MASSACHUSETTS MARITIME ACADEMY

BUZZARDS BAY, MASSACHUSETTS

MARINE ENGINEERING DEPARTMENT

Machine Tool Technology

EN -2112
FALL 15
Course Policy and Syllabus

CADET _____

CLASS SECTION_____LAB SECTION_____

DATE _____

Massachusetts Maritime Academy
Machine Tool Technology, EN-2112
SYLLABUS AND COURSE POLICY

Instructor: Lt. Mahoney
Licensed USCG Chief Engineer, Steam.
3rd Asst. Engineer, Motor
Office Hours: 11:00-12:00, Monday
11:00-12:00, Tuesday
12:00-13:00, Wednesday

Texts:
Machine Tool Practices **(MTP)**. Authors: Kibbe, Neely, Meyer, White. Publisher, Prentice Hall; (10 TH EDITION)
How To Run A Lathe **(HTRAL)**. Publisher, South Bend Lathe
Welding Technology Fundamentals **(WTF)** Publisher, Goodheart-Willcox Inc.
Handouts

Course Composition:
Course consists of a 1 hour lecture and a 3 hour lab weekly. Labs alternate weekly between Machine Shop and Welding Lab. Course credit is 2

Learning Objectives:

- **Set-up and dress the wheels on the bench grinder.**
- **Off-hand grind a 60 degree thread form tool and radius form tool on a high speed steel tool blank.**
- **Set-up and operate the lathe and tooling for facing, centerdrilling, turning and threading a test coupon to blueprint specifications.**
- **Correctly align tool and test coupon and chase an existing thread.**
- **Operate the band saws, drill press, hydraulic press and hand tools.**
- **Use precision measuring instruments**
- **Set up and use an oxy- fuel cutting torch**
- **Set-up and adjust SMAW equipment and weld a lap joint in the flat position**
- **Set-up and adjust SMAW equipment and weld a lap joint in the vertical position**
- **Be able to identify welding defects using dye penertrant testing.**
- **Demonstrate proficiency in the following STCW elements.**
  OICEW-1-1A Cut a circular hole using oxyacetylene process
  OICEW-1-1B Form two steel plates using brazing process
  OICEW-1-1C Form two steel plates using electric arc welding process
  OICEW-1-1F Visual test of welded joint
  OICEW-1-1G Dye-penetrant test of welded joint
  OICEW-8-1A Lathe project.

Course Policy:
Attendance is **mandatory**. The students must come prepared with appropriate safety equipment, books and materials. **Students will not be admitted to class or labs after the start of the period.** Each missed class will result in a reduction of the final grade by **4** points. Weekly quizzes will be given; quiz material will be from lectures, labs and reading assignments. **Reading assignments must be read before the due date listed on the syllabus.** All missed quizzes must be rescheduled within 24 hours. No cell phone use is allowed in class. No programmable calculators are allowed in class.

Labs:
Students must sign the muster sheet for each lab. The student must attend on their scheduled day and session. Labs run in 2 week cycles. Students must make arrangements with the instructor to make up a missed lab within **24** hours of the missed lab. The lab needs to be made up during the two week cycle, **while that lab is still being conducted**. Failure to do so will result in an **incomplete.** Lab grades are determined by participation, work habits, conduct, instructor assessment, pop quiz grades, and the

successful completion of projects. Each student must complete the lab projects successfully. All students will come prepared for the lab with a 3 ring binder containing the semester labs handouts and PPE.

Grading:
There will be weekly quizzes. The questions will be drawn from lectures, lab sessions, and the Marine Engineering Workbook and texts.
The final grade will be determined as follows:

Machine Shop Lab	x .20
Weekly Quizzes	x .60
Final Exam	x .20

Welding lab is pass or fail
A minimum grade of C- is required to pass this course.

Massachusetts Maritime Academy is committed to providing reasonable accommodations for students with documented disabilities. The Director of Disability Compliance works in collaboration with faculty and other campus departments to provide support for students with disabilities. This coordination of efforts complies with the mandates of Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990.

Week	Book & Topic VER 10	PAGES	Due Date Month/Day
2. Safety (lathe)	Safety (Lab 1 handout)		
	(MTP) Hazards in lathe operations)	375-377	
Safety (welding)	(WTF) Weld safety, checklist	13-19	
.			
Tooling	(MTP) Toolholders, cutting tools	386-400	9/9
OFW & Gas Cutting	(WTF) Equipment & Supplies	Chap 20	.
3. Lathe Basics	(MTP) Engine lathe	379-385	9/16
Spindle	(MTP) Spindle tooling	401-406	
Operating Controls	(MTP) Controls	407-411	
Facing, Ctr. Drilling	(MTP) Facing, ctr. drilling	413-421	
OFW & Gas Cutting	(WTF) Equipment assy. and adj	Chap 21	.
4. Turning between Centers	(MTP) Work between centers	422-434	9/23
Alignment of Centers	(MTP) Alignment of centers	435-437	
Oxyfuel Gas Cutting	(WTF) Gas cutting	Chap 22	.
5. Other Lathe Operations	(MTP) Drilling, boring etc.	438-451	9/30
Brazing and Braze Welding	(WTF) Brazing and Braze Welding	Chap 25	.
6. 60 deg. Thread	(MTP) Calculations	452-455	10/7
Cutting Ext Thrd.	(MTP) Cutting ext. UNC thrd.	457-467	
Physics Of Welding	(WTF) The physics of welding	Chap 3	
Weld Joints	(WTF) Weld joints and positions	Chap 4	.
7. Hand Tools	(MTP) Hacksaws	55-57	10/14
	(MTP) Files	58-63	
	(MTP) Hand reamers	64-67	
	(MTP) Taps	68-78	
	(MTP) Dies	79-82	
SMAW	(WTF)Equipment & Supplies	Chap 5	
SMAW	(WTF) Equipment Assy & Adj.	Chap 6	.
8. Measurement	(MTP) Steel rules (inch)	105-111	10/21
Direct Measurement	(MTP) Vernier caliper (inch)	114-117	
	(MTP) Dial caliper (inch)	120-121	
Micrometer Inst.	(MTP) Types, readings	123-138	
Vernier Mics.	(MTP) Reading vernier mics.	141-143	
Comparison Instruments	(MTP) Comparison Instruments	144-155	
SMAW	(WTF) Electrodes	Chap 7	.
	(WTF) Flat welding position	Chap 8	.
9. Lathe Tapers	(MTP) Cutting tapers	472-482	10/28
SMAW	(WTF) Horizontal, vert. & OH positions	Chap 9	.
10. Steady & Follower Rests	(MTP) Using rests	483-488	11/4
SMAW	(WTF) Surfacing	Chap 10	.
11. Sawing Machines	(MTP) Sawing machines	293-301	11/18
	(MTP) Using recip & horz machines	302-311	
	(MTP) Abrasive & Cold saws	312-314	
Vertical Band Machine	(MTP) Prep & usage	315-323	
Welding Symbols	(WTF) Welding symbols	Chap 33	.
12. Drilling Machines	(MTP) Types	331-334	
	(MTP) The drill press	335-337	12/2
Drilling tools	(MTP) Drilling tools	338-346	
	(MTP) Hand grinding	347-350	
Drilling operations	(MTP) Operating drilling machines	351-362	
Countersinking & boring	(MTP) Countersinking	363-365	.
13. Inspection & Testing Welds	(WTF) Inspection and testing welds	Chap 34	12/9

Week	Book & Topic VER 9	PAGES	Due Date Month/Day
2. Safety (lathe)	Safety (Lab 1 handout)		
	(MTP) Hazards in lathe operations)	387-390	
Safety (welding)	(WTF) Weld safety, checklist	13-19	
.			
Tooling	(MTP) Toolholders, cutting tools	399-412	9/9
OFW & Gas Cutting	(WTF) Equipment & Supplies	Chap 20	.
3. Lathe Basics	(MTP) Engine lathe	391-398	9/16
Spindle	(MTP) Spindle tooling	413-419	
Operating Controls	(MTP) Controls	420-424	
Facing, Ctr. Drilling	(MTP) Facing, ctr. drilling	425-434	
OFW & Gas Cutting	(WTF) Equipment assy. and adj	Chap 21	.
4. Turning between Centers	(MTP) Work between centers	435-447	9/23
Alignment of Centers	(MTP) Alignment of centers	448-450	
Oxyfuel Gas Cutting	(WTF) Gas cutting	Chap 22	.
5. Other Lathe Operations	(MTP) Drilling, boring etc.	451-464	9/30
Brazing and Braze Welding	(WTF) Brazing and Braze Welding	Chap 25	.
6. 60 deg. Thread	(MTP) Calculations	465-469	10/7
Cutting Ext Thrd.	(MTP) Cutting ext. UNC thrd.	470-480	
Physics Of Welding	(WTF) The physics of welding	Chap 3	
Weld Joints	(WTF) Weld joints and positions	Chap 4	.
7. Hand Tools	(MTP) Hacksaws	54-56	10/14
	(MTP) Files	57-62	
	(MTP) Hand reamers	63-66	
	(MTP) Taps	67-76	
	(MTP) Dies	77-80	
SMAW	(WTF)Equipment & Supplies	Chap 5	
SMAW	(WTF) Equipment Assy & Adj.	Chap 6	.
8. Measurement	(MTP) Steel rules (inch)	107-113	10/21
Direct Measurement	(MTP) Vernier caliper (inch)	116-119	
	(MTP) Dial caliper (inch)	122-123	
Micrometer Inst.	(MTP) Types, readings	125-139	
Vernier Mics.	(MTP) Reading vernier mics.	143-145	
Comparison Instruments	(MTP) Comparison Instruments	146-157	
SMAW	(WTF) Electrodes	Chap 7	.
	(WTF) Flat welding position	Chap 8	.
9. Lathe Tapers	(MTP) Cutting tapers	485-495	10/28
SMAW	(WTF) Horizontal, vert. & OH positions	Chap 9	.
10. Steady & Follower Rests	(MTP) Using rests	496-501	11/4
SMAW	(WTF) Surfacing	Chap 10	.
11. Sawing Machines	(MTP) Sawing machines	302-312	11/18
	(MTP) Using recip & horz machines	313-322	
	(MTP) Abrasive & Cold saws	323-325	
Vertical Band Machine	(MTP) Prep & usage	326-340	
Welding Symbols	(WTF) Welding symbols	Chap 33	.
12. Drilling Machines	(MTP) Drill machine types	341-345	
	(MTP) The drill press	346-348	12/2
Drilling tools	(MTP) Drilling tools	349-357	
	(MTP) hand grinding drills	358-361	
Drilling operations	(MTP) Operating drilling machines	362-373	
Countersinking & boring	(MTP) Countersinking	374-375	.
13. Inspection & Testing Welds	(WTF) Inspection and testing welds	Chap 34	12/9

