PALO VERDE
NUCLEAR GENERATING STATION

Mechanical Maintenance Training
Machining Between Centers
Classroom Lesson

Mechanical Maintenance Training	**Date: 10/1/2010 11:37:30 AM**
LP Number: NMS60C000203	**Rev Author: MARK TAGUE**
Title: Machining Between Centers	**Technical Review:** Fredrickson, Rodney J(Z36022) Digitally signed by Fredrickson, Rodney J(Z36022) DN: cn=Fredrickson, Rodney J(Z36022) Date: 2010.10.28 08:44:30 -07'00'
Duration : 6 HOURS	**Teaching Approval:** Baker Sr, Lee E(Z07641) Digitally signed by Baker Sr, Lee E(Z07641) DN: cn=Baker Sr, Lee E(Z07641) Reason: I am approving this document Date: 2010.11.18 08:20:36 -07'00'

INITIATING DOCUMENTS

Task Analysis of Tasks

REQUIRED TOPICS

None

CONTENT REFERENCES

Machine Tool Practices, Fifth Edition

Machinery's Handbook

Technology of Machine Tools, Third Edition

PVNGS OSHP Manual

INPO OE9559 Mechanic Injured when he became entangled in lathe.

TCS 03-0414 Revise NMS60 to incorporate Prevent Events

Palo Verde Standards & Expectations Preventing Events

Technology of Machine Tools sixth edition Krar, Gill & Smid

LESSON PLAN REVISION DATA

Oct 01, 2010	Mark Tague	TCSAI 3534033 to update references, re-word Course terminal objective and Lesson terminal objectives.add more prevent event tools, add content to clarify various instructions.

Tasks and Topics Covered

The following tasks are covered in Machining Between Centers :

Task or Topic Number*	**Task Statement**
Lesson:	Machining Between Centers
LATH002	Perform precision engine lathe operations
LATH001	Perform basic engine lathe operations and maintenance

Total task or topics: 2

LESSON TERMINAL OBJECTIVE:

1 Given the lathe operation of “machining between centers”, the Maintenance Mechanic will describe the various methods used and tooling required to safely and properly operate the lathe machining between centers. Mastery will be demonstrated by successfully completing a written examination with a score of 80% or better.

1.1 Describe the methods of mounting and aligning lathe centers

1.2 Describe the process of facing between centers

1.3 Describe the various processes of machining between centers

1.4 Describe the processes of knurling, grooving, and form turning on a lathe

1.5 Describe the process of turning tapers on a lathe

1.6 Describe the processes of thread cutting on a lathe

CONTENT	METHODS & ACTIVITIES
I. Motivation	Focus student attention on "What's In It For Me".
II. Pre-Job Brief	
A. Pre-job briefing on the day's activities modeling the use of the ***Palo Verde Standards & Expectations, Preventing Events***	
B. Focus On Five (Task Preview)	
Familiarize worker with the scope of work, task sequence, and critical steps.	
1. Critical Steps (Lesson Terminal Objective)	PVNGS Standards & Expectation book (Focus on five) Highlight the critical steps (Terminal Objectives) on the power point presentation.
Given the lathe operation of "machining between centers", the Maintenance Mechanic will describe the various methods used and tooling required to safely and properly operate the lathe machining between centers. Mastery will be demonstrated by successfully completing a written examination with a score of 80% or better.	
2. Identify error likely situations (error traps)	Look at Error Precursors in S&E book
a. Discuss at least one specific error likely situation	
3. Identify the Worst thing that can happen.	Apply to the setting you're in. (Lab versus Classroom)
4. Identify specific error prevention defenses to be used.	What defenses can we employ to prevent the "Worst thing that could happen"
5. Identify actions to assure proper configuration control.	This may not be applicable in every training setting.
C. Break policy	
1. Two Minute Drill – After lunch at a minimum	At Instructor's discretion, not to interrupt class flow

CONTENT	METHODS & ACTIVITIES
III. Lesson Enabling Objectives	Read and/or discuss the lesson objectives
EO01 Describe the methods of mounting and aligning lathe centers	
EO02 Describe the process of facing between centers	
EO03 Describe the various processes of machining between centers	
EO04 Describe the processes of knurling, grooving, and form turning on a lathe	
EO05 Describe the process of turning tapers on a lathe	
EO06 Describe the processes of thread cutting on a lathe	

TO: 1 Given the lathe operation of "machining between centers", the Maintenance Mechanic will describe the various methods used and tooling required to safely and properly operate the lathe machining between centers. Mastery will be demonstrated by successfully completing a written examination with a score of 80% or better.

