Disc Brake Systems

GWS 155 – 08: Brake Rotor Resurfacing Procedures
Instructor Version

Name: _________________________

Learning Outcome

• Inspect and recondition disc brake rotors.

Prerequisites

• P553
• M512A
• GWS 155 – 07
• 553 TW01

Required Resources

• 553 Technician Handbook
• Automotive Chassis Systems textbook
• Disc brakes procedure guide (handout)
• TIS / AllData (as appropriate)
• Vehicle
• Hand tools
• Dial indicator
• Brake rotor micrometer
• Caliper grease
• Caliper piston compressor
• Pro-Cut PFM 9.2 on-car brake lathe
• Pro-Cut Operating Instructions Video
• Ammco Off-Car Rotor Lathe (or equivalent)

Instructor’s Note: Operating instructions video included with this curriculum package in the “Instructor Resources” directory. It is recommended you watch the video in class before engaging in this exercise and that you make the file available to students for their review. The procedure guide referenced above is also in that directory.
Objectives

- Using the Toyota 553 technician handbook, generic text, TIS, brake rotor micrometer, hand tools and vehicle, measure brake rotors and describe condition with 100% accuracy.
- Using the Toyota 553 technician handbook, generic text, brake rotor micrometer, hand tools, vehicle and on-car brake lathe, machine brake rotor and describe procedure with 100% accuracy.
- Using the Toyota 553 technician handbook, generic text, micrometer, hand tools, and off-car brake lathe, machine brake rotor and describe procedure with 100% accuracy.
- Using the Toyota 553 technician handbook, generic text, and TIS, determine brake rotor inspection and service procedures and describe procedures with 100% accuracy.

Skill Checks

- Student will inspect, measure, evaluate, machine and re-measure brake rotors and answer questions on a written knowledge assessment with 100% accuracy.

<table>
<thead>
<tr>
<th>Grading Criteria</th>
<th>Points Possible</th>
<th>Points Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student measured brake rotors and described condition with 100% accuracy.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Student machined brake rotors on-car and described procedure with 100% accuracy.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Student machined a brake rotor off-car and described procedure with 100% accuracy.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Student determined brake rotor inspection and service procedures and described procedures with 100% accuracy.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Totals:</td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>
NATEF Tasks

- V-A-4. Install wheel and torque lug nuts. P-1
- V-D-2. Remove and clean caliper assembly; inspect for leaks and damage/wear to caliper housing; determine necessary action. P-1
- V-D-3. Clean and inspect caliper mounting and slides/pins for proper operation, wear, and damage; determine necessary action. P-1
- V-D-4. Remove, inspect, and replace pads and retaining hardware; determine necessary action. P-1
- V-D-5. Lubricate and reinstall caliper, pads, and related hardware; seat pads and inspect for leaks. P-1
- V-D-6. Clean and inspect rotor; measure rotor thickness, thickness variation, and lateral run-out; determine necessary action. P-1
- V-D-8. Refinish rotor on vehicle; measure final rotor thickness and compare with specifications. P-1
- V-D-9. Refinish rotor off vehicle; measure final rotor thickness and compare with specifications. P-1
1) Disc brakes use a caliper with one or more pistons to force brake pads against a rotor to generate friction to slow the vehicle.

2) Disc brakes generate a large amount of clamping force by using a piston(s) with a greater amount of surface area than the pistons in the master cylinder.

3) A disc brake rotor that is not perfectly straight, or that is mounted to a bent or imperfectly machined hub, will have excess run out.

4) Excess brake rotor run out, over time and after prolonged use, leads to thickness variation.
5) Some rotors have an integral hub. Others are held to a separate hub by the lug nuts.

6) Run out is common in hubless rotors because the hub and the rotor are machined separately as part of the manufacturing process and may be subject to tolerance stacking.

7) Run out can be eliminated once and for all by using an on car brake lathe.
8) Complete the following passage regarding rotor run-out:

With **excessive** rotor run-out, the rotor contacts the **brake pad** with each rotation. The **contact point** of the rotor over time will **wear** the rotor, causing **thickness variation**. Eliminating run-out is the only way to solve **pedal pulsation** for good.

9) Complete the following passage regarding stacked tolerances:

- **Hubs** and **rotors** are manufactured with slight **tolerances** for run-out.
- Should **run-out** of the rotor and the hub be **indexed** together, run-out may exceed the limit.

10) This indexing of run out does not always occur in a way that leads to excess run out at the rotor when the vehicle is placed in service. Sometimes, however, it does. Initially, there is no problem. With time and mileage, however, what started out as run out becomes **thickness variation**.
11) Complete the following passage regarding rotor parallelism:

- Measure at 8 **equidistant** places around the diameter, approximately **10 mm** from the outer edge.
- The **difference** between the **smallest** and **largest** measurement is **thickness variation**.
- Rotors with thickness variation greater than **0.0008 in.** (0.02 mm) should be **resurfaced** or **replaced**.