	Monday	Tuesday	Wednesday	Thursday	Friday
		1 Orientation	2 LAB 1	3 LAB 1	4
SEPT	7 HOLIDAY	8 ADD LAB 1	9 CLASS 1 LAB 2A	10 LAB 2A	11
	14 LAB 1	15 LAB 2A	16 CLASS 2 LAB 2B	17 LAB 2B	18
	21 LAB 2A	22 DROP LAB 2B	23 CLASS 3 LAB 3A	24 LAB 3A	25
	28 LAB 2B	29 LAB 3A	30 CLASS 4 LAB 3B		
				1 LAB 3B	2
OCT	5 LAB 3A	6 LAB 3B	7 CLASS 5 LAB 4A	8 LAB 4A	9
	12 HOLIDAY	13 MONDAY SCH LAB 3B	14 15 CLASS 6 LAB 4B	15 LAB 4B	16
	19 LAB 4A	20 LAB 4A DEFICIENCIES	21 CLASS 7 LAB 5A	22 LAB 5A	23
	26 LAB 4B	27 LAB 4B	28 CLASS 8 LAB 5B	29 LAB 5B	30
	2 LAB 5A	3 LAB 5A	4 CLASS 9 LAB 6A	5 LAB 6A	6
NOV	9 LAB 5B	10 LAB 5B WITHDRAW	11 HOLIDAY	12 LAB 6B	13
	16 LAB 6A	17 CLASS 9 LAB 6A	18 CLASS 10 LAB 6B	19 LAB 7A	20
	23 LAB 6B	24 LAB 6B	25 HOLIDAY	26 HOLIDAY	27 HOLIDAY
	30 LAB 7A				
DEC		1 LAB 7A	2 CLASS 11 LAB 7A	3 LAB 7B	4
	7 LAB 7B	8 LAB 7B	9 CLASS 12 LAB 7B	10	11 End Classes
	14 Finals	15 Finals	16 Finals	17 Finals	18 Finals

MASSACHUSETTS MARITIME ACADEMY

BUZZARDS BAY, MASSACHUSETTS

ENGINEERING DEPARTMENT

Machine Tool Technology

EN -2112

Lab #1
Safety
Lathe Introduction
OXY-FUEL

CADET _____

SECTION _____

MACHINE SHOP SAFETY

Students should realize that a major part of shop safety is based upon common sense and thinking ahead. It is an accepted fact that forethought and the elimination of carelessness can avoid virtually all shop accidents. The shop is a potentially dangerous place.

Types of hazard you may encounter, noise, fumes, flying chips, slips, pinch points.

Accidents can be career ending—losing an eye, hand,

Before you make a move, think about what might occur. THINK AHEAD. Develop the habit of never trusting mechanical devices. Never place yourself in a position where you could be hurt if something mechanical failed. Your hands are especially vulnerable. Always be on the watch for possible pinch points that could develop. Give your undivided attention and thought to the task before you. Daydreaming or talking with a friend reduces your attention on the job.

Maintaining shop safety is a full-time job. You can never relax in your accident prevention habits. Remember that safety is a habit, and it must be practiced until it is automatic. If you ever encounter a situation you're not sure of with regard to safety, consult the instructor.

General Safety Precautions

1. Always wear eye protection and PPE equipment when in shop. (**Safety glasses, shoes etc.**)
2. Loose clothing or long sleeves should not be worn in the shop. Machines can easily grab loose clothing in rotating parts. If long sleeves are worn they must be rolled above the elbow. No hooded sweatshirts with drawstrings are allowed.
3. No jewelry should be worn which might get caught in a machine.
4. Make sure the machine is OFF before making any adjustments or repairs.
5. Do not set up or operate any machinery unless an instructor is in the shop.
6. Do not operate any machine unless authorized to do so by an instructor or under an instructor's supervision.
7. Be sure that all machines have effective and properly working guards and covers, and that they are always in place when machines are operating.
8. Even after the power is off, do not leave the machine until it has stopped running. Someone else may not notice that it is still in motion and be injured. Do not leave a machine until it has come to a complete stop.
9. Stop the machine tool to make speed and feed changes that require the shifting of a gear lever.
10. Always use correct speeds and feeds. A broken tool becomes a hazard and can cause great personal injury.
11. **Remove all keys from chucks before starting machines.**
12. Do not attempt to oil, clean, adjust, or repair any machine while it is running.
13. Do not try to stop the machine with your hands or body.

14. No horseplay……..
15. Always see that work and cutting tools on any machine are clamped securely before starting to work.
16. Only one person should operate the machine or switches.
17. Use the proper tool for the job. Many cuts in the shop occur because a wrench slips and a hand hits a sharp cutting tool.
18. Check tools before use to assure they are safe to use.
19. Do not leave tools or work on the table of a machine even if the machine is not running. Tools or work may fall off and cause a toe or foot injury.
20. Put tools away when not in use.
21. Place all scrap pieces in the correct containers.
22. Never handle chips with your hands or fingers. Chips are extremely sharp and can easily cause cuts.
23. Use a brush to remove chips -- not hands, fingers, or rags.
24. Use a pair of pliers to remove chips, especially the long, stringy type.
25. Never wear gloves or use rags to clean the workpiece or any part of a machine that is running. Rotating tools or parts can grab gloves and rags and pull you into the machine.
26. Always remove gloves before turning on or operating any machine. If material is rough or sharp and gloves must be worn, place or handle material with the machine turned off.
27. Never use compressed air to clean any machine.
28. Never use compressed air to clean your clothes or yourself.
29. Do not run in the shop; there should be no "fooling around" in the shop at any time.
30. Get first aid immediately for any injury.
31. Get help for handling large, long, or heavy pieces of material or machine attachments.
32. Follow safe lifting practices; lift with your leg muscles, not your back. If you do not know how to lift safely, ask an instructor to show you.
33. Be sure you have sufficient light to see clearly. Check with an instructor if you do not have enough.
34. Aisles should be clear at all times to avoid tripping or other accidents.
35. Store materials in such a way that they cannot become tripping hazards.
36. Keep the floor free of oil, grease, or any other type of liquid. Clean up spilled liquids immediately; they are slipping hazards.
37. All set-screws should be of the flush or recessed type. If they are not, move with caution when near them. Projecting set-screws are very dangerous because they may catch on sleeves or clothing.
38. Do not walk behind a person operating a machine; you may bump him/her by accident or startle them and cause an accident.
39. Do not lean against the machine (s).
40. Concentrate on the work and do not talk unnecessarily while operating the machine.
41. Do not talk to others when they are operating a machine. A distraction may lead to an injury.

BENCHWORK SAFETY

HACKSAW SAFETY

1. Use the Correct Blade for the job.
2. See that the Blade is correctly secured in the frame
3. Be sure that the work is held securely in the vice.
4. When the saw breaks through the work, ease up on the pressure so the hand will not strike the work or the vise.
5. Do not force the cut.

TAPS AND DIE SAFETY

1. Be sure the work is firmly mounted in a vice
2. Secure the proper size tap wrench
3. Avoid cutting hands on a broken tap end.
4. If a tap is removed with a punch and hammer make sure goggles are worn.
5. If a long thread is cut with a die watch out for sharp threads coming through the die.

FILE SAFETY

1. Always use a file with a handle.
2. When filing in a lathe, learn to file left-handed.
3. Keep the file and hands clear of the chuck jaws or dog.
4. Do not use a file as a pry bar.
5. Keep a firm grip on the file at all times.
6. Do not blow away filings.

CHISEL SAFETY

1. Keep the Chisel head free from burring by grinding. Grind mushroomed head
2. Hold the Chisel and hammer firmly and keep the chisel head and hammer free from grease.
3. Make sure you are wearing safety glasses.

HAMMER SAFETY

1. Hammers that are chipped should be thrown out.
2. Never use a hammer with a loose or split handle.

SCREWDRIVER SAFETY

1. Select screw drivers to fit the screw head being used.
2. Keep Screwdriver handles smooth.
3. Do not use a hammer on a screw driver handle.
4. Avoid holding work in hand when using a screwdriver on it, as it may slip and cause a stab wound.
5. Never Grind a Screwdriver to a chisel edge.

WRENCH SAFETY

1. Discard wrenches that are spread.
2. Select the correct size wrench
3. Avoid using adjustable wrenches
4. It is safer to pull a wrench than to push a wrench
5. Be sure your knuckles will clear obstructions when the wrench turns.

MACHINE SAFETY

GRINDER SAFETY Pedestal or Bench

1. **Stand to one side out of line of wheel when starting it up especially if wheel is new.**
2. The face of the wheel must be flat and free of grooves.
3. Work must be fed slowly and gradually. Using too much pressure or striking the wheel suddenly my cause the wheel to break.
4. Make sure that tool rest is 1/8" or less from the face of the wheel. Too much clearance may cause work to jam the wheel and break it.
5. Do not set the tool rest while machine is in motion.
6. Use the face of the wheel only unless it has been designed for grinding on the side.
7. Use entire face of the wheel to avoid grooving.
8. Never use a grinding wheel that is loose on its shaft.
9. Never use a wheel that is not rated for the speed of the grinder.
10. Stop the wheel if it chatters or vibrates excessively. (this may mean wheel is not balanced or not attached securely on the spindle .)
11. All wheels should be tested for soundness. (ring tested) Hold wheel on a pin or in your hand and tap lightly with a wooden mallet or screw driver handle. A good wheel will give a clear ringing sound a cracked wheel will sound dull.
12. Use clamp or other suitable device for holding short pieces.
13. Always use face shield or goggles even if grinder has glass shields.

GRINDER SAFETY (SURFACE)

1. Be sure magnetic chuck is thoroughly clean.
2. Test holding power of chuck before starting machine.
3. Stand to one side of wheel before starting up.
4. Check to see that the wheel properly clears the work.

