

L-02

TOOLMAKER TRAINING

SKILL DEVELOPMENT GUIDE

Duty L: External Grinder

L-02: Grind Surfaces

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Task Preview

Grind Surfaces

To finish the external surfaces of a workpiece, a Journeyman or Apprentice Toolmaker uses an external grinding machine. First the Toolmaker secures the workpiece in the external grinding machine. Then the Toolmaker grinds the workpiece or part. The process includes selecting, checking, installing and dressing a grinding wheel; consulting the part print and process sheet; setting the machine traverse and feed parameters (if the part will be ground under automatic control); monitoring the automatic grinding or manually controlling the movement of the part and grinding wheel; and checking the part against the dimensional and finish specifications.

The grinding machine operator must be careful. If this task is performed incorrectly or incompletely, the part and/or the grinding machine may be damaged. Also, the grinding machine can be dangerous; caution is essential to avoid physical injury.

How your skills will be checked

The Skill Check will require you to grind surfaces on the external grinder. All tools, materials, and resources will be available. The Evaluator will verify that your demonstration meets the skill objective by observing or measuring each task standard. You must demonstrate safe work practices during the Skill Check. Contact your Evaluator when you are ready for the Skill Check.



Skill Objective

Given a part set up in an external grinding machine, the print of the part, and the process sheet for the job, check specifications, prepare the grinder, and grind the part.

Task Standards

1. The part must be ground to the finish, dimensions, and tolerances specified in the print and process sheet.
2. There must be no damage to the external grinder.
3. All safety requirements must be demonstrated.

What You Will Need

This section contains the safety information, tools, and resources you will need before grinding the surface of a part.

SAFETY FIRST

DON'T TAKE
CHANCES

- Follow all Caterpillar facility safety standards when performing this task.
- The grinding wheel is extremely hazardous. Touching a spinning wheel, even lightly, instantly removes flesh. If the wheel is defective, it may explode and cause extensive damage to the machine and severe injury to personnel.
- Be aware of the turning part, and the automatic movements of the table and grinding head.



- external grinder, equipped with wheel and coolant
- part (workpiece to be ground)
- fixtures and/or tooling to adapt the part to the external grinder
- dressing stone or other wheel dressing equipment
- measuring instruments to check the dimensions of the ground part
- piece of wood
- marking tool
- Allen wrenches
- sine bar
- gage bar



- print specifying part finish, dimensions, and tolerances
- process sheet specifying how the part should be made
- external grinder documentation
- conversion charts



