
FERROSILICON
DUCTILE IRON
NODULE COUNT
HOMOGENEOUS
NODULARITY
METALLURGY
PROPERTIES
MAGNESIUM
DUCTILITY
CHEMISTRY
RECOVERY
BASE IRON
VARIABLE
ELEMENT
SILICON
MATRIX
SULFUR
CARBON
COPPER
CHOKE
ALLOY
ATOM
ETCH
SLAG
FADE

Vocabulary - The Pouring Department: An Overview

1. **Alloy** - A metal-like material added to molten iron to change one or more properties. Magnesium, ferrosilicon and copper are common alloys used at Southern Ductile.

2. **Atom** - A very small particle of matter. The atom is considered the basic building block of matter.

3. **Base iron** - The iron before treatment and inoculation.

4. **Carbon** - The main alloying element of ductile iron. The form in which carbon occurs in ductile iron determines many of its most important properties. The symbol for carbon is C.

5. **Chemistry** - The kind and amount of elements that make up a substance.

6. **Choke** - To keep the sprue full of iron by maintaining a constant flow. This allows the gating system to trap slag before it enters the mold cavity.

7. **Copper** - An alloying element added to ductile iron to increase its strength and hardness. The chemical symbol for copper is Cu.

8. **Ductility** - The ability of a metal to stretch when pulled rather than break.

9. **Ductile iron** - Cast iron that has a large amount of carbon in the form of balls called nodules. These nodules are produced by adding a small amount of magnesium to the molten iron.

10. **Element** - A substance that is made up of the same kind of atoms. Atoms of the same element are alike. Atoms of different elements are different.

Vocabulary - The Pouring Department: An Overview

11. **Etch** - To place an acid on the surface of an iron sample to reveal the microstructure of the iron.

12. **Fade** - The process by which magnesium and ferrosilicon alloys lose their effectiveness over time.

13. **Ferrosilicon** - An alloy that is added to molten iron as it is transferred to the pouring ladle. It promotes the formation of large numbers of graphite nodules and helps prevent carbides.

14. **Homogeneous** - The same throughout.

15. **Magnesium** - An alloy added to the treatment ladle immediately before the base iron is tapped. Magnesium causes the carbon in the molten iron to form round ball-like structures called nodules during solidification. The chemical symbol for magnesium is Mg.

16. **Matrix** - A substance in which something is embedded. The ductile iron matrix is the metal around the graphite nodules. The matrix normally consists of ferrite or pearlite or some combination of the two.

17. **Mechanical properties** - Those characteristics of a material that describe how it acts when force is applied.

18. **Metallurgy** - The study of the structure and properties of metals and their production and processing.

19. **Micro sample** - A small iron sample taken from the last iron poured. It is used to check the nodularity of the iron.

20. **Microstructure** - The structure of a metal as revealed by the appearance of a ground, polished and etched specimen under the microscope.

Vocabulary - The Pouring Department: An Overview

21. **Modified keel block** - Often called a Y-block. An iron sample with two round bars. These bars are carried to the QC lab where they are machined and tested to determine the mechanical properties of the iron.

22. **Nodularity** - The proportion of well-formed graphite nodules in a ductile iron micro sample.

23. **Nodule count** - The number of graphite nodules in a given area of an iron micro sample.

24. **Post-inoculation** - The addition of an iron-silicon alloy called ferrosilicon to the treated iron while it is transferred from the bull ladle to the pouring ladle. This addition promotes the formation of large numbers of graphite nodules and prevents carbides.

25. **Recovery** - The percentage of the total amount of magnesium added to the iron that is still in the iron when poured.

26. **Silicon** - The major component of ferrosilicon used to produce large numbers of graphite nodules and prevent carbides. Its chemical symbol is Si.

27. **Slag** - A nonmetallic material that forms on the surface of molten iron as a result of impurities in the iron.

28. **Spectrometer** - An instrument in the QC lab used to quickly analyze the chemistry of a spectro sample.

29. **Spectro sample** - A small chilled iron sample formed by pouring iron in a copper mold. This sample is carried to the QC lab where it is tested to determine the chemistry of the iron being poured.

30. **Sulfur** - An element in ductile iron that interferes with the ability of magnesium to produce graphite nodules. Its chemical symbol is S.

Vocabulary - The Pouring Department: An Overview

31. **Solidification** - The process by which a liquid changes into a solid. It is during the process of solidification that nodular graphite is formed in ductile iron.

33. **Variable** - A factor that influences the production process. A variable can cause unwanted changes in the production process and therefore must be controlled.

The Pouring Department - An Overview

In the next two lessons we will look at the metallurgy of ductile iron. In this lesson we will consider:

- the key steps in the production of ductile iron.
- the critical control variables in the production of ductile iron.

The pouring department plays the critical role in the production of ductile iron castings. It is responsible for transforming the base iron in the melting furnaces into quality ductile iron. To achieve this goal, pouring employees perform a number of key production operations. They include:

- treating the furnace base iron,
- transferring the molten iron from the treatment ladle to the pouring ladle,
- post-inoculating the molten iron,
- pouring the molten iron into the molds, and
- checking the quality of each ladle of iron poured.

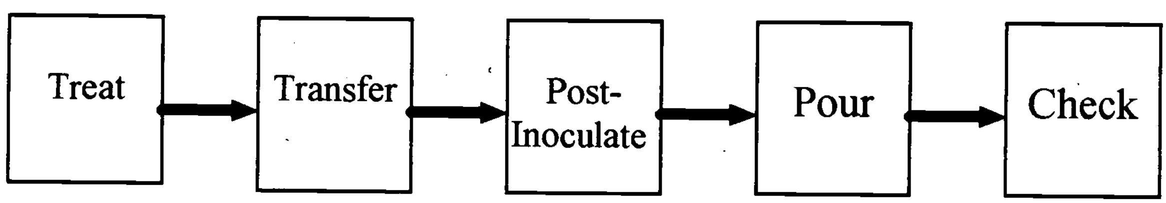
The work of the pouring department is done through the cooperation of employees in several different job classifications:

- The ladle liner prepares all treatment and pouring ladles for use.
- The ladle pushers treat and transfer the iron from the furnace to the pouring line.
- The iron pourers pour the iron into the molds.
- The sample catchers check the nodularity of the iron by examining a microsample poured from the last iron of each ladle of iron.

Flow Chart Exercise

A flow chart is one way of putting ideas and facts in a form you can see. Flow charts can help you understand and remember complex ideas and processes. One example of a flow chart is the diagram of the foundry process. Notice two things about the foundry process flow chart. First, each step of the foundry process has its own box. Second, these boxes are connected with arrows. These arrows show the overall direction of the foundry process. They also show how the steps in the process are related to each other.

Look back to "The Pouring Department - An Overview." Reread this passage, then draw a flow chart showing the operations listed in the second paragraph.



Steps in Ductile Iron Production

1. **Melt** base iron with low sulfur content.

2. **Treat** by tapping base iron from the melting furnace into a treatment ladle containing a magnesium alloy.

3. **Post-inoculate** by adding a ferrosilicon alloy to the stream of iron as it is poured from the treatment ladle to the pouring ladle. If necessary, add copper or copper-nickel alloy along with the ferrosilicon alloy.

4. **Pour** iron into molds before excessive fade of magnesium and/or inoculation occurs.

Critical Control Variables in Ductile Iron Production

In order to produce quality ductile iron several variables must be controlled.

1. **Treating temperature:** Base iron is tapped from the melting furnace into the treatment ladle at temperatures between 2700° F and. 2720° F. Higher treating temperatures increase magnesium losses due to burnout and increase magnesium and inoculation fade rates. Lower treating temperatures, on the other hand, result in pouring temperatures that are too low. The treating temperature is controlled by melting employees who check and, if necessary, adjust the temperature of the base furnace iron.

2. **Pouring temperature:** Pouring temperatures at Southern Ductile range from 2480° F to 2550° F. Lower pouring temperatures increase slag and cause cold runs. Higher pouring temperatures may cause metal penetration which may produce a rough casting surface finish. Higher pouring temperatures may also result in shrinkage, cause carbide in thin sections and increase magnesium and inoculation fade.
   What steps do pouring department employees take to control the pouring temperature?

3. **Time:** The time factor is critical to the production of ductile iron. Once treated the iron must be transferred and poured quickly to prevent excessive magnesium and ferrosilicon fade. Excessive delays will result in poor quality ductile iron.
   What procedures do pouring employees follow to make sure that the iron is poured in a timely manner?

4. **Metal cleanliness:** Slag forms on the surface of the molten iron in the furnace and in the treatment ladle. If not removed, slag may end up in the mold and cause casting defects. Slag may also buildup in the pouring ladle. This buildup reduces magnesium recovery and increases the rate of magnesium fade. After adding slag coagulant, melting employees skim the slag from the surface of the melt before tapping out into the treatment ladle.
   What do pouring employees do to make sure that the iron poured into molds is clean and free of slag?

5. **Chemistry**: Several chemical elements influence the properties of ductile iron. It is necessary, therefore, to check and control the amounts of these elements in the iron. The control of iron chemistry starts with the base iron in the melting department. Melting employees use the Melt Lab instrument to check the amount of carbon and silicon in the base iron. Also, the amounts of these and other elements in the base iron are checked in the QC lab. The base iron chemistry changes as a result of the alloys added to the iron during treatment and post-inoculation.
What role do pouring employees play in the control of the final chemistry of the iron?

Pouring Department Control Procedures

1. **Pouring Temperature:**
- The iron pourer checks the process sheet to find the correct pouring temperature for each job.
- The ladle pusher checks and records the temperature of each ladle of iron.
- If the temperature is too high the iron pourer adds chill iron.
- If the temperature is too low the iron pourer notifies the supervisor.

2. **Time:**
- All iron must be poured within 12 minutes of the time the base iron is treated.
- At the start of the tap the furnace operator pushes a button to start the 12-minute timer.
- At the end of the 12-minute period a buzzer sounds and a red light comes on in the pouring area to signal that all pouring should stop.

3. **Metal Cleanliness:**
- After the iron is treated, the Hunter ladle pushers skim the slag from the surface of the iron.
- The BMM and Hunter iron pourers skim the slag from the surface of each pouring ladle before starting to pour.
- The ladle liner places a skimmer tile in each pouring ladle to trap the slag and prevent it from entering the mold.

4. **Final Chemistry:**
- The ladle pusher carefully weighs the magnesium alloy and cover steel (if used) according to the amount of iron to be treated.
- The iron pourer measures the ferrosilicon alloy before adding it to the stream of iron as it is poured into the pouring ladle.
- The sample catcher weighs the correct amount of copper or copper-nickel alloy when called for by the process sheet.

Number the following steps to indicate the proper sequence.

___3_ Post-inoculate by adding a ferrosilicon alloy to the stream of iron as it is poured from the treatment ladle to the pouring ladle. If necessary, add copper or copper-nickel alloy along with the ferrosilicon alloy.

___1_ Melt base iron with low sulfur content.

___4_ Pour iron into molds before excessive fade of magnesium and/or inoculation.

___2_ Treat by tapping base iron from the furnace into a treatment ladle containing a magnesium alloy.

List three critical variables in the pouring department and explain the procedures used to control them.

1. **Pouring Temperature:**
- The iron pourer checks the process sheet to find the correct pouring temperature for each job.
- The ladle pusher checks and records the temperature of each ladle of iron.
- If the temperature is too high the iron pourer adds chill iron.
- If the temperature is too low the iron pourer notifies the supervisor.

2. **Time:**
- All iron must be poured within 12 minutes of the time the base iron is treated.
- At the start of the tap the furnace operator pushes a button to start the 12-minute timer.
- At the end of the 12-minute period a buzzer sounds and a red light comes on in the pouring area to signal that all pouring should stop.

3. **Metal Cleanliness:**
- After the iron is treated, the Hunter ladle pushers skim the slag from the surface of the iron.
- The BMM and Hunter iron pourers skim the slag from the surface of each pouring ladle before starting to pour.
- The ladle liner places a skimmer tile in each pouring ladle to trap the slag and prevent it from entering the mold.

4. **Final Chemistry:**
- The ladle pusher carefully weighs the magnesium alloy and cover steel (if used) according to the amount of iron to be treated.
- The iron pourer measures the ferrosilicon alloy before adding it to the stream of iron as it is poured into the pouring ladle.
- The sample catcher weighs the correct amount of copper or copper-nickel alloy when called for by the process sheet.

Pouring - Overview II

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to the pouring process
- explain the effects of carbon, silicon, sulfur and copper on ductile iron
- list the three main tests of ductile iron performed in the Southern Ductile QC lab
- define the term "degenerate graphite" and explain why it is undesirable in ductile iron.
- identify the main parts of a typical ductile iron microstructure

Instructor Notes	Activities	Materials	Time
	Set Induction Divide class into two groups. Have one group build a bridge made of toothpicks. Have the other group use popsicle sticks. Drop a steel marble on each bridge. Does it make a difference what material you use to build your bridge?	Toothpicks Popsicle Sticks Rubber Bands Four Wooden Blocks Small Steel Marble	5-10 Minutes
	Guided Practice Read the introduction. Display and explain the following transparencies: (1) How is Ductile Iron Formed?, (2) The Ductile Iron Microstructure, (3) The Main Parts of Ductile Iron Microstructure, (4) The Major Elements in Ductile Iron and (5) The Testing of Ductile Iron. Take learners on a field trip to QC lab to observe microstructure evaluation, chemical analysis and tensile testing.	Overhead Projector Transparencies Workbook	30-35 Minutes
	Applied practice Have learners work in pairs to complete the workbook exercises. Circulate around the room and assist if necessary.	Workbook	20 Minutes
	Closure Go over the answers to the exercises. Ask if there are any questions.	Workbook	5-10 Minutes

The Pouring Department - An Overview- Part Two

Introduction

The previous lesson focused on the procedures and practices required to produce quality ductile iron. This lesson will look at:

- the **microstructure** of ductile iron. You will discuss the various parts that make up the internal structure of ductile iron. You will view this structure using a metallurgical microscope.
- the **chemistry** of ductile iron. You will discover the main effects of the most important elements in ductile iron.
- the **testing** of ductile iron. You will learn about the three major tests of ductile iron: microstructure analysis, spectrometer analysis and tensile testing.

How Ductile Iron is Formed

Ductile iron is formed when molten iron containing carbon, silicon and several other elements solidifies (changes from a liquid to a solid). As a liquid, iron can hold large amounts of carbon in solution. As a solid, however, it can hold only a small amount of carbon. The rest separates from the iron, forming either **carbides** or **graphite.**

- **Carbides** - Carbides form as a result of rapid cooling or an excess of carbide-forming elements such as chromium or vanadium. Carbides are chemical compounds formed when carbon combines with iron. They are hard, brittle and almost impossible to machine. For this reason, a major goal of ductile iron production is to prevent carbides. When you view an etched microsample under the microscope, carbides look like small icicles scattered throughout the iron.

- **Graphite** - Graphite forms if there is an effective amount of graphite-forming elements, mainly silicon, present when the molten iron solidifies. A slow cooling rate also helps to form graphite. Graphite in ductile iron is of two basic types: nodular and degenerate.

  1. Nodular graphite - The round or nodular shape of graphite is what makes ductile iron different from other cast irons. Under the microscope, graphite nodules appear as small, black balls embedded in the iron matrix. Several well-formed graphite nodules will form if there is an effective amount of magnesium in the iron.

  2. Degenerate graphite - Degenerate graphite is any graphite particle that is not a well-formed, nearly perfect ball. It can assume a variety of irregularly shaped forms. This type of graphite is undesirable because it weakens the iron, decreasing its strength and ductility. Degenerate graphite is often caused by treatment and/or inoculation problems. Typical problems include undertreatment or overtreatment, underinoculation, late inoculation and excessive magnesium fade. Degenerate graphite is also caused by "subversive" elements such as lead that interfere with the formation of nodular graphite.

The Ductile Iron Microstructure

The microstructure of ductile iron consists of two main parts:

1. **The Graphite**: The majority of graphite particles in ductile iron appear as small, well-formed black nodules scattered throughout the rest of the iron. There may also be present a fewer number of more irregularly shaped graphite particles (degenerate graphite).

2. **The Matrix**: The matrix is the majority of the iron surrounding the graphite particles. It normally consists of one or more of the following structures:
   - ferrite,
   - pearlite, and
   - carbides

The table below describes the main parts of the ductile iron microstructure.

The Main Parts of the Ductile Iron Microstructure

Name	Definition	Appearance	Properties
Ferrite	Almost carbon-free iron that may contain other elements in solution.	The white area surrounding graphite nodules.	Soft, ductile and easily machinable.
Pearlite	A mixture consisting of alternate plates or layers of ferrite and iron carbide.	The dark colored area scattered throughout the iron matrix. Under high magnification, it has a striped appearance.	Harder and stronger than ferrite, but softer and more ductile than carbides.
Carbides	A chemical compound made up of iron and carbon. Also called cementite or combined carbon.	Structures with sharp jagged edges that look like icicles.	Very hard and brittle; almost impossible to machine.
Graphite particles	A crystalline form of carbon. Also called free carbon.	Dark or black ball-like structures embedded in the iron matrix.	Graphite has very little strength or hardness. In its compact, ball form however, it does not significantly weaken the mechanical properties of the iron.

Ductile Iron Chemistry

Ductile iron is made up of several elements. The most important of these are:

- carbon
- silicon
- sulfur
- magnesium
- manganese
- copper

Carbon is the most important alloy in ductile iron. The form in which carbon occurs in the iron determines the microstructure and properties of the iron. Most of the other elements in ductile iron are important because of how they affect the shape or form of carbon in the iron. The table below lists the acceptable ranges of some of the most important elements in ductile iron and describes their influence.

The Major Elements in Ductile Iron

Element	Symbol	Acceptable Range	Influence on Ductile Iron
Carbon	C	3.50-3.80%	The main alloy in ductile iron; present as graphite or carbides.
Silicon	Si	2.45-2.75%	Causes carbon to form graphite rather than carbides.
Sulfur	S	Less than 0.013	Combines with magnesium; decreases the ability of magnesium to form graphite balls or nodules.
Manganese	Mn	Less than 0.55%	Increases pearlite; strengthens ferrite.
Copper	Cu	Less than 0.20%	Increases pearlite; increases strength and hardness.
Magnesium	Mg	0.025-0.050%	Causes carbon graphite to form balls called nodules.

The Testing of Ductile Iron

Testing is an essential part of producing ductile iron castings. It allows us to check and control the quality of the iron. The three most common tests are microstructure evaluation, chemical analysis and tensile testing.

Microstructure Evaluation: Microstructure evaluation involves examining the internal structure of the iron under the microscope. Two things are checked:

- the proportion of well-formed graphite nodules in the iron
- the amount of carbides in the iron.

Microstructure evaluation is done in the foundry and the Q.C. lab. In the foundry, the sample catcher examines a microsample from every ladle poured, checking the nodularity and checking for carbides. These same microsamples are rechecked in the Q.C. lab the next day.

Chemical Analysis: Chemical analysis determines the relative amounts of the various elements that make up ductile iron. The amounts of these elements must be constantly checked to control the quality of the iron. This is done both in the foundry and in the Q.C. lab.

- The Q.C. lab technician uses an instrument called a spectrometer to quickly analyze the overall chemistry of the iron being melted and poured.
- The furnace operator uses the Melt Lab equipment to continuously check the base iron carbon and silicon during melting.

Tensile Testing: Tensile testing is performed to check the mechanical properties of the iron being produced. Mechanical properties tell us if the castings will stand up to the intended uses of the customer. Tensile testing is done to check three of the most important properties of ductile iron:

- The tensile strength - The ability of ductile iron to resist being pulled apart.
- Yield strength - The point ductile iron starts to deform or stretch.
- The elongation - The extent to which ductile iron will stretch, when pulled,before breaking.

Practice Exercises - Pouring

1. Describe the main effect of each of the elements below on ductile iron.

   Carbon: **Carbon is the main alloy of ductile iron. The forms of carbon in the iron and their size, shape and distribution is the single most important factor in determining the properties of ductile iron.**

   Silicon: **The main effect of silicon is to cause the carbon in ductile iron to form graphite.**

   Sulfur: **The main effect of sulfur is to reduce the ability of magnesium to cause graphite to form nodules.**

   Copper: **The main effect of copper is to increase the amount of pearlite in the iron, thus increasing its strength and hardness.**

2. Write the chemical symbols for the following elements:

Carbon	**C**
Copper	**Cu**
Magnesium	**Mg**
Manganese	**Mn**
Silicon	**Si**
Sulfur	**S**

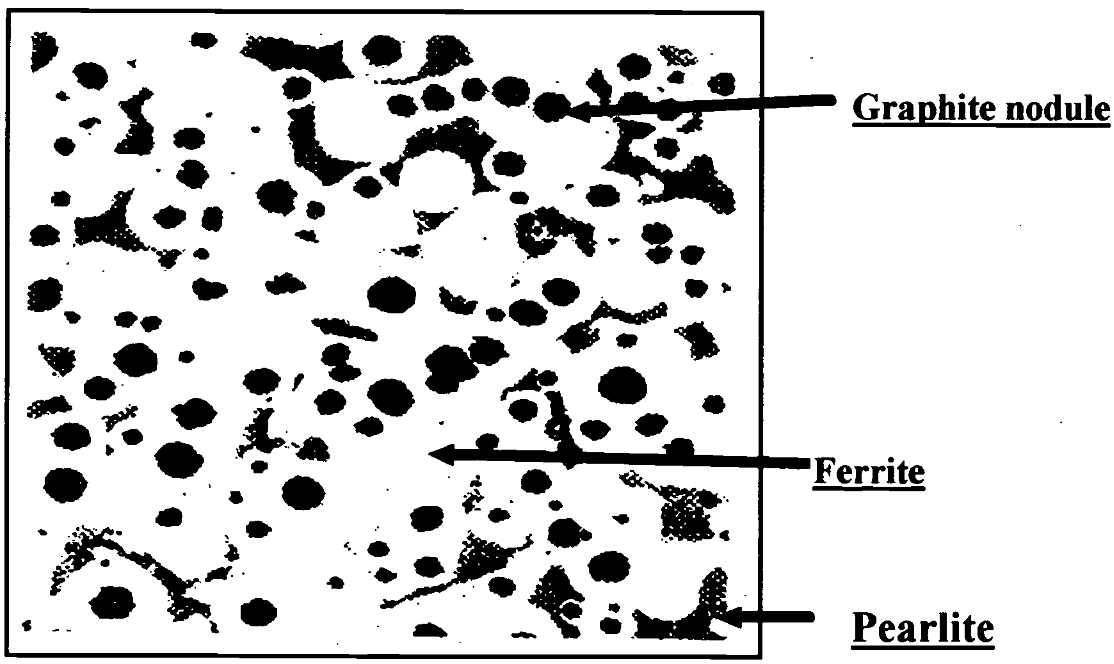
3. List the three main tests of ductile iron performed at Southern Ductile.

   Microstructure evaluation
   Chemical analysis
   Tensile testing

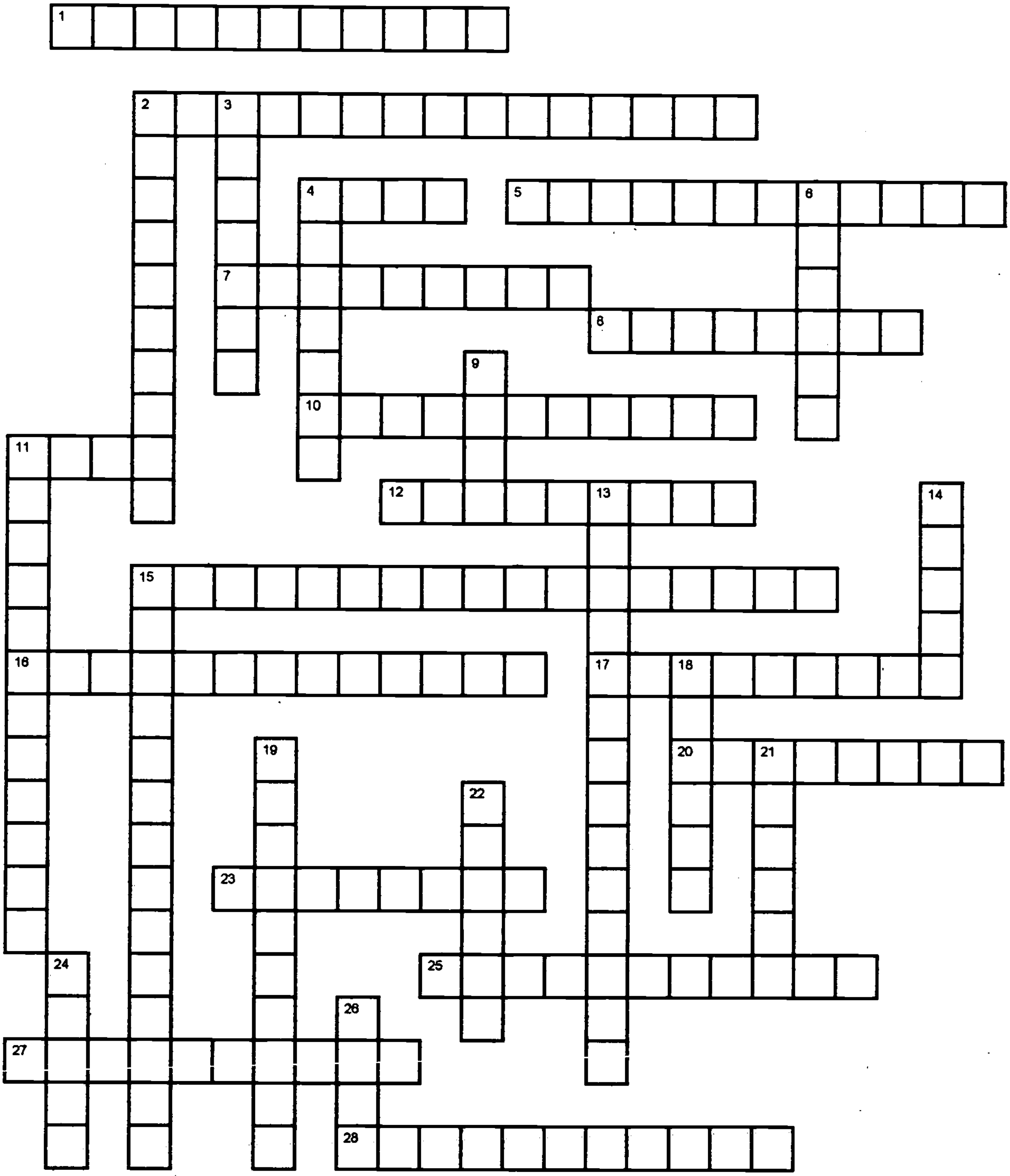
4. What is degenerate graphite? Why is it undesirable in ductile iron?

   Degenerate graphite is any graphite in ductile iron that is not a well-formed, almost perfect ball. It is undesirable because it weakens the iron, decreasing its strength and ductility.

5. Label the main parts of the ductile iron microstructure below. Write the name of each part on the line beside the arrow pointing to the part in the picture.



Pouring Overview



Across

1. The same throughout.
2. The addition of an iron-silicon alloy called ferrosilicon to the treated iron while it is transferred from the bull ladle to the pouring ladle.
4. To palce an acid on the surface of an iron sample to reveal the microstructure of the iron.
5. An instrument in the Q.C. lab used to quickly analyze the chemistry of the iron being poured.
7. The kind and amount of elements that make up a substance.
8. The iron before treatment and inoculation.
10. The number of graphite nodules in a ductile iron micro sample.
11. The process by which magnesium and ferrosilicon alloys lose their effectiveness over time.
12. An alloy added to molten iron as it is transferred to the pouring ladle.
15. An iron samplle with two round bars.
16. A small chilled iron sample formed by pouring iron in a copper mold.
17. The ability of a metal to stretch when pulled rather than break.
20. The percentage of the total amount of magnesium added to the iron that is still in the iron when poured.
23. A factor that influences the production process.
25. Cast iron that has a large amount of carbon in the from of balls called nodules.
27. The proportion of well-formed graphite nodules in a ductile iron micro sample.
28. A small iron sample taken from the last iron poured.

Down

2. The characteristics of a material that describes how it will act when force is applied is mechanical ____________.
3. The major component of ferrosilicon used to produce large numbers of graphite nodules and prevents carbides.
4. A substance that is made up of the same kind of atoms.
6. A substance in which something is embedded.
9. A nonmetallic material that forms on the surface of molten iron as a result of impurities in the iron.
11. An alloy added to the treatment ladle immediately before the base iron is tapped.
13. The process by which a liquid changes into a solid.
14. A metal-like material aded ato molten iron to change one or more properties.
15. The structure of a metal as revealed by the appearance of a ground, polished and etched specimen under the microscope.
18. The main alloying element of ductile iron.
19. The study of the structure and properties of metals and their production and processing.
21. An alloying element added to ductile iron to increase its strength and hardness.
22. An element in ductile iron that interferes with the ability of magnesium to produce graphite nodules.
24. To keep the sprue full of iron by maintaining a constant flow.
26. A very small particle of matter.

Word List

ALLOY
ATOM
BASE IRON
CARBON
CHEMISTRY
CHOKE
COPPER
DUCTILE IRON
DUCTILITY
ELEMENT
ETCH
FADE
FERROSILICON
HOMOGENEOUS
MAGNESIUM
MATRIX
METALLURGY
MICRO SAMPLE
MICROSTRUCTURE
MODIFIED KEEL BLOCK
NODULARITY
NODULE COUNT
POST-INOCULATION
PROPERTIES
RECOVERY
SILICON
SLAG
SOLIDIFICATION
SPECTROMETER
SPECTRO SAMPLE
SULFUR
VARIABLE

Melting - An Overview

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to the melting process
- correctly sequence the main steps in the melting process
- list four critical melting control variables
- explain why it is important to "slag" the base iron before "tapping out"

Instructor Notes	Activities	Materials	Time
	Set Induction Display the foundry process transparency. Ask learners to identify the steps in the foundry process performed by melting employees. Discuss how these steps fit into the overall foundry process.	Overhead projector, "The Foundry Process" flow chart transparency and several copies of "The Foundry Process" flow chart from the previous lesson..	5-10 Minutes
	Guided Practice Ask for a volunteer to read "The Melting Department - An Overview" passage. Show the "Steps in the Production of Ductile Iron" transparency. Which of these steps are melting employees responsible for? Have learners list the steps involved in the melting process. Show the "Steps in the Melting Process" transparency. Have learners complete the flow chart exercise. Display the "Melting Process Flow Chart" transparency for learners to check their work. Show and discuss the "Critical Melting Control Variables" transparency.	Workbook Overhead Projector Transparencies	20-30 Minutes
	Applied practice Have learners work in pairs to complete the exercises in their workbook. Circulate around the room and assist if necessary.	Workbook	20 Minutes
	Closure Go over the answers to the exercises. Ask if there are any questions.		5-10 Minutes

Vocabulary - The Melting Department: An Overview

1. **Base iron** - The furnace iron before treatment and inoculation.

2. **Carbon** - The main alloying element of ductile iron. The form in which carbon occurs in cast iron determines many of the most important properties of ductile iron. The chemical symbol for carbon is C.

3. **Chemistry** -The kind and amount of elements that make up a substance.

4. **Ductile iron** - Cast iron that has a large amount of carbon in the form of balls or nodules. These nodules are produced by adding a small amount of magnesium to the molten iron

5. **Element** - A pure substance that is made up of the same kind of atoms. Atoms of the same element are alike. Atoms of different elements are different.

6. **Fade** - Refers to the loss of the effectiveness of the magnesium or ferrosilicon alloys after treatment or post-inoculation. The effect of both these alloys fades or decreases over time.

7. **Magnesium** - An alloy added to the treatment ladle before the furnace base iron is tapped into it. Magnesium causes the carbon in the molten iron to form round ball-like structures called nodules during solidification.

8. **MeltLab**: An instrument used to analyze the amounts of carbon and silicon in the base furnace iron. A small sample of the furnace iron is poured into cup. The cup sits on a stand connected to a thermocouple which measures the changing temperature of the iron as it cools. This cooling information is sent to a computer in the melting office which displays the cooling curve of the iron.

9. **Melting** - The process by which a metal is changed from a solid to a liquid state by applying heat.

10. **Post-inoculation** - The addition of an iron-silicon alloy, ferrosilicon, to the treated iron while it is transferred from the bull ladle to the pouring ladle. This process helps promote the formation of large numbers of graphite nodules.