DRILL PRESS SAFETY

1. Use drills properly sharpened to cut to the right size and see that the drill is running true.
2. Small drills should revolve at high speeds and large drills at low speeds. Reduce speed by 50% when drilling cast iron.
3. Use Correct speed--- (CS X 4)/D
4. Use correct feeds. Smaller drills such as 1/8" use .001 to .002 IPR (inches per revolution) larger drills above ½ inch use .007 to .015 IPR. Forcing or feeding too fast may result in broken or splintered drills and injury.
5. Chuck wrenches must be removed from drill chucks before starting the machine.
6. Never attempt to hold work under the drill by hand. Always clamp work to table.
7. Change belt for speed regulation only when power is off and machine has stopped
8. If work slips from clamp never attempt to stop it with your hands. Stop machine and make adjustments.
9. File or scrape all burs from drilled holes.
10. Keep your head back and well away from any moving part of the drill press.

LATHE SAFETY

1. Before turning on the power, check to see that the tailstock, tool holder, and job are properly clamped.
2. Use hand power only when putting on or removing chuck or faceplate.
3. When assembling or removing the chuck place board on ways to prevent damage to machine and operator in case chuck falls. Have firm grip on chuck as it nears the end of the thread.
4. **Do not leave chuck wrench or any other tool in chuck. Chuck wrench should never leave your hand unless it is in tool box.**
5. Do not use a wrench on revolving work or parts.
6. Never try to measure work or feel the edge, or adjust the cutting tool when the lathe is running.
7. **Remove tool bits before cleaning.**
8. Do not shift or change gears while the lathe is running.
9. Always cycle carriage before use.
10. When filing on a workpiece in the lathe make sure the file has a wooden handle on the tang. Stand to one side so if file is forced upward it will go past your body. File left-handed.

BASIC LATHE COMPONENTS

One of the most important machine tools is the lathe.

A lathe consists of the following basic parts

HEADSTOCK

1. Found on left hand side of lathe.
2. Holds spindle to which are attached chucks, faceplates, live center, collets, drive plates etc.
3. Contains the spindle speed changing mechanism. Gears, belts, Variable speed.
4. Contains Back gears for low speed operation. (usually found with older belt driven machines)
5. Contains bull gear lock pin.
6. Spindle nose (end of spindle that holds chucks) (three types) threaded cam lock and long tapered key type. (SPINDLE IS HOLLOW)
7. Contains feed reverse lever (some lathes) (feed reverse lever sometimes found on carriage. This reverses the direction of the selected feed.

BED

1. Contains the ways
2. Called the backbone of the lathe. (must be rigid to withstand heavy cuts)
3. Contains the gear rack (under the ways for hand feeding the carriage longitudinally)
4. Aligns and supports the carriage and tailstock to the headstock.

CARRIGE

1. Contains the cross slide (movement is 90 degrees to the axis of the lathe).
2. Compound rest (holds tool post) can be swiveled to different angles.
3. Saddle supports cross slide and compound rest.
4. Apron contains gears and clutches for feeding and threading.
5. Clutch initiates the type of feed that you have selected.
6. Feed change lever (determines the type of operation ex longitudinal feed, cross feed, threading)
7. Half nut lever (initiates the carriage movement for threading)
8. Thread dial (tells you the correct position of the lead screw and when to operate half nut lever.
9. Carriage hand wheel for hand movement of carriage parallel to axis of lathe bed.
10. Carriage lock. Used to lock carriage to ways for facing operation
11. Automatic movement of carriage and crossfeed is from gearbox using leadscrew or in some cases a separate feed screw.

TAILSTOCK

1. Contains spindle and spindle clamping lever.
2. Tail stock locking clamp.
3. Set over set screws.
4. Tapered spindle hole. (Morse Taper)
5. Contains dead center or other tooling.
6. Can slide along ways.

QUICK CHANGE GEAR BOX

1. Lead screw. (transmits power to carriage for threading and sometimes for feeding)
2. Feed Screw. (transmits power for Feeding only)
3. Contains levers to provide different feeds and threads.
4. Note difference between longitudinal and cross feeds.
5. Two numbers in each block. (threads and feeds)

WELDING SHOP SAFETY

Personal Safety and Clothing

Clothes

- Dark colored to prevent less light from being reflected.
- Pants or coveralls which cover boot tops no cuffs, and covered pockets to prevent catching slag and sparks.
- Wear hat to keep hair clean and away from process.
- Clothing must cover all bare skin to prevent burns. (Button to top)
- Wear flame resistant clothing Wear cotton or wool clothing. (synthetic may melt)
- Leathers are necessary especially with overhead processes.
- Wear Steel Toe Shoes. (dropping heavy articles)
- Wear dry leather gloves. (Gauntlet gloves especially for overhead processes)
- Ear plugs should be worn for noise and when overhead welding

Contact lenses

- Do not wear contact lenses in the welding shop

Helmet and goggles

- Protect against arc flash. **(burned eyes)**
- Wear helmets for welding with correct safety lenses (SMAW min #10) (The larger the electrode size the darker the shade)
- Wear OFW goggles for cutting (min # 4) (The thicker the plate the darker the shade)
- Safety glasses should be worn under the helmet to protect eyes when helmet lifted.

Screens

- Welding arc should be screened from other personnel using walls, non flammable curtains etc.

Fire Hazards

- Combustibles such as paint, oils, cleaning products are to be kept in steel cabinets
- Loose rags and combustible items should be removed
- Check area before performing process
- Know locations of shutoffs, fire extinguishers, and exits
- Do not weld on containers that have held combustible materials.
- Keep a fire watch during and after welding or use of torch
- Light torches with approved lighter. (never use matches or butane lighter)
- Never carry butane lighters in pockets

Compressed gasses

- Correct storage – upright, safety caps on, secured correctly, stored cylinders separated by 25 ft.
- Cylinders to be clearly marked
- Full and empty cylinders marked and stored and separately

Ventilation

- Insure adequate ventilation. Use caution in confined spaces
- Some gasses are lighter than air or heavier than air and can displace oxygen. Minimum 18 per cent oxygen is needed
- Dangerous chemical elements include cadmium, zinc, lead, nickel, chromium and beryllium.
- Use respirators as necessary (positive pressure supplies constant flow of air and negative pressure filters contaminants)
- The proper selection of a respirator is based on the contaminant present and its concentration.
- Make sure your respirator provides proper protection by performing a positive and negative fit check

Electrical

- Welder must be insulated from work
- Do not contact electrode end when powered
- Use properly insulated electrode holders
- Keep in mind that water conducts electricity
- The potential for electric shock increases when the skin is damp
- High voltages may be present

Other hazards

- Lifting
- Hand and power tools
- Obstacles
- Machinery

MSDS- Material Safety Data Sheet – A form that lists the contents, hazards, and precautions that pertain to a chemical or material.

Hot Work Permit – A document that is issued by a site manager that allows a welder to perform operations with a potential risk of fire.

Note: see chart for Welding Safety Checklist on pg 18-19 in Welding Tech Fundamentals text book.

OXY FUEL SAFETY

CYLINDERS

ALL CYLINDERS-

1. Always store and transport cylinders in an upright position.
2. Always have protective caps on cylinders when moving or not in use.
3. Always secure cylinders. (chained in place) So they can not tip over
4. Do not strike, drop or heat a cylinder
5. Mark cylinders when empty
6. Do not use a cylinder with out a gas identification label
7 Store cylinders in well ventilated areas

ACETYLENE CYLINDERS

1. Special cylinders- filled with a porous material- this creates a solid cylinder - the porous material is soaked with acetone which absorbs the acetylene stabilizing it for storage at higher pressures. Acetylene can not be stored in **hollow** cylinders above **15 PSI.** (At higher pressure the acetylene breaks down chemically producing heat and pressure that could result in an explosion)
2. Must always be used in an upright position. (If the cylinder is tipped over – stand upright and wait **30** minutes before use.) (Acetone could be withdrawn causing the safety check valves and cylinders to gum up.)
3. Do not withdraw more than **1/10** of cylinder capacity per hour. (Acetone could be withdrawn causing the safety check valves and cylinders to gum up.)
4. Acetylene cylinders have **safety fuse plugs** in the top and bottom that melt a approx **212 deg F.** (used to release ACETYLENE to prevent cylinder from exploding)

OXYGEN CYLINDERS-

1. Bronze cylinder valves on top

2. **Safety plug on side of cylinder valve** to allow oxygen to escape if pressure in the cylinder rises too high.
3. When opening oxygen cylinder valves always stand to the side

REGULATORS

Regulators- Are attached to the cylinder valve. They reduce the high cylinder pressures to the required lower working pressures and maintain a steady flow of gas from the cylinder

The pressure adjusting screw controls the gas pressure. Turned clockwise it increases the flow of gas turned counterclockwise it decreases the flow of gas. Turned counterclockwise until loose it stops the flow of gas. Acetylene gas is unstable above 15 PSIG and should never be used above this pressure.

Most regulators contain two gauges. The high pressure or cylinder pressure gauge indicates the actual cylinder pressure. The low pressure or working pressure gauge indicates the pressure of the gas leaving the regulator.

Oxygen regulators differ from Acetylene regulators. Oxygen regulators are often painted green and always have right hand threads on all connections.

Acetylene regulators are often painted red and have left hand threads on all connections. (As a reminder the a v notch may be cut around the nut)

HOSES

Hoses have similar colors and threading and grooving as regulators depending on the type of service. Sometimes the oxygen hose may be painted black

CHECK VALVES AND FLASHBACK ARRESTORS

Check valves and flash back arrestors are safety devices for regulators, hoses and torches. Check valves allow gas to flow in only one direction. Flash back arrestors stop fire.

When a torch is first pressurized or when it is being shut off, back pressure check valves prevent the entry and mixing of acetylene and oxygen in the hoses.

Flashback arrestors prevent flashbacks from reaching the hose and or regulators. They have a flame-retarding filter that will allow heat but not flames to pass through. Most flashback arrestors also contain check valves.

Add on check valves and flame arrestors are designed to be attached to either torch handle connections or regulator outlets.

As a minimum flashback arrestors and check valves should be attached to torch handle connections.