EO: 1.1 Describe the methods of mounting and aligning lathe centers

Main Idea

CONTENT	METHODS & ACTIVITIES
A. . Machining Between Centers	
If a work piece is removed from a lathe and then returned to a chuck as opposed to a set of centers there is always the possibility of the work being anywhere from one to several thousandths off from where it was, before removing it from the chuck.	HU tools – Maintain a questioning attitude. One small burr or piece of grit on the work installed in a chuck will offset the work from where it was before.
If the work is off even 0.001 inch the next cut made will not be concentric with the rest of the work piece.	If the work isn't set in exactly the same place in the jaws it could be offset in the chuck from its previous point.
Therefore, machining work between centers saves much valuable time in setting up work accurately and ensures the work piece will be set to exactly the same reference point in the lathe as it was before it was removed and assures that any further cuts made to the piece will be concentric with the rest of the work piece.	
1. The first thing to do is find the center of the stock that is going to be turned.	
a. If the work is relatively round it can be mounted in the chuck of a lathe with no more than ½" to 1" sticking out of the chuck. A center drill is then used to drill a hole in each end of the work. This hole will provide the spot for the Live and Dead centers to engage.	
b. If the work is "out of round" or is square stock, then it will need to be mounted in a four jaw chuck and centered using dial indicators. With no more than ½" to 1" of material sticking out of the chuck, use a center drill to drill a hole in the center of each end of the work piece.	

CONTENT	METHODS & ACTIVITIES
C. Mounting Lathe Centers	*Discuss what the result will be if the taper has burrs on it.*
1. Live center must run absolutely true.	
a. This can be checked by setting live center in the tail stock and checking run out with a dial indicator.	
2. Inspect and remove any burrs	
a. Any burrs not removed from the shank of the center could gall and damage the tailstock requiring rework.	
b. Burrs on the taper of the centering end could interfere with the work piece seating properly on the center and offset the work piece. This would ruin the accuracy and repeatability of machining between centers.	
3. Thoroughly clean tapers and centers	
a. Do not attempt to clean taper while machine is running.	
4. Partially insert center in the lathe spindle or tailstock spindle; and then with a quick slapping motion force the center onto the taper.	
a. Confirm the installation by grasping the center's shank and try to spin it. If the shank doesn't turn the center has been installed properly.	
5. Check (headstock) center for trueness or run out using a dial indicator.	
D. Removing centers	
1. Headstock Center – (Use a Knockout bar)	
a. Knockout bar is used to remove a dead center from the headstock. Ensure knockout bar is made of softer material than the center to prevent damage to the center.	STOP if unsure - ASK
b. Place knockout bar through hole in spindle. Slide the knockout bar in and out lightly tapping the center until it dislodges the center.	