11. **Recovery** - A measure of the amount of magnesium loss.

12. **Silicon** - A major element in ductile iron. Its chemical formula is Si. n

13. **Slag** - A nonmetallic product which forms on the surface of molten iron as a result of the impurities in the iron.

14. **Spectro-sample** - A small wafer sample produced by pouring iron into a copper mold. It is ground on one side and tested using a spectrometer to determine the chemistry of the iron.

15. **Sulfur** - An element in ductile iron. Its chemical symbol is S. The amount of base iron sulfur affects the amount of magnesium required to promote and maintain graphite spheroidization. Sulfur is held below 0.02% in base iron.

16. **Solidification** - Also called freezing. The process by which a liquid changes into solid. It is during this process of solidification that spheroidal graphite is formed.

17. **Variable** - A factor that can influence the production process.

The Melting Department - An Overview

Melting is the first major step in the production of ductile iron castings. Melting employees perform a number of operations that transform solid raw materials into molten base iron. They are responsible for supplying the foundry with the continuous flow of iron needed to keep the production process going.

Steps in Ductile Iron Production

1. Melt base iron with low sulfur content (0.020% maximum).

2. Treat by tapping base iron from the melting furnace into a treatment ladle containing a magnesium alloy.

3. Postinoculate by adding a ferrosilicon alloy to the stream of iron as it is poured from the treatment ladle to the pouring ladle. If necessary, add copper or copper-nickel alloy along with the ferrosilicon alloy.

4. Pour iron into molds before excessive fade of magnesium and/or inoculation occurs.

Steps in the Melting Process

1. Weigh a solid metal charge of steel scrap and foundry returns.

2. Preheat the prepared charge.

3. Dump the charge into the furnace.

4. Melt the charge.

5. Monitor the temperature and chemistry of the melt. Make the adjustments needed to make sure the temperature and chemistry of the melt are in range.

6. Slag the furnace.

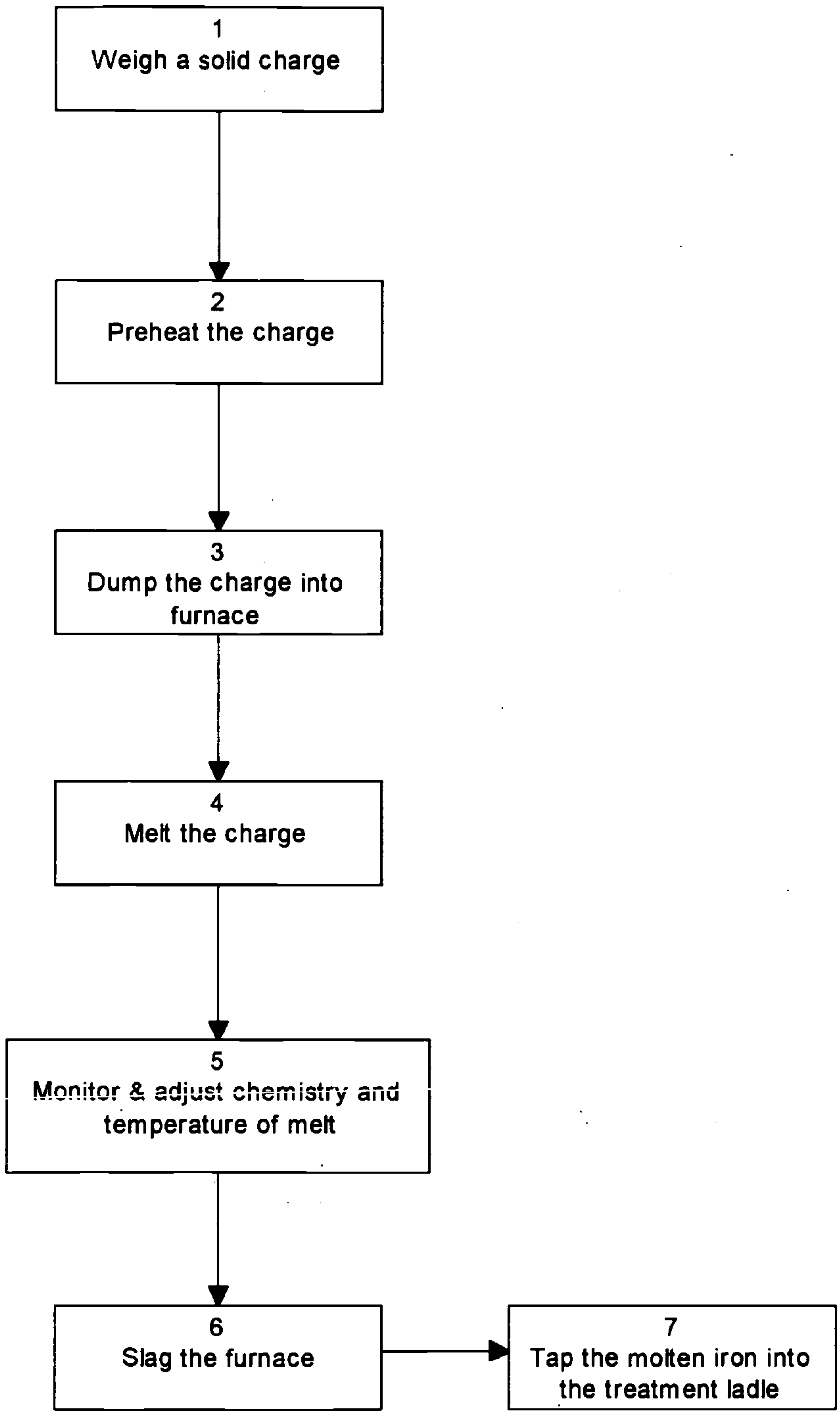
7. Tap the molten iron into the waiting treatment ladle.

Flow Chart Exercise

A flow chart is one way of putting ideas and facts in a form you can see. Flow charts can help you understand and remember complex ideas and processes. One example of a flow chart is the diagram of the foundry process. Notice two things about the foundry process flow chart. First, each step of the foundry process has its own box. Second, these boxes are connected with arrows. These arrows show the overall direction of the foundry process. They also show how the steps in the process are related to each other.

Reread the "Steps in the Melting Process" above and then draw a flow chart showing these seven steps.

Melting Process Flow Chart



Critical Melting Control Variables

1. **Base iron chemistry** - Several chemical elements affect the production and properties of ductile iron. For this reason it is necessary, to monitor and control the amounts of these elements in the iron. The control of the final ductile iron chemistry starts with the base iron in the melting department. Base iron chemistry must fall within the following ranges:

   Carbon - The amount of carbon in base iron must be between 3.80-3.90%. The carbon must be relatively high so that graphite will form during later stages of the production process.

   Sulfur - The amount of sulfur in base iron must be below 0.02%. Sulfur interferes with the ability of magnesium to produce round, well-formed graphite nodules. The higher the sulfur the more magnesium will be required to produce ductile iron.

   Silicon - Base iron silicon must be between 1.30 -1.50%. It must be keep relatively low. This is to allow for the additional silicon added to the iron during the treatment and inoculation processes.

   Other elements - Base iron should have very low levels of most other elements, many of which interfere with the production of ductile iron. Large amounts of chromium, for example, causes carbides to form in ductile iron. A very small amount of lead will interfere with the formation of graphite nodules.

Melting employees use the MeltLab instrument to check and control the amount of carbon and silicon in the base iron. Melting employees also pour spectro-samples that are carried to the QC lab. Here these samples are analyzed for carbon, sulfur and several other elements as well.

2. **Melting temperature -** The melting temperature of the iron should be as low as possible. High melting temperatures: have several disadvantages. They increase the wear of the furnace lining. They result in longer melting times and increase power costs. They make it more difficult to slag the iron. Finally, high melting temperatures can hinder the formation of graphite later in the production process.

3. **Tap or treatment temperature** - Base iron must be tapped out of the furnace at temperatures between 2700^0 and 2720^0F. Tapping out too high will cause low magnesium recovery and may result in excessive carbides.. The tap temperature must be just high enough so that the iron will be at the desired pouring temperature when it arrives at the pouring line.

4. **Metal cleanliness -** Slag forms on the surface of the molten iron. If not removed, slag can end up in the mold and cause casting defects. It also builds ups in the pouring ladle. This buildup reduces magnesium recovery and increases the rate of magnesium fade. Slag control begins with melting. Melting employees skim the slag from the surface of the melt just before tapping out into the treatment ladle.

Exercises

1. The following steps in the melting process are not in the correct order. Number the steps in the proper sequence.

__4__ Melt the charge.

__1__ Weigh a solid metal charge of steel scrap and foundry returns.

__5__ Monitor the temperature and chemistry of the melt. Make the adjustments needed to make sure the temperature and chemistry of the melt are in range.

__2__ Preheat the prepared charge.

__6__ Slag the furnace

__7__ Tap the molten iron into the waiting treatment ladle.

__3__ Dump the charge into the furnace.

2. List the four critical melting control variables.

1. **Base iron chemistry**
2. **Melting temperature**
3. **Tap or treatment temperature**
4. **Metal cleanliness**

3. Explain why it is important to slag the base iron just before tapping out.

Slag forms on the surface of the molten iron. If not removed, slag can end up in the mold and cause casting defects. It also builds ups in the pouring ladle. This buildup reduces magnesium recovery and increases the rate of magnesium fade. Slag control begins with melting. Melting employees skim the slag from the surface of the melt before tapping out into the treatment ladle.

4. At what temperature should base iron be tapped out of the furnace?

Base iron must be tapped out of the furnace at temperatures between 2700° and 2720°F.

Safety -General

Upon completion of this lesson the learner will be able to:

- define safety vocabulary words
- read and apply safety rules
- scan safety rules for job-specific information

Instructor Notes	Activities	Materials	Time
	Set Induction Word Search - Allow learners to work together if they choose.	Workbook	5 - 10 minutes
	Guided Practice Introduce Vocabulary. Have learners follow along with you as you take a look at the company safety rules. Have learners help you locate information about safety for the molders. List the safety rules on the markerboard as the learners locate them. Discuss Safety Rules and talk about why it is important for all employees to follow them.	Safety Rules for Southern Ductile	15 - 20 minutes
	Applied Practice Have learners work as a group to state some safety rules for their department. Write their choices on the markerboard and have someone record the rules on paper. Read each rule to the group when the learners have completed the task. Remind learners that safety rules are given to an employee when they are hired, so their rules should be easy to understand.	Workbook	10 - 15 minutes
	Closure Read each safety rule. Discuss the rules after reading each of them. Ask learners if they agree with the rules. You may want to use thumbs-up, thumbs-down after each rule and discuss reasons they agree or disagree.		15 - 20 minutes

SAFETY

R	E	C	O	M	M	E	N	D	E	D	U	V	M	O	U	H
E	E	Q	U	I	P	M	E	N	T	H	B	B	Z	G	F	R
S	S	Q	B	L	W	Y	T	I	L	I	B	U	L	O	S	Z
P	E	E	U	S	D	L	E	I	H	S	E	D	I	S	U	X
O	O	C	W	I	I	M	H	P	Y	Q	E	Q	G	X	O	H
N	H	T	S	C	R	E	A	R	P	L	U	G	S	E	D	K
S	S	F	Q	T	B	E	L	I	C	F	O	N	W	R	R	R
I	L	O	S	S	F	I	D	Y	N	Q	N	K	Q	D	A	U
B	A	C	K	S	U	P	P	O	R	T	B	E	L	T	Z	M
I	S	P	F	J	S	D	S	M	W	A	E	L	V	C	A	A
L	R	S	C	L	O	T	H	I	N	G	Y	N	F	F	H	C
I	A	D	Y	O	P	E	R	A	T	O	R	X	A	A	G	H
T	T	N	C	C	N	S	Q	G	O	U	S	Q	R	N	S	I
Y	A	B	V	K	W	D	I	O	S	T	E	D	C	Z	C	N
Q	T	F	Y	O	N	S	U	B	E	O	H	P	M	W	U	E
D	E	O	Z	U	M	G	V	C	K	A	B	O	H	H	X	R
N	M	O	L	T	E	N	M	E	T	A	L	Y	W	P	K	Y

Word List

BACK SUPPORT BELT
METATARSAL SHOES
RESPONSIBILITY
MOLTEN METAL
RECOMMENDED
MAINTENANCE
SIDE SHIELDS
SOLUBILITY
HAZARDOUS
MACHINERY
EQUIPMENT
REQUIRED
EARPLUGS
OPERATOR
CLOTHING
CONDUCT
LOCKOUT
HARD HAT
TAGOUT
MSDS
PPE

Vocabulary - Safety

1. **Conduct** - The way you act or behave.

2. **Personal Protective Equipment (PPE)** - Things such as; safety glasses, hard hats, and metatarsal shoes, used to protect you from injury.

3. **Material Safety Data Sheet (MSDS)** - Written information explaining a chemical or a substance's properties and potential hazards.

4. **Lockout** - To place a lock on a machines power source so that it can not be turned on while maintenance is doing the repair work.

5. **Operator** - A person who runs a machine.

6. **Responsibility** - A duty or obligation.

7. **Maintenance** - A group of people who keep machines in working order.

8. **Equipment** - The machinery, tools, protection, etc., needed to do a job.

9. **Recommended** - Something that is not required, but should be accepted.

10. **Tagout** - To place a tag on a machine or part that is being worked on in order to warn others of danger.

11. **Earplugs** - A device used to protect hearing.

12. **Machinery** - The working parts of a machine.

13. **Required** - Necessary, without exception.

14. **Hazardous** - Harmful or dangerous.

15. **Hard Hat** - A type of protection worn on the head.

16. **Clothing** - Garments in general.

Vocabulary - Safety

17. **Solubility** - The ability to dissolve.

18. **Side shields** - An added protection on the sides of safety glasses that help prevent objects from harming the eyes from the side.

19. **Metatarsal shoes** - Shoes designed to cushion the foot from the blow of a heavy object.

20. **Molten Metal** - Liquid metal.

21. **Back Support Belt** - A protective device used to help prevent injury to the back.

Southern Ductile - Plant Safety Rules

Conduct: Each employeeis responsible to work in a safe manner and follow all safety instructions for his job.

Clothing: Operators of moving machinery must wear properly fitting clothes, with shirt-tails in and sleeves buttoned. No rings, bracelets, or jewelry may be worn by mold or maintenance personnel. Watches may not be worn in molding. Only non-conductive watches may be worn in maintenance. Employees working around molten metal (melting and pouring) must wear cotton clothing (no polyesters).

Safety Equipment: Each employee entering the plant is required to have his/her personal safety equipment on.
Personal Safety Equipment for <u>all</u> employees in all parts of the plant is:

(1) Hard hats
(2) Safety Glasses with side shields.

In addition, employees in the following areas will wear equipment as listed:
Molding - metatarsal shoes, ear plugs (note: Utility persons are required to wear no lace metatarsal foundry molder's shoes)
Melting - No lace metatarsal foundry molder's shoes, long sleeve cotton shirts, face shields, gloves, full size aprons and spats.
Pouring - No lace metatarsal foundry molder's shoes, long sleeve cotton shirts, face shields, gloves, full size aprons and spats.
Shakeout - Metatarsal shoes, gloves and ear plugs.
Breakoff - Metatarsal shoes, gloves and ear plugs.
Grinding - Metatarsal shoes, face shield, gloves and ear plugs.
Core Room - Metatarsal shoes.
Pattern - Metatarsal shoes (No hard hat is required when working in the pattern shop).
Maintenance - Standard Safety Shoes (not metatarsal) and ear plugs.
Q.C. Lab - Standard Safety Shoes (not metatarsal) and ear plugs.
Forklift operator - (Any Dept.) Standard Safety Shoes (not metatarsal) and ear plugs.

Note: All newly hired production employees are required to wear no lace metatarsal foundry molder's shoes. If you transfer or are working temporarily in another department, you must wear the equipment required in the department where you are working. Employees who work in melt or pour are required to wear no-lace metatarsal foundry molder's shoes. If you are temporarily transferred there and do not own a pair, you may borrow a pair at the personnel office.

Safety Rules

<u>Back Support Belts:</u>

Back support belts are <u>required</u> to be worn by employees working in the following jobs:

Mold - Hunter molders, molder helpers, gatebreakers, clean-up men, set-up men and utility men.
Pour - Hunter iron pourers, ladle pushers, and sample catchers.
Melt - Electric furnace operators, electric furnace operator helpers, and ladle liners.
Grind/Shipping - Grinders and Shipping Inspectors.
Core - Core Room Lead Man.
Pattern - Pattern Repair Man.
Quality - Sample Pattern Man and QC Inspectors.

Back support belts are <u>recommended</u> (but not required) to be worn by employees working in the following jobs:

Mold - BMM Molders
Pour - BMM Iron Pourers
Grinding - Shotblast Operators and Heat Treat Operators.
Core - Coremakers and Coremaker Helpers.

In order to provide for the health and safety of employees, the company reserves the right to amend safety rules of any employee or group of employees at any time.

I HAVE READ AND UNDERSTAND THE SAFETY RULES ABOVE AND HAVE RECEIVED A COPY OF THOSE RULES. I AGREE TO COMPLY WITH THESE SAFETY RULES.

______________________________ ______________

Signature Date Signed

Safety - Molders

We have read and talked about the company safety rules. Answer the questions below. Work with a partner. Talk about each question.

1. According to the safety rules, utility personnel are required to wear **<u>no-lace metatarsal foundry molder's</u>** shoes.

2. List the safety equipment that molders should wear. **<u>Molders should wear hard hats, safety glasses, ear plugs, metatarsal shoes, and back supports (Hunter molders, molder helpers, gatebreakers, clean-up men, set-up men and utility men).</u>**

3. If you transfer or are temporarily working in another department you must **<u>wear the equipment required for that department.</u>**

4. List safety concerns that you feel are important for new employees to know.
   <u>Accept any reasonable answer.</u>

5. Back support belts are recommended, but not required for the **<u>BMM molders</u>**.

Safety - Coremakers

We have read and talked about the company safety rules. Answer the questions below. Work with a partner. Talk about each question.

1. According to the safety rules, utility personnel are required to wear **no-lace metatarsal foundry molder's** shoes.

2. List the safety equipment that core room personnel should wear. **Core room personnel should wear hard hats, safety glasses, and metatarsal shoes. Back supports are required for core room lead man. Back supports are recommended but not required for coremakers and coremaker helpers.**

3. If you transfer or are temporarily working in another department you must **wear the equipment required for that department.**

4. List safety concerns that you feel are important for new employees to know.
   Accept any reasonable answer.

5. Back support belts are recommended, but not required for the **coremakers and coremaker helpers**.

Safety - Pouring

We have read and talked about the company safety rules. Answer the questions below. Work with a partner. Talk about each question.

1. Why is it important that the iron pourers wear no-lace metatarsal foundry molder's shoes? **No-lace metatarsal foundry molder's shoes can be removed quickly and easily. Quick removal of shoes is important if molten metal should happen to enter the shoes.**

2. List the safety equipment that pouring should wear. **Pourers should wear hard hats, safety glasses, no-lace foundry metatarsal molder's shoes, long sleeve cotton shirts, gloves, full size aprons and spats, and back supports (Hunter iron pourers, ladle pushers sample catchers and ladle liners.**

3. If you transfer or are temporarily working in another department you must **wear the equipment required for that department.**

4. List safety concerns that you feel are important for new employees to know.
   Accept any reasonable answer.

Safety - Grinding

Instructor Notes	Activities	Materials	Time
	Set Induction Show the Grinding Wheel Safety video, part I.	Video Television VCR	20-25 Minutes
	Guided Practice Introduce Vocabulary. Discuss the video. Have learners follow along with you as you take a look at the company safety rules. Have learners help you locate information about safety and PPE for the grinders. List the PPE on the markerboard as it is located. Discuss safety rules and PPE. Why does the company require you to wear personal protective equipment? What might happen if you did not wear your PPE? Talk about why it is important for all employees to follow rules and use PPE.	Safety Rules for Southern Ductile	15 - 20 Minutes
	Applied Practice Have learners complete the exercise in their workbook.	Workbook	10 - 15 Minutes
	Closure Discuss the exercise. Talk about the fact that grinding is safe when everyone is alert and following all safety guidelines.		15 - 20 Minutes

Vocabulary - Grinding Safety

1. **Conduct** - The way you act or behave.

2. **Personal Protective Equipment (PPE)** - Things such as safety glasses, hard hats, and metatarsal shoes, used to protect you from injury.

3. **Material Safety Data Sheet (MSDS)** - Written information explaining a chemical or a substance's properties and potential hazards.

4. **Lockout** - To place a lock on a machine's power source so that it cannot be turned on while maintenance is doing the repair work.

5. **Operator** - A person who runs a machine.

6. **Responsibility** - A duty or obligation.

7. **Maintenance** - A group of people who keep machines in working order.

8. **Equipment** - The machinery, tools, protection, etc., needed to do a job.

9. **Recommended** - Something that is not required, but should be accepted.

10. **Tagout** - To place a tag on a machine or part that is being worked on in order to warn others of danger.

11. **Earplugs** - A device used to protect hearing.

12. **Machinery** - The working parts of a machine.

13. **Required** - Necessary, without exception.

14. **Hazardous** - Harmful or dangerous.

15. **Hard Hat** - A type of protection worn on the head.

16. **Clothing** - Garments in general.

Vocabulary - Grinding Safety

17. **Solubility** - The ability to dissolve.

18. **Side shields** - An added protection on the sides of safety glasses that help prevent objects from harming the eyes from the side.

19. **Metatarsal shoes** - Shoes designed to cushion the foot from the blow of a heavy object.

20. **Molten Metal** - Liquid metal.

21. **Back Support Belt** - A protective device used to help prevent injury to the back.

22. **Grinding Wheel** - A round cutting tool made of abrasive grains bonded together.

23. **Spindle** - The rod on which the grinding wheel is mounted.

24. **Blotter** - A disc made of wood fiber paper used between a grinding wheel and its flanges when mounting.

25. **Flanges** - The circular metal plates against which the wheel is mounted. The flanges drive the grinding wheel.

26. **Dress** - To remove dulled grains from the cutting face of a grinding wheel to restore cutting ability.

We have read and talked about the company safety rules. Answer the questions below. Work with a partner. Talk about each question.

1. According to the safety rules, utility personnel are required to wear **no-lace metatarsal foundry molder's** shoes.

2. List the PPE that grinders should wear and explain why each is necessary. **Grinders should wear hard hats, safety goggles, ear plugs, metatarsal shoes face shields, gloves, and back support belts.**

3. If you transfer or are temporarily working in another department you must **wear the equipment required for that department.**

4. Back support belts are recommended, but not required for the **shotblast and heat treat operators.**

5. List the PPE used by the grinding department and tell why each is important.

   Hard Hat - Accept any reasonable explanation.

   Safety Goggles with side shields - Accept any reasonable explanation.

   Ear Plugs - Accept any reasonable explanation.

   Metatarsal Shoes - Accept any reasonable explanation

   Face Shield - Accept any reasonable explanation

   Gloves - Accept any reasonable explanation

Grinding Safety - Part I

Read the information about the "Grinding Safety" video - Part I and answer the questions.

Grinding is a safe but demanding job. All precautions should be taken to keep the job safe. The grinding wheel must be handled with care to prevent accidents.

The grinding wheel is made up of thousands of abrasive grains held together by bonding material. The grinding wheels used at Southern Ductile are organic, resin bonded grinding wheels. As the wheel is used the grains become dull and come off exposing new, sharper grains. It is necessary to dress the wheel to keep the operating surface smooth and in good working condition.

Safe use of the grinding wheel should include the following:

1. Use care when handling wheels - Take care not to drop a wheel. Store wheels in a dry area when not in use. Wheels should be stored in racks. Large wheels in an upright position and smaller wheels stacked. Wheels of the same size and specification need to be kept together. Older wheels should always be used first.

2. Inspect the grinding wheel for chips, cracks, and gouges before use. The wheel should be visually inspected for any defects. Perform a ring test after the visual inspection. The ring test should be performed with a non-metallic object. If the wheel has a muffled ring do not use it.

3. Check the wheel to be sure you have the correct wheel for the job. The wheel speed should not exceed the specifications for the grinding machine.

4. Inspect the spindle on the machine. Be sure it is smooth and that the wheel slides on easily.

5. Properly position blotters. Blotters are used to evenly distribute mounting pressure and to protect the wheel from wear. Always use blotters of the correct size and material for the job.

6. The flanges should be clean and in good condition. Flanges in poor condition can put pressure on the wheel causing it to crack. Flanges should be the same size and design. Check flanges for flatness - no gaps or high spots. The 4 types of flanges are: straight relieved, straight unrelieved, adapter, and sleeve adapter.

Questions - Grinding Safety Video - Part I

1. Why are blotters necessary? **Blotters are used to evenly distribute mounting pressure and to protect the wheel from wear.**

2. What are the grinding wheels made of? **The grinding wheels at Southern Ductile are made of thousands of abrasive grains held together by a resin bond.**

3. What measures can be taken to prevent eye injury? **Safety goggles and face shields are used to protect the eyes from sparks and debris. Due to the heat in the grinding room you may want to wear a headband or bandanna to keep sweat and dust from running down into your eyes.**

Instructor Notes	Activities	Materials	Time
	Set Induction Show the Grinding Wheel Safety video, part II.	Video Television VCR	20-25 Minutes
	Guided Practice Discuss the video. List the steps that should be followed to lockout/tagout a machine. Seek assistance from learners. Ask the following questions: (1) Why is lockout/tagout necessary? (2) What should be used to lockout the power source? (3) Who should remove the lock? (4) What procedure should be followed to lockout/tagout a machine?	Markerboard Kit	15 - 20 minutes
	Applied Practice Have learners complete the exercise in their workbook.	Workbook	10 - 15 minutes
	Closure Check the exercises. Discuss the importance of proper wheel handling and mounting.	Workbook	15 - 20 minutes

Grinding Safety Video - Part II

The grinding wheel mounting procedures are out of order. Place the numbers on the line beside each step to indicate the proper order.

__4__ Slide another blotter on the spindle. Be sure it is positioned properly.

__6__ Stand aside and start the machine with the guard down. Let the machine get up to operating speed and run it for a while at that speed to be sure the wheel is sound enough to use. Check the speed of the spindle with a tachometer.

__3__ Slide the wheel onto the spindle. It should slide on easily.

__1__ Check to be sure the spindle surface is clean and free of burrs and distortion.

__5__ Be sure flange is clean and free of old blotters. Place flange on and tighten bolt. Take care not to overtighten. Check with feeler gauge. There should not be any gaps.

__2__ Place a blotter on the spindle. Be sure the attached flange is clean and free of old blotters.

Mounting of the Grinding Wheel

1. Check to be sure the spindle surface is clean and free of burrs and distortion.

2. Place a blotter on the spindle. Be sure the attached flange is clean and free of old blotters.

3. Slide the wheel onto the spindle. It should slide on easily.

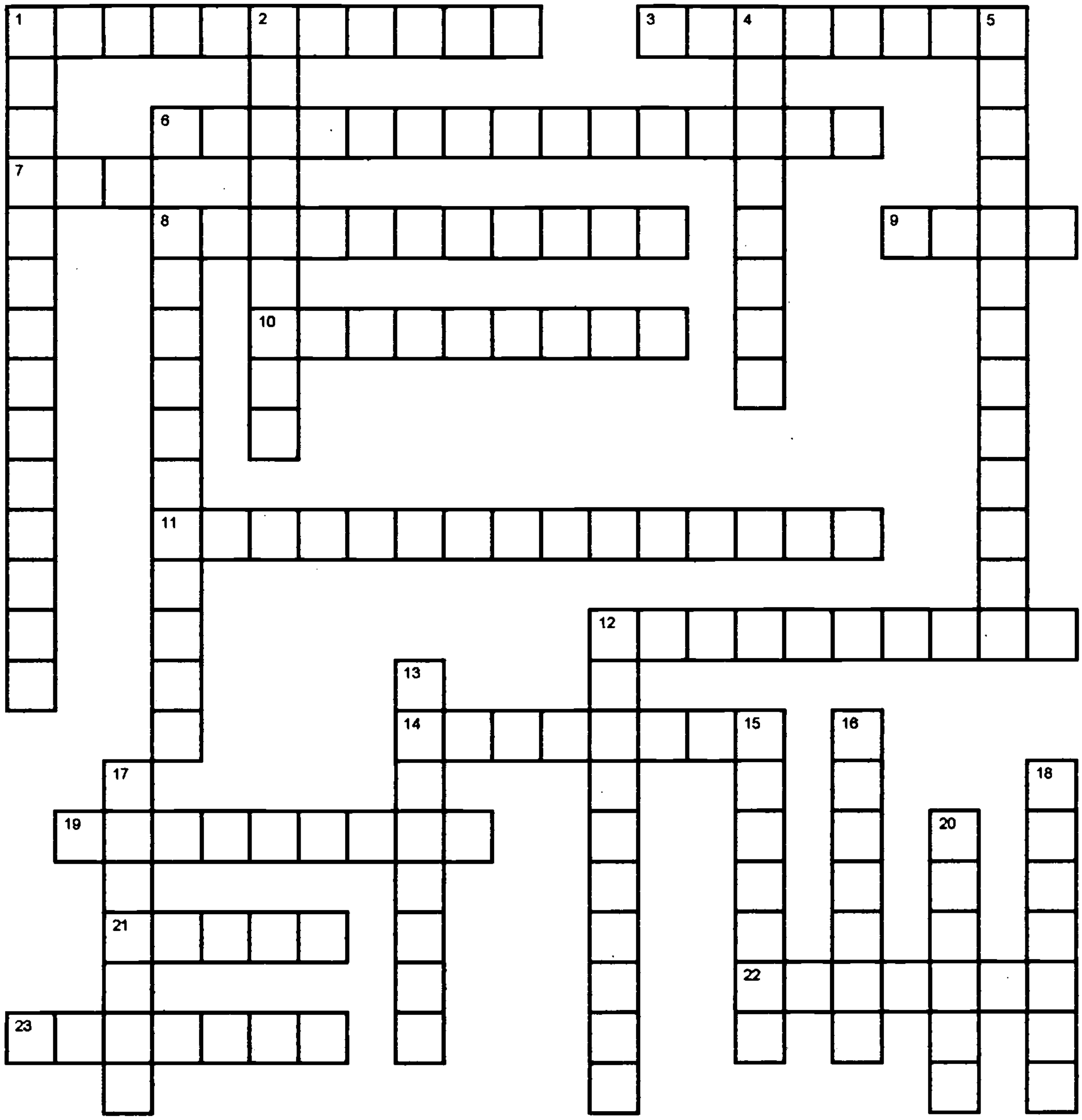
4. Slide another blotter on the spindle. Be sure it is positioned properly

5. Be sure flange is clean and free of old blotters. Place flange on and tighten bolt. Take care not to overtighten. Check with feeler gauge. There should not be any gaps.

6. Stand aside and start the machine with the guard down. Let the machine get up to operating speed and run it for a while at that speed to be sure the wheel is sound enough to use. Check the speed of the spindle with a tachometer.

Explain the wheel mounting procedure. Write your explanation below.

Safety



Across

1. Something that is not required, but should be accepted.
3. Garments in general.
6. A protective device used to prevent injury to the back.
7. Personal protective equipment. (abbreviation)
8. A group of people who keep machines in working order.
9. Material Safety Data Sheets (abbreviation)
10. The machinery, tools, protection, etc., needed to do a job.
11. Shoes designed to cushion the foot from the blow of a heavy object.
12. An added protection on the side of safety glasses that help prevent objects from harming the eyes from the side.
14. A device used to protect hearing.
19. Harmful or dangerous
21. To remove dulled grains from the cutting face of a grinding wheel to restore cutting ability.
22. To place a lock on a machine's power source so that it cannot be turned on while maintenance is doing the repair.
23. The circular metal plates against which the wheel is mounted.

Down

1. A duty or obligation
2. The working parts of a machine
4. A person who runs a machine.
5. A rouns cutting tool made of abrasive grains bonded together.
8. Liquid metal
12. The ability to dissolve
13. Necessary, without exception
15. The rod on which the grinding wheel is mounted.
16. The way you act or behave
17. A type of protection worn on the head
18. A disc made of wood fiber paper used between a grinding wheel and its flanges when mounted.
20. To place a tag on a machine or part that is being worked on in order to warn others of danger.