SETTING UP OXYFUEL EQUIPMENT

1. Transport cylinders to the workstation on a hand truck or bottle cart.
2. Secure the cylinders at the workstation.
3. Remove the protective caps from the cylinders and inspect the output nozzles to insure the seat and thread are not damaged. Place the caps where they will be available when cylinders are empty.
4. Crack open the cylinder valve momentarily to remove any dirt from the valves. (Always stand to one side to avoid injury)
5. Wipe out the connection seat with a clean cloth.
6. Attach regulators. Check that the regulator is closed. (adjustment screw loose) Check regulator fittings to ensure that they are free of oil and grease.
7. Slowly open the oxygen cylinder valve until maximum pressure registers on the high pressure gauge then open the oxygen cylinder valve completely to seal the valve packing.
8. Slowly open the acetylene cylinder valve until maximum pressure registers on the high pressure gauge then open the acetylene cylinder valve no more than ¼ to - 1/2 turns to allow the cylinder valve to be closed quickly if necessary. (If necessary keep the cylinder valve wrench on the cylinder to close the valve if necessary.)
9. Connect check valves and flashback arrestors to hose connections on regulators
10. Connect hoses to flashback arrestors and check valves on regulators
11. Adjust oxygen regulator to 3-5 lbs and clear hose for 5 to 10 seconds then shut off flow.
12. Repeat with acetylene regulator (make sure this is done in a well ventilated area.)
13. Examine hoses before connecting to the torch
14. Inspect torch handle head, valves and hose connections for oil, grease or damaged parts.
15. Inspect welding hose connections for oil, grease or damaged parts
16. Connect flashback arrestors and check valves to torch handle if not part of the torch handle.
17. Connect the green hose to the oxygen connection and the red hose to the acetylene connection.

SHUTTING DOWN OXYFUEL CUTTING EQUIPMENT

1. Close the fuel gas and oxygen cylinder valves
2. Open the fuel gas ands oxygen torch valves to allow gas to escape (Wait till the all pressure is released and all regulator valves read 0

3. Back out the fuel gas and oxygen regulator adjusting screws until they are loose
4. Close the fuel gas and oxygen torch valves
5. Coil up the hose and secure the torch to prevent damage

DISASSEMBLING OXYFUEL EQUIPMENT

1. Check that equipment has been properly shut down
2. Remove both hoses from Torch
3. Remove both hoses from the regulators
4. Remove both regulators from the cylinder valves
5. Replace the protective caps on the cylinders
6. Return the oxygen and acetylene cylinders to the proper storage places **(Never store fuel and oxygen cylinders together)**

Torch tips- Size

1. The torch tip orifice size determines the amount of oxygen and acetylene fed to the flames - Make sure that the size does not allow an acetylene flow rate in excess of 1/10 the volume of the cylinder in use. If it does you may withdraw acetone along with the acetylene and gum up the regulators.

Types of flames-

1. Carburizing Flame – Excess acetylene - used with high carbon Steel, non ferrous alloys, special heating applications, never used with cutting
2. Neutral Flame – proper proportions of acetylene and oxygen – Used for all but special cutting applications
3. Oxidizing Flame – Excess oxygen- hottest flame- usually not used - produces oxides.

Test Yourself

The following test covers the tip of the iceberg of SMAW safety.

Remember, safety is about common sense, education, and respecting equipment and processes — not gambling. If these seem easy, good;you are safety-conscious. If not, study up.

1. Why should the top button on the welder's shirt be buttoned?

2. Clothing worn during welding should be made of what?

3. Which kind of light waves are the most harmful?

4. What are the two types of burns?

5. Why do you need proper ventilation when welding?

6. Why is it important *never* to weld or cut on used containers?

7. Why should professionals check eye injuries?

8. What is meant by lockout and tagout?

9. How do you avoid electrical shock when welding?

10. What is the best preventive measure in safety?

Answers

1. *Keeping your shirt buttoned prevents throat burns. UV rays can burn the skin. Skin cancer is one of the most pervasive cancers in America. Burning your throat over and over is inviting the possibility of cancer later on.*

2.*You should always wear cotton or wool clothing for welding jobs. Wool usually is too hot, except in winter.*

3. *Ultraviolet light waves are the most harmful. It's as if you have a little sun at the end of your electrode that emits radiation that will sunburn your skin and can even blister your corneas.*

Flash burn doesn't hit until that night, causing what some have described as the sensation of rubbing sand into the eyes. Make sure your hood doesn't have any leaks. Even a pinhole can let in enough light to burn your eyes.

4. *Light and contact. Light burns are caused by UV or infrared light. Contact burns are caused by touching something that burns the heck out of you!*

5. *The vaporization of flux and metal forms a haze that should not be breathed. The welder should always stay out of the welding plume. If not outside, then forced ventilation must be used at the point of welding.*

Galvanized steel can make a welder sick from breathing the zinc. Some metals, such as beryllium, can cause deadly illness even with minimum exposure. You always should know what you are working with.

6. *There are three reasons you should never weld on used containers. They are:*

1. ***Explosive.*** *They can blow you to kingdom come!*

2. **Flammable.** You can be burned severely by flames shooting out of the tank from residual fumes.

3. **Toxic.** You can be poisoned or asphyxiated if toxic chemicals have been stored in the tank. This can happen even in a tank that seems empty, because the toxins can be absorbed into the pores of the steel.

7. *Eye injuries are common in welding because of the sparks, chipped slag, grinding rooster tails, and dust particles. It is very important that all eye injuries be checked; if something is in the eye, it may cut or scratch the surface or cause an infection.*

Always wear safety glasses and use the correct number lenses when cutting and welding.

8. *Lockout and tag out mean the equipment you are working on has had the power shut off and has been locked to prevent anyone from accidentally turning it on.*

9. *You prevent shocks by not becoming a conductor of electricity. Make sure your connections are tight, wear gloves and work boots, and stay dry.*

10. The best preventive measure in safety is common sense!

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MARINE ENGINEERING DEPARTMENT

Machine Tool Technology

EN 2112

Lab # 2
Making HSS Cutting Tools

CADET _____

SECTION _____

60 DEGREE THREAD CUTTING TOOL

The secret to cutting good threads is to have a good threading tool. Threading tools must have the proper shape to cut an accurately shaped thread, but the clearance and relief angles must be correct to produce a clean thread. The shape of the thread corresponds directly with the form of the thread to be cut (**Figure 1**).

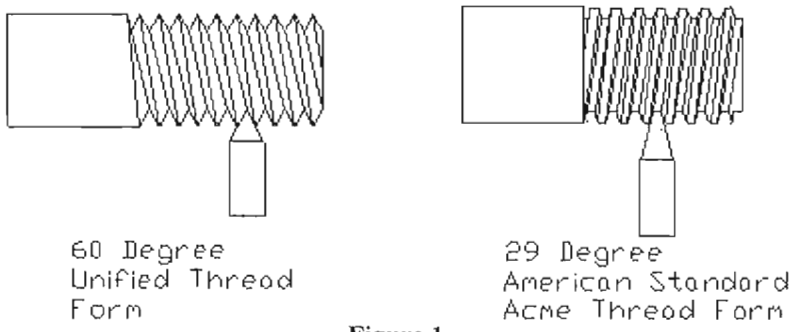


Figure 1

Grinding a thread cutting tool on a pedestal grinder is not that difficult, but you need to inspect the tool carefully. Accuracy in the tool is of great importance to the outcome of the thread. The design of the high-speed, steel cutting tool for cutting 60-degree **external right hand** unified threads is shown in **Figure 2**.

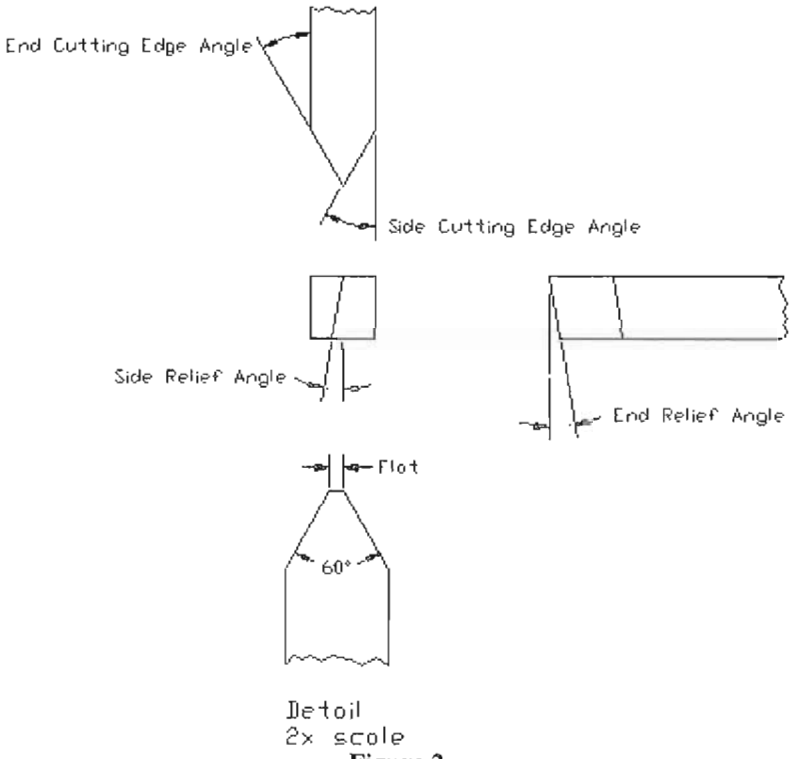


Figure 2

This tool has a 60-degree included angle and a flat on the tip which corresponds to the pitch of the thread to be cut. The larger the thread pitch, the larger the flat. The **pitch is defined as the distance from a point on one thread to the same point on the next thread** (**Figure 3**).