CONTENT	METHODS & ACTIVITIES
(1). Ensure to maintain positive control of the center with one hand so it doesn't get violently ejected.	Error precursor – Inaccurate RISK perception.
2. Tailstock center	
a. Turn the hand wheel of the tailstock so that the spindle is drawn back into the tailstock. When the tailstock spindle retracts far enough the spindle screw will dislodge the center.	
(1) DO NOT retract the spindle so far that it jams the spindle in the tailstock as this can damage the equipment.	
E. Alignment of Centers In order to produce a parallel diameter when doing lathe work between centers, the centers must be aligned. Meaning they must be in line with each other and run true to the centerline of the lathe. If the centers are not aligned each cut on the machine will only produce a tapered part.	HU Tool – Questioning Attitude. Challenge the assumption that the centers are aligned. PROVE it! *Demonstrate methods of aligning centers*
1. Align centerline alignment marks on tailstock	
a. This only a visual check that will get alignment close but is not accurate.	
2. Trial cut method	
a. This method involves installing some roundstock between centers and taking a .005 deep cut for a length of about ½" at the tailstock end. You will need to record the reading of the graduated collar on the crossfeed handle. Perform the same cut at the headstock end returning the crossfeed to the same reading as was recorded.	
b. Measure both of these diameters with an O.D. micrometer. If both diameters are not the same size then adjust the tailstock either towards or away from the cutting tool ½ the difference of the two readings.	

CONTENT	METHODS & ACTIVITIES
3. Parallel Test bar and Dial Indicator a. Install a test piece of round stock between centers and set up a dial indicator on the tool post. Indicate off of the test piece at the tailstock end and zero indicator. Move carriage along the piece to the headstock end. If the indicator does not stay zeroed at both ends adjustment is needed. b. This is accurate. 4. Indicate tailstock (dead) center with a dial indicator a. Install dial indicator in lathe chuck and indicate directly off the center installed in the tailstock. a. Fast and accurate	

EO: 1.2 Describe the process of facing between centers

Main Idea

CONTENT	METHODS AND ACTIVITIES

I. FACING BETWEEN CENTERS

A. Work pieces being machined are usually cut a little longer than the required length and then face cut to the proper length. Facing is a machine operation that allows cuts on the ends of a work piece to be square with its axis.

B. Setting up Tool bit

1. Move tool post to the left side of compound rest.

2. Mount tool holder.

3. Insert proper cutting tool.

a. Extend cutting tool approximately ½" past the end of the tool holder. (Never extend tool more than twice its thickness)

4. Tighten tool holder setscrew with light pressure.

a. Must be tight enough to prevent it from slipping back as cut is made.

5. Set the cutting tool point height to the center of the live center.

6. Tighten tool post securely.

C. Mounting Work

1. Check live center for trueness.

2. Clean center points and tapers.

CONTENT	METHODS AND ACTIVITIES
3. Adjust tailstock to project 2-1/2 to 3 "	
4. Loosen tailstock clamp.	
5. Fit lathe dog on left-hand end of work.	
a. Leave loose	
6. Apply suitable center (high pressure grease) lubricant to the right-hand of the work piece where the center hole was drilled if a “Dead Center” is being used in the tailstock.	
7. Place the lathe dog in the drive/face plate slot and insert center hole on left end of work onto the center.	
8. Slide the tailstock, with center installed up to the other end of the work and engage the center into the center hole drilled in the right-hand end of work.	
9. Tighten tailstock clamp.	
10. Turn drive plate by hand to check clearance.	
a. Always turn the work piece 360 degrees by hand in the lathe to ensure the work is not going to run into any obstructions. If the part hits something unexpectedly at spindle speed it could eject the part from the lathe and injure personnel or damage equipment.	HU Tool – Questioning Attitude. Error precursor - Complacency
11. With tail of dog in slot, tighten tailstock hand wheel.	
12. Tighten tailstock spindle handwheel.	
13. Check the center tension. The part should rotate easily by hand in the drive dog slot.	

CONTENT	METHODS AND ACTIVITIES
14. Turn lathe by hand to check clearance.	*Discuss what might happen if you don't check rotation by hand prior to starting the lathe.*
a. Always turn the work piece 360 degrees by hand and run the carriage up and down the full length of the work in the lathe to ensure no part of the face plate, lathe dog etc. is not going to run into the compound rest or any other obstruction.	HU Tool – Questioning Attitude. Error precursor - Complacency
D. Facing Operation	
1. Purposes	
a. Provides true, flat surface or surfaces on the end of a work piece that are concentric and perpendicular to the work axis.	
b. Provides accurate surface from which to take measurements	
c. Cut work to required length	
2. Process	
a. Move tool post to left side of T-slot on compound rest. This will afford maximum clearance.	
b. Clean centers and tapers and mount work between centers.	
1) Use half center if available	
c. Set facing tool bit pointing left	
d. Set lathe to correct speed	
e. Start lathe and bring tool bit as close to center as possible	