Word List

BACK SUPPORT BELT
BLOTTER
CLOTHING
CONDUCT
DRESS
EARPLUGS
EQUIPMENT
FLANGES
GRINDING WHEEL
HARD HAT
HAZARDOUS
LOCKOUT
MACHINERY
MAINTENANCE
METATARSAL SHOES
MOLTEN METAL
MSDS
OPERATOR
PPE
RECOMMENDED
REQUIRED
RESPONSIBILITY
SIDE SHIELD
SOLUBILITY
SPINDLE
TAGOUT

Safety - Melting

Instructor Notes	Activities	Materials	Time
	Set Induction Show the video"Personal Safety in the Foundry II" section 1 and 2.	Video TV and VCR	5 - 10 Minutes
	Guided Practice Introduce Vocabulary. Discuss the video. Have learners follow along with you as you take a look at the company safety rules. Have learners help you locate information about safety and PPE for melting. List the PPE on the markerboard as it is located. Discuss safety rules and PPE. Why does the company require you to wear personal protective equipment? What might happen if you did not wear your PPE? Talk about why it is important for all employees to follow rules and use PPE.	Workbook	15 - 20 Minutes
	Applied Practice Have learners complete the exercise in their workbook.	Workbook	10 - 15 Minutes
	Closure Discuss the exercise. Discuss the importance of being alert and constantly aware of your surroundings.		15 - 20 Minutes

Vocabulary - Safety

1. **Conduct** - The way you act or behave.
2. **Personal Protective Equipment (PPE)** - Things such as; safety glasses, hard hats, and metatarsal shoes, used to protect you from injury.
3. **Material Safety Data Sheet (MSDS)** - Written information explaining a chemical or a substance's properties and potential hazards.
4. **Lockout** - To place a lock on a machine's power source so that it cannot be turned on while maintenance is doing the repair work.
5. **Operator** - A person who runs a machine.
6. **Responsibility** - A duty or obligation.
7. **Maintenance** - A group of people who keep machines in working order.
8. **Equipment** - The machinery, tools, protection, etc., needed to do a job.
9. **Recommended** - Something that is not required, but should be accepted.
10. **Tagout** - To place a tag on a machine or part that is being worked on in order to warn others of danger.
11. **Earplugs** - A device used to protect hearing.
12. **Machinery** - The working parts of a machine.
13. **Required** - Necessary, without exception.
14. **Hazardous** - Harmful or dangerous.
15. **Hard Hat** - A type of protection worn on the head.
16. **Clothing** - Garments in general.

Vocabulary - Safety

17. **Solubility** - The ability to dissolve.

18. **Side shields** - An added protection on the sides of safety glasses that help prevent objects from harming the eyes from the side.

19. **Metatarsal shoes** - Shoes designed to cushion the foot from the blow of a heavy object.

20. **Molten Metal** - Liquid metal.

21. **Back Support Belt** - A protective device used to help prevent injury to the back.

22. **Bridging** - The condition that exists when cold charge material in the top part of the furnace is not in contact with the molten metal in the bottom part of the furnace.

Safety - Melting

We have read and talked about the company safety rules. Answer the questions below. Work with a partner. Talk about each question.

1. Why is it important that furnace operators wear no-lace metatarsal foundry molder's shoes? **No-lace metatarsal foundry molder's shoes can be removed quickly and easily. Quick removal of shoes is important if molten metal should happen to enter the shoes.**

2. List the safety equipment that "melting" should wear and tell why each is important.
   Melting should wear:
   hard hats - accept any reasonable explanation
   safety glasses with side shields - accept any reasonable explanation
   face shields - accept any reasonable explanation
   no-lace metatarsal foundry molder's shoes - accept any reasonable explanation
   long sleeve cotton shirts - accept any reasonable explanation
   gloves - accept any reasonable explanation
   full size aprons - accept any reasonable explanation
   spats - accept any reasonable explanation
   back supports - accept any reasonable explanation

3. If you transfer or are temporarily working in another department you must **wear the equipment required for that department.**

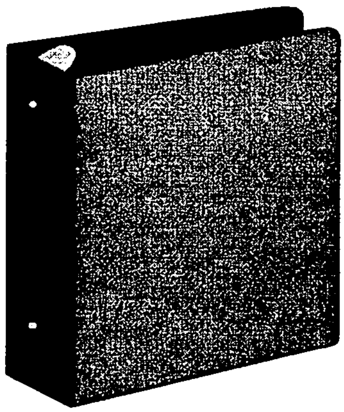
4. Explain the importance of safety in the furnace area.
   Accept any reasonable answer.

The following questions are taken from the information in the video. Please answer each question completely.

1. What are the causes of molten metal splash? **<u>Damp or wet charge material, dropping heavy charge material into the molten metal, damp tools or additives</u>**

2. Why are dryers or preheaters used? **<u>Dryers or preheaters are are used to heat the charge material and to remove moisture that may have collected on the material.</u>**

3. Where is lining wear more intense? **<u>Lining wear is more intense at the point the side walls join the base of the furnace, at the slag/metal interface, and at thin spots caused by poor lining procedures.</u>**



Safety - MSDS

Upon completion of this lesson the learner will be able to:

- define vocabulary words used on a material safety data sheet (MSDS)
- utilize key words to locate information
- locate and apply information on a material safety data sheet (MSDS)

Instructor Notes	Activities	Material	Time
	Set Induction Have a few products to display to the learners. Ask what they all have in common. They are all chemicals. Show how the three are labeled. Read the label on the Clorox. Why does it have a warning on it? The warning is a detailed description of what you should and should not do. Explain how important details can be when you are talking about safety.	Clorox Alcohol Comet	20 minutes
	Guided Practice Ask learners if they know what a Material Safety Data Sheet (MSDS) is. Show how to locate information on a MSDS. (I) Product identification, (II) Hazardous ingredients, (III) Physical data, (IV) Fire and explosion data, (V) Health hazards, (VI) Reactivity, (VII) Spill and leakage procedures, (VIII) Safe handling and use. Explain that there is not a standard format for MSDS, but they should all contain the basic information.	Transparency, Overhead Projector	10 minutes
	Applied Practice Have learners complete the practice exercises working together if necessary. Circulate around the room to assist learners if necessary.	Workbook	20 minutes
	Closure Discuss how being able to locate information on the MSDS could help them be more safety conscious on the job.		10 minutes

Instructor Notes

1. **Identity** - The name of the chemical, the manufacturer, the chemical abstract services (CAS) number and an emergency phone number to call for assistance in cleaning up spills or for assistance in emergency treatment.

2. **Hazardous ingredients** - The ingredients are listed by name. They have an OSHA personal exposure limit (PEL) and a threshold limit value (TLV) which measure the toxicity of the material or chemical.

3. **Physical data** - This includes the boiling point, melting point, solubility, appearance and odor.

4. **Fire and explosion information** - Flash point - The lowest temperature it will ignite with a flash. Flammable limits - the point at which it will automatically ignite. How to extinguish a fire, including any special fire fighting procedures. Unusual fire and explosion hazards.

5. **Health hazards** - Routes of entry - skin, inhalation and ingestion. Health problems that could occur. Emergency first-aid procedures.

6. **Reactivity** - The stability of the chemical. The incompatibility of this chemical when mixed with others. Will the chemical polymerize (form a giant molecule from smaller molecules of the same kind) under certain condition? Conditions that should be avoided. Hazardous decomposition or by-products.

7. **Spill and leakage procedures** - Instructions stating what must be done in case of a spill or leakage. The methods you must use for properly disposing of waste.

8. **Safe handling and use** - The type of respiratory protection, if required. The personal protective equipment necessary for safe use and any special clothing required.

Molders

Use the Material Safety Data Sheet (MSDS) for Super Slik Liquid Parting to complete the following.

1. What is the CAS number for Super Slik Liquid Parting? **64742-46-7**.

2. Look under the fire and explosion information. How do you extinguish or put out a fire? **Water may be ineffective. Use CO2 or alcohol foam to extinguish**.

3. What are the primary routes of entry for the parting liquid? **The primary routes of entry are skin contact and inhalation.**

4. What should you do if you get parting liquid in your eyes? **Flush your eyes with clear flowing water for at least 15 minutes. If irritation persists, seek medical attention.**

5. What hazardous ingredient does the parting liquid contain? **Petroleum Distillate.**

Molders

Use the Material Safety Data Sheet (MSDS) for Crystalline Silica (Quartz) to complete the following.

1. What are the color and odor of Crystalline Silica? **Crystalline Silica is white or tan sand, granular, crushed, or ground and has no odor or taste**.

2. What does the material safety data sheet (MSDS) say about local exhaust? **Use sufficient local exhaust to reduce the level of respirable dust to the personal exposure limit (PEL)**.

3. What is the solubility of Crystalline Silica? **Crystalline Silica is insoluble in water**.

4. What is the manufacturer's name? **The manufacturer is U.S. Silica Company**.

5. What is the route of entry of Crystalline Silica? **The route of entry for Crystalline Silica is inhalation.**

Coremakers

Use the Material Safety Data Sheet (MSDS) for Isocure I LF 305 to complete the following.

1. What are the primary routes of entry for the Isocure I LF 305? **The primary routes of entry are inhalation, skin absorption, and skin contact.**

2. Look under the fire fighting measures. How do you extinguish or put out a fire? **Use regular foam, water fog, carbon dioxide, dry chemical, or sand to put out a fire.**

3. List the ingredients in Isocure I LF 305.
   Phenol Formaldehyde Resin
   Aromatic Petroleum Distillates
   Dioctyl Adipate
   Phenol
   Aromatic Petroleum Distillates
   Dimethyl Glutarate
   Dimethyl Adipate
   Dimethyl Succinate
   Naphthalene
   1, 2, 4-Trimethylbenzene

4. What should you do if you get Isocure I LF 305 in your eyes? **If symptoms develop, immediately move individual away from exposure and into fresh air. Flush your eyes gently with water for at least 15 minutes while holding eyelids apart; seek immediate medical attention.**

Coremakers

Use the Material Safety Data Sheet (MSDS) for 65-500-SVR Resin Coated Silica Sand to complete the following.

1. What are the ingredients in Resin Coated Silica Sand? **The ingredients in Resin Coated Silica Sand are Silica Sand, Phenolic Resin, and Hexamethylenetetramine.**

2. What does the material safety data sheet (MSDS) say about ventilation? **Ventilation should be sufficient to maintain dust levels below the applicable exposure limit.**

3. What are the first aid and medical emergency procedures for skin contact and inhalation? **The procedure for skin contact is wash with soap and water. The procedure for inhalation is remove to fresh air.**

4. What is the manufacturer's name? **The manufacturer is Southern Precision Corporation.**

5. What are the routes of entry for Resin Coated Silica Sand? **The routes of entry for Resin Coated Silica Sand are inhalation and skin.**

Grinders

Use the Material Safety Data Sheet (MSDS) for Resin Bonded Aluminum Oxide Abrasive Wheels to complete the following.

1. What is the CAS number for Aluminum Oxide? **1344-28-1.**

2. What are the emergency and first aid procedures? **If inhalation overexposure occurs remove to fresh air and contact physician if necessary.**

3. What protective equipment is required or may be required when using the wheel? **Eye protection is required and a MSHA or NIOSH approved dust respirator and gloves may be required.**

4. The dust that results from the break down of the grinding wheel during use is classified by OSHA as **inert** or **nuisance** dust.

5. What is the emergency telephone number? **(617) 366-4431**

MSDS - Pouring

Use the Material Safety Data Sheet (MSDS) for Ferrosilicon Alloy to complete the following.

1. List the hazardous ingredients and their CAS number.
   Silicon - 7440-21-3
   Iron - 7439-89-6
   Calcium - 7440-70-2
   Aluminum - 7429-90-5

2. Look under the fire and explosion information. What extinguishing procedures and special procedures should be followed to put out a fire? **Use dry chemical, dry sand or CO_2 to smother fire. Fire may also be isolated and allowed to burn itself out.**

3. What are the routes of entry for Ferrosilicon Alloy? **The routes of entry are inhalation, eyes, skin, and ingestion.**

4. What does the MSDS say about the appearance and odor of Ferrosilicon Alloy? **Ferrosilicon Alloy is silver-gray metallic and has no odor.**

5. Why are gloves recommended? **Gloves are recommended during handling because lump material may have sharp edges.**

MSDS - Melting

Use the Material Safety Data Sheet (MSDS) for Graphite to answer the following questions.

1. What steps should be taken in case of a spill? **Use normal housekeeping practice.**

2. Look under the fire and explosion information. What extinguishing procedures and special procedures should be followed to put out a fire? **Use water, CO_2, or sand.**

3. What are the routes of entry for Carbon? **The route of entry is inhalation.**

4. What is the chemical family for Graphite? **The chemical family for graphite is Carbon.**

5. What is the CAS number for graphite? **The CAS number is 7782-42-5.**

MSDS - Melting

Use the Material Safety Data Sheet (MSDS) for Silicon Carbide to answer the following questions.

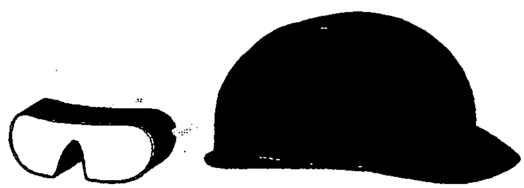
1. What are the signs and symptoms of exposure? **The signs symptoms of exposure are respiratory distress, coughing and shortness of breath.**

2. What does the material safety data sheet (MSDS) say about unusual fir and explosion hazards? **The MSDS says that no fire hazard exists. Silicon Carbide is not combustible.**

3. What are the ingredients of Siklicion Carbide? **The ingredients for Silicon Carbide are Silicon Carbide, Graphite, Free Si, And Free SiO2.**

4. What is the supplier's name? **The supplier is Miller and Company**.

5. What is the route of entry for Silicon Carbide? **The route of entry for Silicon Carbide is inhalation.**



Safety - Lockout/tagout and PPE

Upon completion of this lesson the learner will be able to:

- explain lockout/tagout procedures
- list personal protective equipment (PPE) used in their department and tell why each is important

Instructor Notes	Activities	Materials	Time
	Set Induction Have volunteers role play the script on lockout/tagout and personal protective equipment (PPE)	Role Playing Script	10 - 15 minutes
	Guided Practice List the steps that should be followed to lockout/tagout a machine. Seek assistance from learners. Ask the following questions: (1) Why is lockout/tagout necessary? (2) What should be used to lockout the power source? (3) Who should remove the lock? (4) What procedure should be followed to lockout/tagout a machine? Why does the company require you to wear personal protective equipment? What might happen if you did not wear your PPE?	Markerboard Kit	15 - 20 minutes
	Applied Practice Have learners complete the exercise in their workbook.	Workbook	10 - 15 minutes
	Closure Review the safety lessons. Vocabulary Review	Workbook	15 - 20 minutes

E	L	D	N	I	P	S	I	D	E	S	H	I	E	L	D	E	R	I	U	Q	E	R
A	M	E	T	A	T	A	R	S	A	L	S	H	O	E	S	I	S	U	G	U	K	E
R	O	Z	A	J	I	I	C	W	E	T	F	Y	T	U	J	W	F	J	H	I	Q	C
P	L	K	G	R	I	N	D	I	N	G	W	H	E	E	L	K	P	M	Q	U	Q	O
L	T	G	O	E	U	L	C	M	A	I	N	T	E	N	A	N	C	E	I	Q	P	M
U	E	U	U	S	E	E	S	Q	A	T	R	A	H	P	T	R	V	P	S	E	M	M
G	N	O	T	P	H	D	S	O	L	U	B	I	L	I	T	Y	M	J	R	S	Q	E
S	M	B	N	O	S	R	B	L	O	T	T	E	R	F	I	E	U	A	R	M	L	N
K	E	N	E	N	G	E	P	P	C	L	O	T	H	I	N	G	T	I	Y	A	I	D
S	T	O	N	S	F	S	M	D	K	M	J	E	X	T	C	O	N	D	U	C	T	E
Y	A	R	C	I	R	S	F	W	O	E	R	V	F	T	R	M	U	F	H	H	F	D
Y	L	E	Z	B	A	C	K	S	U	P	P	O	R	T	B	E	L	T	A	I	I	L
K	N	G	J	I	T	I	N	Z	T	B	I	I	K	N	B	F	V	Z	R	N	C	X
W	C	W	C	L	E	K	U	A	L	K	O	Y	G	I	V	C	A	B	D	E	Q	V
G	H	V	V	I	X	T	H	F	E	G	N	Q	E	E	B	R	R	W	H	R	V	P
F	V	U	R	T	N	I	E	M	R	S	T	M	Q	I	D	Y	G	F	A	Y	X	F
N	Y	J	I	Y	H	I	L	R	M	E	Z	B	P	O	K	N	X	W	T	B	K	G
L	H	H	B	U	A	T	S	T	P	E	F	F	U	R	W	Q	Q	L	M	D	M	F
Q	W	Y	V	U	M	B	Y	L	P	U	B	S	N	N	T	X	W	R	V	K	K	M

Word List

BACK SUPPORT BELT
METATARSAL SHOES
RESPONSIBILITY
GRINDING WHEEL
MOLTEN METAL
RECOMMENDED
MAINTENANCE
SIDE SHIELD
SOLUBILITY
HAZARDOUS
MACHINERY
EQUIPMENT
REQUIRED
CLOTHING
OPERATOR
EARPLUGS
FLANGES
BLOTTER
HARD HAT
CONDUCT
LOCKOUT
SPINDLE
TAGOUT
DRESS
MSDS
PPE

Role Playing Script - Lockout/Tagout and Personal Protective Equipment (PPE)

Bob - Hey Ralph, there is a tag on my machine. Do you know why it is there?

Ralph - Maintenance is working on the machine. They will have it ready in a few minutes. Do some housekeeping around your machine while they work. **(Ralph Leaves.)**

(Bob Takes off his hard hat and safety glasses and begins to clean up around the machine.)

(Ralph walks back to Bob's machine)

Ralph - Bob, where are your safety glasses and hard hat?

Bob - I did not think I needed them to do housekeeping.

Ralph - This is a hard hat area at all times. It does not matter whether you are working, doing housekeeping, or walking to and from your work area. Bob, it is for your own safety.

Read the following and fill in the blanks using the word list.

Word List	
lock	prevent
machine	power
safely	switch
tag	energy

1. Lockout/tagout is needed to **prevent** accidental injury or death.

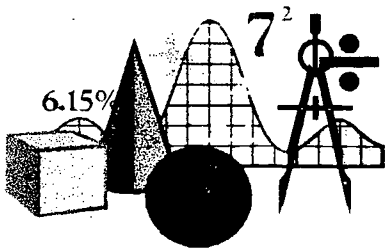
2. The only person who should remove a lock or a tag is the person who put it on the **machine**.

3. These are the steps that should be followed to lockout/tagout a machine. (1)Turn off the machine and disconnect the **power** sources. (2) Place your **lock** on the power source. (3) **Tag** the machine at the place you are working to let others know what you are doing. (4) Check to be sure all **energy** sources are locked by turning on the **switch**. If no energy is released you have **safely** locked the machine.

4. List the PPE used by employees in your department and tell why each is important.
***See the safety rules for PPE required for each department.**

Hard Hat - Accept any reasonable explanation.

Safety Glasses with side shields - Accept any reasonable explanation.



Basic Math & Measurement

Upon completion of this lesson the learner will be able to:

- define math vocabulary words
- add, subtract, and multiply single and multiple digit whole numbers with 100% accuracy using a calculator
- add and subtract time
- read a standard tape measure to the nearest 1/16th of an inch

Instructor Notes	Activities	Materials	Time
	Set Induction Divide learners into two groups. Give each group a bus schedule and tell them they will be using it to answer some questions. They should try to answer as quickly as possible. Discuss the activity. Ask learners how they felt while completing the exercise. They may have been unsure as to whether they should add or subtract time to determine the answers.	Bus Schedule	10 Minutes.
	Guided Practice Introduce Vocabulary. Show the problems on the transparency one problem at a time. Have learners follow along as you read the problem. Seek assistance from the learners to determine what operation to perform and how to set up the problem.	Transparency Overhead Projector	10-15 Minutes
	Applied Practice Have learners complete the exercise in their workbook. Ask learners to assist each other if necessary.	Workbook	20-30 Minutes
	Closure Check the exercise. Provide additional assistance for learners who have difficulty with the lesson.	Workbook	5 Minutes

Math Problems

1. Jack's machine was down three times today. Jack had to wait 10 minutes for sand. The machine was down for 23 minutes for maintenance. The Power was off for 2 Minutes. What was the down time for Jack's machine?

2. Malcom's Machine broke down at 10:47 AM. Maintenance had the machine ready to start at 11:15 AM. How long was the machine down?

3. Kate worked 1 hour and 25 minutes overtime on Monday. She worked 3 hours and 10 minutes overtime on Thursday and 25 minutes overtime on Friday. What was Kate's overtime for the week?

MATH AND SPC

A	D	D	I	F	F	E	R	E	N	C	E	W	M	E	D	I	A	N	U
V	A	R	I	A	T	I	O	N	E	I	N	C	O	N	T	R	O	L	S
E	S	N	F	Q	B	H	B	H	Z	C	N	Z	D	A	T	A	J	D	O
R	S	O	E	J	X	E	L	L	D	P	N	S	E	S	A	M	P	L	E
A	I	K	E	T	U	U	J	E	O	T	U	A	P	P	U	A	S	C	O
G	G	T	D	L	S	R	F	R	Q	B	L	C	H	E	B	M	K	O	G
E	N	M	I	Q	U	A	L	I	T	Y	J	C	Z	C	C	B	U	N	J
W	A	S	D	M	H	D	D	R	A	N	G	E	Z	I	K	T	D	T	H
J	B	H	W	F	J	C	A	D	Q	Q	P	X	N	F	J	U	I	R	O
D	L	O	W	E	R	C	O	N	T	R	O	L	L	I	M	I	T	O	G
Y	E	N	X	A	T	U	E	D	P	V	A	Y	D	C	G	Y	Y	L	N
X	C	R	F	M	R	Q	U	O	C	S	D	C	K	A	M	W	W	C	T
H	A	H	Q	D	P	G	J	D	I	H	T	M	Q	T	G	L	I	H	W
K	U	P	P	E	R	C	O	N	T	R	O	L	L	I	M	I	T	A	K
G	S	T	A	C	Y	U	V	F	Y	Y	C	H	O	O	W	N	C	R	G
Q	E	U	O	D	Q	H	T	P	B	U	K	O	U	N	S	F	O	T	W
O	S	V	I	Q	K	C	N	R	Y	Y	S	P	N	S	M	W	K	S	O

Word List

LOWER CONTROL LIMIT
UPPER CONTROL LIMIT
ASSIGNABLE CAUSES
SPECIFICATIONS
CONTROL CHARTS
INSPECTION
DIFFERENCE
IN CONTROL
VARIATION
SUBTRACT
AVERAGE
QUALITY
CHANCE
SAMPLE
MEDIAN
RANGE
MODE
DATA
SUM
ADD
SPC

Vocabulary - Math and SPC

1. **Statistical Process Control (SPC)** - The use of statistical methods to analyze a process in order to make improvements in the process.

2. **Add** - To put together or combine.

3. **Subtract** - To take away.

4. **Sum or Total** - The whole amount.

5. **Difference** - The amount two numbers differ. (EX. - The difference between the numbers 2 and 6 is 4.)

6. **Average** - The average of a set of values is found by adding the values and then dividing the sum by the number of values.

7. **Mode** - The number appearing the most often in a set of values.

8. **Median** - The number in the middle when a set of values is ordered from the smallest to the largest or vice versa.

9. **Range (R)** - The difference between the largest and the smallest number in a set of values.

10. **Quality** - A product or a service that meets standards set by the customer.

11. **Control Charts** - The charts used to collect data on a process to determine if and when corrections are needed.

12. **Upper Control Limit (UCL)** - The highest value a process can reach and still be in control.

13. **Lower Control Limit (LCL)** - The lowest value a process can fall to, and still be in control.

Vocabulary - Math and SPC

14. **In Control** - A process is said to be in control if it is operating between t he UCL and the LCL.

15. **Sample** - Part, of a whole group, taken out to measure or observe for problems that may be occurring in the process.

16. **Inspection** - Checking a product, based on a set of standards, to determine if it is acceptable.

17. **Specifications** - Requirements for a product, usually determined by the customer.

18. **Data** - Numerical information used to analyze and monitor a process.

19. **Variation** - The inevitable difference among the parts produced in a process.

20. **Assignable Causes** - Variation in a process caused by man, method, material, machine, or environment. They can usually be detected and removed.

21. **Chance** - The natural variation in a process that cannot be removed.

Molders

Read the problems below. Decide how to set up each problem. Complete the problems. Show your work.

1. The order you are working on calls for 400 molds. You have finished 142 molds. Three of the molds were bad. How many more good molds do you need to complete the order? **261**

2. You start to work at 6:00 AM. Work is slow in your area due to machine problems. Your supervisor sends you home at 11:45 AM. How long did you work? **5 hours and 45 minutes**

3. You start making molds at 3:15 PM. At 4:08 PM you only have 6 molds. How long have you been working on these 6 molds? **53 minutes**

4. You started to work at 6:00 AM and got off work 9 hours and 15 minutes later. What time did you get off work? **3:15 PM**

Look at the downtime report on the next page. The downtime and the time up are filled in for you. Complete the report by filling in the total minutes for each downtime and by figuring the total downtime for the day.

Coremakers

Read the problems below. Decide how to set up each problem. Complete the problems. Show your work.

1. The order you are working on calls for 400 cores. You have finished 142 cores. Three of the cores were bad. How many more good cores do you need to complete the order? **261**

2. You start to work at 6:00 AM. Work is slow in your area due to machine problems. Your supervisor sends you home at 11:45 AM. How long did you work? **5 hours and 45 minutes**

3. You started to work at 6:00 AM and got off work 9 hours and 15 minutes later. What time did you get off work? **3:15 PM**

4. The first hour you make 19 cores and 2 of them are bad. The second hour you make 73 cores and 4 of them are bad. The third hour you make 51 cores and 3 of them are bad. How many good cores do you have after three hours of making cores? **134**

Instructor Notes	Activities	Materials	Time
	Set Induction Read the story and have each learner figure the problem. Each learner should decide if there was a gain, a loss or if the person broke even. Ask how they solved the problem. Seek out different ways of solving the problem. Explain that although there may be different ways of solving a problem, everyone should get the correct answer.	Story	5 Minutes
	Guided Practice Introduce Vocabulary Show learners one problem at a time and ask them to solve the problem. Check after each one. Seek different ways to solve the problem.	Overhead Projector Transparency	15-20 Minutes
	Applied Practice Have learners complete the math problems in their workbook	Workbook	15-20 Minutes
	Closure Have each learner check their work. Provide additional practice for learners if necessary.	Workbook	10 Minutes

MATH

R	S	U	B	T	R	A	C	T	R	B
E	U	U	O	U	J	N	E	Q	E	K
B	U	T	M	S	R	L	L	S	J	Q
X	A	Y	Q	Z	U	C	P	P	T	V
L	D	Q	V	G	C	Z	O	X	V	M
W	D	I	F	F	E	R	E	N	C	E

Word List

DIFFERENCE
SUBTRACT
TOTAL
ADD
SUM

Vocabulary - Math - Grinders

1. **Add** - To put together or combine.

2. **Subtract** - To take away from or to find the difference.

3. **Sum** The answer to an addition problem.

4. **Difference** - The answer to a subtraction problem. The amount left after you subtract.

5. **Total** - The whole amount.

Math Story

Joe bought a mule for $80.00 and sold it for $95.00. Joe bought another mule for $90.00 and sold it for $85.00. Did Joe profit, lose, or did he break even?

Math Problems - Grinders

1. You have 50 parts in the first box and 37 parts in the second box. How many parts do you have in all?

2. The order you are working on calls for 1,500 parts. The first shift grinder has 837 parts of the order finished. How many more parts do you need to grind to complete the order?

3. You have 4 boxes with 75 parts in each box. How many parts do you have in all?

Math - Grinders

Solve the problems below. Show your work.

1.

20 castings	97 castings	25 castings
+43 castings	+26 castings	+79 castings
63 castings	**123** castings	**104** castings

2.

235 castings	1434 total weight	98 castings
- 17 bad castings	- 49 tare weight	- 19 bad castings
218 good castings	**1385** net weight	**79** good castings

3.

92 castings	25 castings	27 castings
x 3 boxes	x 5 boxes	x 2 boxes
276 castings	**125** castings	**54** castings

4. You are a second shift grinder. You grind parts the entire eight hour shift.

The part # and the pieces for each part # are as follows:

part # - 10696 number of pieces - 33
part # - 645232 number of pieces - 202
part # - 53QK5111 number of pieces - 17
part # - 939-57538 number of pieces - 115
part # - 9695-7549 number of pieces - 137
part # - Z-50 number of pieces - 301

How many total pieces did you grind on your shift?
805 pieces

Math - Pouring

The treatment rate of magnesium addition ranges from 1.80% to 2%. You have a chart to tell you the number of pounds of magnesium to add to the molten metal. The amount of magnesium added depends on the tap weight of the molten metal. Look at the example below to see how to figure the pounds of magnesium you should add.

You need to add 1.85% to a tap weight of 1400 pounds.
To figure this, change the percent to a decimal and multiply.

Example: 1.85% of 1400

(1) Change the percent to a decimal by moving the decimal 2 places to the left. Remove the percent sign.

1.85% = .0185

(2) Multiply.

```
   1400
 x .0185
   7000
 11200
 1400
 259000
```

(3) Count the number of decimal places in the problem and place your decimal in the answer.

25.9000

(4) Round the number. 25.9000 = 26 pounds of magnesium

Solve the problems below. Look back at the example if necessary.

1. Find 1.90% of 1200 pounds.
   23 pounds of magnesium

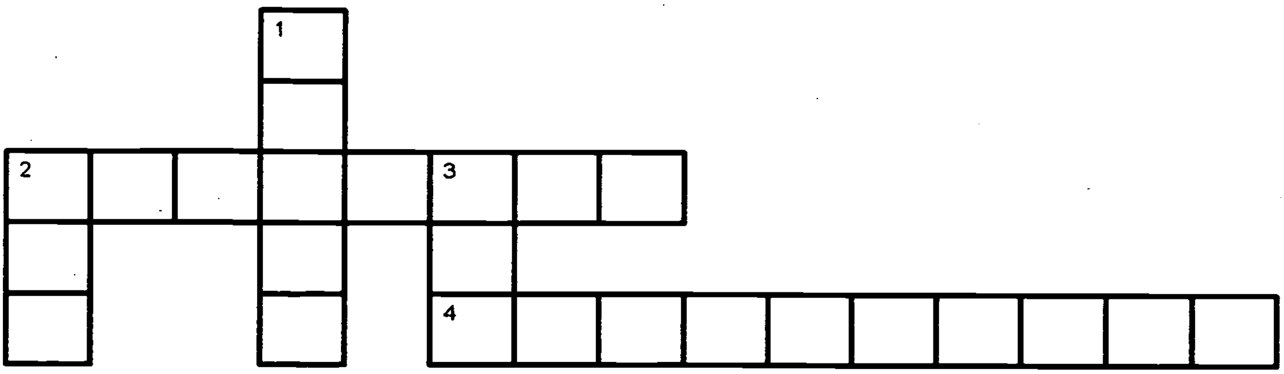
2. Find 2% of 900 pounds.
   18 pounds of magnesium

3. Find 1.95% of 600 pounds.
   12 pounds of magnesium

4. Find 1.80% of 1800 pounds.
   32 pounds of magnesium

5. Find 1.85% of 1100 pounds.
   20 pounds of magnesium

MATH



Across

2. To take away from or to find the difference.
4. The answer to a subtraction problem.

Down

1. The whole amount.
2. The answer to an addition problem.
3. To put together or combine.

Word List

ADD
DIFFERENCE
SUBTRACT
SUM
TOTAL

Instructor Notes	Activities	Materials	Time
	<u>Set Induction</u> Divide learners into two groups. Give each group a bus schedule and tell them they will be using it to answer some questions. They should try to answer as quickly as possible. Discuss the activity. Ask learners how they felt while completing the exercise. They may have been unsure whether they should add or subtract time to determine the answers.	Bus Schedule	10 Minutes.
	<u>Guided Practice</u> Show the problems on the transparency one problem at a time. Have learners follow along as you read the problem. Seek assistance from the learners to determine what operations to perform and how to set up the problem.	Transparency Overhead Projector	10-15 Minutes
	<u>Applied Practice</u> Have learners complete the exercise in their workbook. Assist learners if necessary. <u>Review Vocabulary</u>	Workbook	20-30 Minutes
	<u>Closure</u> Check the exercise. Provide additional assistance for learners who have difficulty with the lesson.	Workbook	5 Minutes

Grinding

Read the problems below. Decide how to set up each problem. Complete the problems. Show your work.