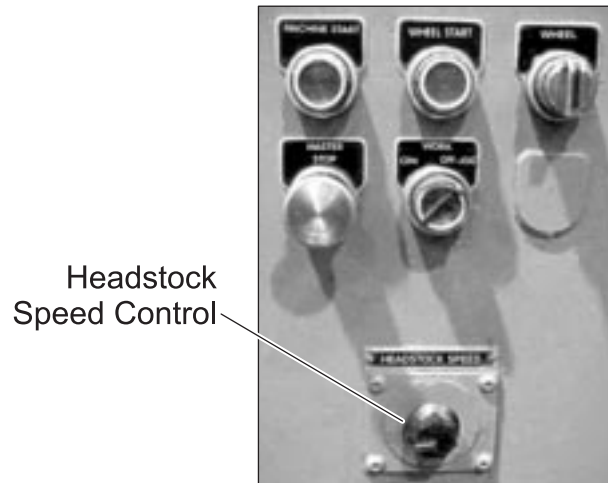
Task Steps

Grind Surfaces

Groove

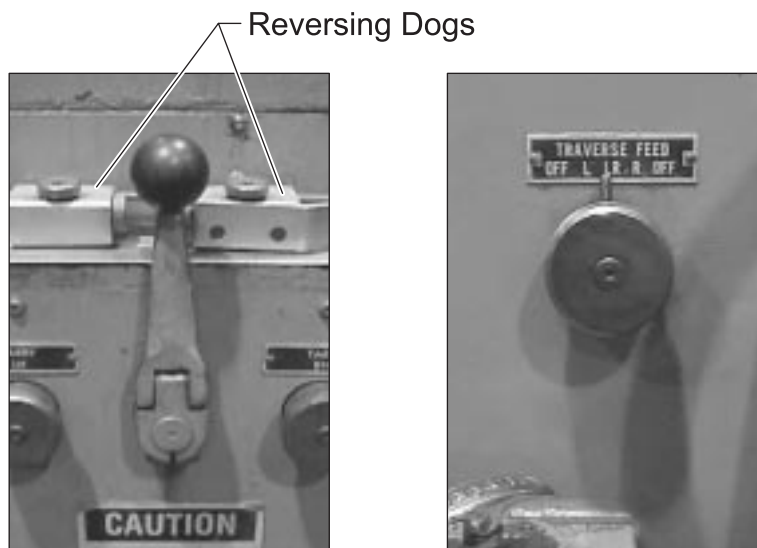
1. **Check the part print for the groove dimensions.**
2. **Select a wheel.**
 - The wheel must be at least slightly narrower than the specified groove width, or have a projecting ring at least slightly narrower than the specified groove width.
 - The projecting ring must have adequate clearance to grind to the specified groove depth.
 - The wheel must be appropriate for the type of material to be ground.
3. **Check the wheel integrity.**
 - Tap the wheel with a piece of wood and listen for a ringing sound.
4. **Mount the wheel on the arbor and in the grinding machine.**
5. **Dress and true the wheel.**
 - If necessary, round the wheel edges to provide the specified radius in the groove corners.
 - Dress both sides of the wheel appropriate to the groove faces (ends).
 - If the groove is narrow, common procedure is to dress the wheel to the groove width.
6. **Set up the part in the grinder as described in the procedure for setting up the external grinder.**

7. **Set a headstock speed appropriate for the part material, the part surface speed, the desired finish, and the wheel type. See the figure below.**



Power Controls on the External Grinder

8. **If the groove is much wider than the wheel (or projecting ring) and can be ground under automatic control, set traverse and feed parameters.**
- Set the reversing dogs so that the wheel will not quite reach the groove sides. See the following figure for typical traverse controls.



Traverse Controls

- ❑ Set a traverse speed appropriate for the desired speed of stock removal and finish.
- ❑ Set adequate LH and RH tarry (dwell) times to complete grinding at each end of the traverse before reversing.
- ❑ Set a wheel head feed appropriate for the part size and material, the specified part finish, and the desired speed of stock removal. The feed stop location differs per machine. See the following figure for typical feed controls.



Grinding Wheel Head Controls

- ❑ It is very important to set the feed stop just short of the desired groove depth (depends on closeness of tolerances).
- 9. Set an initial traverse position to place the part where grinding will begin.**
 - 10. Step to the side and start the wheel drive motor.**
 - 11. Grind the groove manually, if required.**
 - ❑ Traverse the part to place the groove in front of the wheel.
 - ❑ Set the grinder controls for the part rotation.
 - ❑ Feed the wheel into the part to begin grinding.
 - ❑ Turn on the coolant flow as soon as the wheel touches the part.

- If the groove is wider than the wheel, shift the hand traverse control to low gear, and traverse the part as required to grind the groove.
- 12. Grind the groove with automatic control, if not done manually.**
 - Set the grinder controls to provide part rotation and automatic traverse and feed.
 - Turn on the coolant flow as soon as the wheel touches the part.
 - Grind the piece to cleanup, then check for taper and adjust accordingly (using marking tool).
 - Carefully monitor the grinding progress.
 - When automatic grinding stops, set the machine for part rotation only and finish the groove sides and final depth manually.
 - 13. Retract the wheel head.**
 - 14. Shut off coolant flow.**
 - 15. Shut off part rotation.**
 - 16. Verify that the groove meets print and process sheet specifications.**
 - 17. Shut off the wheel head drive after removing excess coolant.**

Taper (Angle)

Note: The only difference between “taper” and “angle” is that taper is usually specified in thousandths or ten-thousandths per inch, and angle is specified in degrees from the part center line. Taper and angle both involve turning the headstock and/or the grinding machine table. If the part is mounted between centers or on a steady rest, the only option is to turn the table. The maximum angle available by turning the table is limited, but very accurate adjustment is possible.

Polish centers before mounting piece part.

- 1. Check the part print for the taper specifications in ten-thousandths per inch; if the specifications are in other units (*i.e.* degrees, inches per foot), convert them to ten-thousandths per inch.**
- 2. Select, check, and install a suitable grinding wheel, if necessary.**