CONTENT	METHODS AND ACTIVITIES
f. Move carriage to left until tool bit just touches spinning work	
g. Feed with cross feed hand wheel and cut from the inside out.	
h. Continue until cut is complete	

EO: 1.3 Describe the various processes of machining between centers

Main Idea

CONTENT	METHODS AND ACTIVITIES
II. MACHINING OPERATIONS BETWEEN CENTERS	
A. Set toolholder up at right angles	
B. Parallel turning	*Demonstrate the interpreting of the feed change data plate*
1. Cut work to size	
2. Produce true diameter	
3. Minimum number of cuts – Two	
a. Roughing (0.020" - 0.030")	
b. Finishing (0.003" - 0.005")	
4. Setting Depth of Cut	
a. Move toolpost to left-hand side of compound rest	
1) Center toolbit	
b. Tighten toolpost	
c. Start lathe and take very light cut - .005"	
1) True diameter for 1/4"	
2) NOTE the hand wheel dial setting and then Disengage the tool.	
a) This is done so that when the next cut is made the cross feed hand wheel can be set to the same setting for accuracy.	
d. Back the cutting tool off the end of work, Stop the lathe	

CONTENT	METHODS AND ACTIVITIES
e. Measure diameter and calculate amount to be removed	
f. Set graduated collar for the amount to be removed.	
g. Repeat the process until the work is the correct dimension.	
5. Rough Turning	
a. Accuracy and surface finish not important	
b. 0.020" to 0.030" recommended depending on the type of material.	
c. Taken to within .003" to .005" of final diameter	
6. Finish Turning	
a. Produces a smooth finish on the work piece and cuts the piece to the final diameter size.	
7. Filing	
a. Turn piece to within .003" of final size	
b. Cover lathe ways with paper	
1) Filing produces very fine debris that we don't want trapped between the ways and the carriage. If this debris gets trapped there it has the tendency to wear the ways and over time produce inaccuracies in the lathe.	*Discuss why it is important to cover the lathe ways with paper*
c. Process	
1) Mount work properly	
2) Move carriage out of the way	
3) Disengage lead screw	
4) Use mill or long angle lathe file	
5) Apply light pressure	

CONTENT	METHODS AND ACTIVITIES
6) Release pressure on return stroke	
7) 30 - 40 strokes/minute	
8) Too much pressure results in out of roundness	
9) Clean file frequently with file card.	
a) Rub chalk or soap stone on file teeth to prevent clogging	
III. Operating Experience	
A. **Plant: FitzPatrick (USA) Title: Injury Due to Lathe Accident** (Reference: INPO OE9559)	
1. On November 21, 1998 at James A. FitzPatrick, while performing polishing of a valve plug using a lathe, an individual's glove/sleeve became entangled around the plug stem. The worker was pulled onto the lathe wrapping his arm around the stem causing severe personal injury. Co-workers secured the lathe, notified the Control Room, and assisted the individual by unwinding him from the lathe and making him comfortable until the Fire Brigade arrived.	*The individual was transported to the hospital with extensive injuries.*
2. Polishing in Lathe	
a. Select type and grade of abrasive cloth	
1) A minimum of 12" long - 1" wide. Using 2 hands. One on each end of the emery cloth. In case it catches it will pull loose without pulling you into it. **LET IT GO**!	*Demonstrate the correct method of use for emery cloth. Point out the potential hazards.*
2) Aluminum oxide - ferrous metals	
3) Silicon Carbide – nonferrous	
b. Lathe at high speed	
c. Disengage lead screw	