1. The order you are working on calls for 250 castings. You have finished 136 castings. How many more castings do you need to complete the order? **114**

2. You start to work at 4:00 AM. Work is slow in your area due to machine problems. Your supervisor sends you home at 9:45 AM. How long did you work? **5 hours and 45 minutes**

3. You have three boxes of ground castings. One box has 27 castings, one box has 73 castings, and the other box has 49 castings. How many total castings are in the three boxes? **149 parts**

4. You started to work at 1:00 PM and got off work 9 hours and 15 minutes later. What time did you get off work? **10:15 PM**

5. You have 5 boxes with 73 parts in each box. How many parts do you have in all? **365 parts in all**

Vocabulary - Math - Pouring

1. **Add** - To put together or combine.

2. **Subtract** - To take away.

3. **Sum or Total** - The whole amount.

4. **Difference** - The amount two numbers differ. (EX. - The difference between the numbers 2 and 6 is 4.)

5. **Percent** - One part of 100.

6. **Decimal** - Any number expressed in base 10.

Pouring

Read the problems below. Decide how to set up each problem. Complete the problems. Show your work.

1. The order you are working on calls for 400 molds. You have finished pouring 142 molds. Three of the molds were bad. How many more good molds do you need to complete the order? **261**

2. You start to work at 6:00 AM. Work is slow in your area due to machine problems in molding. Your supervisor sends you home at 11:45 AM. How long did you work? **5 hours and 45 minutes**

3. You poured the following molds during a part of your shift: 10, 11, 11, 11, 11, 11, 11, 11, 11,10, 9, 10, 10, and 10.

   What is the total number of molds you poured?
   147

4. You started to work at 6:00 AM and got off work 9 hours and 15 minutes later. What time did you get off work? **3:15 PM**

Melting

Read the problems below. Decide how to set up each problem. Complete the problems. Show your work.

1. You started to work at 6:00 AM and got off work 9 hours and 15 minutes later. What time did you get off work? **3:15 PM**

2. How many counts does it take to raise the furnace temperature from 2280° to 2500°? **You would need to add 220 counts to raise the temperature from 2280° to 2500°.**

3. The temperature of the furnace is at 2680° and you need to have the temperature at 2710°. How many counts do you have to add to get the temperature to 2710°? **You need to add 30 counts to raise the temperature to 2710°.**

4. You worked 8 hours on Monday, 9 and 1/2 hours on Tuesday, 8 hours on Wednesday, 9 hours on Thursday, 9 hours on Friday, and 6 hours on Saturday. How many hours did you work in all for the week?
You worked 49 and 1/2 hours for the week.

5. The temperature is at 2330° and you need to raise the temperature to 2550°. How many counts do you need to raise the temperature to 2550°? **You need to add 220 counts to raise the temperature to 2550°.**

6. Fill in the cumulative counts for the five hour Period. Show your work.

HOUR	COUNTS	CUMULATIVE COUNTS
1	4 X 6	**24**
2	4 X 8	**56**
3	4 X 12	**104**
4	4 X 15	**164**
5	4 X 22	**252**

Instructor Notes	Activities	Materials	Time
	<u>Set Induction</u> Have learners estimate the length of their foot. The height of the door. The width of the table where they are sitting. Have learners measure these things. Ask: Were your estimates correct? Was your foot 12 inches long? Are estimates good enough for furnace measurements or do they need to be exact?	Tape Measure	15 Minutes
	<u>Guided Practice</u> Show overhead and explain the increments on the standard tape measure. Have learners help you determine the readings.	Overhead Projector Transparency	20 Minutes
	<u>Applied Practice</u> Have learners complete the exercise in their workbook.	Workbook	20 Minutes
	<u>Closure</u> Discuss the exercises and check for discrepancies.		5 Minutes

Estimate:

1. The length of your foot.

__________ in.

2. The height of the door.

__________ in.

3. The width of the table where you are sitting.

__________ in.

Measure:

1. The length of your foot.

__________ in.

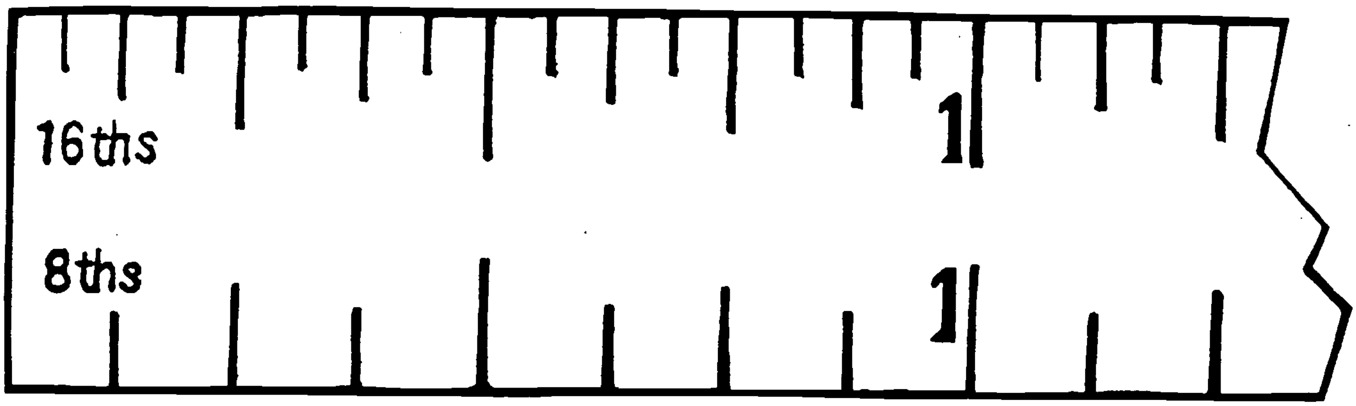
2. The height of the door.

__________ in.

3. The width of the table where you are sitting.

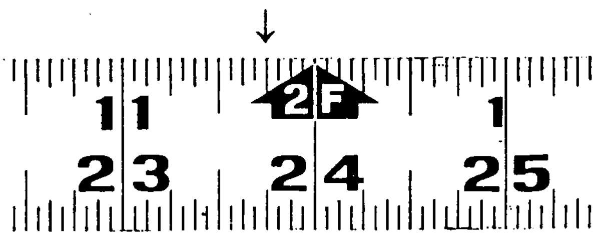
__________ in.

STANDARD TAPE MEASURE

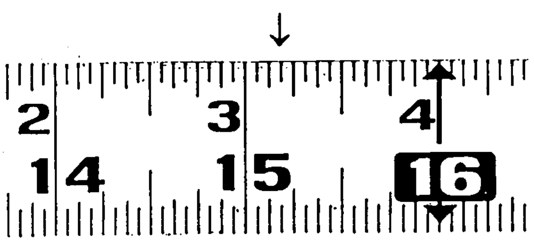


The tape measure shows increments of 8ths and 16ths. The more increments on the tape measure, the more accurate the measurement. The measurements taken on the furnace need to be exact, to the nearest 16th of an inch.

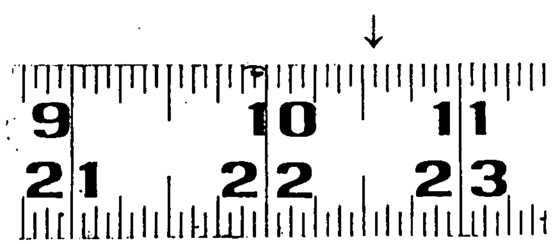
Look at the tape measure. The arrow points to a reading on each of the sections of the tape measure. Record the reading for each tape measure section.



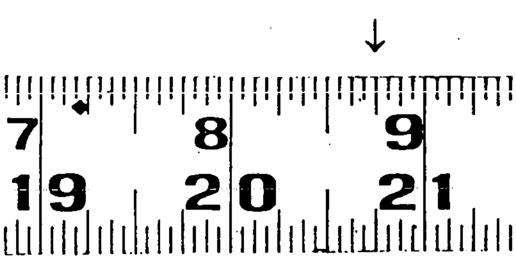
1. ___23 3/4___ inches



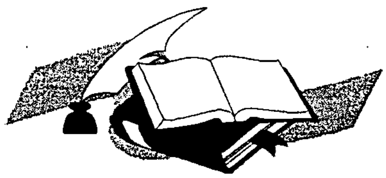
2. ___15 3/16___ inches



3. ___22 9/16___ inches



4. ___20 3/4___ inches



SPC - History and Principles

Upon completion of this lesson the learner will be able to:

- define SPC vocabulary words
- read and answer comprehension questions about the "History of SPC"
- apply the basic principles of SPC

Molding and Coremaking

Instructor Notes	Activities	Material	Time
	Set Induction		
	Hold up two things that are almost alike, such as two apples of different size, shape, and color. Ask how the apples are alike and how they are different. Explain that it is not possible for two things to be exactly alike. Variation is natural. Ask for examples of variation in the parts produced on the job. Explain that some variation is acceptable.	Apples	5-10 Minutes
	Guided Practice		
	Show transparency of the "Principles of SPC" and explain each principle. Give a brief overview of the "History of SPC".	Transparency	15-20 Minutes
	Applied Practice		
	Have learners read the "History of SPC" and the "Principles of SPC". Have learners complete the exercise in their workbook.	Workbook	15-20 Minutes
	Closure		
	Discuss the exercise. What key points did you learn in this lesson?	Workbook	10-Minutes

Read the "History of Statistical Process Control" and answer the questions.

History Of Statistical Process Control (SPC)

Statistical Process Control (SPC) is a quality control measure that requires the cooperation of all employees. SPC is designed to monitor the machines and the products they make. The monitoring of machines and products allows Southern Ductile to meet the quality standards of the customers. As an employee of Southern Ductile, your role is to record data on a process and to alert supervision and/or management to any situations that are out of control. They should also be alerted to variations that could result in defective parts.

The History of SPC began in the early 1900s. Standards of quality became necessary when the need for mass producing products was realized. Before this time, if a part broke, a new one had to be custom made and this process could take a great deal of time. With the use of SPC a company could mass produce parts that were interchangeable. Although SPC was started in the early 1900s, it was more widely used after the end of World War II.

Japan realized that in order to rebuild their economy they had to change their manufacturing methods. With the help of Edwards Deming, Japan started implementing statistical process control. Improvements occurred in the overall quality of the products produced and Japan became regarded as one of the world's greatest industrial nations.

When Japan was beginning to implement SPC, American industries were actually moving away from it, concentrating on the quantities produced rather than the quality. The concentration on quantities produced lots of scrap and the cost of rework was high. Due to these factors not only did the prices rise, but defective products were sold to consumers. In the last few years American industries have felt the effects of foreign competition. American industries, including Southern Ductile, must make SPC a part of their continuous improvement effort to be competitive in today's global market.

SPC History Questions

1. What does SPC stand for? **SPC stands for Statistical Process Control**.

2. What does SPC monitor? **SPC monitors machines and products**.

3. What is the employee's role in SPC? **The employees role is to record data on a process and to alert supervision/management to any situations that are out of control**.

4. American industries moved away from SPC about the time Japan was getting started and moved back to SPC in the last few years. What is the main reason for the shift back to SPC? **American industries, having felt the effects of foreign competition, realize that in order to remain competitive in a global market they must improve their processes through the use of SPC**.

Read the "Principles of Statistical Process Control" and complete the fill in the blank exercise.

Principles of Statistical Process Control (SPC)

Statistical process control is used to measure changes or variation in the process. We all know that no two parts are exactly alike. There are many things that can cause variation in a process. Changes in the process will result in undesirable changes in the product.

In order to reduce changes in the process it is important to understand what causes these variations. Recording information on a process is the first step in helping you understand variations. At Southern Ductile you use forms to record information about the process. The forms used by the molders are the mold count report, the downtime report, and the mold inspection report. The information on these reports can help to improve the process. To get a better understanding of how things are operating, a visual picture is always helpful. SPC uses charts to help us better understand the information we collect on a process. The principles of SPC are:

1. No two things are exactly alike. It does not matter how hard you try to make parts alike, there will always be a slight difference in the shape, size, or finish of the product. In order for the parts to be interchangeable, the difference must be kept to a minimum.

2. Some variation in a product or process is normal and can be measured. If the process is not watched carefully, the variations will increase and the process will become out of control.

3. Variations are a result of either assignable causes or chance causes. Assignable causes are things that are caused by man, method, material, machine, or environment. Chance causes are natural variations in the process that cannot be removed.

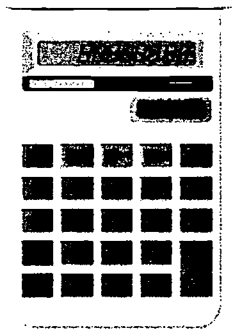
Read the "Principles of Statistical Process Control" and fill in the blanks using the word list.

assignable	charts
chance	process
changes	variation

1. Statistical process control is used to measure **changes** or **variation** in the process.

2. SPC uses **charts** to help us better understand the information we collect on a **process**.

3. Variations are a result of either **assignable** causes or **chance** causes.



SPC - Math

Upon completion of this lesson the learner will be able to:

- define SPC vocabulary words
- calculate mode, median, range, and average with pencil and paper and with the use of a calculator

Instructor Notes	Activities	Material	Time
	Set Induction Have learners line up from shortest to tallest. Have the tallest person and the shortest person step out away from the others. Explain that the difference in their height is the range. Have everyone try to determine which person is in the middle. Explain that the middle is the median.		5 Minutes
	Guided Practice Write examples of average, mode, median, and range on the board. Describe orally the steps for finding the average, mode, median, and range. Encourage learners to assist you.	Markerboard Kit Instructor Notes	15-20 Minutes
	Applied Practice Have learners complete the practice exercise in their workbook.	Workbook	20-25 Minutes
	Closure Check the exercise. Ask how this lesson will help them on the job and in their daily life.	Workbook	10 Minutes

<u>Instructor Notes</u>

The **mode** is the number that occurs most often in a set of values. When you look at the values (89, 83, 87, 81, 83, 86, and 85), the mode or most frequently occurring value is 83.

The **median** is the middle value in a set of values. First rank the values in order, smallest to largest.
(89, 83, 87, 81, 83, 86, and 85)
Rank the values smallest to largest.
(81, 83, 83, 85, 86, 87, and 89) The median or middle value is 85.

The **range** is the difference between the highest value and the lowest value in a set of values.
(89, 83, 87, 81, 83, 86, and 89) The highest value is 89. The lowest value is 81. To find the difference you need to subtract.

$$\begin{array}{r} 89 \\ \underline{-81} \\ 8 \end{array}$$

The range or difference is 8.

To **average** a set of values you must get a sum or total of these values.

$$\begin{array}{r} 79 \\ 84 \\ \underline{+83} \\ 246 \end{array}$$

The sum or total is 246.
Take the sum or total and divide it by the number of values in the set, in this case, 3.

$$3\overline{)246}^{\,82}$$

The average of the set of values is 82.

Molders

Complete the exercises that follow. Look back at your notes if necessary.

Find the mode.

1. (84, 82, 83, 84, 85, and 86) **84**

2. (88, 91, 86, 91, 89, and 95) **91**

Find the median.

3. (88, 89, 92, 95, and 91) **91**

4. (79, 89, 85, 80, and 84) **84**

Find the range.

5. (84, 89, 79, 80, 95, and 88) **16**

6. (88, 89, 92, 95, 91, and 80) **15**

Molders

Complete the exercise below. Look back at your notes if necessary.

Find the average.

7. (86, 77, and 87) **83.3 or 83**

8. (76, 83, and 84) **81**

9. (86, 89, and 95) **90**

10. (88, 91, and 93) **90.6 or 91**

11. (88, 91, and 91) **90**

12. (71, 74, and 76) **73.6 or 74**

13. (90, 92, and 95) **92.3 or 92**

Coremakers

Complete the exercises that follow. Look back at your notes if necessary.

Find the mode.

1. (52, 50, 52, 57, and 52) **52**

2. (57, 53, 55, 58, and, 55) **55**

Find the median.

3. (50, 58, 62, 60, and 58) **58**

4. (54, 49, 56, 48, and 53) **53**

Find the range.

5. (65, 58, 62, 52, and 59) **13**

6. (62, 58, 59, 70, and 62) **12**

Coremakers

Complete the exercise below. Look back at your notes if necessary.

Find the average.

7. (65, 58, 62, 52, and 59) **59.2 or 59**

8. (62, 58, 59, 70, and 62) **62.2 or 62**

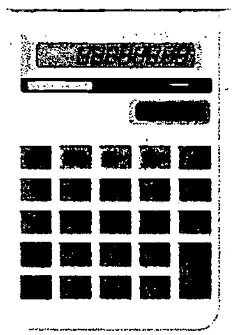
9. (70, 70, 60, 60, and 66) **65.2 or 65**

10. (57, 52, 62, 56, and 58) **57**

11. (58, 59, 56,50, and 60) **56.6 or 57**

12. (60, 57, 65, 58, and 60) **60**

13. (48, 49, 53, 54, and 56) **52**



SPC - Math

Upon completion of this lesson the learner will be able to:

- define SPC vocabulary words
- calculate average and range with the use of a calculator
- plot average and range on a control chart

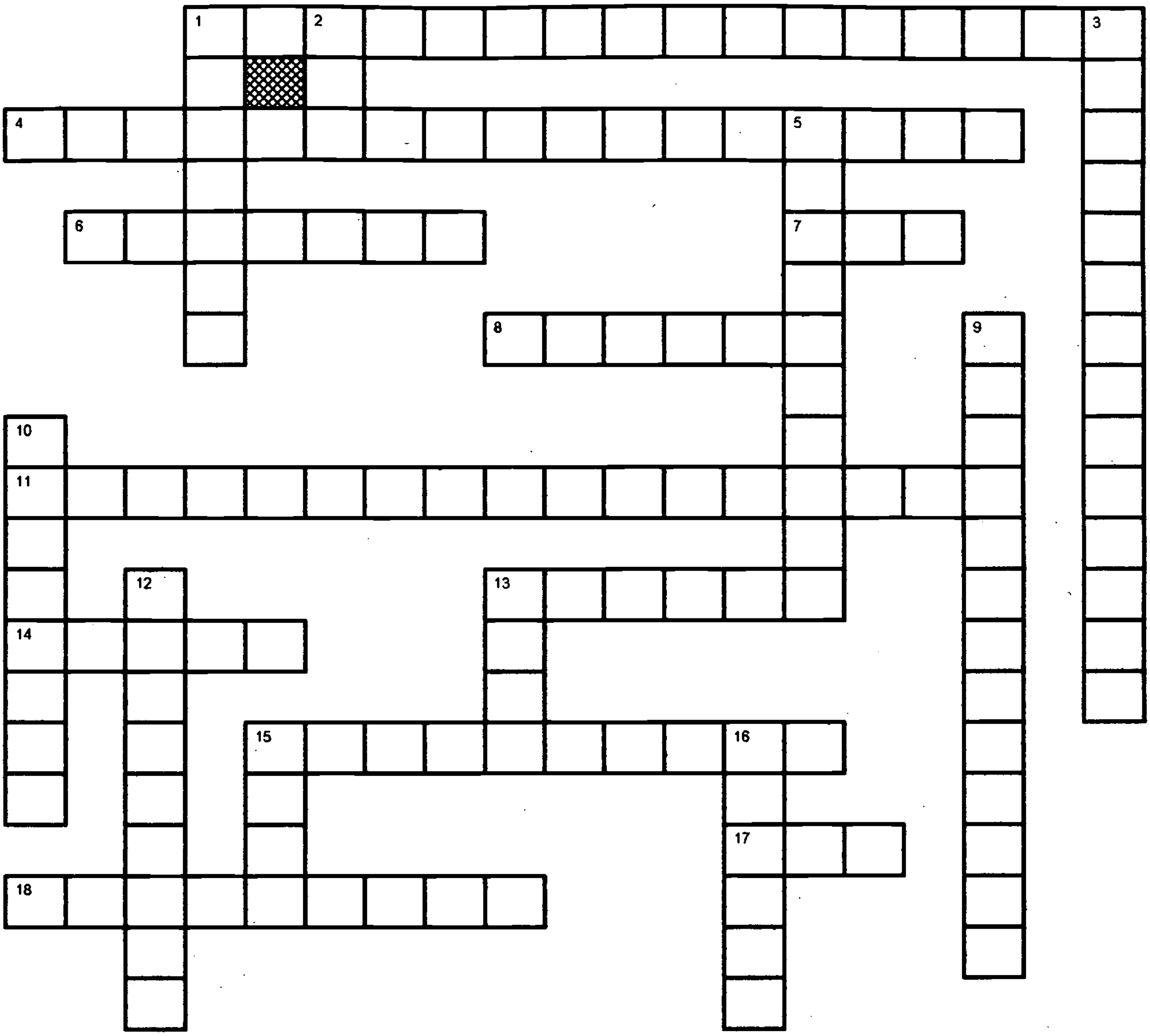
Instructor Notes	Activities	Material	Time
	Set Induction Divide the group into pairs. Give each pair a bag of M&M's®. Have them separate the M&M's® by color and place them in a column going up from the color word. What does this look like? You have just created a chart. You could add a number scale to the left side of your chart. Explain that charts are a necessary part of SPC.	M&M's® Chart	10 Minutes
	Guided Practice Show transparency of the control chart. Explain what information is recorded on each area of the control chart. Show how to chart the information.	Transparency Overhead Projector	10-15 Minutes
	Applied Practice Have learners chart the cope and drag hardness on the control chart. Allow them to work in pairs.	Control Chart	20-30 Minutes
	Closure Have learners display their charts for others to see. Discuss any difficulties they may have had.	Sticky-tak	5 Minutes

Instructor Notes

Have each pair take the mold inspection record from the workbook. Have the learners chart the information. Remind learners that they need to average the three values for cope and then the three values for drag. The points should be plotted using half of the chart for the cope and half of the chart for the drag. The learners have figured some of the averages. Let them know that it is not necessary to figure them again.

Have learners chart the range for the cope and the range for the drag.

Assist learners if necessary.



Across

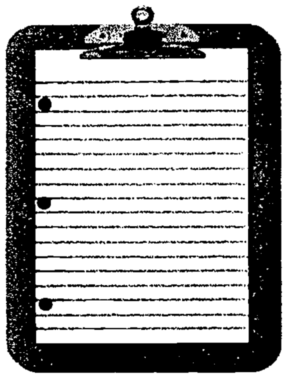
1. Variation in a process caused by man, method, material, machine, or environment. (2 wds.)
4. The lowest value a process can fall to, and still be in control. (3 wds.)
6. A product or a service that meets standards set by the customer.
7. The whole amount.
8. Part, of a whole group, taken out to measure or observe for problems that may be occurring in the process.
11. The highest value a process can reach and still be in control. (3 wds.)
13. The number in the middle.
14. The difference between the largest and the smallest number in a set of values.
15. The amount two numbers differ.
17. To put together or combine.
18. The inevitable difference among the parts produced in a process.

Down

1. The value found by adding the numbers and dividing the total by the number of values.
2. Statistical Process Control
3. Requirements for a product.
5. Checking a product to determine if it is acceptable.
9. Used to collect data on a process. (2 wds.)
10. To take away.
12. A process is said to be _________ if it is operating between the UCL and the LCL. (2 wds.)
13. The number appearing the most often in a set of values.
15. Numerical information used to analyze and monitor a process.
16. The natural variation in a process that cannot be removed.

Word List

ADD
ASSIGNABLE CAUSES
AVERAGE
CHANCE
CONTROL CHARTS
DATA
DIFFERENCE
IN CONTROL
INSPECTION
LOWER CONTROL LIMIT
MEDIAN
MODE
QUALITY
RANGE
SAMPLE
SPC
SPECIFICATIONS
SUBTRACT
SUM
UPPER CONTROL LIMIT
VARIATION



Form Completion

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to forms used at Southern Ductile
- utilize math skills to determine missing information
- complete the forms for their department with 100% accuracy
- explain how to calibrate a mold hardness tester

Instructor Notes	Activities	Materials	Time
	Set Induction Have tax forms on each table. It really does not matter what information is on the form ... , or does it? Discuss the importance of recording information correctly.	Tax Forms	5-10 minutes
Adapt lesson for other jobs as necessary.	**Guided Practice** Show the transparency of each of the forms. Explain the different areas of each form. Discuss the information that should be recorded in each area. Show the mold hardness tester and have learners tell you how to use the tester. Ask learners how a mold hardness tester is calibrated.	Transparencies Mold Hardness Tester	20-25 Minutes
	Applied Practice Have learners complete the exercise in their workbook.	Workbook	20-25 Minutes
	Closure Discuss how the lesson might help the learner on the job.		5 Minutes

Forms - Molders

Forms are a necessary part of the job at Southern Ductile. They allow the worker to keep up with downtime, how many molds were made, and the inspections done on the molds. This information helps to keep the process running smoothly by identifying problems and correcting them immediately. The three forms completed by the molders are: the mold count report, the mold inspection record, and the downtime report.

Record the information below on the mold count report. Some of the information is missing. Fill in the missing information.

Job	Counter	Previous	Scrap	Molds
Customer #1	53	0	4	**49**
Customer #2	168	53	1	114
Customer #3	**345**	168	36	141
Customer #4	393	345	0	48
Customer #5	398	393	0	**5**
Customer #6	**430**	398	0	32

The Downtime report is incomplete. Look for missing information and complete the report.

Using A Mold Hardness Tester

A mold hardness tester is an instrument used to determine the hardness of a green sand mold. The mold hardness test is done every 1/2 hour and is recorded on the mold inspection record. The mold hardness test is done to determine if adjustments need to be made in the sand or the squeeze pressure of the machine. The mold hardness test is done on three areas of the cope and on three areas of the drag. The results are recorded on the mold inspection record. The hardness of a mold has been pre-determined to match the sand, the type of casting, and the type and condition of the metal used. The mold hardness range for an order is on the process sheet.

Look at the chart below for the ranges of hardness of a green sand mold.

Type of Mold	Hardness
very soft rammed mold	20-40
soft rammed mold	40-50
medium rammed mold	50-70
hard rammed mold	70-85
very hard rammed mold	85-100

The mold hardness tester is calibrated by pressing against a smooth hard surface until the tip is flush with the frame. The reading should be 100. If the reading is not 100, hold the tester firmly against the surface and turn the outer rim until the dial reads 100.

Complete the exercise using the mold inspection record and "Using A Mold Hardness Tester".

Who is the customer for the order that is running at 9:33? **Customer X**

How do you calibrate a mold hardness tester? **To calibrate the mold hardness tester, press it firmly against a smooth hard surface until the tip is flush with the frame. The reading should be 100. If the reading is not 100, hold the tester firmly against the surface and turn the outer rim until the dial reads 100.**

How often should the mold hardness test be performed? **The mold hardness test should be performed every 30 minutes.**

Forms - coremakers

Forms are a necessary part of the job at Southern Ductile. They allow the worker to keep up with downtime, core weights, core hardness, and how many cores are made per hour or per day. This information helps to keep the process running smoothly by identifying problems and correcting them immediately. The forms completed by the coremakers are: the core department production log, the core machine operator report, the core weight form, and the scratch hardness reading form.

Complete the exercise using the core department production log.

1. Who are the customers for the orders that are listed under " today's line-up"? **Customer X and Y are the customers under " today's line-up".**

2. How many cores were made between 8:15 to 8:50? **There were 130 cores made between 8:15-8:50.**

3. What machine ran the orders shown on this form? **The orders were run on the Laempe.**

4. How often should the core production log be filled out? **The core production log should be filled out hourly.**

5. Part number 72295 is a **sample** for Customer Y
6. .

Scratch Hardness Tester - Coremakers

Calibrate the scratch hardness tester using the following method:

1. Check to see that there is no friction in the rotation of the knurled index ring assembly. It should rotate freely.

2. Grasp the body of the core hardness tester and push up and down on the knurled index ring. If the play is more than .001 in., this can affect the reading.

3. Press the core hardness tester against a hard flat surface (glass) and note the dial reading. The unit should read 100. If the reading is incorrect, check for sand grains or a burr on the base plate that would cause the error.

4. If the surface is clear and there are no burrs or sand grains interfering with the reading, hold the tester firmly in place on the flat, hard surface and turn the indicator bezel as required to obtain a reading of 100. Do not loosen the bezel screws.

5. When the indicator has been set to read correctly (100) on a flat surface, remove it from the surface allowing the pointer to return. The zero reading may be off by 1.5 divisions. This is not a cause for alarm as the load spring is in its "unloaded" condition and there may be a slight discrepancy in the internal contact with the indicator.

Test Procedure:

1. Place an appropriate cold box specimen on a solid surface.

2. Refer to process sheet for test location.

3. Position tester on the surface of the specimen after proper calibration.

4. Holding the tester firmly against the surface of the core, rotate the collar two revolutions and read hardness number directly from the dial.

5. Record all results.

Scratch Hardness Tester - Coremakers

Corrective Action:

1. If hardness readings are outside established limits, stop production.

2. Test cores by containers until acceptable values are found.

3. Hold containers that do not meet established limits.

4. Check the calibration of sand and resin and make corrections.

Complete the exercises using the information about core hardness testing. The calibration steps are not in the correct order. Number the steps to indicate the correct order.

_4_ If the surface is clear and there are no burrs or sand grains interfering with the reading, hold the tester firmly in place on the flat, hard surface and turn the indicator bezel as required to obtain a reading of 100. Do not loosen the bezel screws.

_5_ When the indicator has been set to read correctly (100) on a flat surface, remove it from the surface allowing the pointer to return. The zero reading may be off by 1.5 divisions. This is not a cause for alarm as the load spring is in its "unloaded" condition and there may be a slight discrepancy in the internal contact with the indicator.

_2_ Grasp the body of the core hardness tester and push up and down on the knurled index ring. If the play is more than .001 in., this can affect the reading.

_1_ Check to see that there is no friction in the rotation of the knurled index ring assembly. It should rotate freely.

_3_ Press the core hardness tester against a hard flat surface (glass) and note the dial reading. The unit should read 100. If the reading is incorrect, check for sand grains or a burr on the plate that would cause the error.

Scratch Hardness Tester - Coremakers

Answer the following questions.

1. How do you know where to place the core hardness tester to get your reading? **Look at the process sheet for test location.**

2. What is the first thing you would do if the core you checked was outside the established limits? **If you check a core and it is outside the established limits, stop production.**

There are three cores on the table. Place the cores on the scale one at a time and record the weights on the form. The cores are numbered for you. We will compare weights when we discuss the lesson.

Record the information below on the core department production log. Some of the information is missing. Fill in the missing information.

HR	CUSTOMER	PART NO.	SCRAP CORES	TOTAL BOXES/HR	TOTAL BOXES/SHFT	DAILY PRODUCTION LOG FROM	TO	OPERATION
1	Customer X	1234	2	19	17	6:00	7:00	
2	"	"	**3**	20	34	7:00	**8:00**	
3	"	"	1	22	55	8:00	9:00	
4	"	"	2	**31**	86	9:00	10:00	
5	"	"	**1**	35	120	**10:00**	11:00	
6	"	"	1	31	**150**	11:00	12:00	
7	"	"	1	17	166	12:30	1:00	
8	"	"	**2**	37	201	1:00	**2:00**	
9	"	"	0	9	**210**	2:00	2:30	
10								

Forms - Grinders

Forms are a necessary part of the job at Southern Ductile. They allow the worker to keep up with downtime, how many castings were ground, and the inspections done on the castings. This information helps to keep the process running smoothly by identifying problems and correcting them immediately. The forms completed by the grinding department are: the grinding/shipping production time report, the grinding/special processing/inspection log, the inspection tag, the shipping tag, and the heat treating log. You may not have to fill out each of these forms now, but it is good to know how to fill them out in case you are asked to fill them out in the future.

Inspection Tag

The inspection tag is placed in each box of castings that you grind. The inspection tag records the customer name and part number, the date, the shift that started and/or finished the box, and the name(s) of the grinder and inspector. The actual tare weight of the container must be determined before placing any parts into the container. Each shift inspector or different inspector that places parts in this box must attach a separate tag to the box. At the end of each shift, place a cardboard sheet in the box to separate parts from each shift.