12) Complete the following passage regarding thickness variation:

- Causes **thickest** part of **rotor** to push the **piston** into the caliper **cylinder** with each rotation.
- Piston’s **movement** causes **hydraulic circuit** to feed back to the **brake pedal**.
- Caused by **rotor run-out** and or excessive **rust** on rotor braking surface.

It is this thickness variation that causes steering wheel shimmy when using the brakes, brake pedal pulsation and/or unwanted vibration. Machining the rotors on any lathe will eliminate the thickness variation, thus eliminating the immediate cause of the problem. However, the root cause of the problem may still be present.

13) The root cause of the problem is **run out**.
14) As a brake rotor wears out, expect its **thickness** to decrease.

15) Brake rotor thickness is measured using what type of tool? **Brake rotor micrometer.**

Use the specifications below to answer questions 16 and 17.

<table>
<thead>
<tr>
<th>Nominal Thickness:</th>
<th>24 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine to:</td>
<td>22 mm</td>
</tr>
<tr>
<td>Discard at:</td>
<td>21.6 mm</td>
</tr>
</tbody>
</table>

16) Convert these measurements to inches and complete the information below:

*Hint: 1 inch = 25.4 millimeters.*

<table>
<thead>
<tr>
<th>Nominal Thickness:</th>
<th>0.945 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine to:</td>
<td>0.866 inches</td>
</tr>
<tr>
<td>Discard at:</td>
<td>0.850 inches</td>
</tr>
</tbody>
</table>

17) Based on these specifications, what is the minimum thickness you would still consider serviceable? **0.880 inches or 0.896 inches.**

**Instructor’s Note:** There is some disagreement in the industry as to the significance of “machine to” and “discard at” specifications. Many technicians feel a brake rotor can be placed in service anywhere just shy of the discard-at limit. Others feel, if it is beyond the machine-to specification, it is time for a new rotor. The two possible answers above are based on a “rule of thumb” that there should be at least .030 inches of remaining material on a rotor if it is to be machined. This will accommodate two 0.012-inch passes (0.006 machining depth on each side) on the lathe and leave room for wear.

Use the specifications below to answer questions 18 – 19.

<table>
<thead>
<tr>
<th>Nominal Thickness:</th>
<th>25.4 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Thickness:</td>
<td>23 mm</td>
</tr>
</tbody>
</table>

18) Convert these measurements to inches and complete the information below:

<table>
<thead>
<tr>
<th>Nominal Thickness:</th>
<th>1.000 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Thickness:</td>
<td>0.906 inches</td>
</tr>
</tbody>
</table>
19) Based on these specs, what is the minimum thickness a rotor could be that you would still consider serviceable? 0.936 inches.

Instructor’s Note: Specifications given in this format (as they often are) remove the ambiguity we saw in question 16.

20) Two rotors on the same axle should be within 0.010 inches of each other.

Instructor’s Note: While there is some disagreement in the industry about the significance of side-to-side rotor thickness differences, students should be instructed that it is still wise to keep the rotors as close in thickness as can reasonably be attained. Under heavy, prolonged use of the brakes, such as when descending a grade on a curvy mountain road, the thinnest brake rotor will become hotter than the other resulting (potentially) in a change in the coefficient of friction. You may remove or modify this section (questions 20 – 26) if you do not wish to emphasize this topic with your students.

21) To be sure to comply with the maximum-specified difference in thickness for rotors on the same axle, which rotor would you machine first? Whichever is thinner.

22) Post machining, you have one rotor that is 0.975 inches. The rotor for the opposite side is 0.990 inches. The specified minimum thickness is 0.950 inches. What must you do to bring these rotors into compliance? Machine the thicker rotor.

23) Assuming the thinner rotor remains 0.975 inches, what is the largest acceptable size for the rotor intended for the opposite side of the vehicle on the same axle? 0.985 inches.

Use the following scenario and measurements for questions 24 – 26:

A vehicle with the following specifications arrives in your service bay for a brake inspection.

<table>
<thead>
<tr>
<th>Nominal Thickness:</th>
<th>21.9 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Thickness:</td>
<td>19.0 mm</td>
</tr>
</tbody>
</table>

Instructor’s Note: Nominal Specification is 0.862 inches. Minimum Specification is 0.748 inches.
You find the front brake pads are in need of replacement, along with a sticking caliper. The rotor measurements are as follows:

<table>
<thead>
<tr>
<th>Rotor</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Rotor</td>
<td>0.799 inches</td>
</tr>
<tr>
<td>Right Rotor</td>
<td>0.793 inches</td>
</tr>
</tbody>
</table>

24) Are these rotors serviceable? Yes.