CONTENT	METHODS AND ACTIVITIES
d. Remove tool post and tool bit holder. *Hazard Analysis-Verify there isn't a sharp edge or point you may come into contact with.*	Prevent Events – **2-minute drill – hazard analysis**
e. Lubricate center or use revolving center	
f. Roll sleeves and tuck in clothing	
g. Start lathe	
h. Hold cloth on work	
1) Don't allow long end to wind	
i. Move back and forth along the work until desired finish is obtained	
B. Turning Shoulders	
1. Change from one diameter to another	
a. Three types of shoulders:	
1) Square	
2) Filleted	
3) Beveled	
2. Turning a Square Shoulder	
a. Lay out shoulder position from finished end	
b. Position tool bit and take marking cut	
c. Rough and finish to within 1/16"	
d. Set up end facing tool and chalk small diameter	
e. Just touch chalk mark with tool bit	
f. Note reading on graduated collar	
g. Face the shoulder square using hand feed	
h. Return to reading for successive cuts	

CONTENT	METHODS AND ACTIVITIES

3. Machining a Filleted Shoulder
    a. Purpose - to strengthen the shoulder
    b. Lay out length
        1) shoulder punch or marking cut
    c. Rough and finish cut to length minus radius to be cut
    d. Mount correct radius tool bit and center
    e. Lathe speed one-half of cutting speed
    f. Chalk small diameter
    g. Start lathe and bring tool bit in to touch chalk
    h. Feed cutting tool sideways with carriage hand wheel until shoulder is cut
4. Machining a Beveled Shoulder
    a. Beveled from 30 to 60 degrees
        1) most common is 45 degree
    b. Turn large diameter to size
    c. Lay out position of shoulder
    d. Rough and finish cut the small diameter (minus the length of the bevel)
    e. Mount side cutting tool and center
    f. Use a protractor and set tool to desired bevel angle
    g. Chalk small diameter
    h. Lathe speed one-half of normal cutting speed
    i. Just touch the chalk
    j. Feed the carriage hand wheel by hand

CONTENT	METHODS AND ACTIVITIES
k. Apply cutting fluid	
l. Continue until bevel is correct size	
5. Large beveled angles	
a. Set compound rest to desired angle	
b. Install point cutting tool	
c. Machine bevel by feeding compound rest by hand.	

EO: 1.4 Describe the processes of knurling, grooving, and form turning on a lathe

CONTENT	METHODS & ACTIVITIES
KNURLING, GROOVING, AND FORM CUTTING	
A. Knurling – The forming of diamond-shaped or straight lined patterns into the surface of work for gripping purposes.	
B. Process	
1. Mount the work between centers and mark the area to be knurled	
2. Lathe speed the lowest to start. Increase as needed	
3. Set carriage feed .015 - .030"	
4. Install and center knurling tool bit	
Before starting the lathe employ the use of HU Tools like self checking to insure work is installed correctly and speeds/feeds are set properly. Maintain a questioning attitude about how the evolution should proceed. When the expected results are not encountered we need to STOP!, and do a reset so the problem can be straightened out.	Prevent Events

CONTENT	METHODS & ACTIVITIES
5. Start lathe and check tracking 6. Move to start of knurling - end of work piece a. Half of the roller face on work 7. Force knurling tool approx. 0.025" into work - start lathe 8. Check pattern without backing tool away a. Most common problem is that tool is not centered 9. Restart lathe with automatic carriage feed engaged 10. Apply cutting or lubricating oil 11. Knurl to proper length 12. If pattern is not pointed - reverse and take another cut	

CONTENT	METHODS & ACTIVITIES
C. Grooving 1. Also called recessing, undercutting and necking 2. Three common shapes a. Round b. Square c. V-shaped 3. Grind tool bit to desired size and shape 4. Layout location of groove 5. Lathe speed is one-half normal cutting speed 6. Mount work piece. *Ensure work is securely installed prior to starting machine.* 7. Center tool bit 8. Position tool bit on work where groove is to be cut 9. Start lathe and just touch work - zero collar 10. Calculate depth of cut 11. Feed tool bit slowly with cross feed hand wheel a. If chatter - reduce speed 12. Stop lathe and check groove depth	*Have groove and parting tools on hand*