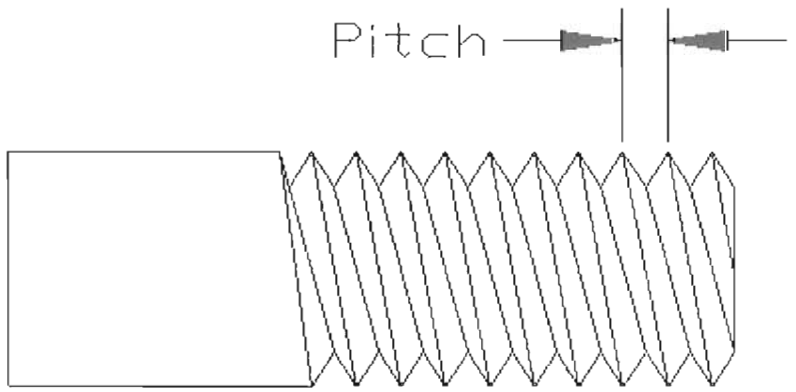


Figure 3

The thread pitch is calculated by dividing the number of threads per inch into 1, or 1 over the number of threads per inch. The flat on the tip of the threading tool is calculated from the pitch of the thread. The flat width is equal to the pitch of the thread divided by the constant of 8. The flat on the tool to cut 10 threads per inch should be 0.0125. The side relief and end cutting edge angles should have 10 to 12 degrees of clearance, much like a standard turning tool. Remember, the location of the side cutting edge angle is on the opposite side when cutting left hand threads. The front end relief will be 10-17 degrees depending on the tool holder and the hardness of the material being cut. The harder the material, the more support you want under the tool tip. If the tool tip keeps breaking off, you may have too much front clearance. Because of the fact that we use a tool holder that holds the HSS tool bit at a 16 1/2 deg. angle, it will be necessary to grind a negative back rake on the top face of the tool. **(Figure 4 & 5)**

The first step in preparing to grind a 60-degree threading tool is to dress the wheel if necessary. Wheel dressing is done to keep the wheel face straight, sharp, and true. A dull grinding wheel can cause heat to get built up in the tool, especially a sharp-pointed threading tool. Heat buildup in the tool is not good because it may make the cutting tool softer, and when we go to cut with it, the tool dulls prematurely. Start the wheel on the pedestal grinder. Always stand to the side when starting a grinder. Let the machine come up to speed and run for at least 30 seconds. Place the wheel dresser on the tool rest. Grip the handle with both hands. Slightly raise the handle. Bring the dresser up to the wheel. Move the dresser back and forth to get rid of the groove in the middle of the wheel face. Look down between the tool rest and the wheel to make sure that the wheel face is flat. Check the distance between the tool rest and the wheel. There should be no more than 1/8" clearance between them.

Before you begin grinding the tool, make sure that there is an ample supply of water or coolant available near the grinder. You are going to need to dip the tool into the water or coolant occasionally. Again, this is to avoid heat building up in the tool.

When you first attempt to grind a threading tool, it helps to lay out the tool. This way you can concentrate more on your technique rather than on your skill at judging angles.

Use a center gage, a scribe, and some dye to lay out the shape of the tool. You won't need to lay out the side relief because you won't be able to see your layout line. The side relief will come as a matter of feel.

Line the side cutting edge layout line parallel with the face of the *rough* grinding wheel. Bring the tool into light contact with the wheel. Now take and roll the bottom of the tool into the grinding wheel to achieve the 10-12 degree side relief angle. Run the tool back and forth across the face of the wheel to avoid grooving the middle of the wheel. If you are doing this correctly, the bottom of the tool will be ground more than the top. As the side cutting edge angle becomes larger, you should see the side relief angle forming. Check the relief angle using the tool bit grinding gauge. We want to keep this relief at about 10-12 degrees. But, when you do this for the first time, you are better off having too much angle rather than not enough. Remember to cool the tool off before the layout dye burns off. The layout dye will be a good indicator of heat buildup in the tool.

As you approach completion of the side cutting edge angle, look for the sparks hitting the entire top face of the tool along the cutting edge. When the sparks are hitting the top of the tool, it is a good indicator that you are getting a smooth, one-facet, grind.

When we have completed the rough side cutting edge angle, the next portion of the tool we will need to grind is the end cutting edge angle.

The end cutting edge angle helps form the thread and prevents the end of the tool from rubbing on the work. If this tool were being used to only cut right hand external threads it would not be necessary to grind a relief on the end cutting edge angle. However we are making the tool for use on both LH and RH threads.

Line the end cutting edge layout line parallel with the face of the grinding wheel. Bring the tool into light contact with the wheel. Again, roll the bottom of the tool into the grinding wheel. Remember to cool the tool off before the layout dye burns off. As you approach completion of the end cutting edge angle, look for the sparks hitting the top face of the tool. When the sparks are hitting the top of the tool and the end cutting edge angle meets the side cutting edge angle, you are finished with the rough grind.

The negative back rake angle is the next step in grinding your tool bit.

Hold the face of the tool (top) parallel with the face and centerline of the grinder. Point the tip of the tool into the wheel at a 16 degree angle and grind the face of the tool back as far as the beginning of the side and end cutting edge angles. This surface should be a one-facet grind and have no side rake.

Inspect the tool for the condition of the ground surfaces and use the center gage and cutter bit grinding gauge to check the accuracy of the angles **(Figure 6 & 7)**. Move to the finish grinding wheel. Lightly grind the side cutting edge angle making any minor modifications to the 60-degree angle. The need for these modifications may have become apparent when checking the tool with the center gage. Remember to roll the bottom of the tool into the grinding wheel to achieve the 10-12 degree side relief. As you approach completion of the side cutting edge angle look for the sparks hitting the top of the tool. This is a good indicator that you are getting a smooth, one facet, grind.

When we have completed the side cutting edge angle, the next portion of the tool we will need to finish grind is the end cutting edge angle.

Bring the tool into light contact with the wheel. When you have completed the end cutting edge angle, inspect the tool for the condition of the ground surfaces, and using the center gage and cutter bit grinding gauge check the accuracy of the angles. Depending on the width of the flat, you may want to hold the tool lightly on the finishing wheel, or you can hone the flat on the cutting tool. Finally, lightly hone the cutting edges of the tool to remove any burrs that may have formed on the tool during grinding. Next we will grind a form tool for use in turning and forming a radius.

****

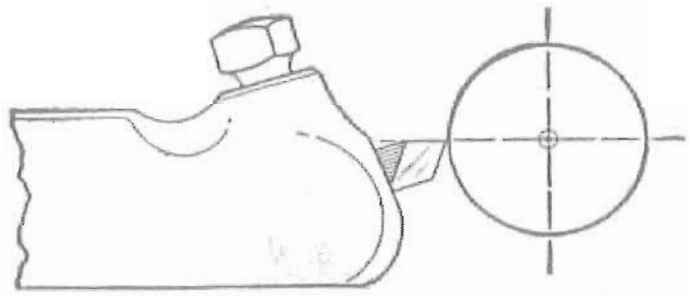
FORM TOOL USED FOR RADIUS GROOVING

Tools that have specially shaped cutting edges are called form tools. Form tools are ground so that the contour of the cutting edge corresponds to the desired shape required. The end and side relief angles are the same as needed for the threading tool. A side and end relief of 10-12 degrees will need to be ground to allow the tool to cut with only the cutting edge contacting the work. The form tool will be used to cut the radius on the lab project. The 5/16" tool bit will be ground to the radius of 5/32 nds. The radius can be checked with a radius gage.

Line one side of the tool bit parallel with the face of the *rough* grinding wheel. Bring the tool into light contact with the wheel. Now take and roll the bottom of the tool into the grinding wheel to achieve the 10-12 degree side relief angle. Run the tool back and forth across the face of the wheel to avoid grooving the middle of the wheel. If you are doing this correctly, the bottom of the tool will be ground more than the top. Continue to grind until the side relief meets the face of the tool for a length of approximately 1/4 in. Cool the tool bit in water so that it does not overheat during the grinding process.

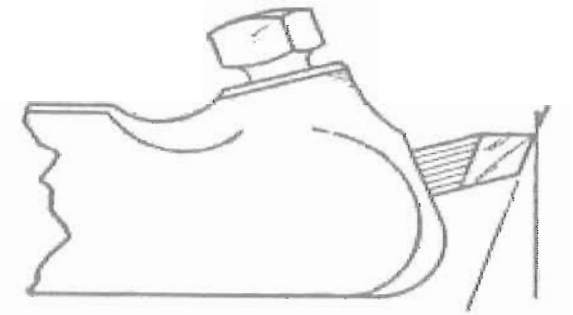
Line the other side of the tool bit parallel with the face of the *rough* grinding wheel. Bring the tool into light contact with the wheel. Now take and roll the bottom of the tool into the grinding wheel to achieve the 10-12 degree relief angle. Run the tool back and forth across the face of the wheel to avoid grooving the middle of the wheel. If you are doing this correctly, the bottom of the tool will be ground more than the top. Continue to grind until the relief meets the face of the tool for a length of approximately 1/4 in. Cool the tool bit in water so that it does not overheat during the grinding process.

Hold the tool bit perpendicular with the face of the rough grinding wheel and tilt the bottom of the tool bit into the wheel. Bring the tool into light contact with the wheel and grind the end relief angle. If you are doing this correctly the bottom of the tool will make contact with the grinding wheel first. Rotate the tool bit back and forth to shape the radius on the front of the tool. Inspect the tool for the condition of the ground surfaces and use the radius gage and cutter bit grinding gauge to check the accuracy of the angles. Remember this must be done with the tool bit in a tool holder. Move to the fine grinding wheel and make any small corrections as necessary. Hone the cutting edges on a stone to remove any burrs.