- 3. Set up the part in the grinder as described in the procedures for setting up the external grinder.**
- 4. Dress and true the wheel.**
- 5. Swivel the grinder table to the required taper.**
 - If necessary, loosen the clamps at both ends of the table and turn the adjusting cap screws to set the table to the zero position on the swivel scale.
 - Mount the special (grinder specific) dial indicator on the tailstock end of the table, with the plunger on the adjusting screw.
 - Set an indicator preload of about one turn and zero the indicator dial.
 - Consult the chart on the headstock drive cover to determine the number of indicator graduations to set for the specified part taper.
 - If the part taper is steeper than 0.0002" per inch, use the formula on the chart.
 - Use the adjusting screw to set the required number of graduations on the indicator dial; turn the adjusting screw the direction according to whether the large end of the taper is at the headstock or the tailstock end of the grinder table.
 - Turn the adjusting cap screws to swivel the table, bringing the dial indicator reading back to zero.
 - Tighten the table clamps at both ends of the table.
- 6. Set a headstock spindle speed appropriate for the part material being ground, the part surface speed, the desired finish, and the wheel type.**
- 7. If part will be ground under automatic control, set traverse and feed parameters.**
 - Set the reversing dogs.
 - Set a traverse speed appropriate for the specified part finish and the desired speed of stock removal.
 - Set the LH and RH tarry (dwell) times.
 - Set a wheel head feed appropriate for the part size and material, the specified part finish, and the desired speed of stock removal.
 - Set the feed stop just short of the desired part dimension.

- 8. Set an initial traverse position to place the part where grinding will begin.**
- 9. Step to the side and start the wheel drive motor.**
- 10. Grind the part manually, if required.**
 - Shift the hand traverse control to low gear.
 - Feed the wheel into the part to begin grinding.
 - Turn on the coolant flow as soon as the wheel touches the part.
 - Traverse the part.
- 11. Grind the part under automatic control, if not ground manually.**
 - Set the grinder controls for part rotation and automatic traverse and feed.
 - Turn on the coolant flow as soon as the wheel touches the part.
 - Carefully monitor the grinding progress.
 - When automatic grinding stops, set the machine for part rotation only and finish grinding to the final taper manually.
- 12. Retract the wheel head.**
- 13. Shut off coolant flow.**
- 14. Shut off part rotation.**
- 15. Shut off the wheel head drive.**
- 16. Take the piece part out.**
- 17. Verify that the part taper meets print and process sheet specifications.**
 - Use a sine bar or taper gage to inspect the taper.

Radius

- 1. Check the part print for the radius specifications.**
- 2. If necessary, select and install a suitable grinding wheel.**
- 3. Dress and true the wheel.**

- Dress one or both sides of the wheel if a face will be ground.
- 4. Dress the radius onto the wheel.**
 - If the specified radius is small, use a hand dressing stone to dress the radius onto one or both sides of the wheel, as required.
 - If the radius is large, mount a diamond holder base on the grinder table, and adjust the diamond position in several steps to dress the radius onto one or both sides of the wheel.
- 5. Set up the part in the grinder as described in the procedures for setting up the external grinder.**
- 6. Position the wheel to the part and grind the radius.**
 - Re-dress the radius onto the wheel as necessary.
- 7. Retract the wheel head.**
- 8. Shut off coolant flow.**
- 9. Shut off part rotation.**
- 10. Verify that the part radius meets print and process sheet specifications.**
- 11. Shut off the wheel head drive.**

Outside Diameter (OD)

- 1. Check the part print for the OD specifications.**
- 2. If necessary, select and install a suitable grinding wheel.**
- 3. Dress and true the wheel.**
- 4. Set up the part in the grinder as described in the procedures for setting up the external grinder.**
- 5. Verify that the headstock tapered index pin is in place and that the grinder table swivel is set to zero.**
- 6. Set an initial traverse position to place the part where grinding will begin.**

- 7. Step to the side and start the wheel drive motor.**
- 8. Grind the part manually, if required.**
 - Shift the hand traverse control to low gear.
 - Feed the wheel into the part to begin grinding.
 - Turn on the coolant flow as soon as the wheel touches the part.
 - Traverse the part.
 - Verify that no taper exists.
- 9. Grind the part under automatic control, if not ground manually.**
 - Set the grinder controls for part rotation and automatic traverse and feed.
 - Turn on the coolant flow as soon as the wheel touches the part.
 - Carefully monitor the grinding progress.
 - When automatic grinding stops, set the machine for part rotation only and finish grinding to the final taper manually.
 - Verify that no taper exists.
- 10. Retract the wheel head.**
- 11. Shut off coolant flow.**
- 12. Shut off part rotation.**
- 13. Verify that the part OD meets print specifications.**
- 14. Shut off the wheel head drive.**

Face

Note: Polish centers before mounting piece parts.