CONTENT	METHODS & ACTIVITIES
D. Form Turning 1. Three methods: Freehand, Form-turning tools, and special attachments a. Freehand turning is most difficult lathe operation to learn 2. Form turning tools a. The shape and radius is ground on a tool bit and used to form contours on the work piece b. Work turned slowly with cutting fluid added c. Templates and followers used for few pieces of special form 3. Hydraulic tracer attachment a. Cross-slide controlled by hydraulic pressure b. Stylus follows template and controls oil pressure 1) Template duplicated	*Discuss stylus types, shapes and uses*

EO: 1.5 Describe the process of turning tapers on a lathe

Main Idea

CONTENT	METHODS AND ACTIVITIES

IV. Turning tapers on a Lathe Overview

A. Uniform change of diameter measured along its axis

B. Expressed in terms of taper per foot, taper per inch, or degree of taper

C. Self-holding tapers

1. Morse

2. Brown and Sharpe 3/4" per foot Machine taper

D. Steep Tapers

1. 3 1/2" per foot Milling machine taper

E. Three Methods of Turning a Taper

1. Tailstock offset

2. Taper attachment

3. Compound rest

V. Turning a Taper

A. Must first calculate the Taper per Foot (TPF)

1. Need to know the diameter at the large end of the taper. This will be represented in the formula as the capital “D”.

2. Need to know the diameter at the small end of the taper. This will be represented in the formula as the small “d”.

3. Also need to know the length of the taper.

CONTENT	METHODS AND ACTIVITIES

4. The formula looks like the following:

   a. $\frac{D - d}{\text{length of taper}} \times 12$

   b. Example $\frac{1.250" - 1.000"}{3"} \times 12$

      1) 1.250 – 1.000 = .250

      2) .250 ÷ 3 = .0833

      3) .0833 X 12 = 1” tpf (1 inch of taper per foot.)

5. Now for offsetting the tail stock another formula will need to performed and is as follows:

   a. $\frac{\text{TPF x Total length of work}}{24}$

   b. This formula will determine how much the tailstock needs to be offset for the taper desired.

6. Loosen tailstock clamp

   a. Offset the tailstock the required amount

   b. Set up cutting tool as for parallel cutting

   c. Starting at small diameter - take successive cuts until taper is .050" - .060" oversized

   d. Check taper for accuracy

   e. Finish turn to correct size

7. Taper Attachments

   a. Advantages

      1) Lathe centers remain in alignment

      2) Setup is simple - no time is lost aligning centers

CONTENT	METHODS AND ACTIVITIES

3) Length of workpiece is not as important

4) Tapers can be produced between centers, in a chuck, or in a collet

5) Internal tapers can be turned

6) Wider range of tapers

b. Types

1) Plain taper attachment

a) depth of cut made with compound rest hand wheel.

2) Telescoping taper attachment

a) Depth set by cross feed handle.

3) Compound rest or slide

a) Calculate taper in degrees

b) Set compound rest for taper

c) Set cutting tool at right angle

d) Check for clearance

e) Move carriage to start of taper and lock

f) Rough turn taper by feeding compound rest hand wheel

g) Check taper for accuracy

h) Finish turn to size

8. Checking Tapers

a. Difference between 2 diameters 1 inch apart

b. Taper ring gage

c. Taper plug gage – internal

CONTENT	METHODS AND ACTIVITIES
d. Taper micrometers	

EO: 1.6 Describe the processes of thread cutting on a lathe

Main Idea

CONTENT	METHODS AND ACTIVITIES
VI. THREAD CUTTING ON A LATHE	*Note: refer to pages 402-403 of Technology of Machine Tools.*
A. Threads	
1. Helical ridge of uniform section formed on the outside or inside of a cylinder or cone	*This should be a review of the material covered in the fasteners lessons*
2. Purpose	
a. Fastening	
b. Accurate measurement	
c. Transmit motion	
d. Increase torque	
3. Parts of a screw thread	
a. Set the depth of cut with compound rest hand wheel.	
B. Lathe Parts	
1. Thread chasing dial	
a. Indicates when half nut lever should be engaged	
2. Half nut lever	
a. Also called split nut lever.	
C. Set up Machine	