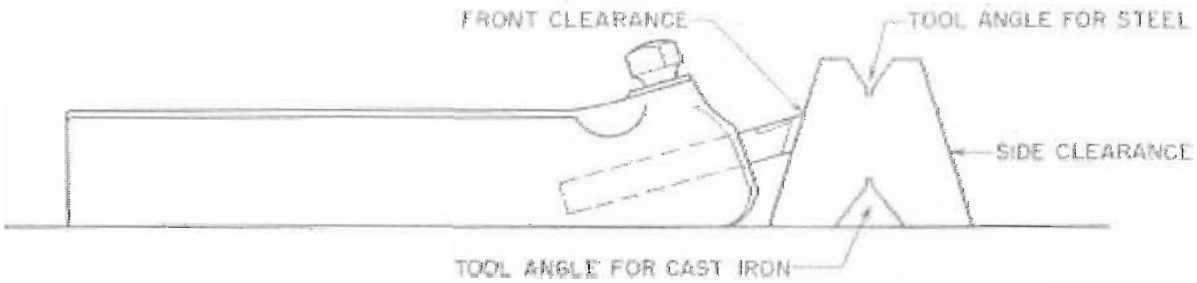
Top of Cutter Bit Set On Center for Cutting Screw Threads

Figure 4



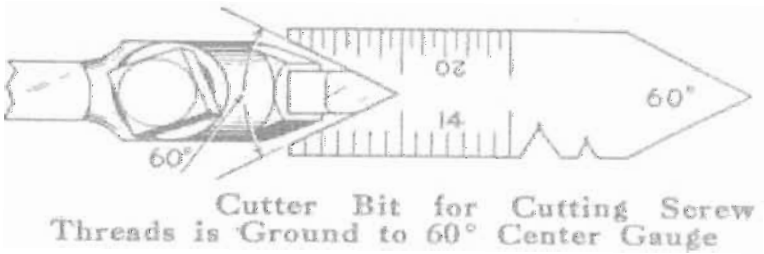
Side View of Lathe Tool Cutter Bit Ground for Cutting Screw Threads

Figure 5



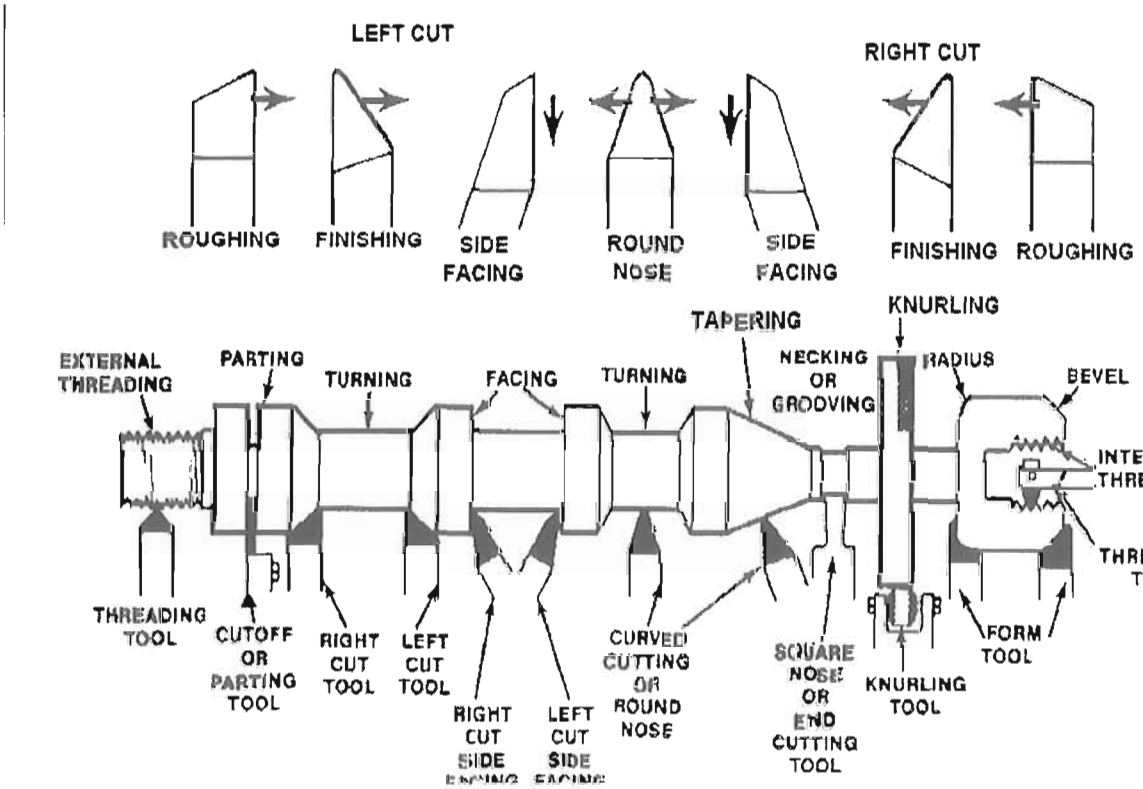
CHECKING THE END-RELIEF ANGLE OF A TOOLBIT (Courtesy South Bend Lathe Co., Inc.)

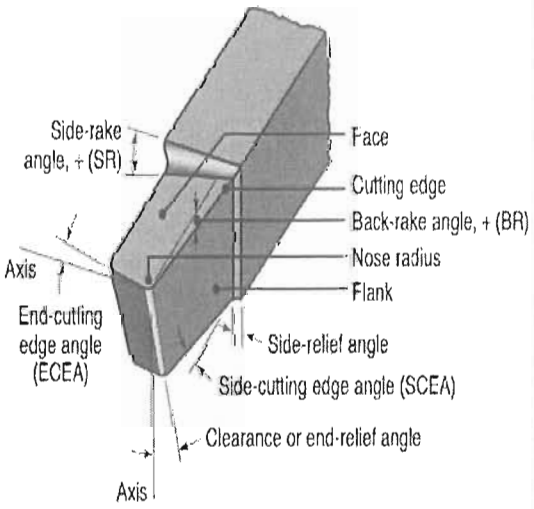
Figure 6

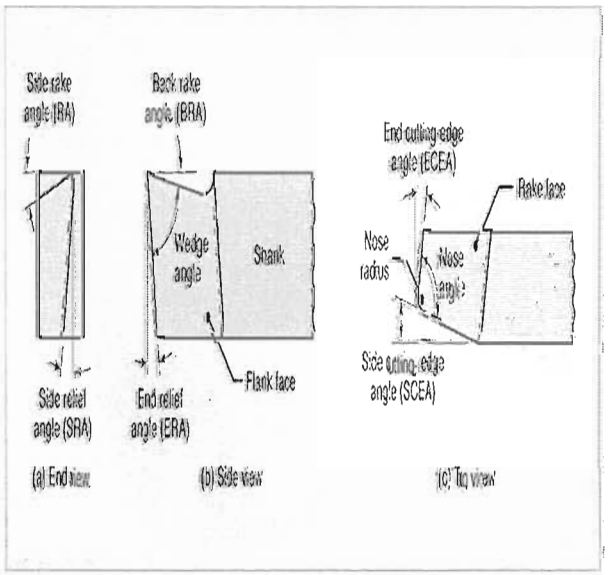


Cutter Bit for Cutting Screw Threads is Ground to 60° Center Gauge

Figure 7


LEFT CUT
RIGHT CUT
ROUGHING
FINISHING
SIDE FACING
ROUND NOSE
SIDE FACING
FINISHING
ROUGHING
EXTERNAL THREADING
PARTING
TURNING
FACING
TURNING
TAPERING
NECKING OR GROOVING
KNURLING
RADIUS
BEVEL
INTERNAL THREADING
THREADING TOOL
THREADING TOOL
CUTOFF OR PARTING TOOL
RIGHT CUT TOOL
LEFT CUT TOOL
RIGHT CUT SIDE
LEFT CUT SIDE
CURVED CUTTING OR ROUND NOSE
SQUARE NOSE OR END CUTTING TOOL
KNURLING TOOL
FORM TOOL


Side-rake angle, + (SR)
Face
Cutting edge
Back-rake angle, + (BR)
Nose radius
Flank
Axis
End-cutting edge angle (ECEA)
Side-relief angle
Side-cutting edge angle (SCEA)
Clearance or end-relief angle
Axis


Side-rake angle (SRA)
Back-rake angle (BRA)
End cutting-edge angle (ECEA)
Rake face
Nose radius
Nose angle
Wedge angle
Shank
Flank face
Side relief angle (SRA)
End relief angle (ERA)
Side cutting-edge angle (SCEA)
(a) End view
(b) Side view
(c) Top view

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Lab # 3
Lathe Maintenance, Set-up &
Practice

CADET _____

SECTION_____

LATHE MAINTENANCE, CLEANING, AND SETUP

A. Instructor demonstrates the following:
   1. Securing stock in 3-Jaw Chuck
   2. Speed set up for both high speed and low speed range
   3. Feed Reverse Lever positions
   4. Set up of Quick Change gear box
   5. Correct position of the Feed Change Lever for Crossfeeding, Threading and Turning.
   6. Set up of Compound Rest
   7. Tool set up in a Standard Tool Post
   8. Positioning and set up of Tailstock
   9. Installation and use of drill chuck for center-drilling.
   10. Maintenance and cleaning of Lathe.

B. Students set up lathe for various operations:

Set up the Lathe for the following problems assuming the following criteria:

	Aluminum	Steel
Cutting Speed (SFPM) Roughing	200	90
Cutting Speed (SFPM) Finishing	300	100

Threading Speed - 40 RPM

Lathe speeds

High Speed Range	940	628	418	270
Low Speed Range	135	90	60	40

Set speeds to closest speed available

Feeds

Roughing feed	Finishing feed
.012	.003

1. Rough turn a piece of 2" diameter steel
2. Finish face a piece of 1" diameter steel from inside out
3. Left-hand thread a piece of ¾" diameter aluminum for 10 threads per inch.
4. Right-hand thread a ¼" steel rod for 20 threads per inch.
5. Right-hand thread a 3/4 steel rod for 10 threads per inch.

C. Students practice facing and center drilling on scrap stock.

Machining notes

Facing

Tool must be on centerline
Align toolbit with dead center.
Move cutter to approx. center of work (but not past)
Check for tool bit angle
Rotate chuck by hand to check for interference with tool holder or compound rest.
Move tool into workpiece and make light contact.
Lock down carriage and apply cutting oil
Move cutter toward center of work till nub disappears. (Adjust height if necessary)
At outside edge slow down on crossfeed.
Do not extend work out of chuck.