Record the information below on the inspection tag. Some of the information may not be necessary. Decide what information is necessary and complete the inspection tag on the next page.

Customer X has ordered part number 1767409. The part has to be painted. You are grinding the parts today. You have ten parts in the last box at the end of your shift.

Grinding/Shipping Production Time Report

The production time report is used to keep a record of how much actual grinding was done on any given day. It can let management know if there is a problem out of the ordinary that kept you from grinding as much as you normally would on your shift. You should record the time you start grinding and the part you are grinding. If you stop grinding for any reason you must record the time you stopped and the time you started grinding again ,as well as the reason you stopped grinding. Report all time you are unable to process castings. (Example: Bathroom, out of iron, load tray, make boxes, clean up area, drink of water, lunch, changing wheel, inspecting, or working at the end of the belt.)

Use the grinding/shipping production time report to answer the following questions.

1. What are the times that you were out of iron? **You were out of iron from: 8:10-8:25, 9:45-9:50, and 11:10-11:20**

2. How many total pieces did you grind on this day? **553 pieces**

3. What is the reason you were not grinding from 8:50-9:00? **From 8:50-9:00 you were on break.**

4. You were unable to grind at the following times:
   8:10-8:25
   8:50-9:00
   9:45-9:50
   11:00-11:10
   11:10-11:20

5. What is the total time you were unable to grind? **You were unable to grind for 50 minutes.**

Heat Treating Log

The heat treating log must be filled out for each job that you put into the furnace. The areas of the form that you fill out are: the date, the furnace number, the time in, the time out, the operator, the customer, and the part number. The other areas of the form are filled out by Quality Control. All information must be correct, and agree with the process sheet and the chart from the temperature recorder.

Look at the heat treating log to answer the following questions.

6. List the customers and part numbers for furnace number 2.
   Customer A - 3205358
   Customer B - 3202058
   Customer C - 3082-271
   Customer D - 886

7. What is the time in and time out for furnace number 3?
   Time in - **5:00 AM**
   Time out - **10:15 AM**

Look at the temperature record chart, the heat treating log, and process card C to answer the following questions.

8. What is the maximum unload temperature for the Customer X order? **1000° F**

9. What was the temperature of the furnace at 6:00 AM? **1500° F**

10. At what time did the furnace reach 1000° F? **10:15 AM**

Forms - Pouring

Forms are a necessary part of the job at Southern Ductile. They allow the worker to keep up with how many molds they poured, how much chill iron and magnesium are added and the class of iron that is being poured.. This information helps to keep the process running smoothly by identifying problems and correcting them immediately. The forms completed by the pouring department are: the iron pourer's weight and iron temperature record, the daily magnesium addition record and the nodularity sheet.

Look at the iron pourer's weight and iron temperature record to answer the following questions.

1. What time was it when you started the second customer X order? **5:18 PM**

2. At what times did you have runouts? **6:45, 9:14 and 9:25 PM**

3. What is the temperature range for the customer X order? **The temperature range for the customer X order is 2450°-2500° F**

4. One of the orders has copper addition. Who is the customer for that order and what is the amount of copper that was added? **The customer is Customer Y and the amount of copper addition is 55 points.**

5. One of the ladle's had to have supervisor authorization. Why was supervisor authorization necessary? **Supervisor authorization was necessary because the iron temperature was below the range.**

Look at the daily magnesium addition record to answer the following questions.

1. List the cover steel weight and the magnesium weight for the following ladles:

	mag. weight	**cover steel weight**
ladle 19 -		
ladle 3 -		
ladle 11 -		

2. There are 3 times that no cover steel was added. Look at the record and record the times below.
   5:58 AM
   6:09 AM
   9:10 AM

3. Several ladles of iron came from the number 4 furnace. List those ladle numbers.
   3
   4
   7
   10
   17
   20

4. List the times that you received iron from the number 1 furnace.
   6:09
   6:50
   7:28
   8:06
   8:15
   9:10
   9:47

Look at the nodularity sheet to answer the following questions.

1. The nodularity sheet has one recording of class C iron. Look at the sheet and record all the information that corresponds to the class C iron.

   Pounds of Magnesium - **31**
   Machine - **Hunter - 10**
   Customer and Part Number - **Customer X - 700705118**
   Tap Time - **8:39**
   Furnace Number - **3**
   Pounds Treated - **1800 pounds**

2. Find part number 16187. Who is the customer for this part?
   Customer Y is the customer for part number 16187.

3. How much iron was treated between 6:30 and 8:00?
   16,600 pounds of iron was tapped between 6:30 and 8:00.

The class system is used to rate the nodularity of the iron. The purpose of the class rating system versus the percentage rating system is to simplify the rating and to reduce errors in rating nodularity. The classes are defined as follows:

Class A is defined by a high nodule count, round nodules, and nodules that are the same size.
Class B is defined by a high or lower nodule count, different size nodules, round nodules, and some irregular nodules.
Class C is defined by a high or low nodule count, same or different size nodules with some vermicular.
Class D is defined as vermicular iron, 50% nodule and 50% vermicular.
Class A and D are passing. **Class C** requires a recheck and further evaluation by cutting the castings. A **class C** can be upgraded to a classB passing or downgraded to a **class D** failing. **Class D** is failing and all the castings need to be pulled and scrapped.

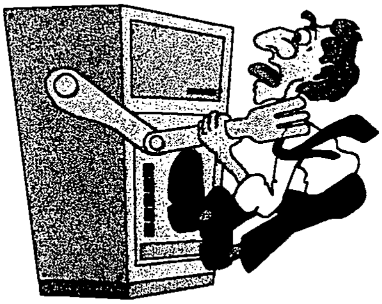
Forms - Melting

Forms are a necessary part of the job at Southern Ductile. They allow the worker to keep up with the furnace charges, the furnace meter readings, the sintering and cold start for the IT6 furnaces, and the crucible measurements. These forms contain information important to the safe operation of the furnace.

Explain the furnace charge sheet as if you were instructing a new employee.

Work with a partner to write an explanation of either the cold start form or the sintering form. Expain why it is necessary to record this information.

Look at the crucible measurements. Explain what should be done to the furnace based on these measurements.



Job Procedure - Hunter

Upon completion of this lesson the learner will be able to:

- define vocabulary words for the job start-up procedure
- sequence the start-up procedure
- demonstrate proper start-up procedure

Instructor Notes	Activities	Materials	Time
	Set Induction Have materials on the table. Have learners think about the steps involved in making a peanut butter sandwich. Write the steps on the board. Check to see if learners agree on the steps. Follow the steps exactly. Did this procedure work? Why or why not?	Jar of peanut butter, loaf of bread, knife and paper plates	5-10 Minutes
	Guided Practice Introduce Vocabulary. Ask learners to list the steps involved in the Hunter start-up- procedure. Write the steps on the board. Show the transparency. How close do the steps listed on the board match the actual procedure? Why is proper start-up procedure important?	Overhead Projector Transparency	20-25 Minutes
	Applied Practice Take learners on a field trip to a Hunter Molding machine. Ask for a volunteer to demonstrate the start-up procedure. Bring learners back together in training room. Ask learners if the demonstration matched the start-up procedure. Have learners complete the exercise in workbook.	Workbook	20-Minutes
* Ask for two volunteers to role play BMM start-up at start of next class.	**Closure** Check the exercise and discuss the importance of proper start-up.		5 Minutes

JOB START-UP PROCEDURE AND PROCESS CARD

S	A	N	D	A	E	R	A	T	O	R	M	X	Y
F	U	N	C	T	I	O	N	U	M	E	O	F	B
R	X	T	U	J	J	O	A	K	E	K	W	U	G
S	I	N	S	P	E	C	T	E	L	P	A	H	C
L	L	Q	T	G	K	R	L	T	M	C	X	Q	B
R	I	M	O	L	D	W	E	I	G	H	T	E	R
S	A	J	M	O	L	D	R	E	L	E	A	S	E
C	R	I	E	B	D	X	R	G	V	I	E	F	H
I	Y	Q	R	V	G	S	P	Q	D	W	D	F	J

Word List

MOLD RELEASE
SAND AERATOR
MOLD WEIGHT
AUXILIARY
FUNCTION
CUSTOMER
INSPECT
CHAPLET

Vocabulary - Job Start-up Procedure and Process Card

1. **Auxiliary** - Serving a secondary or helping function.

2. **Chaplet** - A metal insert or support used to hold a core in position in a mold or to support a part of a mold which is not self-supporting.

3. **Customer** - A company that buys castings from Southern Ductile.

4. **Function** - A particular purpose for which a thing is used.

5. **Inspect** - To view closely.

6. **Mold release** - The parting spray used to keep the sand from sticking to the pattern.

7. **Molds/Shift** - The production standard for a job. The minimum number of molds to be produced in an 8-hour shift.

8. **Mold wt**. - The amount of iron in pounds required to fill a mold.

9. **P.B.Q.** - The squeeze cylinder area of the BMM, where the mold is made.

10. **Pcs/Mold** - Pieces per mold. The number of castings made with one mold.

11. **Sand aerator** - A device used to fluff the sand by mixing it with air.

12. **Wt**. - Short for weight.

13. **(%)** - Symbol for percentage. One part in a hundred. For example 7% scrap means 7 parts in every hundred castings are no good.

14. **#** - Symbol for number.

15. **# on Pattern** - The number of castings a pattern can make at the same time.

Hunter Start-up Procedure

1. Switch on all machine functions.

2. Check the hydraulic oil pre-heater.

3. Switch on the sand feeder belt at the sand feeder belt control panel.

4. Switch on the sand aerator.

5. Check the machine sand bin. It should be clean and free of old sand.

6. Clean the hopper car of old sand and spray with mold release.

7. Inspect the condition of the basin sprue for damage.

8. Machine is now ready for production operations.

Number the following steps to indicate the proper Hunter start-up sequence.

__5__ Check the machine sand bin. It should be clean and free of old sand.

__8__ Machine is ready for production.

__1__ Switch on all machine functions.

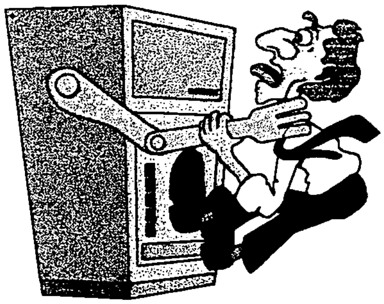
__4__ Switch on the sand aerator.

__7__ Inspect the condition of the basin sprue for damage.

__3__ Switch on sand belt feeder at sand belt control panel.

__6__ Clean hopper car of old sand and spray with mold release.

__2__ Check hydraulic oil pre-heater.



Job Procedure - BMM

Upon completion of this lesson the learner will be able to:

- define vocabulary words for the job start-up procedure
- sequence the start-up procedure
- demonstrate proper start-up procedure

Instructor Notes	Activities	Materials	Time
	Set Induction Have volunteers role play the script. Have an experienced molder explain BMM start-up procedure to new employee. Discuss the importance of correctly sequenced start-up instructions and clear communication.	BMM Role Playing Script	5 Minutes
	Guided Practice Ask learners to list the steps involved in the BMM start-up procedure. Write the steps on the board. Show the transparency. How close do the steps listed on the board match the actual procedure?	Overhead Projector Transparency	20-25 Minutes
	Applied Practice Take learners on a field trip to the BMM. Ask for a volunteer to demonstrate the start-up procedure. Bring learners back together in training room. Ask if the demonstration matched the BMM start-up procedure. Have learners complete the exercise in workbook.	Workbook	20-Minutes
	Closure Check the exercise and discuss the importance of proper start-up.	Workbook	5 Minutes

Role Playing Script - BMM Start-up Procedure

The Situation -*John, an experienced first shift BMM molder who knows his job very well, is training a new employee named Mike to run the BMM. It is not going very well.*

John - Mike, I am going to show you how to start up the BMM. First you set the timers in the control box for the jolt, squeeze and draw times.

Mike - Where do I get the times?

John - You need to check the process card. Here it is.

(John picks up the process card and points to the times.)

1.5 seconds, 1.5 seconds and 2.5 seconds. You also need to check the schedule to see if the correct pattern and squeeze head are on the machine.

Mike - When do I check the schedule?

John - When you first get here.

Mike - What is the purpose of this heater?

John - Oh yes, I almost forgot to tell you. If it is cold outside you need to light the heater to warm up the pattern first thing in the morning.

Mike - I am confused now. Can we start over again? What do you do first?

BMM Start-up Procedure

1. If necessary, light the gas pattern heater. The gas valve is located on the upper left side of the P.B.Q.

2. Check to see if the correct pattern and squeeze head are on machine. Pattern information is on schedule.

3. Set timers located in Control Box under stairs to correspond with Process Sheet.

4. Check to see that all parts of the sand system are operating.

5. Start Shakeout Secondary Starter located on column to the right of the shakeout.

6. At BMM Control Console, turn key switch to MANUAL position, pull emergency STOP button up and press RESET. In approximately 45 seconds MAIN AIR ON light should come on.

7. Start hydraulic pump. HYDRAULICS ON light should come on.

8. Check to see that DRY CYCLE switch is in OFF position and MOLDING/PATTERN CHANGE switch is in MOLDING position.

9. If the AUXILIARY EQUIPMENT light is on, press the SAND HOPPER button and pull on the button marked PLATE FEEDER.

10. When flask is full of sand, turn off the PLATE FEEDER button.

11. Strike off excess sand.

12. Turn keyed switch to AUTO position and press START PLANT button.

Number the following steps to indicate the proper BMM start-up sequence.

__4__ Check to see that all parts of the sand system are operating.

__9__ If the AUXILIARY EQUIPMENT light is on, press the SAND HOPPER button and pull on the button marked PLATE FEEDER.

__5__ Start Shakeout Secondary Starter located on column to the right of the shakeout.

__1__ If necessary, light the gas pattern heater. The gas valve is located on the upper left side of the P.B.Q.

__10__ When flask is full of sand, turn off the PLATE FEEDER button.

__2__ Check to see if the correct pattern and squeeze head are on machine. Pattern information is on schedule.

__12__ Turn keyed switch to AUTO position and press START PLANT button.

__3__ Set timers located in Control Box under stairs to correspond with process sheet.

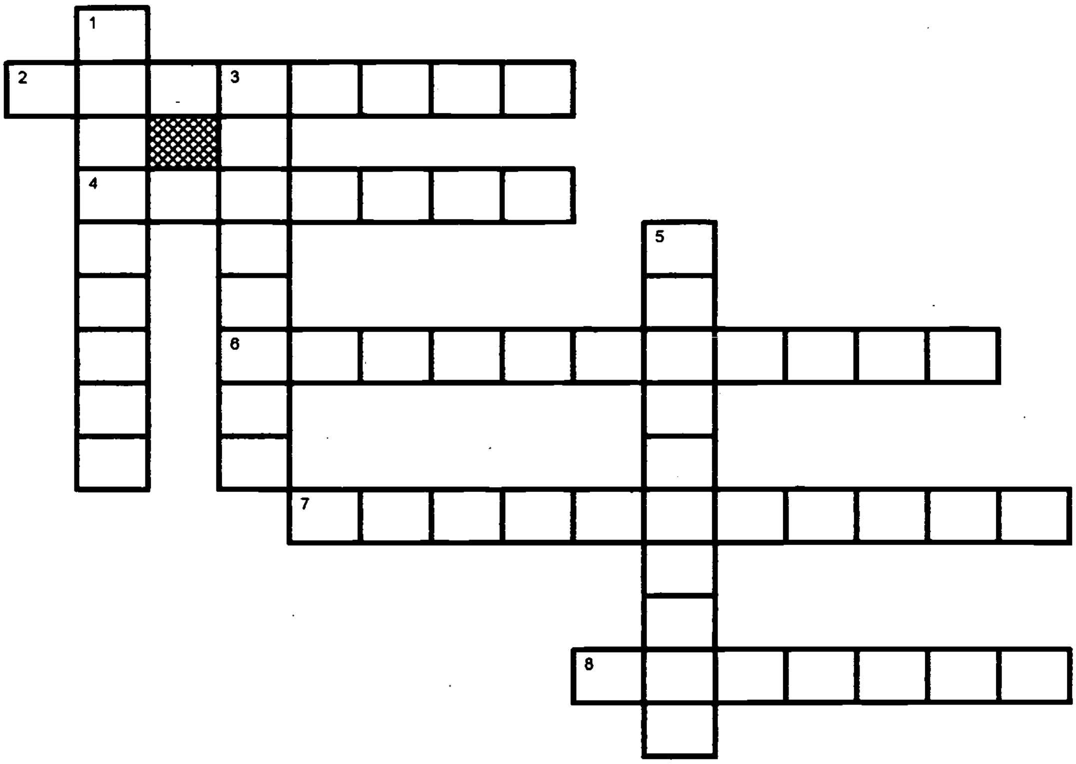
__6__ At BMM Control Console, turn key switch to MANUAL position, pull emergency STOP button up and press RESET. In approximately 45 seconds MAIN AIR ON light should come on.

__8__ Check to see that DRY CYCLE switch is in OFF position and MOLDING/PATTERN CHANGE switch is in MOLDING position.

__11__ Strike off excess sand

__7__ Start hydraulic pump. HYDRAULICS ON light should come on.

Job Start-up Procedure and Process Card



Across

2. A particular purpose for which a thing is used.
4. To view closely.
6. The parting spray used to keep the sand from sticking to the pattern. (2 Wds.)
7. A device used to fluff the sand by mixing it with air. (2 Wds.)
8. A metal insert or support used to hold a core in position in a mold.

Down

1. Serving a secondary or helping function.
3. A company that buys castings from Southern Ductile.
5. The amount of iron, in pounds, required to fill a mold. (2 Wds.)

Word List

AUXILIARY
CHAPLET
CUSTOMER
FUNCTION
INSPECT
MOLD RELEASE
MOLD WEIGHT
SAND AERATOR

Job Procedure - Coremaking

Upon completion of this lesson the learner will be able to:

- define vocabulary words for the job procedure
- correctly sequence the steps in the job procedure
- demonstrate the job procedure
- explain the job procedure

Instructor Notes	Activities	Materials	Time
	Set Induction Have materials on the table. Have learners think about the steps involved in making a peanut butter sandwich. Write the steps on the board. Check to see if learners agree on the steps. Follow the steps exactly. Did this procedure work? Why or why not?	Jar of peanut butter, loaf of bread, knife and paper plates	5-10 Minutes
	Guided Practice Introduce Vocabulary. Ask learners to list the steps involved in the Redford job procedure. Write the steps on the board. Show the transparency. How close do the steps listed on the board match the actual procedure? Why is proper job procedure important?	Overhead Projector Transparency	20-25 Minutes
	Applied Practice Take learners on a field trip to the Redford machine. Ask for a volunteer to demonstrate the job procedure. Bring learners back together in training room. Ask learners if the demonstration matched the written job procedure. Have learners complete the exercises in their workbook.	Workbook	20-Minutes
	Closure Check the exercise and discuss the importance of following proper job procedure.		5 Minutes

JOB PROCEDURE AND PROCESS CARD

J	O	P	P	W	I	F	I	B	J	A	H	M	N	H	M	V	O	Y
C	A	L	I	B	R	A	T	E	I	Y	R	O	E	L	R	N	E	D
U	U	D	E	W	J	L	X	S	F	E	E	M	F	P	T	O	V	M
S	U	R	C	I	V	Z	I	C	B	D	R	V	Y	D	Y	L	C	I
T	W	A	E	I	V	K	B	M	B	K	L	R	B	U	L	J	C	R
O	E	I	S	M	G	V	U	Y	I	B	T	J	E	X	J	F	U	Q
M	G	N	P	Q	J	N	L	V	F	Y	Z	C	V	G	Y	G	P	N
E	L	V	E	X	X	K	U	A	N	Y	K	U	R	C	K	W	F	G
R	B	E	R	O	C	A	C	G	I	I	V	J	D	P	C	N	H	S
K	T	S	B	L	O	W	A	E	K	F	U	X	Z	U	D	U	B	V
U	P	T	O	P	E	R	A	T	O	R	S	T	A	N	D	A	R	D
D	H	M	X	W	S	P	F	S	L	X	K	D	O	Y	F	C	Z	Y

Word List

OPERATOR STANDARD
PIECES PER BOX
BOX NUMBER
CALIBRATE
CUSTOMER
INVEST
DRAIN
CURE
BLOW
CORE

Vocabulary - Job Start-up Procedure and Process Card - Coremakers

1. **Customer** - Someone that buys castings from Southern Ductile.

2. **Cycle/Pcs Per Shift** - The production standard for a job. The minimum number of pieces to be produced in an 8-hour shift.

3. **Oper. Std. Hr.** - The number of pieces to be produced in an hour.

4. **Pcs/Box** - Pieces per box. The number of cores made with one box.

5. **Box #** - The number assigned to the box.

6. **Cure** - The hardening process that a core undergoes as the binder causes the sand grains to form a strong, rigid object as a result of chemical or thermal reaction.

7. **Core** - A rigid sand object placed in a mold to form the internal shape of a casting.

8. **Blow** - The process of forcing sand into the core box to shape the core.

9. **Drain** - The dumping of the unbonded sand from the hollow shell core.

10. **Invest** - The process of hardening the sand in the box until the outside shell reaches a desired thickness.

11. **Calibrate** - To adjust precisely.

Automatic Operation of the Redford Machine

This machine is fully automatic (for shell or furfural) from the time the (No. 14) push button is actuated until the core is ready to be removed from the machine.

When using a shell sand, set the (No. 17) switch to the "SHELL" Position. When this switch is set to the "HOT BOX" position, the rollover mechanism will not operate.

There are four major timers on this model. The function of each is as follows:

a. Blow Timer (No. 34) - This timer actuates after the core box closes, the magazine arm positions and the vertical clamp actuates. For small cores (less than 10 lb.) this timer is set for less the two seconds. On large cores (more than 50 lb.) this timer is typically 5 seconds or longer.

b. Dwell Timer(No. 34) - This timer determines the wall thickness for a shell core. Cradle rollover begins when this timer has timed out.

c. Drain/Reload Timer (No. 13) - For "SHELL" this timer operates the rollover mechanism. The corebox vibrator can be operated during rollover by turning the core box vibrator selector switch (No. 132) to the "AUTO" position. If no vibration is required, then turn this switch to the "OFF" position. For "HOT BOX", this timer operates the hopper vibrator for reloading the sand Magazine.

d. Cure Timer (No. 12) - For "SHELL", this timer starts after the drain timer has timed out. This allows additional baking time for the internal cure of the shell core. For "HOT BOX", this timer starts when the core is blown.

NOTE: TIMER (b) WILL NOT OPERATE IF THE (NO. 27) SELECTOR SWITCH IS SET AT THE "HOT BOX" POSITION.

There are five additional timers located in the control panel. These timers do not normally require adjustment. Their functions are as follows:

a. Magazine Arm Delay Timer (5TR) This timer starts when the "START" push button is actuated (No. 14), and when it times out (usually 1 second later), the magazine arm moves to the forward or blow position.

b. Vertical Clamp Delay Timer (6TR) When the magazine arm reaches its forward most position, a cam (No. 133), located on the upper end of the magazine arm shaft triggers a limit switch (No. 138) and starts this timer. After this timer has timed out.

c. Blow Delay Timer (7TR) This timer starts when the vertical clamp is actuated and when it has timed out, (usually 1/2 second), the blow valve actuates.

d. Exhaust Delay Timer (8TR) This timer starts when the blow valve shuts off and hold the exhaust valve in a closed position. After 8TR has timed out, (usually 1/2 second), the exhaust valve opens.

e. Exhaust Timer (9TR This timer starts when the exhaust valve opens and holds the vertical clamp cylinder in its downward position. Then 9TR has timed out, (Usually 1 second), the vertical clamp returns to its upward position and the magazine arm returns to its retracted position.

NOTE: SEE DRAWING 46101 FOR ADDITIONAL INFORMATION ON TIMER FUNCTIONS.

To start an automatic cycle, depress the (No. 14) push button momentarily. Do not set any of the four cycle flex timers (See Paragraph 4.1) in the white scale range on the dial. This may cause the machine to function improperly. When the machine is in an automatic cycle, the (No. 16) pilot light will be illuminated. If other time ranges are required for the cycle-flex timers, consult the factory for information. A wide variety of time ranges are available.

Job Procedure - B&P cold box

1. Turn on main power at back of core machine.

2. Turn power switch on table panel.

3. Turn pump switch on table panel.

4. Turn sand feed switch on table panel.

5. Turn blow switch on table panel.

6. Turn gas switch on table panel.

7. Open air valve to machine - T-handle.

8. See sand mixer procedures to start sand mixer. Be sure to calibrate sand mix before starting.

9. Fill all three blow stations with mixed sand.

10. Set all timing at terminal on panel at operators station.

11. Open air valve to gas generator which is located above work station.

12. Check gas gauge on generator. Check handles to be sure handles are turned to the run position.

13. Push auto-mode and start cycle together - this starts cycle. To start off it is necessary to double gas in order to heat up gas line to 130° to 150° Fahrenheit.

14. After core is removed,push core remove button. Watch gauge at gassing station during run for back pressure. The gauge should show from 2-10 pounds. Idle back pressure is 5 pounds.

Number the B&P job procedure to indicate the proper sequence.

__14__ After core is removed,push core remove button. Watch gauge at gassing station during run for back pressure. The gauge should show from 2-10 pounds. Idle back pressure is 5 pounds.

__6__ Turn gas switch on table panel

__4__ Turn sand feed switch on table panel

__1__ Turn on main power at back of core machine

__5__ Turn blow switch on table panel

__3__ Turn pump switch on table panel

__7__ Open air valve to machine - T-handle

__12__ Check gas gauge on generator. Check handles to be sure handles are turned to the run position.

__8__ See sand mixer procedures to start sand mixer. Be sure to calibrate sand mix before starting.

__13__ Push auto-mode and start cycle together - this starts cycle. To start off it is necessary to double gas in order to heat up gas line to 130° to 150° Fahrenheit.

__9__ Fill all three blow stations with mixed sand

__2__ Turn power switch on table panel

__11__ Open air valve to gas generator that is located above work station.

__10__ Set all timing at terminal on panel at operators station

Job Procedure - Laempe

The sand heater is the first thing to be turned on when starting up. Raise the main switch on the panel to "ON" and push the "START" button. Make sure you hear air blowing in the heater for a few seconds. Next the scrubber is started by turning on all the switches except the chemical supply pump #2 on the far right, and pressing the "START" button for the blower. After the mixer has been properly calibrated, turn on all switches on the mixer panel. Then swing the mixer out and run a small pile of sand (10 pounds) out on the ground. To run sand out push the green start button on the control box hanging from the head, then push the toggle lever to "Machine On". To stop sand, move toggle lever to "Machine Off". Now swing mixer back over core machine hopper and leave blades running (green button). Next, turn on the air for the core blower and the power on the large side panel. Now go to the gassing unit and make sure no one is smoking before opening the door. Now go to the control panel on front of core machine and turn the operation switch at the top to "manual". Push power on and run machine through the following sequences manually.

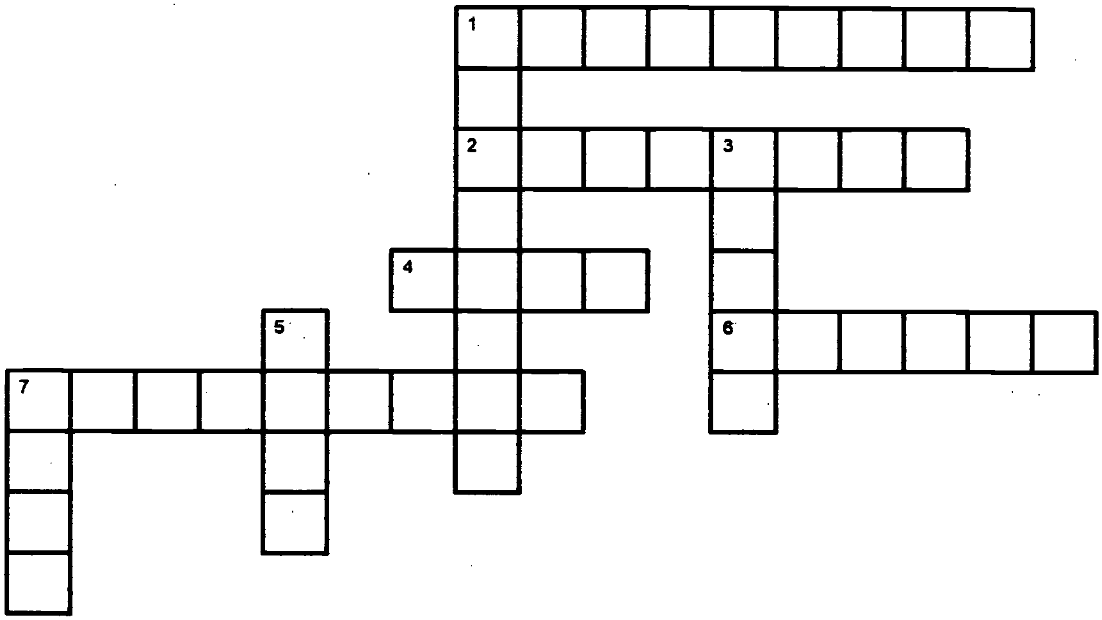
For start position, machine should have the ram back, the door open, the hopper up, and the gas head swung back.

1. Door Close
2. Ram Forward
3. Hopper Down
4. Hopper Up
5. Gassing Head In
6. Hopper Down
7. Butterfly Open
8. Butterfly Close
9. Hopper Up
10. Gassing Head Out
11. Ram Retract
12. Door Open

If everything checks out, open butterfly and turn "Control Power" off. Now switch everything to "Auto" including butterfly valve. Turn control power on. Push toggle on mixer to "Machine On". When the blow head magazine is full, the butterfly will close and a yellow light will light up on the panel. Push toggle to "Machine Off" and push "Start" button on core machine. Sequence will start.

In you own words, explain the Laempe job procedure.

JOB PROCEDURE & PROCESS CARD



Across

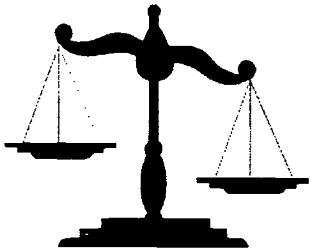
1. To adjust precisely
2. The number of pieces to be produced in an hour is the operator ________________.
4. A rigid sand object placed in a mold to form the internal shape of a casting.
6. The process of hardening the sand in the box until the outside shell resches a desired thickness.
7. The number assigned to a box.

Down

1. Someone that buys castings from Southern Ductile.
3. The dumping of the unbonded sand from the hollow shell core.
5. The hardening process that a core undergoes.
7. The process of forcing sand into the core box to shape the core.

<u>Word List</u>

BLOW
BOX NUMBER
CORE
DRAIN
STANDARD
CUSTOMER
CALIBRATE
CURE
INVEST



Calibration of Sand and Resin

Upon completion of this lesson the learner will be able to:

- explain the calibration of sand and resin for the Laempe and the BP Rotomatic.
- write the formula for the calibration of sand.
- perform the calibration of sand and resin.

Instructor Notes	Activities	Materials	Time
	Set Induction Show the transparency listing the ingredients for a cake. Ask learners what is wrong with the list of ingredients and what would happen if they made the cake using the ingredients as listed. Explain the importance of proper mixture of sand and resin in the making of good cores.	Transparency Overhead Projector	5-10 Minutes
	Guided Practice Show the transparencies of the sand and resin calibration procedures one at a time. Seek learner assistance in explaining the procedures.	Transparency Overhead Projector	10-15 Minutes
	Applied Practice Have learners walk to the core making area. Have a learner demonstrate how to do the calibration of the sand and resin on the Laempe. Have the learner explain the procedure as he/she does the demonstration.		20-25 Minutes
	Closure Ask how the information will help on the job.		5-10 Minutes

Instructions for Calibration of Resins and Sand - Laempe

Calibration of Resins: (Part One and Part Two)

1. To check resin amount for lean enter 0 on the control monitor. To check loamy enter 1. **(Only check resins for the type mix currently being run.)**

2. Switch off control valve marked resin at the mixer.

3. Establish tare weights of two measuring containers. Indicate weight on containers and record (Part 1 and Part 2).

4. Open the relief valves on top of the dosing tube marked "dosing valves". Drain the resin into containers.

5. Weigh each container separately.

6. Calculation of resin weight

   Example: Container No. 1 - weight 1 lb. (cw 1)
   Container No. 2 - weight 1 lb. (cw 2)
   Part 1 - weight 1.56 lb. (p1)
   Part 1 - weight 1.69 lb. (p2)
   Resin weight = (p1-cw 1)=1.56-1=.56 lb.
   (p2-cw 2)=1.69-1=.69 lb.
   .56+.69=1.25 lb.