CONTENT	METHODS AND ACTIVITIES
1. Speed is the lowest to start. Then increase as necessary	*Demonstrate on a lathe, have students participate*
2. Set quick change gear box for required pitch in threads per inch (tpi).	
3. Engage the lead screw	
4. Secure a 60 degree threading tool bit in the tool holder and check the angle with a thread center gage.	
5. Set compound rest at 29 – 29 ½ degrees to the right for right hand thread, or to the left for left hand thread.	
6. Center the cutting tool	
7. Set the tool bit at right angles to the work	
8. Arrange apron controls to allow half-nut lever to be engaged	
D. Thread Cutting	
1. Close attention must be paid to where the cutting tool is on the work. As soon as the tool gets to the end of its cut, the cross feed hand wheel must be backed out at the same time the half nut lever is disengaged. These two things happen simultaneously. If the machine operator is not watching closely the tool will crash into the chuck or the end of the work. This could injure personnel or damage the equipment and will most definitely do damage to the work piece.	*Hazard Prevention* *Error Precursors* *Unfamiliarity with task* *Overconfidence* *Tables exist with actual compound feed values for the threads being cut (Machinist's Handbook)*
2. Check major diameter of the work	
3. Start the lathe and chamfer the end to just below the minor diameter	
4. Mark the length to be threaded	
5. Move carriage to right hand end of work	

CONTENT	METHODS AND ACTIVITIES

6. Turn cross feed handle until tool close to work - leave handle in 3 o'clock position

    a. Leaving handle in 3 o’clock position will allow for quicker backing out of the tool when the time comes.

7. Set graduated collar on cross feed hand wheel to zero.

    a. This creates a reference point for the cross feed hand wheel so that each time the hand wheel is backed out at the end of a cut; it can be returned to exactly the same place for the next cut.

8. Turn compound rest until tool lightly touches work. Set graduated collar to zero.

9. Move carriage to the right past work

10. All tool cut depths will be controlled by the compound rest hand wheel NOT the cross feed hand wheel. Start the first cut at .003 depth.

11. Engage half-nut at proper mark on dial and take trial cut

12. At end of cut, back off cross feed handle and disengage half-nut lever simultaneously and quickly.

13. Stop lathe and check thread for accuracy

    a. Use a thread pitch gage to determine if cut is on proper track.

14. After each cut

    a. Turn the carriage hand wheel to bring tool bit to start of thread

    b. Return cross feed hand wheel to zero

15. Apply cutting fluid and take successive cuts until crest and root are the same width

CONTENT	METHODS AND ACTIVITIES
E. Checking Threads	*Discuss alternate methods for threading acme, square and buttress threads*
1. Master nut	
2. Thread micrometer	
3. Three wires	
4. Thread roll - snap gage	
5. Thread ring - plug gage	
6. Thread pitch gages	

SUMMARY OF MAIN PRINCIPLES

The following items are things to consider in your lesson summary. They are not mandatory. You should develop your own summary.,

Objectives Review

Review the Lesson Objectives

Topic Review
Restate the main principles or ideas covered in the lesson. Relate key points to the objectives. Use a question and answer session with the objectives.

Questions and Answers

Oral questioning

Ask questions that implement the objectives. Discuss students answers as needed to ensure the objectives are being met.

Problem Areas

Review any problem areas discovered during the oral questioning, quiz, or previous tests, if applicable. Use this opportunity to solicit final questions from the students (last chance).

Concluding Statement

If not done in the previous step, review the motivational points that apply this lesson to students needs. If applicable, end with a statement leading to the next lesson.
You may also use this opportunity to address an impending exam or practical exercise.

Should be used as a transitional function to tie the relationship of this lesson to the next lesson. Should provide a note of finality.