Turning

Have as rigid a setup as possible. (Short hold on toolbit and toolholder)
Come in contact with the work, reset micro collar to zero, Dial in about .010 for cut.
For smooth finish slowdown on feed, use fluid, use sharp tool.
Rough cuts take about .010 - .020 inches,
Fine cuts take about .005 to .010

Threading
Set compound rest a t 29 deg
Use left hand offset tool holder.
Align 60 deg tool bit at dead center
Set Spindle Speed to approx ¼ turning speed. For al use 200 FPM CS, o 200 x 4 = 800/.75 = 1066 for turning , but set threading speed to 40 FPM.
Use center gauge(fishtail) gauge to align cutter.
Bring tool to about .005 from work
Set micro collar to zero (use as reference on crossfeed)
Feed Change Lever should be in neutral
THREAD DEPTH = CONSTANT OF .750 / TPI = DEPTH OF THREAD

(CS IN SFPM x 4) / SIZE OF STOCK = RPM OF SPINDLE

Back Gear Lever

Pulled Forward for Slow Speeds
Pushed Back for High Speeds

Compound Rest

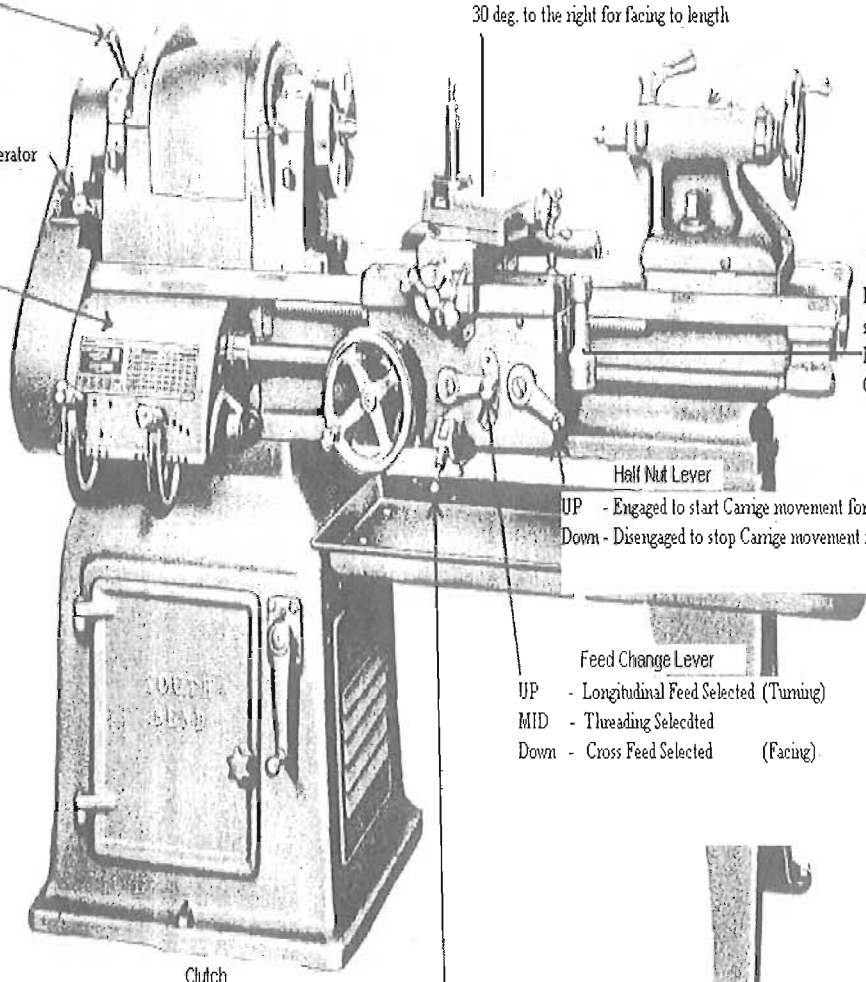
29-30 deg. to the right for external RH threading
29-30 deg. to the left for external LH threading
30 deg. to the right for facing to length

Feed Reverse Lever

UP - Toward Headstock /Toward Operator
MID - Neutral
DOWN - Away from Headstock/Away from Operator

Quick Change Gearbox

Chart shows TPI and Longitudinal Feeds in each block. Crossfeeds are 1//3 the stated Longitudinal Feeds in each block.
Blocks are selected by positioning the two Sliding Gear Levers.



Thread Dial

Determines when Half Nut lever should be engaged.
Even thread - Any Line
Odd thread - Any Numbered line

Half Nut Lever

UP - Engaged to start Carrige movement for Threading
Down - Disengaged to stop Carrige movement for Threading

Feed Change Lever

UP - Longitudinal Feed Selected (Turning)
MID - Threading Selecdted
Down - Cross Feed Selected (Facing)

Clutch

UP - Engaged for feeding operations longitudinal or crossfeed
Down - Disengage for feeding operations

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Labs 4-5 & 6

LAB 4 OPERATE CONTROLS- FACE, CENTER-DRILL AND TURN

LAB 5 & 6 THREADING & FINISH WORK

CADET _____

SECTION_____

Facing, Center Drilling, Layout, Turning

A. Obtain stock from instructor

B. Measure and cut stock in horizontal Band saw to 8-1/8 inches.

C. Install stock in lathe chuck for facing. (do not let stock extend more than 5 diameters from jaws) (Preferably 1-1/2 diameters)

Work is usually faced for the following reasons

1. To smooth and square the ends
2. To provide a square, flat surface from which to take measurements
3. To machine work to the required length

D. Face the first end.

(Remove no more than necessary to get smooth even face)Be careful not to take too much material, leave enough material to face stock to length as per attached drawing) (8" + OR – 1/64")

1. Obtain general purpose tool bit from instructor and install in left hand tool holder then tool post.
2. Set height to dead center height or tailstock quill line
3. Set the tool post to the left hand side of the compound rest and align the tool to the correct angle for facing the work.
4. Set the speed of the Lathe. (The cutting speed of Steel is 100 SFPM for Aluminum the cutting speed is 300 SFPM) (Use formula to determine correct spindle speed.) ((CS X 4)/DIA)
5. Face this first end from the inside towards the out side. (put feed reverse lever in correct position) (UP)
6. Set the feed rate for .001 IPR. (use .003 longitudinal feed)
7. Correctly set the feed change lever for a facing operation. (DOWN)
8. Start the lathe turning in the forward direction
9. Move the carriage to the left until tool bit contacts the work close to center.
10. Lock the carriage in position.
11. Move the crossfeed hand wheel to advance tool bit towards the center of the work. (correct the tool height if necessary)
12. Face first end until a smooth square surface is obtained.

E. Layout work for length

13. Remove work from chuck and layout stock for correct length. (Use layout fluid spray and surface gauge.)
14. Reinstall work in chuck and face to length (face from outside toward inside) (move feed reverse lever to correct position) (Down)

F. Complete layout

15. Remove work from chuck and complete layout as per drawing. (use square and scribe to mark layout lines
16. Reinstall stock in chuck and using 60 deg threading tool mark layout lines on circumference of workpiece. (**Do not start machine to do this**)

G. Center drill

Install drill chuck in tailstock with #4 centerdrill

17. Install workpiece in chuck for center drilling.
18. Correctly set speed of lathe to drill a center hole. (tip of center drill measures 1/8") Use cutting speed formula
19. Center Drill both ends of workpiece.

H. Turn out center section and produce radii.

20. Install form tool in left hand tool holder and post and set height and correct position on compound rest. (Tool should be perpendicular to workpiece.)
21. Fasten work between chuck and dead center with 1-1/2" layout line at edge of chuck jaws.
22. Set correct spindle speed (The speed when using a form tool is ¼ to ½ the turning speed.) (Use 628 RPM)
23. Set feed reverse lever to correct position. (UP)
24. Set feed rate to between .010 - .020 IPR for rough feed (.021) if using AL)
25. Start machine and advance the crossfeed until the tool just contacts the work.
26. Set micrometer collar on both the compound and crossfeed to zero.
27. Turn out center section of workpiece to .525" (take micrometer readings as cutting progresses.)
28. Monitor the heat and lubrication at the dead center
29. Rough in radii as instructed. (Use form tool method)
30. Adjust feed rate to .003 IPR for finish feed and finish cutting center section of workpiece to .500" (remember to leave at least .004 for final cut)

I.THREADING

1. Verify that the compound rest is set correctly to make external right hand threads.
2. Check threading tool for correct angle and install in left hand tool holder and tool post.
3. Set height of the threading tool to dead center height.
4. Advance tailstock quill shaft to 2-1/2 – 3 "

5. Install stock between 3-jaw chuck and tailstock dead center with 1-1/2" layout line at edge of chuck jaws. (Make sure to lubricate the dead center.)
6. Move the tool post to the left side of the compound rest. Align the 60 degree thread cutting tool perpendicular to the workpiece using a center gauge and tighten .(Do not change the height)
7. Set the speed of the lathe to the correct speed for threading (Usually this is about ¼ of the turning speed, however use 40 RPM as your threading speed
8. Set the feed reverse lever in the correct position for making external right hand threads (UP)
9. Set the gear box to the correct number of threads per inch for the project. (10)
10. Set the feed change lever in the correct position for threading. (Mid)
11. Set the compound rest so that it just covers the dovetail underneath it.
12. Line up the tool to an area where the threads are to be cut.
13. Advance the compound rest one full turn to remove any lost motion.
14. Advance the crossslide (at least 1 full turn) until the tool **almost** touches the workpiece and the hand wheel of the crossslide is in the **9 0'clock position**
15. Set the crossslide micrometer collar to zero with out moving the tool
16. Back-out on the crossslide 2 full turns
17. Advance the crossslide in **almost** 2 full turns (stop at approx .220 0n the dial) and install thread stop screw in crossslide and tighten. Advance to zero. (Do not go past this zero)
18. Start the lathe.
19. Advance the compound rest until the tool **just** touches the work. Set the compound rest micrometer dial to zero with out moving the compound rest. (Loosen the set screw and move micrometer dial to "0" and retighten.)
20. Backout on the crossslide 2 full turns
21. Move carriage to the right of starting point of the threads and advance the crossslide back to zero
22. Engage half-nut lever at correct line for making even numbered threads and make a scratch cut.
23. At 1-1/2 in layout line ***quickly*** back out crossslide 2 full turns then disconnect half-nut lever
24. Move carriage to the right of the thread starting point.
25. Advance crossslide 2 full turns back to zero
26. Stop lathe and check TPI with Screw Thread Pitch Gauge.
27. Advance the compound the desired amount and engage the half nut lever and make cuts. (**Use attached chart for depth**)
28. At 1-1/2 in layout line quickly back out crossslide 2 full turns then disconnect half-nut lever
29. Move the carriage to the right of starting point of threads and advance the crossslide to 0 and the compound the desired amount
30. Engage half nut lever at correct point
31. Repeat steps 28-30 until .010 under desired depth (for unified 10 TPI -- 132 on compound dial, for American national 140 on compound dial.)
32. Try trial UNC nut and check threads for fit.
33. Continue to cut for American National thread depth.