7. Corrective action: Call maintenance to adjust proximity switches.

8. Record all weights on the calibration form.

Calibration of Sand:

1. Zero scale
2. Establish tare weight of measuring container
3. Switch resin valve to off
4. Make up empty proximity switches
5. Place measuring container in machine at the same position as a core box
6. Turn on mixing cycle
7. Open sand shoot (turn switch to the right)
8. Close doors
9. Open doors and weigh sand (if sand is not 95 lb. ± 5 lb., repeat test)
10. Subtract container weight from the total weight

In you own words, explain how to perform the calibration of sand and resin for the Laempe.

Instructions for Calibration of Resins and Sand - BP Rotomatic

Calibration of Resin:

1. Zero scale
2. Establish tare weight of measuring container
3. Power must be on
4. Turn on mixer. Turn valve marked "resin"
5. Manually drain resin into container for 1 minute
6. Calculation of resin into container

Example: Container weight - 5 lb. (cw)
Total weight after 1 minute - lb. (tw)
Resin weight = (tw-cw/t)=7-5/1=2

Calibration of sand:

1. Zero scale
2. Establish tare weights of measuring container
3. Turn valve marked "sand" and manually time sand flow into container
4. Weigh container, subtract container weight from total weight, and divide by time

   Example: Container weight = 5lbs (cw)
   Total weight after 1 minute = 105 lb. (tw)
   Sand amount(tw-cw/t)=105-5/1=100

Number the steps for the calibration of sand and resin to indicate the proper sequence.

Calibration of Resin:

__3__ Power must be on

__5__ Manually drain resin into container for 1 minute

__4__ Turn on mixer. Turn valve marked "resin"

__6__ Calculation of resin into container

__2__ Establish tare weight of measuring container

__1__ Zero scale

Calibration of sand:

__3__ Turn valve marked "sand" and manually time sand flow into container

__1__ Zero scale

__4__ Weigh container, subtract container weight from total weight, and divide by time

__2__ Establish tare weights of measuring container

Write the formula for the calibration of sand and resin for the B&P.

<u>Total weight minus container weight divided by time (tw-cw/t)</u>

Job Procedure - Grinding

Upon completion of this lesson the learner will be able to:

- define vocabulary words for the job procedure
- correctly sequence the steps in the job procedure
- demonstrate the job procedure

Instructor Notes	Activities	Materials	Time
	Set Induction Have materials on the table. Have learners think about the steps involved in making a peanut butter sandwich. Write the steps on the board. Check to see if learners agree on the steps. Follow the steps exactly. Did this procedure work? Why or why not?	Jar of peanut butter, loaf of bread, knife and paper plates	5-10 Minutes
	Guided Practice Introduce Vocabulary. Ask learners to list the steps of the grinding operator procedure. Write the steps on the board. Show the transparency. How close do the steps listed on the board match the actual procedure? Show the transparencies for the following procedures: annealing castings, using the Toledo Weight Scale, operating the Wheelabrator and operating the Blastec. Discuss each one. Why is proper job procedure important?	Overhead Projector Transparencies	20-25 Minutes
	Applied Practice Have learners complete the exercises in their workbook.	Workbook Pages	20-Minutes
	Closure Check the exercise and discuss the importance of following proper job procedure.		5 Minutes

Vocabulary - Job Start-up Procedure and Process Card - Grinders

1. **Customer** - Anyone that buys castings from Southern Ductile
2. **Inspect** - To view closely
3. **Casting** - A part formed by pouring molten metal into a mold
4. **Grinding machine** - Any machine on which a grinding wheel operates
5. **Gate** - The extra iron left on the casting after the gates and risers are removed
6. **Exterior** - Outside
7. **Interior** - Inside
8. **Q.C.** - Quality Control
9. **Specification** - A description of work to be done as well as instructions on how to do the work
10. **Inspector** - A person who looks at or examines a product for defects
11. **Special processing** - Any additional processing done to the casting other than the grinding operation

GRINDING OPERATOR PROCEDURE

1. Receive castings from grinding belt.
2. Read and sign process sheet.
3. Remove gates and exterior parting line, per process sheet, using the snag grinders.
4. Remove interior parting line with air file, if required.
5. Perform any additional processing required by the process sheet.
6. Fill out a grinding inspection tag and attach to the container.
7. Direct castings to the Q.C. final inspection for a complete audit.

PROCEDURES FOR ANNEALING CASTINGS

1. Read process sheet to determine metal specifications.

2. Activate crane and lift off hoods.

3. Take barrels, two at a time when possible, and place in heat-treat area.

4. Place a new lot of barrels (5 or 6) in furnace, place hoods over drums, and start the furnace on a new cycle.

   CYCLE: Castings must be heat-treated according to the process sheet for each job.

   Castings 5 lbs. or more, 1550° for 2 hours. Let cool to 1000° and then pull hoods.

   Castings thinner or smaller, 1450° for 2 1/2 hours. Let cool to 1000° and then lift hoods.

5. The oven controllers are to be used to record the temperature and time data of the heat-treat process. The operator must record the part number adjacent to the pertinent information on this heat-treat record.

6. Repeat cycles by following these instructions.

INSTRUCTIONS FOR OPERATING WHEELABRATOR

1. Operator must distinguish between "as cast" or "heat-treated" castings

2. "As cast" castings should run 9 minutes.

3. "Heat-treated" castings should run 14 to 20 minutes, depending on casting characteristics:

   Different sizes
   Different designs
   Different weights

4. Open door and discharge casting on distribution belt enroute to grinding stations

5. Repeat loading and unloading cycle

INSTRUCTIONS FOR OPERATING BLASTEC

1. Operator must distinguish between "as cast" or "heat-treated" castings

2. "As cast" castings should run 10 minutes.

3. "Heat-treated" castings should run 12 to 20 minutes, depending on casting characteristics:

   Different sizes
   Different designs
   Different weights

4. Open door and discharge casting on distribution belt enroute to grinding stations

5. Repeat loading and unloading cycle

Explain the process for annealing castings. Use your own words.

The grinding operator procedures are not in the correct order. Write the number on the line next to each to indicate the proper sequence.

__3__ Remove gates and exterior parting line, per process sheet, using the snag grinders.

__1__ Receive castings from grinding belt.

__7__ Direct castings to the Q.C. final inspection for a complete audit.

__4__ Remove interior parting line with air file, if required.

__2__ Read and sign process sheet.

__6__ Fill out a grinding inspection tag and attach to the container.

__5__ Perform any additional processing required by the process sheet.

The Instructions for operating the Wheelabrator and the Blastec are very similar. Answer the following questions about the instructions.

1. How long should "as cast" castings run in the Wheelabrator? **"As cast" castings should run for 9 minutes.**

2. Who distinguishes between "as cast" and "heat-treated" castings? **The operator must distinguish between "as cast" and "heat-treated" castings.**

3. How long should "heat-treated" castings run in the Blastec? **"Heat-treated" castings should run for 12-20 minutes in the Blastec.**

Toledo Weight Scale Procedures

1. Clear all the previous information before using the Toledo scale. This must be done every time to remove any previously saved information.

2. Place the container on the scales and verify that the tare weight has been written on the container. Enter the tare weight into the scale. If a tare weight has not been written on the container, then the castings must be transferred to another container that does have a previously determined tare weight written on it.

3. Take a representative sample of pieces from the container and place them on the smaller sample scale. The scale will then calculate the average piece weight and the number of total pieces in the container.

4. Print the shipping ticket.

5. Place the sample castings back in the container. Affix the shipping ticket to the container and stage the container for shipment.

Explain the Toledo Weight Scale procedure in your own words.

Job Procedure - Pouring

Upon completion of this lesson the learner will be able to:

- define vocabulary words of the job procedure
- correctly sequence the steps in the job procedure
- explain the job procedure

Instructor Notes	Activities	Materials	Time
	Set Induction Have materials on the table. Have learners think about the steps involved in making a peanut butter sandwich. Write the steps on the board. Check to see if learners agree on the steps. Follow the steps exactly. Did this procedure work? Why or why not?	Jar of peanut butter, loaf of bread, knife and paper plates	5-10 Minutes
	Guided Practice Introduce Vocabulary. Divide the class into three groups. Have each group discuss and list the steps involved in performing one of the following jobs: 1) iron pourer, 2) bull pusher and 3) sample catcher. Have each group present its list to the entire class. Show the transparencies for the iron pourer, ladle pusher and sample catcher job procedures. How close do the steps listed on the transparencies match the steps already discussed. Show and discuss the ladle liner job procedure transparency.	Overhead Projector Transparency	20-25 Minutes
	Applied Practice Have learners work in pairs to complete the exercises in their workbook. Circulate. around the room and assist if necessary.	Workbook	20-Minutes
	Closure Check the exercises and discuss the importance of following proper job procedure.		5 Minutes

Vocabulary - Job Procedure and Process Card - Pouring

1. **Alloy** - A metal-like material added to molten iron to change one or more of its properties. Magnesium, ferrosilicon and copper are common alloys used at Southern Ductile.

2. **Carbides** - A compound of iron and carbon. Carbon unites with iron to form iron carbide or cementite, Fe_3C. Carbides are hard, brittle and almost impossible to machine.

3. **FeSi** - The chemical formula for ferrosilicon.

4. **Mold wt.** - The amount of iron in pounds required to fill a mold.

5. **Microstructure** - The structure and condition of metals as revealed by the appearance of a ground and polished specimen under the microscope.

6. **Nodularity** - The rating of the proportion of well-formed graphite nodules in ductile iron.

7. **Recheck** - Checking the nodularity of a casting poured from a ladle in which the nodularity of the microsample is questionable.

8. **Slag** - A nonmetallic product which forms on the surface of molten iron as a result of the impurities in the iron.

9. **Special Operations** - Extra work that must be performed during the pouring operation in order to produce a casting that meets customer specifications.

10. **Metal Specification** - A shorthand description of the type or grade of ductile iron a customer wants. The different grades of ductile iron have different degrees of strength and ductility. Common metal specifications or grades produced at Southern Ductile include: 60-40-18, 65-45-12, 80-55-06 and 100-70-03.

Iron Pourer Job Procedure

1. Read and sign the process sheet for the job you are about to pour. Particular note should be made of the following:

   - Should copper (or other alloys) be added?
   - What is the pouring temperature range?
   - What is the estimated pouring time?
   - What is the mold weight?

   The Hunter 21 and Hunter 22 pourers should read and sign the process sheets for both the Hunter 21 and Hunter 22 pouring lines.

2. Position your ladle on the reladling stand in preparation for receiving iron.

3. As the ladle pusher pours the iron into the pouring ladle, add a pre-measured cup of 75% ferrosilicon alloy to the stream of molten metal. Make sure that the iron going into the ladle is above the bottom of the skimmer tile before making the ferrosilicon addition.

4. After the iron transfer is completed, use a skimmer to remove the slag from the surface of the iron in the ladle.

5. Note the temperature of the iron. If the temperature is outside the pouring range specified by the process card, notify you supervisor.

6. Pour the waiting molds using good pouring technique, including the following:

   - Do not overpour molds
   - Pour with the ladle spout as near to the mold sprue as possible
   - Pour at or near the pour time as specified on the process sheet
   - Keep the sprue choked at all times during the pour

7. Immediately after pouring the last mold, pour a microsample to check the iron's nodularity. Do not interrupt the pouring stream to take the sample.

8. Mark the last mold poured by placing raw sand on top of it.

9. If iron remains in the ladle after pouring the last mold, pour it into a pig mold or starter block.

10. Record this total number of molds poured on the pouring weight and temperature record sheet.

11. Return your ladle to the reladling station.

12. Inspect your ladle between pours. Check the skimmer tile. If it is broken or burned through, notify your supervisor. Also check the ladle spout. Use a metal rod to remove any slag buildup from the spout that may clog it up.

Note: If at any time during the pouring process the red lights comes on and the buzzer sounds, stop pouring immediately.

Ladle Pusher Job Procedure

1. Observe the pouring operation. Anticipate the need for additional iron by considering the mold weight and the molding and pouring rates.

2. Weigh the required amount of magnesium alloy and, if necessary, cover steel.

3. Blow the whistle to signal the furnace operator for iron.

4. Clearly communicate to the furnace operator the number of pounds of iron to be tapped into the treatment ladle.

5. Place the alloy and cover steel in the treatment ladle just before the iron is tapped.

6. Push the treatment ladle in front of the furnace to be tapped. Tilt the bull forward toward the spout of the furnace.

7. Push the treatment ladle to the slagging station.

8. Skim slag from the surface of the iron.

9. Push the treatment ladle to the pouring station.

10. Pour the proper amount of iron into the pouring ladle(s).

11. Take the temperature of the iron and record it on the Pouring Weight And Temperature Record sheet.

12. If iron remains in the treatment ladle, pig it out.

13. Return the empty ladle to the furnace area.

14. Record the ladle number, tap weight, the magnesium weight, the cover steel weight, the time and the furnace number on the Daily Magnesium Addition Record sheet.

Sample Catcher Job Procedure

1. Obtain a microsample for each ladle of iron poured.

2. Properly prepare each microsample.

3. Rate the nodularity of each microsample microstructure using the class rating system.

4. Take the following action(s) based on the result of the microsample rating:

   a. If the microstructure rating is class A or class B, accept the castings poured from the ladle.

   b. If the microstructure is rated class C or D, get a recheck by cutting and polishing a section from the last mold poured from the ladle in question. If the microstructure of the recheck is class A or class B, accept the castings. If the microstructure recheck is less than class B, then pull the castings poured from the ladle.

4. Mark each microsample with the number of the ladle from which it was poured and place it in the proper slot in the mircrosample holder.

5. Record the rating for each microsample on the nodularity sheet.

6. Check every fifth microsample for carbides. Record the carbide percentage on the nodularity form.

7. Carry all spectrosamples poured to the QC lab.

Note: Any ladle rated less than class B should be immediately brought to the attention of the pouring supervisor.

Ladle Liner Job Procedure

1. Inspect all pouring and treatment ladles.

2. Repair, reline or replace all pouring and treatment ladles as needed.

3. Set up ladles for first and second shift startup, making sure the ladles are in their proper locations.

4. Repair or replace all starter blocks.

Exercises

We discussed flow charts in an earlier lesson. Flow charts are especially useful in showing the steps in a process such as a job procedure. Flow charts are made up of two basic parts:

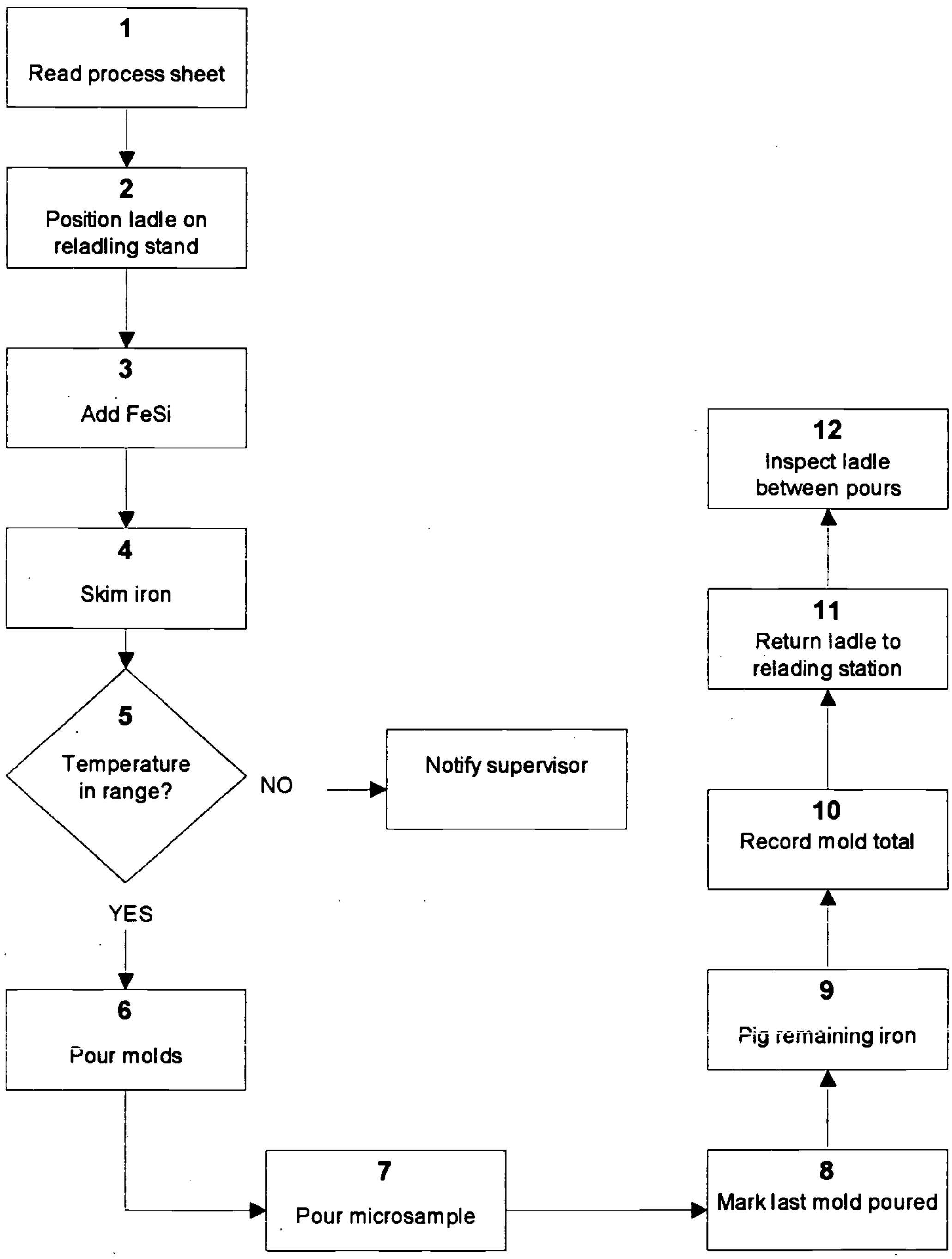
1. Different shapes that stand for various events. Two common boxes are rectangles and diamonds.

- Squares or rectangles stand for various actions that take place.
- Diamonds represent decision points in the process. A diamond shaped box, for example, can represent a yes or no question.

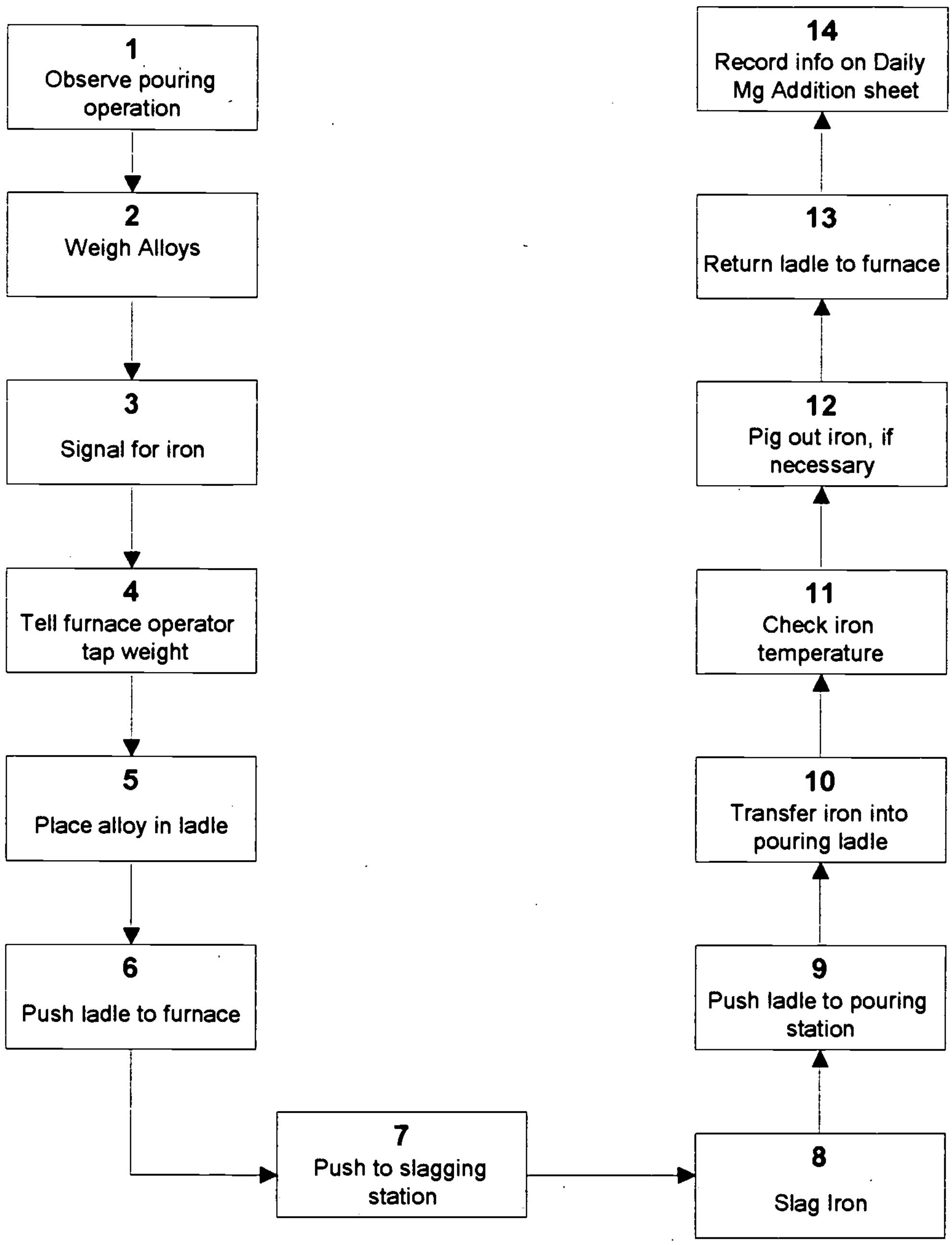
2. Arrows that show the movement sequence and direction of the process under consideration.

Below is a flow chart showing the steps of the iron pourer job procedure. Study this example and then create your own flow charts for the ladle pusher and the sample catcher job procedures. Look back at the written steps for these jobs if necessary.

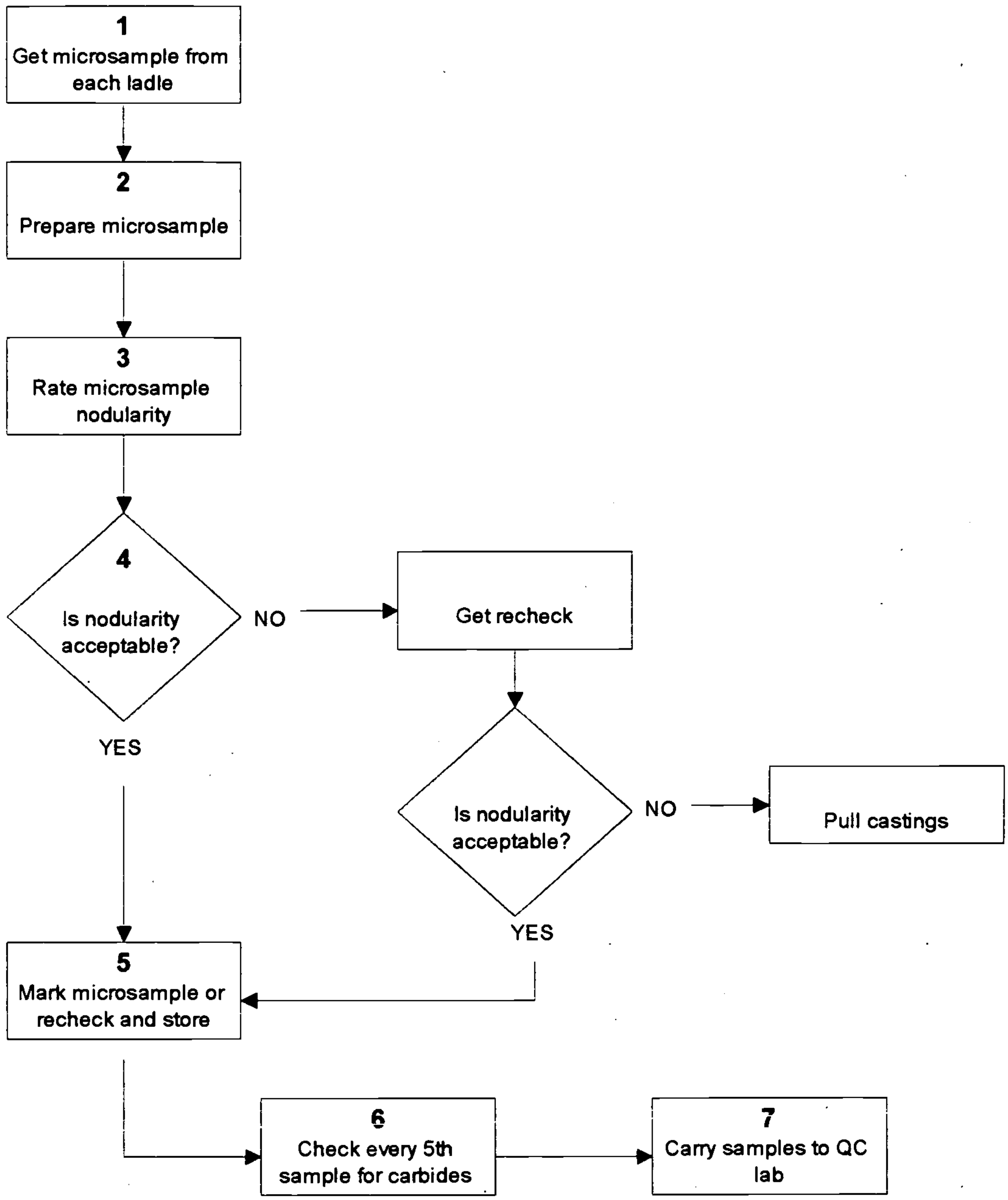
Iron Pourer Job Procedure



Ladle Pusher Job Procedure



Sample Catcher Job Procedure



In you own words, explain the ladle liner's job.

Job Procedure - Melting

Upon completion of this lesson the learner will be able to:

- define vocabulary words of the job procedure
- correctly sequence the steps in the job procedure
- explain the job procedure

Instructor Notes	Activities	Materials	Time
	Set Induction Have materials on the table. Have learners think about the steps involved in making a peanut butter sandwich. Write the steps on the board. Check to see if learners agree on the steps. Follow the steps exactly. Did this procedure work? Why or why not?	Jar of peanut butter, loaf of bread, knife and paper plates	5-10 Minutes
	Guided Practice Introduce Vocabulary. Divide the class into two small groups. Have each group discuss and list the steps involved in performing the furnace operator job. Have each group present its list to the entire class. Show the transparency for the furnace operator job procedure. How close do the steps listed on the transparency match the steps already discussed. Does the job procedure correspond to how you actually perform your job?	Overhead Projector Transparency	20 Minutes
	Applied Practice Have learners read and complete the exercises in their workbook.	Workbook	20-Minutes
	Closure Discuss the exercises and emphasize the importance of following proper job procedure. Ask if there are any questions..		10 Minutes

Vocabulary - Job Procedure

1. **Alloy** - A metal-like material added to molten iron to change one or more of its properties. Magnesium, ferrosilicon and copper are common alloys used at Southern Ductile.

2. **Charging bucket** - A container linked to a crane. It receives the metal charge from the preheater. It is used to drop the charge in the furnace.

3. **Conveyor** - A device for carrying or transporting something.

4. **Preheater** - A device used to heat a metal chug that will be melted in a furnace.

5. **Melt** - To change a solid metal charge into a liquid through the application of heat. This term is also used to refer to the liquid metal in the furnace.

6. **MeltLab** - A computerized thermal analysis instrument used to analyze carbon and silicon.

7. **Monitor**. - To check, watch, or keep track of, often by means of an electronic device.

8. **QuickLab** - A non-computerized thermal analysis instrument used for analyzing carbon and sulfur.

9. **Slag** - A nonmetallic product which forms on the surface of molten iron as a result of the impurities in the iron.

10. **Slag coagulant** - A product that causes impurities in the iron to stick together in a mass so that they can be skimmed off the surface of the iron.

Furnace Operator Job Procedure

1. Weigh the metal charge on the scale conveyor according to the instructions on the charge blackboard. Keep the steel scrap separated from the returns on the conveyor.

2. Start the scale conveyor to move the charge to the gas preheater.

3. Start the preheater conveyor to dump the charge into the charging bucket.

4. Add the amount of graphite specified on the charge blackboard to the furnace to be charged.

5. Turn the furnace power on and dial in the estimated counts on the melt energy counter needed to melt the charge and bring up to the desired temperature.

6. Move the charging bucket containing the charge to the furnace to be charged.

7. Open the furnace lid.

8. Position the charge bucket directly over the open furnace. Drop the charge into the furnace.

9. Move the charge bucket away from the furnace. Close the furnace lid. Return the charge bucket to the pit in front of the preheater.

10. After approximately 200 counts, check the chemistry and temperature of the furnace melt.

- **Temperature Check** - Insert the temperature lance into the melt. Note the temperature on the digital readout. Based on the temperature reading, add the number of counts needed to bring the base iron temperature up to 2700°F. (Note: One count will raise the furnace temperature one degree F.)

- **Chemistry Check** - Do not check the furnace chemistry until the iron temperature reaches 2500°F.

a) **MeltLab Procedure**: Pour a base iron sample from the furnace into the thermocouple cup to check carbon and silicon. After the sample solidifies, note the carbon and silicon values on the MeltLab screen displayed on the computer monitor in the melting office. If the carbon and/or silicon value(s) are low, make graphite and/or silicon additions according to the MeltLab recommendations displayed on the screen and then recheck. If the values are too high, add steel scrap to the melt and then recheck.

b) **QuickLab Procedure**: Pour a base iron sample from the furnace into the thermocouple cup to check carbon and silicon. After the sample solidifies, note the carbon and silicon values on the QuickLab display in the melting office. If these values are low, use the following rule of thumb to increase carbon and silicon values: one pound of graphite will raise the carbon level one-hundredth of a percent. For example, to raise the carbon from 3.70% to 3.80%, add 10 pounds of graphite. Similarly, one pound of silicon carbide will increase the silicon level one hundredth of a percent.

11. Before tapping from furnace, recheck the temperature of the melt to make sure that the base iron temperature is in range. If it is too low, add additional counts and then recheck. If it is too high, add returns to the furnace and then recheck.

12. Throw slag coagulant on the surface of the furnace melt and slag.

13. Tare the furnace scales. Push the button to start both the 30 second tap timer and the 12 minute treatment timer. Watch for the magnesium flare as you pour the iron into the treatment ladle. After completing the tap, push the button to send the tap weight to the printer in the melting office.

Practice Exercise

The following steps in the furnace operator job procedure are all mixed up. Number the steps so that they will be in the correct order.

__7__ Open the furnace lid.

__3__ Start the preheater conveyor to dump the charge into the charging bucket.

__12__ Throw slag coagulant on the surface of the furnace melt and slag.

__5__ Turn the furnace power on and dial in the estimated counts on the melt energy counter needed to melt the charge and bring up to the desired temperature.

__8__ Position the charge bucket directly over the open furnace. Drop the charge into the furnace.

__6__ Move the charging bucket containing the charge to the furnace to be charged.

__13__ Tare the furnace scales. Push the button to start the 12 minute treatment timer. Watch for the magnesium flare as you pour the amount of iron called for by the ladle pusher into the treatment ladle.. After completing the tap, push the button to sent the tap weight to the printer in the melting office.

__9__ Move the charge bucket away from the furnace. Close the furnace lid. Return the charge bucket to the pit in front of the preheater.