- 1. Check the part print for the face inner and outer diameters, inner radius, if any, and the specified position of the face along the length of the part.**
- 2. If necessary, select and install a suitable grinding wheel.**

- 3. Set up the part in the grinder as described in the procedures for setting up the external grinder.**
- 4. Dress and true the wheel.**
 - Use a dressing stone or a side dressing attachment to dress an appropriate relief on the side of the wheel that will grind the face.
 - Dress any specified radius onto the wheel.
- 5. Verify that the headstock tapered index pin is in place and that the grinder table swivel is set to zero.**
- 6. Feed the wheel.**
 - If the face is a shoulder, so that its smaller diameter is an OD to be ground, set the wheel short of the rough OD.
 - If the face is relieved on its smaller diameter, set the wheel inside the face smaller diameter.
- 7. Set an initial traverse position to locate the face next to the side of the wheel.**
- 8. Step to the side and start the wheel drive motor.**
- 9. Grind the face.**
 - Shift the manual traverse control to low gear.
 - If the face is a shoulder, manually feed the wheel to grind the OD that corresponds to the face inner diameter.
 - Manually traverse the part into the side of the wheel. Adjust the cross hatch.
 - Turn on the coolant flow as soon as the wheel touches the part.

Note: Do not dwell once the cross hatch is complete.

- Re-dress the wheel as necessary.
- 10. Traverse the part slightly away from the wheel, and withdraw the wheel.**
 - 11. Shut off coolant flow.**
 - 12. Shut off part rotation.**

- 13. Verify that the face inner and outer diameters, and the location of the face along the length of the part, meet print specifications.**
- 14. Shut off the wheel head drive.**



Concept Check

Grind Surfaces

Answer the following questions to check your understanding of grinding surfaces. Circle the correct answer in each question. Then compare your responses with the answers at the end of the Concept Check. Some of the questions may have more than one correct answer. If you have difficulty answering a question, review the Skill Development Guide or ask your Trainer for assistance.

1. Before a workpiece (part) can be ground, the:
 - a. grinding machine must be calibrated.
 - b. marks left from machining must be removed.
 - c. part must be secured in the grinding machine.
 - d. grinding wheel must be balanced.

2. The last step in grinding a surface is to:
 - a. check the part dimensions and finish against specifications.
 - b. wash off grinding wheel dust.
 - c. reset the grinding machine to standard configuration.
 - d. take one pass with the lightest possible cut.

3. A defective grinding wheel is likely to:
 - a. grind the part out of round.
 - b. start fires.
 - c. slip on its arbor.
 - d. explode.

4. When grinding a narrow groove, common procedure is to:
 - a. dress the wheel to the groove width.
 - b. use automatic traverse control for a precise groove width.
 - c. grind dry, without coolant.
 - d. set the reversing dogs slightly outside the groove width.
5. To grind a taper (or an angle):
 - a. turn the grinding wheel head with respect to the part axis.
 - b. rotate the part axis by turning the headstock or the table.
 - c. mount the part in an eccentric steady rest.
 - d. the part must be mounted in a chuck.
6. Before grinding a radius, the:
 - a. adjoining shoulder and OD must be ground.
 - b. wheel head feed and traverse parameters must be interlocked.
 - c. part must be mounted to rotate about the radius axis.
 - d. radius must be dressed on the wheel.

Answers 1. c 2. a 3. d 4. a 5. a, b 6. d

Next Step

If you are ready to demonstrate the task now, ask your Evaluator or Trainer to schedule the Skill Check. However, if you need to practice some of the steps first, continue to the next section.



Practice

The following practice will help prepare you for the Skill Check. Ask your Trainer to set up the practice for you. After you complete a practice, ask your Trainer to check your work.

Practice 1:

Grind an OD and a radius on the shoulders of the part.

Tools and equipment for Practice 1:

- External grinder, equipped with wheel and coolant
- Part (workpiece to be ground) with a process sheet and print
- Fixtures and/or tooling to adapt the part to the external grinder

Practice Objective 1:

The finished groove width, depth, and corner radii must be as specified on the process sheet, and the groove must be located on the part as shown on the part print.

Practice 2:

Practice putting the correct cross hatch on the face of the part.

Tools and equipment for Practice 2:

- External grinder, equipped with wheel and coolant
- Part (workpiece to be ground) with a process sheet and print
- Fixtures and/or tooling to adapt the part to the external grinder

Practice Objective 2:

The OD, taper, and taper-start location must be as shown on the process sheet and print.

Next Step

Continue to practice until you are ready for the Skill Check. When you are ready to demonstrate the task, ask your Evaluator or Trainer to schedule the Skill Check.