34. When the nut has a full tight fit, increase the speed of the lathe to 270 RPM and file a flat of .012 on top of threads.
35. Loosen the thread stop bolt and advance the crossslide in an additional .070 and chamfer the end of the work almost to the point of the tool.

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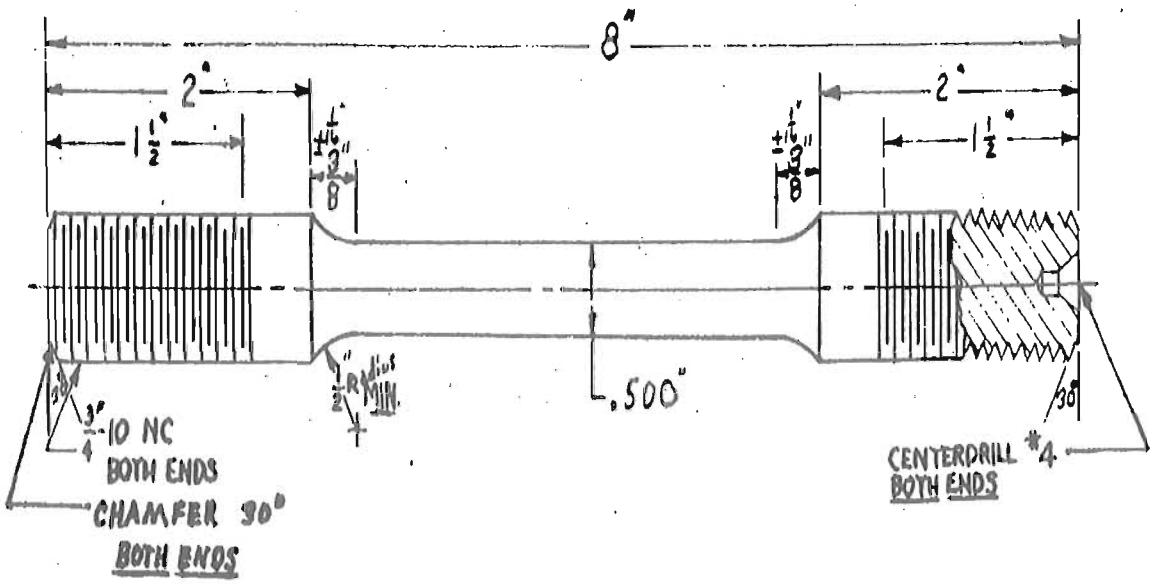
36. Thread other end of coupon.
37. Hold coupon on .500" diameter in 3 jaw chuck
38. Mark position of jaws on coupon for reference.
39. Repeat threading procedure.

National Course Cuts		Compound Reading
1. .020	------	20
2. .020		40
3. .020		60
4. .020		80
5. .010		90
6. .010		100
7. .010		110
8. .005		115
9. .005		120
10. .005		125
11. .005		130
12. .005		135
13. .003	------	138

National Course Cuts	Compound Reading
14. .003	141
15. Test UNC trial nut	
16. .002	143
17. See Note	

NOTE : Continue cutting in .002 increments until die nut goes on half way. Reduce to .001 cuts and repeat for 2 cuts before increasing depth again. Die nut must have firm fit.

Face off and centerdrill both ends (#4 centerdrill). Turn center portion to .525 inches. Rough-in radaii. Finish cut cent portion to .500 inches. and finish radii. Chamfer both ends to print. Thread each end for 3/4-10 UNC to print. Remove from chuck, reinstall and chase threaded ends for 3/4-10 NC. Turn in for grading.



MASSACHUSETTS MARITIME ACADEMY
BUZZARDS BAY, MASSACHUSETTS

TEST COUPON

DR.BY: dem	TR.BY: dem	MATL: 1141 STEEL
CK.BY:	APP.BY:	MS-10
SCALE: FULL	DATE: 9-25-78 REV. 7-24-79	

MASSACHUSETTS MARITIME ACADEMY

BUZZARDS BAY, MASSACHUSETTS

MARINE ENGINEERING DEPARTMENT

Machine Tool Technology

EN 2112

Lab # 7
Dye Penetrant Testing

CADET _____

SECTION_____

LIQUID PENETRANT TESTING DESCRIPTION

Liquid penetrant testing is a non-destructive method used to detect surface breaking defects in any nonporous material. Liquid penetrant is applied to the surface and is drawn into defects by capillary action. Once a preset dwell time has passed, excess penetrant is removed and developer applied to draw out penetrant from defects. Visual inspection is then performed. Visible and Fluorescent Liquid Penetrant Examinations are Non-Destructive methods of revealing discontinuities that are open to the surfaces of solid and essentially non-porous materials, ferrous or non-ferrous.

SIX STEPS TO LIQUID PENETRANT TESTING

1. Surface prep (cleaning) Sand blasting, wire brushing, metal scraping are not generally recommended because they may close a discontinuity and prevent penetrant from being pulled in. You must clean all dirt, oil, slag, and other contaminants from testing area. Obviously any paint must be removed. This is to insure that the penetrant will not be blocked from entering a discontinuity. A solvent cleaner is generally used. (Caution solvent cleaners are usually toxic.) They have a chemical added to make them non-flammable.

Surface Prep

a. Cleaning. Generally with a solvent, however most of these are toxic
   1. do not breathe fumes
   2. some are flammable
b. The cleaner must be capable of dissolving and flushing away dirt and grease. (make sure that contaminants can be flushed, adjust angle of tested sample)
c. It should be a volatile so that it will evaporate
d. It should leave no contaminants.

2. Penetrant Application

a. Pulled into discontinuity by capillary action like the wick of an oil lamp or sap in a tree. Penetrant does not relay on gravity

b. Penetrant must have 5 characteristics
   1. Hold a dye (in suspension)
   2. Spread a dye (evenly over a surface)
   3. Carry a dye (into the discontinuity)
   4. Bring up a dye (bring dye to surface)
   5. Easily removed (able to clean)

c. Two types of dyes. Fluorescent and Visible
   1. Fluorescent is visible only with a black light, shows yellow green

This is a good indicator for telling when the sample is cleaned sufficiently

2. Visible dye or color contrast does not need black light. Visible dye can be seen with the naked eye. The indication will be seen as brilliant red against a chalk white.

d. Application of penetrant may be done by many methods.
   1. Sprayed on
   2. Dipped in solution
   3. Brushed on
   4. Poured on

e. Should be applied at least ½ in to each side of a weldment or 1 inch around other areas to be tested

f. Penetrant application must be between 50 to 100 degrees. below 50 degrees the penetrant might not flow, above 100 degrees penetrant may vaporize

1. **Dwell time** --- penetrant remains wet - is time given for penetrant to soak in. Material may have to be rewet.

A. Dwell time depends on 2 things
   1. material being tested
   2. type of discontinuity

B. Dwell time is given by manufacturers, the number given is the minimum time.

3. Removal of excess Penetrant

A. The penetrant must still be wet when you start removal. If penetrant is not wet you must start over with cleaning.

1. Remove as much as possible with a lint free dry cloth.
2. Uses a dampened solvent (cleaner) lint free cloth (Not soaked) do not flush. Use only the solvent for that particular Penetrant.
3. a. Finish with a lint free dry cloth. (The check is when a clean cloth is rubbed over the surface that no die is noticed.)

b. Fluorescent is visible only with a black light, shows yellow green This is a good indicator for telling when the sample is cleaned sufficiently

4. Developer application

The developer absorbs the dye from the discontinuities with a blotting action. The size, shape and time it takes to indicate all tell us something about the discontinuity. The developer diffuses the dye; any indication is larger than the discontinuity

5. Inspection
   Discontinuities were not visible in the original sample.

6. Post test cleaning

Primary Advantages

- The method has high sensitive to small surface discontinuities.
- The method has few material limitations, i.e. metallic and nonmetallic, magnetic and nonmagnetic, and conductive and nonconductive materials may be inspected.
- Large areas and large volumes of parts/materials can be inspected rapidly and at low cost.
- Parts with complex geometric shapes are routinely inspected.
- Indications are produced directly on the surface of the part and constitute a visual representation of the flaw.
- Aerosol spray cans make penetrant materials very portable.
- Penetrant materials and associated equipment are relatively inexpensive.

Primary Disadvantages

- Only surface breaking defects can be detected.
- Only materials with a relative nonporous surface can be inspected.
- Pre-cleaning is critical as contaminants can mask defects.
- Metal smearing from machining, grinding, and grit or vapor blasting must be removed prior to LPI.
- The inspector must have direct access to the surface being inspected.
- Surface finish and roughness can affect inspection sensitivity.
- Multiple process operations must be performed and controlled.
- Post cleaning of acceptable parts or materials is required.
- Chemical handling and proper disposal is required.

Students shall perform a penetrant test on one sample and note discontinuities to instructor. The student shall identify discontinuities found on an additional four samples and identify these to the instructor.

The liquid penetrant inspection shall be conducted in general accordance with ASTM E 1417. The general procedure is provided.

Visible Dye Penetrant Procedure (Type II, Method C)

1. Specimens should be visually examined for flaws before the application of penetrant.

2. Specimens should be cleaned to remove contaminates that could prevent penetrant from entering discontinuities and thoroughly dried.

3. Apply a thin, even coating of penetrant to the part by spraying.

4. Allow the penetrant to dwell on the surface for 10 minutes or longer.

5. Remove excess surface penetrant by wiping the surface with a dry lint-free cloth. Try to minimize the number of times the surface is wiped as each pass of the cloth could pull penetrant from a flaw.

6. Finish the cleaning by dampening a cloth by spraying with solvent and wiping the surface one final time.

7. Apply a light uniform coating of well agitated, non-aqueous wet developer by spraying. Excess developer will reduce the sensitivity of the inspection; this is the most common error made with liquid penetrants.

8. Inspect the surface as the developer works to pull the penetrant from any surface breaking flaws to produce an indication. Allow the sample to develop for a minimum of 10 minutes.

9. Record the location, size, orientation and other features of interest of any indications produced by the inspection.

10. Clean all specimens by rinsing off the developer.