__4__ Add the amount of graphite specified on the charge blackboard to the furnace to be charged.

__10__ **After approximately 200 counts, check the chemistry and temperature of the fur**

__2__ **Start the scale conveyor to move the charge to the gas preheater.**

__11__ **Before tapping from furnace, recheck the temperature of the melt to make sure that the base iron temperature is in range. If it is too low, add additional counts and then recheck. If it is too high, add returns to the furnace and then recheck.**

__1__ **Weigh the metal charge on the scale conveyor according to the instructions on the charge blackboard. Weigh the steel scrap first, then the returns. Position the returns behind the steel the steel scrap on the conveyor.**

Flow Chart Exercise

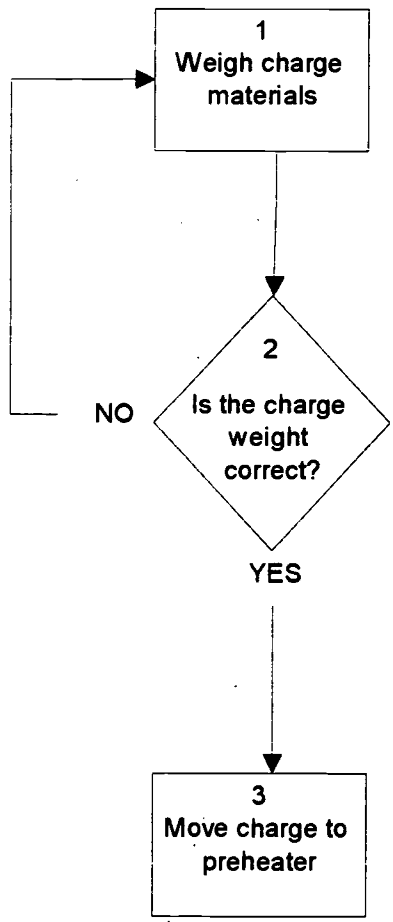
The furnace operator job procedure consists of several steps. Aside from working safely, the most important steps in this procedure involve testing and controlling the critical variables of the melting process.

Study the flow chart below. It is an example of how to show the decisions involved in performing your job, in this case, preparing a charge.

Note the two different shapes in the flow chart.

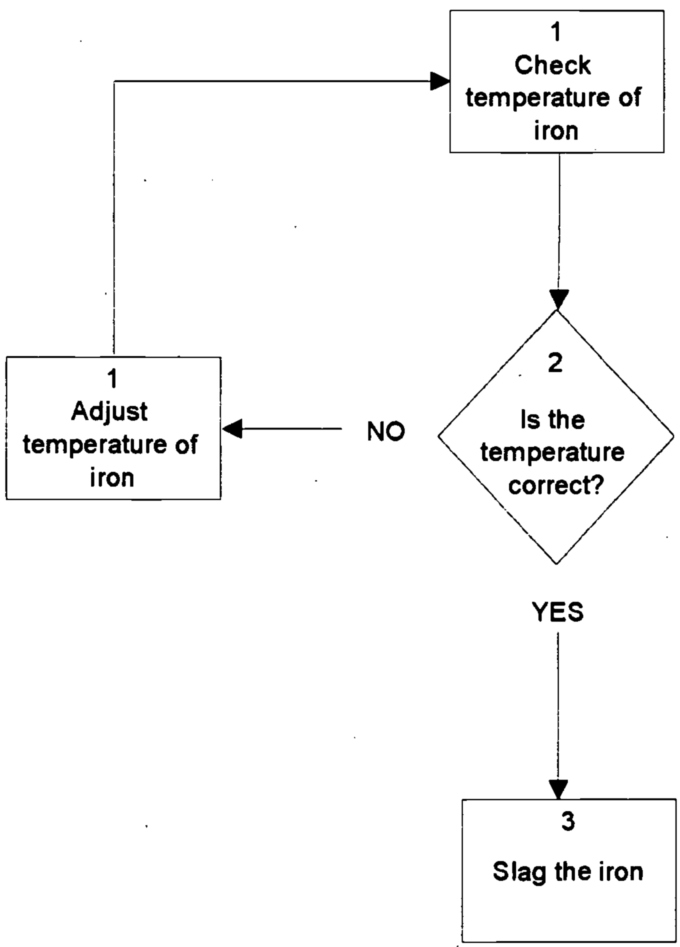
- The rectangles show the action steps involved in preparing the charge: weighing the charge and moving the charge to the preheater.
- The triangle shows the thinking or decision-making step in the process. To answer the question, "Is the charge weight correct?, you must compare the charge weights show on the scales with the weight requirements on the charge blackboard. If the charge weight is correct, the arrow labeled "YES" directs you to the next step in the melting process. If the charge weight is not correct, the arrow labeled "NO" takes you back to the previous step. In this case, you must reweigh the charge until the weight is correct.

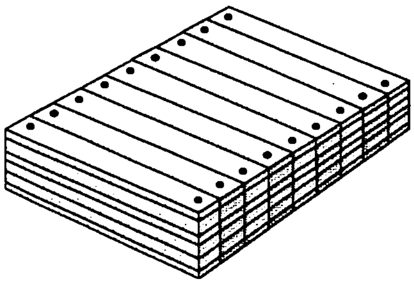
Charge Preparation



Draw a flow chart showing steps 11 and 12 in the furnace operator job procedure. Hint: You will need to use a triangle to show a decision you must make between step 11 (checking the temperature) and step 12 (slagging the furnace).

Temperature Process Control





Process Cards

Upon completion of this lesson the learner will be able to:

- define the process card vocabulary words
- locate information on the process cards
- answer questions relating to the process cards in the workbook

Molders

Instructor Notes	Activities	Materials	Time
	Set Induction Have learners work in pairs to assemble a cardboard box without instructions. After three minutes call time. Ask if anyone had difficulty assembling the boxes. If so, why? Explain that a set of written instructions can help us better perform our jobs.	Unassembled Cardboard Boxes	10 Minutes
	Guided Practice Display the transparencies. Have learners help you identify the important information on the process card. For each entry identified ask learners why it is important. Ask if there are any questions. Review vocabulary.	Overhead Projector, Transparencies Workbook	15-20 Minutes
	Applied Practice Have learners complete the exercises.	Workbook	20 Minutes
Note: Ask Pattern Inventory Clerk at least one day in advance to set out patterns for the next lesson.	**Closure** Review the correct answers to the exercises. Ask if there are any questions.	Workbook	5-10 Minutes

Molders

Look at Process Card A and answer the following questions.

1. Is this a Hunter or a BMM process card? **Hunter**.

2. What is the customer name and part #? **Customer X, part # 12345**.

3. How many pieces are on the pattern? **16**.

4. Is this a core job? **No**.

5. What squeeze head is required to run this job? **Squeeze head #20-A**.

Molders

Look at Process Card B and answer the following questions.

1. Where should the date code be located? **<u>On the cope side of the pattern</u>.**

2. Is this a core job? **<u>Yes</u>.**

3. How many molds are to be produced? **<u>219</u>.**

4. What was the major cause of scrap for the prior six month period? **<u>Sand</u>.**

5. What special operations should be performed? **<u>Set squeeze pressure to 1000 pounds per square inch</u>. <u>Watch for core setting</u>.**

Molders

Look at Process Card C and answer the following questions.

1. Are chaplets required for this job? **No.**

2. Is this a Hunter or a BMM process card? **BMM.**

3. Is this a core job? **Yes.**

4. How many pieces are on the pattern? **2.**

5. How many molds are to be produced? **281.**

Coremakers

Look at Core Card A and answer the following questions.

1. What machine is to run this order ? **The order is to be run on the Redford coremaking machine.**

2. What are the customer name and part #? **Customer X, part # 12345.**

3. What does the card say about special operations? **The core card says to:**
   remove all fins
   use only 95-400 sand
   jaw pocket pads must fill out completely
   watch for shifted cores

4. How many boxes or pieces are to be produced? **1,204 boxes or pieces are to be made for this order.**

5. Record the following:
   blow pressure - **40.0 PSI**
   invest time - **15.0 Seconds**
   cure time - **20.0 Seconds**
   blow time - **4.0 Seconds**
   drain time - **6.0 Seconds**

Coremakers

Look at Core Card B and answer the following questions.

1. What does the card say about special operations? **Do not mud cores in holes that produce posts.**

2. How many cavities does the box have? **2**

3. How many cores are to be produced? **127**

4. Record the following:
   blow pressure - **40.0 PSI**
   gas pressure - **14.0 PSI**
   purge pressure - **17.0 PSI**
   blow time - **2.0 Seconds**
   drain time - **6.0 Seconds**

Coremakers

Look at Process Card C and answer the following questions.

1. What is the core process for this order? **The core process for this order is Isocure.**

2. Who is the customer? (Proprietary information)

3. What are the special operations instructions? **The special instructions are: all blows at parting line of both cores must be mudded. Remove all fins. Core 2 must be bubble wrapped to prevent corners from damage. Make sure cores blow up well, with no rats and no iron oxide.**

4. How many good cores do you need to make? **You need to make 1,338 good cores.**

5. What is the standard per hour? **The standard per hour is 43.**

Grinders

Look at Process Card A and answer the following questions.

1. Is this a heat-treated order? How can you tell? **Yes, this is a heat-treated order. The second page of the process sheet is for the heat-treat. The metal specification is 60-40-18 full anneal.**

2. What is the customer name and part #? **Customer X, part # 12345**.

3. What are the instructions for packing the order? **The order should be packaged in customer containers (FMC metal tubs), do not overfill, grinder and inspectors name must be in the container. Hand count one out of every ten boxes, cover with cardboard and log in Joe's office.**

4. If special processing is necessary, what special processing should be done for this order? **The special processing for this order is air file the parting line inside if needed.**

5. What is the range for the Brinell hardness on this order? **The range for the Brinell hardness is 143-187.**

Grinders

Look at Process Card B and answer the following questions.

1. What should you look for when performing a visual inspection? **You should look for sand/slag, cold run, shift, and bent/warped castings.**

2. The order should be reblasted. What is the reblast comment? **The reblast comment says to reclean after grinding to remove sharp edges and burn-in sand.**

3. What is the part number and who is the customer?

4. What should you grind on this casting? **You should grind the gate flush and grind the parting line.**

5. What special processing should be performed? **Remove any parting fins that the rock grinder cannot remove.**

Grinders

Look at Process Card C and answer the following questions.

1. What are the special operations for heat-treating? **Cover all drums with K-Wool before putting in the furnace. After pulling the lid leave the K-Wool on the drums to slow cool.**

2. What is the special processing for this order? **The special processing for this order is clean the castings after grinding.**

3. How should this order be packaged? **This order should be packaged in wire bound boxes and the boxes should be full.**

4. What is the temperature for the heat-treating process and how long should the castings be heat-treated? **The temperature for this order is 1500° and the castings should be treated for 2.5 hours.**

5. What is the part number? **The part number is C-886-DI.**

Pouring

Look at Process Card A and answer the following questions.

1. What is the mold weight for this order? **<u>47.85</u>**

2. What is the customer name and part #? **<u>Customer X, part # 12345</u>**.

3. What does the process sheet say about alloy addition(s)? **<u>The order does not have any alloy additions.</u>**

4. How many pound of iron should there be per ladle? **<u>600 pounds</u>**

5. What is the metal specification for this order? **<u>100-70-03 normal</u>**

Pouring

Look at Process Card B and answer the following questions.

1. What is the temperature range for this order? **The temperature range for this order is 2500° to 2540° F.**

2. How many pieces do you have to pour for this order? **You need to pour 1,163 pieces for this order.**

3. Who is the customer for this order? **Customer X, part # 12345**.

4. Does the process card tell you that weights are needed? If you answer yes, tell how many weights should be used. **Yes, three weights should be used for this order.**

5. How much does each mold weigh? **The mold weight is 25.79.**

Pouring

Look at Process Card C and answer the following questions.

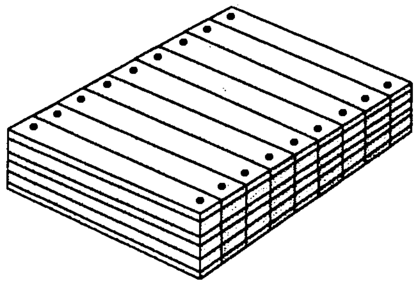
1. What alloy should be added to the iron and how much alloy does the process card tell you to order? **40 points of final copper should be added to the iron before pouring.**

2. Special operations are special instructions you must follow. What does the special operations section say? **The special operations section says to tap 1000 pounds of iron.**

3. What is the temperature range for this order? **The temperature range is 2510° to 2530 F°.**

4. What is the metal specification? **The metal specification is 80-55-06 "as cast".**

5. How many pieces does this mold have on the pattern? **1.**

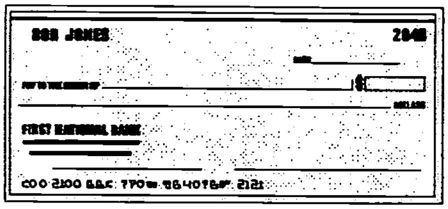


Process Cards

Upon completion of this lesson the learner will be able to:

- define the process card vocabulary words
- match the process cards to the correct patterns

Instructor Notes	Activities	Materials	Time
	Set Induction Divide class into two groups. Have learners in each group work together to assemble a puzzle that has one piece that does not fit. Explain that if the set up of a molding job does not match the process card something is wrong.	Two puzzles	10 Minutes
	Guided Practice Have learners walk to pattern storage area. Demonstrate how to match a process card with the right pattern. Have learners help you think of questions to ask to find the right pattern. Ask if there are any questions.	Process Card Matching Pattern	15-20 Minutes
	Applied Practice Give each learner a process card. Have learners match their process cards with the right pattern.	Ten patterns Matching Process Cards	20-25 Minutes
	Closure Check to make sure each process card matches the right pattern. Ask if there are any questions.		5-10 Minutes



Benefits

Upon completion of this lesson the learner will be able to:

- explain vocabulary words relating to benefits
- read and explain the key points covered in the benefits
- locate answers to questions about company benefits

Instructor Notes	Activities	Material	Time
	Set Induction Have two learners act out the role playing script. Discuss the importance of understanding benefits.	Role Playing Script	5 Minutes
	Guided Practice Introduce Vocabulary Ask learners what benefits they have as an employee of Southern Ductile. List their responses on the board. Discuss what is covered by each benefit.	Markerboard Kit	20-30 Minutes
	Applied Practice Work through the exercises one benefit at a time, checking after each. Review Vocabulary	Workbook	10-20 Minutes
	Closure Ask learners what they learned in this lesson.		5-10 Minutes

BENEFITS

B	K	S	B	V	A	C	A	T	I	O	N	Y	A	P	O	C
Q	S	G	D	E	D	U	C	T	I	O	N	S	Y	X	V	P
K	L	N	I	S	N	D	E	D	U	C	T	I	B	L	E	D
Z	O	I	M	T	F	E	D	E	R	A	L	H	Q	O	R	H
M	U	N	Y	I	B	J	F	G	Q	B	G	B	D	C	T	M
S	I	R	C	N	J	P	H	I	J	H	W	H	X	A	I	E
Z	P	A	C	G	Z	B	G	L	T	V	G	T	U	L	M	C
O	H	E	A	L	T	H	I	N	S	U	R	A	N	C	E	D
S	T	A	N	D	A	R	D	L	I	F	E	G	O	D	T	K
U	Y	Z	Y	S	R	E	T	I	R	E	M	E	N	T	A	R
U	E	N	E	J	I	T	F	B	H	E	O	D	G	U	T	X
C	V	V	L	L	Z	O	Y	R	J	N	G	R	O	S	S	T
I	H	K	J	D	Q	T	N	K	T	R	A	U	U	I	V	E
P	Q	E	N	V	E	W	O	P	F	X	O	D	L	G	T	B
R	O	Y	F	D	Q	X	L	O	L	E	D	S	L	A	U	O
R	B	V	D	F	B	J	K	D	J	A	N	R	A	L	R	E
I	P	N	Q	B	C	H	W	X	W	V	N	S	H	O	T	L

Word List

HEALTH INSURANCE
STANDARD LIFE
PENSION PLAN
DEDUCTIONS
RETIREMENT
DEDUCTIBLE
OVERTIME
EARNINGS
VACATION
FEDERAL
BENEFIT
REGULAR
VESTING
CO-PAY
STATE
LOCAL
GROSS
FICA
PAC

Role Playing Script

(Sitting in the breakroom.)

Sam - Hi! My name is Sam. I am a new employee here at Southern Ductile.

David - Hi! My name is David. We are glad to have you working with us.

Sam - This may sound silly, but I really cannot remember all of the things I was told about benefits during my orientation. I sure could use some help understanding all this.

David - I will help you all I can, but to tell you the truth, there are some things about benefits that I do not understand either.

Vocabulary - Benefits

1. **Benefit** - Aid provided for you.

2. **Retirement** - Leaving your job due to age or years of service.

3. **Pension Plan** - Retirement plan provided by the company.

4. **Vesting** - Fully guaranteeing a benefit.

5. **Deductible** - Amount of the initial cost of care you pay before insurance will start paying.

6. **Co-pay** - Small amount the patient pays the health care provider.

7. **PAC** - Pre-admission certification.

8. **Earnings** - Money you earn.

9. **Deductions** - Things that are subtracted from your earnings.

10. **Regular Pay** - The pay you earn for your 40 hour week.

11. **Overtime Pay** - The pay you earn for anything over your regular 40 hour week.

12. **Vacation Pay** - The pay you receive for time off that you have accumulated.

13. **Gross Earnings** - The total before deductions.

14. **FICA** - Social Security retirement taxes taken out of your check.

15. **Medicare** - A Social Security tax taken out of you check to help cover medical expenses when you reach age 65.

16. **Federal Tax** - The tax you pay to the Federal Government.

Vocabulary - Benefits

17. **State Tax** - The tax you pay to the State Government.

18. **Local # 1** - Bessemer City tax

19. **Local # 2** - Jefferson County tax

20. **Standard Life Insurance** - Life insurance provided for you at a small cost.

21. **Health Insurance** - Medical insurance provided for you at a small cost.

Benefits

You receive many benefits as an employee of Southern Ductile. The benefit package includes, vacation, retirement - pension plan, and insurance.

Vacation

Years of completed service	Week of vacation	Hours paid
1	1	40
2	2	80
9	3	120
14	4	160
20	5	200
25	6	240

To take part or all of your vacation you need to make a request. The request must be made 10 working days in advance of the time requested. The request is subject to the following:

- If you have been laid-off you must work 20 days before you can request any of your vacation.
- No more than 20% of the employees in a department may take their vacation at the same time, seniority rules in this case.

An employee may choose to be paid for his/her vacation and not take any time off work You can receive all of your vacation pay when you take your first week of vacation. You will need to make that request when you ask for your vacation. The accounting department will give you a copy of your request as soon as they process your form.

Read the vacation information and answer the questions.

1. How much vacation time do you get if you have been employed for 11 years? **3 weeks or 120 hours**

2. If you want to take part or all of your vacation what do you need to do to get your time off and your pay? **You need to make a request for your vacation time and/or pay at least 10 working days in advance.**

3. No more than 20% of the people in a department can take off at the same time. Why do you think this rule is necessary? **Accept any reasonable answer**.

Retirement - Pension Plan

Retirement is something most people seem to forget until they get ready to retire. Having a well-thought out plan for your retirement is a good idea. Most companies, including Southern Ductile, have pension plans. The pension plan supplements your social security.

Will the pension plan and social security be enough to provide for you and your family in your retirement years? The answer to this question can be found by doing your retirement homework. We are going to look at the company pension plan.

Normal Retirement Benefits

If you retire at the normal retirement age of 65 you are entitled to receive a monthly benefit. The monthly benefit is paid for the remainder of your life. The monthly benefit is calculated by multiplying the benefit level times the years of participation in the plan. The current benefit level, as of March 18, 1996, is $13.00.

Early Retirement Benefits

You may retire as early as age 55 or older if you have 10 years of vesting service. If you retire early you have two choices.

- You can wait until the normal retirement age of 65 to receive your benefits
- You can receive an immediate monthly benefit that will be reduced.

The immediate early retirement benefit is found by reducing the normal retirement benefit by 5/8% for each month you would have worked if you had worked until age 65.

Read the information about the company pension plan and answer the questions.

1. What is the normal retirement age? **65 years old**

2. How do you figure the immediate early retirement benefit? **The immediate early retirement benefit is found by reducing the normal retirement benefit by 5/8% for each month you would have worked if you had worked until age 65**.

3. What is the current benefit level? **$13.00, as of March 18, 1996**.

Summary of Benefits

Below is a brief summary of your benefits. Refer to the following sections for details.

Hospital Benefits
$50 deductible per hospital admission
365 days of care during each hospital confinement
30 days of care lifetime maximum for mental and nervous disorders
Semi-private accommodations, general nursing care, x-rays, drugs, and other hospital ancillary services covered in full
$75 outpatient hospital Co-pay for non-emergency medical treatment at any facility
$25 outpatient hospital Co-pay for outpatient surgery at any facility and medical emergencies at a Preferred Outpatient Facility (medical emergency services received in a Non-Preferred Outpatient Facility are covered under Major Medical)
Outpatient hospital charges for accidental injury within 72 hours of the injury not subject to the deductible

Pre-admission Certification - PAC
Required for all hospital admissions, must be approved before the admission; maternity and emergency admissions must be approved by phone within 48 hours of the admission or the next business day

Major Medical Benefits
$1,000,000 contract maximum per person
$100 deductible per person each calendar year
Maximum of three deductibles per family each year
Pays 80% of the usual, customary and reasonable amount (UCR); annual out-of-pocket maximum per person (excluding outpatient mental and nervous) is $1,000 plus the Major Medical deductible; 100% UCR for the remainder of the year
50% UCR of outpatient expenses for mental and nervous disorder
Cancer diagnosed illnesses covered at 100% UCR with no deductible

Blue Cross Preferred Care
Expanded benefits if you go to a Preferred Medical Doctor or Preferred Outpatient Facility
$15 co-pay per visit for office visits and emergency room services by a physician
100% coverage for x-rays, lab, pathology, surgery, anesthesia, inpatient physician visits, chemotherapy and radiation therapy, maternity care and routine immunizations

Comprehensive Managed Care
Alternative benefits through Individual Case Management may be available for your condition

Read the summary of benefits and answer the questions.

1. What is the co-pay per visit for office visits? **$15.00**

2. What does the summary say about pre-admission certification (PAC)? **PAC is required for all hospital admissions, must be approved before the admission; maternity and emergency admissions must be approved by phone within 48 hours of the admission or the next business day.**

3. What is the maximum major medical deductible for a family per year? **$300.00**

4. What is the benefit for cancer illnesses? **Cancer diagnosed illnesses are covered at 100% for usual, customary, and reasonable (UCR) amount.**

Look at the paycheck. It is divided into two sections. One section has your earnings and the other section has your deductions.

Earnings include:

- **your regular pay** - you pay for working no more than 40 hours
- **your overtime pay** - your pay for working more than 40 hours
- **your vacation pay** - your pay for the vacation time you have requested
- **other** - your pay for training, etc.

These make up the gross earnings section of your paycheck. The employee pay rate is shown in the section under the gross earnings section.

Deductions include:

- **FICA** - Social Security Retirement - 6.2%
- **Medicare** - 1.45%
- **Federal Tax** - The percentage withheld depends on the number of exemptions you have listed on your W-2 Form.
- **State Tax** - The percentage withheld depends on the number of exemptions you have listed on your W-2 Form.
- **Local # 1** - Bessemer City Tax - 1%
- **Local # 2** - Jefferson County Tax - .5%
- **Standard Life Insurance** - You pay a small portion, the company pays the remainder for you
- **Health Insurance** - The company pays 85% of the cost and you pay 15% of the cost

These deductions make up the total deductions section of your paycheck. You may have other earnings or deductions listed on your paycheck.

If your paycheck is incorrect you should follow the procedure on the next page to get it corrected.

Answer the questions about the paycheck section of the lesson.

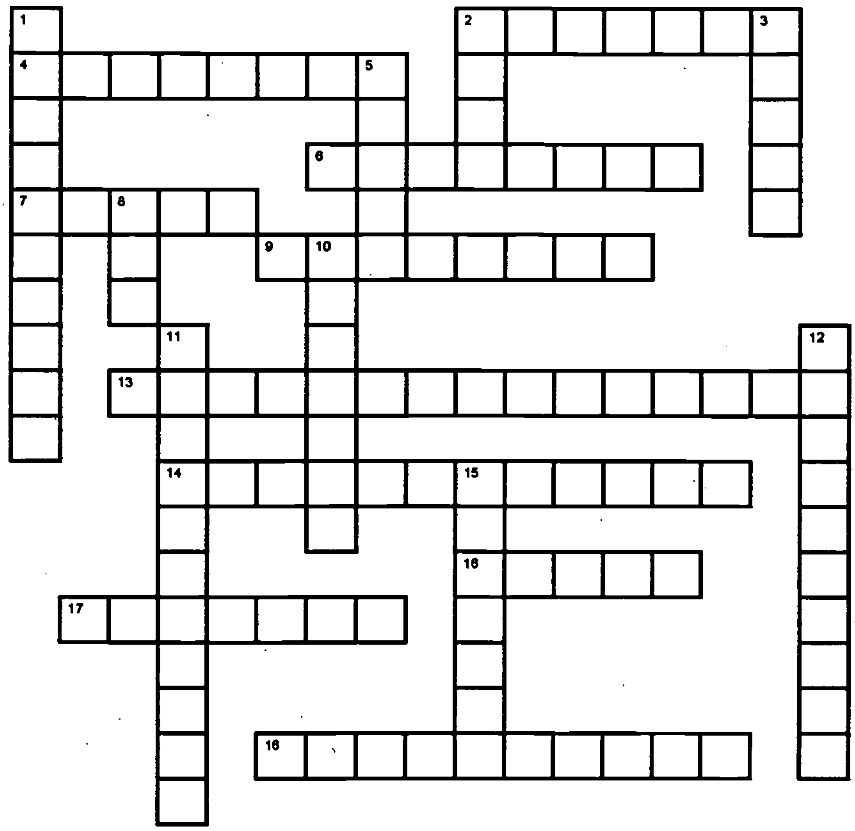
1. What is the percentage withheld for FICA? **6.2**

2. What is the percentage withheld for Medicare? **1.45%**

3. Is Health Insurance an earning or a deduction? **deduction**

4. What should you do if your check is incorrect? **If your check is incorrect you should report it to your supervisor.**

Benefits



Across

2. The tax you pay to the federal government.
4. Money you earn.
6. The pay you receive when you take time off that you have accumulated is ___________ pay.
7. Small amount the patient pays the health care provider.
9. The pay tou earn for anything over 40 hours is ____________ pay.
13. Medical insurance provided for you at a small cost. (2 Wds.)

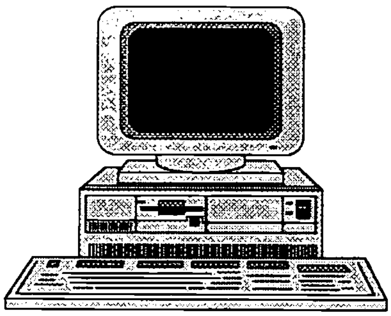
14. Life insurance provided for you at a small cost. (2 Wds.)
16. The total before deductions is __________ earnings.
17. Aid provided for you.
18. Leaving your job due to age or years of service.

Down

1. Things that are subtracted from your earnings.
2. Social Security tax taken out of your check
3. Jefferson County and Bessemer City taxes are _________ taxes.
5. The tax you pay to the state government is __________ tax.
8. Pre-admission Certification (abbreviation)
10. Fully guaranteeing a benefit.
11. Retirement plan provided by the company. (2 Wds.)
12. Amount of initial cost you pay before insurance will start paying.
15. The pay you earn for your 40 hour week is ___________ pay.

Word List

BENEFIT
CO-PAY
DEDUCTIBLE
DEDUCTIONS
EARNINGS
FEDERAL
FICA
GROSS
HEALTH INSURANCE
LOCAL
OVERTIME
PAC
PENSION PLAN
REGULAR
RETIREMENT
STANDARD LIFE
STATE
VACATION
VESTING



Computer - Introduction

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to computers
- correctly sequence the steps of computer operation
- explain the difference between hardware and software

Instructor Notes	Activities	Materials	Time
	Set Induction Review the steps for using a calculator to add two numbers. A calculator adds only when a person presses the buttons. A computer can add and do many other things without direct human control.	Calculator Markerboard Kit	5 minutes
	Guided Practice Introduce Vocabulary Display the transparency. Explain the computer model. Ask if there are any questions. Have learners follow as you read "How a Computer Works". Relate each step to the model.	Transparency Overhead Projector Workbook	25 Minutes
	Applied Practice Have learners complete the exercises in their workbook	Workbook	20 Minutes
	Closure Discuss the answers to the exercises. Ask if there are any questions.	Workbook	5 Minutes

COMPUTER

G	O	N	I	L	H	N	X	U	X	Q	S	B	J	S	H	F
H	I	J	H	E	S	E	L	E	C	T	K	A	E	C	K	B
I	L	X	V	F	E	T	C	Y	M	Y	Y	R	K	X	K	U
Y	K	N	K	E	Y	B	O	A	R	D	G	C	P	S	U	T
G	C	S	O	F	T	W	A	R	E	P	R	O	G	R	A	M
O	I	J	V	H	A	R	D	W	A	R	E	D	M	I	P	W
F	L	O	P	P	Y	D	I	S	K	G	Q	E	R	K	P	V
L	C	O	M	P	U	T	E	R	E	F	E	Y	F	K	L	P
O	P	E	R	A	T	I	N	G	S	Y	S	T	E	M	I	Q
P	U	R	A	T	A	D	O	U	B	L	E	C	L	I	C	K
P	V	Q	I	N	F	O	R	M	A	T	I	O	N	R	A	H
Y	J	V	N	N	B	G	R	A	P	H	I	C	S	M	T	R
D	F	N	P	M	T	T	I	R	G	X	R	N	H	T	I	E
R	W	G	U	O	R	E	I	S	V	B	Y	O	F	E	O	N
I	K	S	T	U	I	N	R	W	T	O	P	C	Y	Q	N	N
V	O	Q	W	S	T	N	U	V	M	O	N	I	T	O	R	A
E	Y	Q	O	E	O	U	T	P	U	T	R	I	L	S	V	C
D	F	F	R	J	B	J	T	I	N	U	M	E	T	S	Y	S

Word List

OPERATING SYSTEM
SOFTWARE PROGRAM
FLOPPY DRIVE
INFORMATION
APPLICATION
DOUBLE-CLICK
FLOPPY DISK
SYSTEM UNIT
KEYBOARD
GRAPHICS
HARDWARE
COMPUTER
PRINTER
PRINTER
SCANNER
MONITOR
STORAGE
BAR CODE
SELECT
OUTPUT
POINT
MOUSE
CLICK
STORE
INPUT
BOOT
DRAG
DATA
ICON
CPU
PC

COMPUTER

W	G	B	Z	K	S	V	P	I	J
M	O	N	I	T	O	R	D	V	P
O	V	D	Y	M	I	W	I	Q	V
U	U	P	W	N	B	U	G	L	D
S	Y	S	T	E	M	U	N	I	T
E	K	E	Y	B	O	A	R	D	R
M	R	G	N	E	E	E	C	X	Y

Word List

SYSTEM UNIT
KEYBOARD
PRINTER
MONITOR
MOUSE

Vocabulary - Computer Basics

1. **Application** - The instructions the computer uses to perform a wide variety of useful tasks such as writing a letter, balancing a checkbook or playing games.

2. **Bar Code** - A symbol consisting of lines and spaces of varying lengths that is used for repeated identification of industrial and commercial products.

3. **Boot** - To start a computer with the operating system files on a disk inside the computer.

4. **Central Processing Unit (CPU)** - Also called a microprocessor or, more simply, a processor. The CPU is the computer's control center. It responds to your commands, carries out software instructions, performs calculations and processes the flow of information throughout the computer.

5. **Click** - To press and release the left mouse button while the tip of the mouse pointer is over the desired text, picture or command.

6. **Computer** - A general-purpose machine that can perform many useful tasks depending on the instructions given it.

7. **Data** - Isolated or unorganized facts or observations that flow into the computer as input.

8. **Double-click** - To press and release the left mouse button twice quickly.

9. **Drag** - To hold the left mouse button down while moving the mouse. You usually drag to select letters or words, move something on screen or draw a line or shape.

Vocabulary - Computer Basics

10. **Floppy Disk** - Also called a diskette. A small item used to store computer information that can be inserted into and removed from a floppy disk drive. A floppy disk allows you to transfer information from one computer to another.

11. **Floppy Disk Drive** - A storage device that is usually found in the system unit. It has an opening in the front or side of the system unit to insert or remove a floppy disk.

12. **Graphics** - A picture, chart or graph produced by a computer and displayed on a printer or screen.

13. **Hardware** - All the physical devices that make up a computer. Any part of the computer you can see or touch.

14. **Hard Disk Drive** - The computer's primary storage device. The hard drive is usually completely enclosed in the system unit case. It is made of metal and coated with a magnetic material which stores your computer's information magnetically.

15. **Icon** - A small picture on a computer monitor screen.

16. **Information** - The meaning human beings assign to data. Processed data.

17. **Input** - The data entered into a computer using a keyboard, mouse, joystick, microphone or other input device. Also refers to the process or act of entering data into a computer.

18. **Keyboard** - An input device you use to send commands or data to the computer.

Vocabulary - Computer Basics

19. **Memory** - Also called Random Access Memory (RAM). Temporary electronic memory which holds your program instructions and data files while you are working on them. The information in memory is lost when the computer is turned off unless you save to a hard disk or floppy disk.

20. **Monitor** - An output device with a display screen similar to a television. The computer uses the monitor to communicate with you by displaying text and graphics on the screen.

21. **Mouse** - A hand-held input device used to select, move and act on text and graphics displayed on the monitor screen.

22. **Operating System** -A special software program that controls the overall activity of the computer, making sure that all the parts of the computer work together smoothly and efficiently. The operating system sets the rules for how computer hardware and applications work together. It also organizes the information on the computer.

23. **Output** - The information a computer produces that the computer sends to the monitor screen, the printer or some other output device.

24. **PC** - Short for personal computer.

25. **Point** - Rolling the mouse on your desktop until the tip of the mouse pointer is touching the desired area or object.

26. **Printer** - An output device that enables computer users to print out information, text or pictures, on paper.

27. **Scanner** - An instrument used to read and analyze a printed bar code.

28. **Select** - To point to an item on the screen and click the left mouse button. The item will usually appear highlighted.

Vocabulary - Computer Basics

29. **Software Program** - Also called a program. A set of instructions that tell the computer what to do. You can't see or touch software, but you can see the package it comes in. There are two main types of software, operating system software and application software.

30. **Store** - To save information in a computer. Hard drives, floppy drives and other storage devices hold computer information like video tape stores movies. Information can also be temporarily stored in the computer's memory.

31. **Storage** - Permanent place where programs and files are kept. Most computers use hard drives and floppy disks to store information. The computer's memory serves as a temporary storage place for programs and files while you are working on them.

32. **System Unit** - Also called the computer console. The box of the computer that contains the central processing unit, memory, the hard drive and other items.

How a Computer Works

1. The computer copies the program from the hard disk and places it in memory.

2. Under the control of the program in memory, the computer reads data entered from an input device, usually a keyboard, and places the data in memory.

3. The computer's CPU processes, that is, changes or reorganizes, the data and places the results in memory as information.

4. The computer sends this information to an output device, usually a monitor or printer.

Answer the following questions?

What is computer memory? **Memory is the computer's ability to temporarily hold program instructions and data while you are working on them.**

1. Explain the difference between hardware and software.

   Hardware refers to the physical parts of the computer that you can see or touch. Software refers to the instructions that tell a computer what to do.

2. Explain the difference between data and information.

   Data are raw, unorganized facts or observations. Information refers to the processed data that has meaning to people.

3. What is an output device? Give one example of an output device.

   A computer uses an output device to display its results. Printers and monitors are two common output devices.

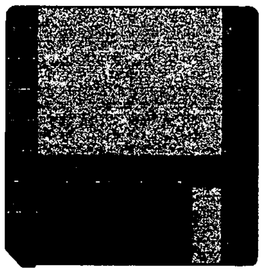
Number the following steps in the proper order.

__4__ The computer sends this information to an output device, usually a monitor or printer.

__3__ The computer's CPU processes, that is, changes or reorganizes, the data and places the results in memory as information

__1__ The computer copies the program from the hard disk and places it in memory.

__2__ Under the control of the program in memory, the computer reads data entered from an input device, usually a keyboard, and places the data in memory.

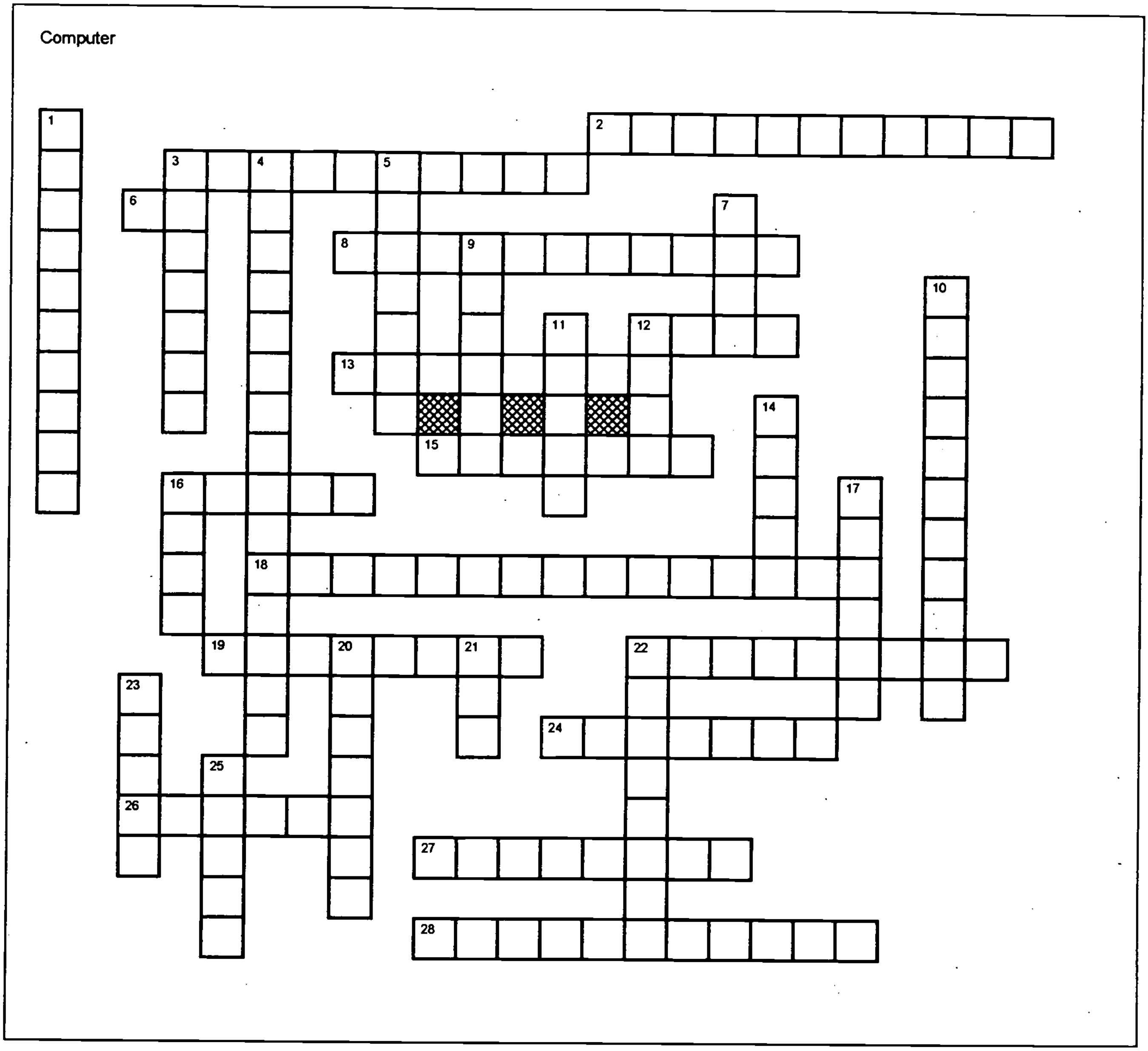


Computer - Applications

Upon completion of this lesson the learner will be able to:

- explain vocabulary words relating to computers
- list some of the most common categories of computer applications
- type a short letter using Microsoft Word for Windows

Instructor Notes	Activities	Materials	Time
	Set Induction Ask learners how these items are alike. We use each to do a specific job. A computer is very useful because it can help us do an almost unlimited variety of jobs.	Newsletter Pen or pencil Toy or Game Telephone Clock or Watch Checkbook Blueprint or Technical Drawing.	5 Minutes
	Guided Practice Point out the main parts of a computer: 1) the system unit, 2) the monitor, 3) the mouse, 4) the keyboard and 5) the printer. Demonstrate the function of each by using a computer to write a short letter. Have learners suggest the wording. Follow the suggested demonstration steps. Have learners follow in workbook as you read the table describing common categories of software. Pass around the software boxes for learners to view. Ask if there are any questions.	4 computers Printer Assorted Software Application Boxes Workbook	25 Minutes
	Applied Practice Have learners work in pairs to compose and print out a short letter. Circulate around the room to help if necessary. Have learners complete crossword puzzle in workbook.	4 Computers Printer Workbook	25 Minutes
	Closure Ask if there are any questions.		5 Minutes



Across

2. The instructions the computer uses to perform a wide variety of tasks.
3. The box that contains the CPU, hard drives, floppy drives and other storage devices. (2 Wds.)
6. Personal computer. (abbreviation)
8. Processed data.
12. Facts that flow into the computer as input.

Across (continued)

13. A general- purpose machine that can perform many useful tasks depending on the instructions given.
15. Permanent place where prograams and files are kept.
16. The data entered into a computer.
18. A special software progeram that controls the overall activity of the computer. (2 Wds.)
19. A picture, chart, or graph produced by a computer.
22. The computer's primary storage device. (2 Wds.)
24. A symbol consisting of lines and spaces of varying lengths. (2 Wds.)
26. To highlight an item by pointing to it and clicking the left mouse button.
27. An input device you use to send commands or data to the computer.
28. To press and release the left mouse button twice. (2 Wds.)

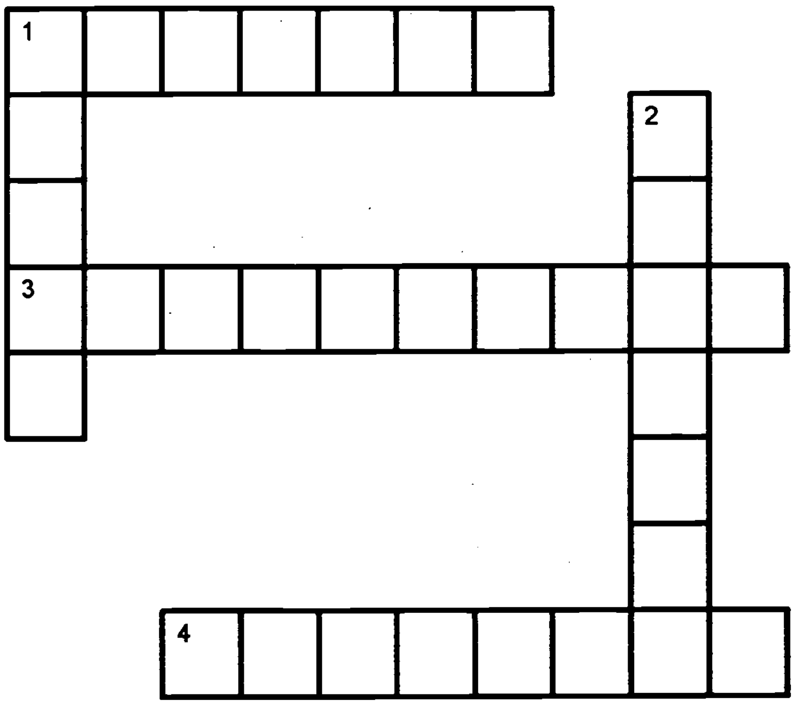
Down

1. Also known as a diskette. (2 Wds.)
3. An instrument used to read and analyze a printed bar code.
4. A set of instructions that tell the computer what to do. (2 Wds.)
5. An output device with a display screen similar to a television.
7. To start the computer.
9. The infromation the computer produces and then sends to the monitor screen, the printer, or some other output device.
10. A storage device that is usually found in the system unit. (2 Wds.)
11. To save information in a computer.
12. To hold the left mouse button down while moving the mouse.
14. Rolling the mouse on your desktop until the tip of the mouse pointer is touching the desired area.
16. A small picture on a computer monitor screen.
17. Temporary electronic __________ holds the program instructions and data files while you are working on them.
20. An output device that enables you to print information, text, or pictures on paper.
21. Central Processing Unit (abbreviation)
22. All the physical devices that make up a computer.
23. A hand-held input device.
25. To press and release the left mouse button one time.

Word List

APPLICATION
BAR CODE
BOOT
CLICK
COMPUTER
CPU
DATA
DOUBLE-CLICK
DRAG
FLOPPY DISK
FLOPPY DRIVE
GRAPHICS
HARD DRIVE
HARDWARE
ICON
INFORMATION
INPUT
KEYBOARD
MEMORY
MONITOR
MOUSE
OPERATING SYSTEM
OUTPUT
PC
POINT
PRINTER
SCANNER
SELECT
SOFTWARE PROGRAM
STORAGE
STORE
SYSTEM UNIT

COMPUTER WORDS



Word List

Keyboard
Monitor
Mouse
Printer
System Unit

Feb 26,1996

Across

1. Shows the data you type from the keyboard.
3. The computer's control center (two words).
4. Used to enter data into the computer.

Down

1. Used to point to and select items on the screen.
2. Transfers computer information onto paper.

Demonstration Steps

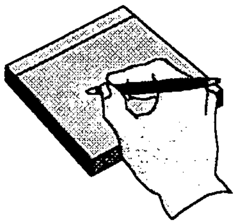
Action	Explanation
1. Open Microsoft Word by moving mouse pointer to the Word program icon and double clicking on it.	Explain that you are using the <u>mouse</u> to start a program by pointing to, selecting and double clicking on an icon on the monitor screen.
2. Use keyboard to type short letter to supervisor.	Explain that you are using the <u>keyboard</u> to enter the words of your letter into the computer.
4. Point to the text displayed on the monitor.	Explain that you are using the <u>monitor</u> to see the information entered into the computer.
4. Print letter.	Explain that you are using the <u>printer</u> to transfer your letter from the computer onto paper.
5. Point to the system unit.	Explain that even though you can not see the activity of the <u>system unit</u> it is the most important part of the computer system. It acts as the computer's control center, processing and directing the flow of information through the system and coordinating the activities of the other computer parts.

Finding the Right Application for the Job

This table will help you find the right software application for the job you want to do.

If you want to ...	You need this application
Write a letter, article or report	A word processing program such as *Microsoft Word*, *WordPerfect* or *Ami Pro*.
Create a newsletter brochure or flyer	A desktop publishing program such as *Microsoft Publisher* or *Aldus PageMaker*.
Balance your checkbook, create a budget or track your personal finances	A personal finance program such as *Quicken*, or *Simply Money*.
Collect and manage large groups of information like mailing or inventory lists	A database manager such as *Approach*, *Access*, *dBase*, *Paradox* or *FoxPro*.
Talk with other computer users, send and receive mail or get the latest news	A modem and an on-line service such as *Prodigy*, *America Online* or *CompuServe*.
Balance accounts, track schedules or create graphs	A spreadsheet program such as *Microsoft Excel*, *Lotus 1-2-3* or *Quattro Pro*.
Make appointments, create to-do lists or keep an address book	A Personal Information Manager (PIM) such as *Lotus Organizer*, *Sidekick* or *Act*!
Manage files, fix damaged files or tune your computer	A utility such as *PC Tools* or *The Norton Utilities*.
Play games	Game software such as *Solitaire*, *Math Blaster* or *Star Wars Rebel Assault*.
Draw blueprints, design a house or create a painting	A drawing, painting or computer aided design program such as *CorelDraw* or *AutoCad*.
Learn more about a certain topic	Educational software such as *AutoWorks*, *ChemistryWorks* or *ComputerWorks*.
Look up medical information, seek legal advice or look up an article	A specialized database file such as *Home Medical Advisor*, *It's Legal* or *HyperBible*.

Adapted from: Kraynak, Joe, 10 Minute Guide to PC Computing, Indianapolis, IN: Alpha Books, 1994



Writing

Upon completion of this lesson the learner will be able to:

- define vocabulary words
- complete the vacation form, the suggestion form, and the safety investigation form using complete sentences and complete information
- communicate to others using messages and memos

Instructor Notes	Activities	Materials	Time
	Set Induction		
	Give each learner a copy of a completed form. Have learners look at the information recorded on the form. Discuss the importance of clear and complete communication.	Message	5-10 Minutes
	Guided practice		
	Introduce Vocabulary Display the transparencies one at a time. Explain the difference between a correctly completed form and one that is not completed correctly. Show the transparency of the questions. Explain each question. Tell learners to check their forms to be certain all necessary information has been included. Remind learners to use complete sentences to express thoughts or ideas.	Transparencies Overhead Projector	10-15 minutes
	Applied Practice		
	Have learners complete the exercises in their workbook. Assist learners if necessary.	Workbook	20-30 minutes
	Closure		5-10 minutes
	Discuss how the information learned can help on the job.		

Vocabulary - Writing

1. **Form** - A document with spaces left blank so information can be added.

2. **Message** - Brief Communication sent from one person to another.

3. **Memorandum or Memo** - An informal written note or reminder, usually longer than a message.

4. **Business Letter** - A formal written communication that follows a standard format.

5. **Friendly Letter** - An informal written communication.

6. **Formal** - Follows the accepted format for a business letter.

7. **Informal** - A more casual format of a letter.

8. **Heading** - The part of the letter that has your address.

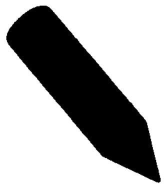
9. **Inside Address** - The part of the letter that has the address of the person who will receive the letter.

10. **Salutation** - The greeting, for example, "Dear Mandy".

11. **Body** - The main part of the letter.

12. **Closing** - The ending, for example, "Sincerely".

13. **Signature** - Your written name.



Writing For Work

Writing can be as simple as filling out a form or as complex as writing a business letter. In this group of lessons you will learn:

- how to fill out forms correctly
- how to write a message
- how to write a memo
- how to write a personal letter
- how to write a business letter

Knowing how to perform these tasks will help on the job and in your daily life.

Written forms, messages, memos and letters are used to pass on information on the job. The information may be passed on to co-workers, supervisors, or customers. All information needs to be accurate, complete, and clear.

You need to answer these questions before you begin.

1. What is my reason for writing?

2. Who am I writing?

3. Do I need to write a message, a memo, a letter, or fill out a form?

4. Should my writing be formal or informal?

5. What tone should I use for my writing?

6. What information do I need to include?

Forms

The forms you fill out at work are usually requests of one kind or another. The forms contain lines for you to record specific information. Your writing needs to be clear and accurate or the intended reader may not be able to honor your request. We are going to take a look at some of the forms you fill out at Southern Ductile.

Vacation Request Form

We will start with the vacation request form. Look at the form. What information do you need to know to complete the form? You need to know:

- how many vacation days you want to take
- how many vacation days you want to be paid for
- when you will start your vacation
- when you will end your vacation
- when you will return to work
- when you want to receive you vacation pay.

Use the information below to fill out the vacation request form. Look at the calendar to get the correct dates.

We want to take our 2 week vacation, the first two weeks in July. We want to be paid for both weeks the Friday before our vacation. Fill out the request using this information. Use your own name. Do not forget to sign and date your request.

SDCC Suggestion Form and Safety Investigation Form

To make a suggestion for improvement or to report a safety concern at Southern Ductile is easy. All you have to do is fill out a suggestion form or a safety investigation form. Because everyone thinks differently, you must explain your idea or suggestion in detail. What you are trying to say may be clear to you, but in order to have your ideas or suggestions considered you need to make it clear to all who might read them.

Look at the suggestion form. Decide what information you need to know to complete the form? Look back at the questions for help. Write your suggestion on the form.

Look at the safety investigation form. Decide what information you need to know to complete the form? Look back at the questions for help. Write your safety concern on the form.

Note: Always go back and read what you have written. If it does not make sense to you, it will not make sense to others.

Instructor Notes	Activities	Materials	Time
	Set Induction		
	Show the transparency containing the message, "The class will write a letter as part of the next lesson". (Use wingdings for the font.) Tell learners they have 30 seconds to read the message. Ask for a volunteer to read the message. Ask learners if they would have written a message or a memo, and why.	Transparency	5-10 Minutes
	Guided practice		
	Show the learners the transparencies of the message and memo one at a time. Explain the difference between a message and a memo.	Transparencies	10-15 Minutes
	Applied Practice		
	Have learners complete the exercises in their workbook.	Workbook	15-20 Minutes
	Closure		
	Discuss the importance of written communication on the job. Ask how the lesson will help the learner be a more effective communicator.		15-20 Minutes

Messages and Memoranda

A message is an informal, written way of communicating to others. A message uses a few words to get the point across to the reader. You may use a message to tell an employee on another shift about a problem you are having with the machine.

Look at the message below. Write a message to your supervisor. Let your supervisor know that you adjusted the machine and now things are running smoothly. Remember to use a few words to get your point across to the reader. Use your own words for the message.

Date:______________________________
William, Clean Laempe and complete the orders on clipboard at B&P.
Signed: Harvey

Look at the memo below. Write a memo to another department asking them to be a member of your softball team. Be sure to include the days and times of your practices along with when and where your games are played. You might want to tell them your team name.

August 10.1995

MEMO TO: ALL EMPLOYEES
FROM: PERSONNEL DEPARTMENT
SUBJECT: SOFTBALL TOURNAMENT

The softball tournament has been scheduled for Saturday, August 19 at 1:00 PM in Centreville, at a field to be announced at a later time.

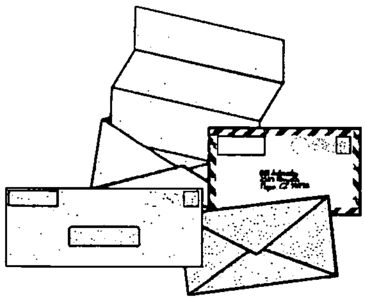
The schedule for the games is as follows;

1:00 PM	Bessemer VS. Selma
2:00 PM	Centreville VS Bessemer
3:00 PM	Selma VS Centreville

There will be a time limit of one (1) hour per game. In the event of a tie, there will be a play-off game at 4:00 PM

Gatorade and soft drinks will be provided by the Company.

Bring the family and come on out to see who comes home with "bragging rights" this time!



Writing

Upon completion of this lesson the learner will be able to:

- define vocabulary words
- write a business letter and a friendly letter using correct form and appropriate tone

Instructor Notes	Activities	Materials	Time
	Set Induction Show the transparency. Ask if the letter is a friendly letter or a business letter. Ask what the difference is between a friendly letter and a business letter. Discuss the tone of the letter.	Markerboard Kit	5-10 Minutes
	Guided practice Write a business letter on the board. Have the learners assist you with the content of the letter. Ask how they feel when they read this letter. Explain the importance of tone. Review Vocabulary	Markerboard Kit	10-15 Minutes
	Applied Practice Have learners complete the exercises in their workbook. Circulate around the room. Assist learners if necessary.	Workbook	20-25 Minutes
	Closure Ask for a volunteer to read one of their letters. Have the class decide if the letter is a business letter or a friendly letter. Ask, "What is the tone of the letter?"		

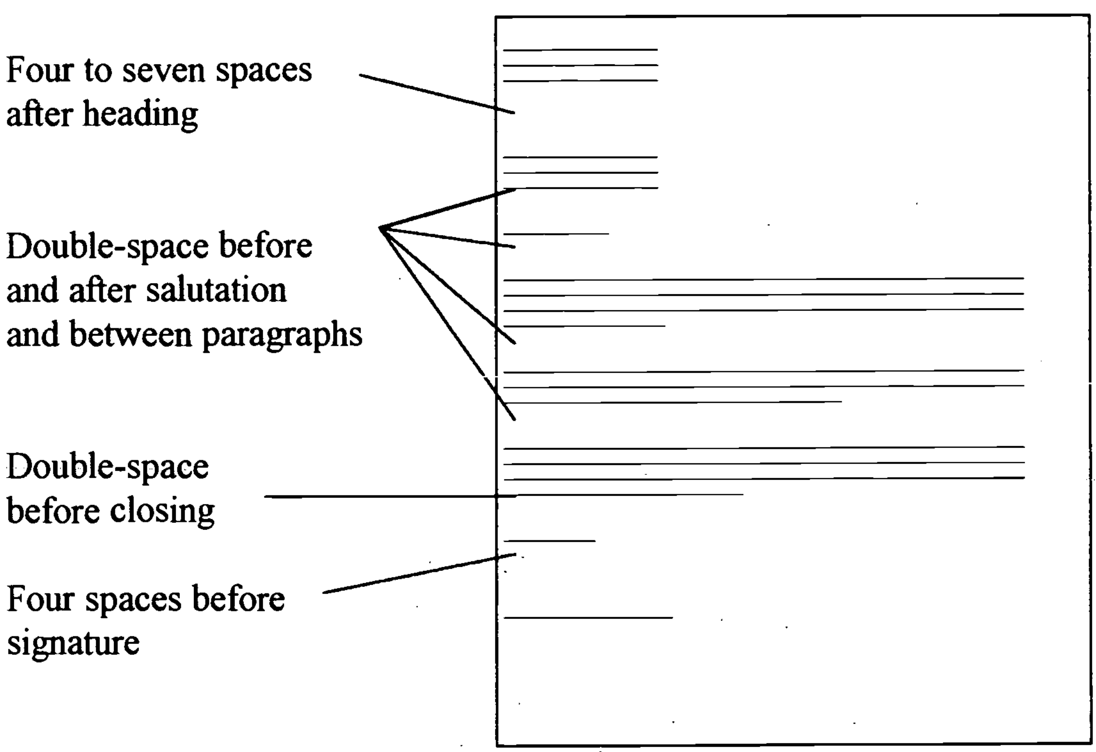
Add POWER to your writing

To communicate effectively you need to put **POWER** in your writing. What does that mean? It means that you should:

Plan
Organize
Write
Edit
Revise
your letter before you put it in the mail.

Writing is a form of communication. The way you communicate depends on what you are writing. A business letter is a more formal letter. A personal letter has more detail. The format or style of the letter is also important. The format or style of a business letter is very different from that of a friendly letter.

Business Letter Format



Look at the sample business letter. Notice the format of the letter. Write a business letter to inform your bank of a change of address.

Sample Business Letter

2998 Short Street
Bessemer, AL 35020
April 10, 1996

George Doe
122 Tennessee Ave.
Washington, DC 20036

Dear Mr. Doe:

I am writing to request your recent catalog. A friend told me you have some great craft projects. I am especially interested in projects with wood. I look forward to seeing the catalog.

Thank you for the catalog.

Sincerely,

Jack Sprig

Look at the sample friendly letter. Notice the format of the letter. Write a friendly letter to tell a relative what you are doing in class.

Sample Friendly Letter

715 Cactus Ave.
El Paso, TX 00000
April 22, 2010

Dear Mike,

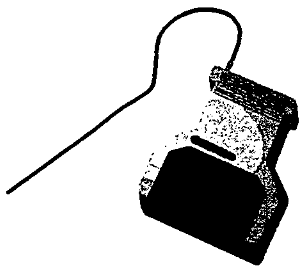
How is the weather in your part of the country? We have had sixteen inches of snow to fall in the past three days. We are out of school due to all this snow. I never thought I would say this but I am sick of the snow. I was told that we may have to go to school on Saturday to make up the days of school we miss.

I really look forward to my two week stay at your ranch this summer. I hope we can go camping while I am visiting. Is Mark coming to visit you while I am there? I really enjoy having him with me on the camping trips. He can tell some great fireside stories. Don't you think his stories are funny?

I haven't been doing much since I wrote you last. In May I will be going to Washington, DC with a group from school. We are going to all the sights we possibly can in four days. I am interested in the Air and Space Museum. What would you like to visit if you were in DC?

The reason I am writing again so soon is because we have to write a friendly letter in my class. I hope my teacher thinks this is a good letter. Please write back soon!

Your best friend,



Bar Coding

Upon completion of this lesson the learner will be able to:

- define vocabulary words relating to bar coding
- explain the benefits of bar coding to the production process at Southern Ductile
- read the general description of bar coding and answer questions
- list the bar coding steps that must be performed before starting the job

Instructor Notes	Activities	Materials	Time
	Set Induction Have learners take turns placing their fingerprints on the transparency. Display the transparency on the overhead projector. Ask learners why fingerprints are useful. Lead the class in a discussion of the various uses of fingerprinting. Explain that Southern Ductile will soon be introducing a product identification system called bar coding.	Ink Pad - Water-based Overhead Projector Blank Transparency	5 minutes
	Guided Practice Have learners follow along in their workbook as you read the "Introduction To Bar Coding." Ask if there are any questions.	Workbook	20 Minutes
	Applied Practice Have learners complete the exercise in their workbook Review Vocabulary.	Workbook	15 Minutes
	Closure Discuss the answers to the exercises. Ask if there are any questions.	Workbook	5 Minutes

An Introduction to Bar Coding

The widespread use of computers created the need for better ways to collect data. Bar coding was developed to meet this need. The first general use of bar codes was in the grocery industry. Today most supermarkets place bar code labels on their products. At the check-out counter cashiers use bar code scanners to read the bar code labels on each item. The bar code scanners transfer the data on each item purchased to the store's computer system. Bar codes have now spread far beyond the supermarket counter. They are now used in many other businesses and organizations. Hospitals, libraries, schools and many manufacturing firms now use bar codes. Very soon bar coding technology will be coming to Southern Ductile.

Bar codes are symbols consisting of lines and spaces of varying lengths. They are used to identify and track many types of commercial products. Bar code scanners are used to read and interpret bar code data. Scanners convert the lines and spaces of the bar code into electrical signals. The electrical signals are then sent to computers to be processed into useful information.

Bar codes have several advantages over more traditional identification systems. Two of the most important advantages are:

1. They are accurate. Since bar code data can be scanned and sent directly to the computer system, keyboard errors will be reduced. This means the customer will get the most accurate information.

2. They are efficient. Bar coding reduces much of the work involved in collecting data. Bar coding eliminates the need to spend time writing product data on paper forms. It also eliminates the need to use the keyboard to enter this same data into the computer.

Bar codes will be introduced as a part of Southern Ductile's data collection and processing system. This will take place in two steps.

1. The first step will bring bar codes to the shipping department. Several customers have requested that bar codes be placed on their shipping containers. Very soon bar code labels will be attached to each shipping container. A bar code label will be printed and placed on the container in the Quality Control inspection area after the castings are released for shipment. This label will contain the customer part number. After the castings are weighed, a shipping inspector will place a second bar code label on the casting container. The second bar code label will contain the customer order number, the container weight and the number of castings. The shipping department forklift operator will use a hand-held radio frequency scanner to scan the boxes to be loaded onto the trucks for shipment. At each stage of the bar code process, data is sent to the company's computer system and updated.

2. The second step will extend bar codes to the molding, coremaking, and grinding operations. This will change the way you, as a molder, perform your job. Before running an order, you will enter the customer order number, the part number and the number of molds to be made into a bar code terminal at your work station. Next you will run your bar code ID through the bar code scanner. Your bar code ID and the start time for the order will then be sent to the company's computer system. You will no longer complete your paper downtime report form. Instead you will enter the downtime information at the bar code terminal. After completing your order you will enter the number of molds produced. You will again run your badge through the bar code scanner. The number of molds and the time you completed the job will be sent to the computer. The computer will then calculate your molding efficiency for that job.

The use of bar coding in the molding, coremaking and grinding departments will help the order administration department. Bar coding data will be continually sent to the computer to be updated. This will allow order administration to better track customer orders during each step of the production and shipping process.

Answer the following questions.

1. Why was bar coding developed?

   Bar coding was developed in response to the need to develop a better way to collect information for computers.

2. Explain one advantage of bar coding.

- **Bar coding is accurate. Because it is automatic it is also more accurate. Errors are reduced because there is less chance of human error.**

- **Bar coding is efficient. It is efficient because it eliminates much of the manual labor involved in collecting and entering data into the computer.**

3. Where will bar codes be introduced first at Southern Ductile?

   Bar codes will first be introduced in the shipping department.

4. What is a bar code scanner?

   A bar code scanner is a device used to read bar code data and transfer this data to a computer.

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