25) What is the remaining material (in inches) for each rotor?

<table>
<thead>
<tr>
<th>Rotor</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Rotor</td>
<td>0.051    inches</td>
</tr>
<tr>
<td>Right Rotor</td>
<td>0.045    inches</td>
</tr>
</tbody>
</table>

26) Which rotor would you machine first? The right rotor.
27) Complete the following passage regarding lug-nut tightening:

Tighten all wheel lug nuts to the specified torque using a star sequence. Improper or uneven torque can distort the rotor, resulting in a comeback.

- The proper torque sequence and correct torque value must be followed to prevent the creation of excessive run out.
- Always follow a star pattern when tightening wheel nuts.
- Tighten all wheel nuts in two steps; first, using a torque wrench, tighten to half of the specified torque value and then tighten to full torque.

Don’t attempt to memorize torque values. Look them up.
Brake Lathe Familiarization—Pro Cut On-Car Lathe

Control Panel
Starts and stops the lathe and provides for run out compensation

Hub Adapter Mount and Set Screw
Attaches lathe drive motor to vehicle hub

Cutting Head
Holds cutting bits and utilizes and oscillating auto-feed to provide a non-directional finish

Lathe Rotating shaft and Set-Screw
Allows lathe to swing upside down and be locked in place

Surplus Adapter Storage
Allows on-cart carry of hub mounting adapters for a variety of vehicle types

Auto-Feed Engagement and Manual Feed Knob
Allows for technician adjustment of cutting head feed and engagement of auto-feed

Instructor’s Note: If you have not already done so, now would be a good time to have your students review the Pro Cut On-Car Brake Lathe Instructional Video included in the “Instructor Resources” directory of this curriculum package.
<table>
<thead>
<tr>
<th>Lathe Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand-alone rotor lathe</td>
<td>Machines brake rotors only. This is the lathe you will use to complete the off-car portion of this lab exercise. Lathe operation will be demonstrated before you machine your rotor.</td>
</tr>
<tr>
<td>Stand-alone drum lathe</td>
<td>Machines brake drums only. You will be using this lathe on GWS 155 – 06. Brake rotors have no business on this type lathe.</td>
</tr>
<tr>
<td>Combo lathe</td>
<td>Convertible and can handle both brake drums and brake rotors. You will not be using this lathe until after you have completed this labsheet and GWS 155 – 06. Once you have demonstrated proficiency with both types of stand-alone lathe, you’ll be introduced to the combo.</td>
</tr>
</tbody>
</table>
Stand-Alone Rotor Lathe

**Arbor**
Rotates whenever the lathe motor is turned on.
Rotor mounts here.

**Auto-Feed Switch**
Two speeds: Fast and Slow.
Final cut must be done using the “slow” setting.

**Cutting Head Thumbscrews**
Must be tightly secured once cutting head depth is set.

**Cutting Head Lock Nut**
Allows technician to position cutting head to accommodate different rotor offsets.

**Cutting Depth Knobs**
Allows technician to adjust the position of the cutting bit and set the cutting depth.

**Manual Feed Knob**
Moves cutting head in or out relative to brake rotor. Should be positioned as far inward as possible before engaging auto-feed.

Stop here after completing all the related activities and answering the questions.
Inform your instructor that you are ready to review this section.

**Instructor Signature:** ________________________________
Practical Procedure 1—Using On-Car Lathe

Brake Inspection

<table>
<thead>
<tr>
<th>Make</th>
<th>Model</th>
<th>Year</th>
<th>Engine</th>
<th>Transmission</th>
<th>Production Date</th>
<th>Model Code</th>
<th>Build Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
</tr>
</tbody>
</table>

Obtain reference material. Print and attach the procedure for brake inspection and replacement on the selected axle.

1) In the spaces provided, document caliper slide-pin torque (floating calipers only) and caliper mounting-bolt torque.

<table>
<thead>
<tr>
<th>Torque Specification</th>
<th>Caliper Slide Pins</th>
<th>Caliper Mountings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Varies</td>
<td>Varies</td>
</tr>
</tbody>
</table>

2) If applicable, document the specified wheel bearing pre-load torque (tapered roller only). Be sure to note the torque units specified.

<table>
<thead>
<tr>
<th>Bearing Preload</th>
<th>Varies</th>
<th>Inch-Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If the vehicle is equipped with hubless (“pop-off”) rotors, indicate N/A above.

Remove the brake caliper from one side.

Remove the brake pads.

Remove the caliper mounting bracket, if equipped.
3) Measure the brake pads with your steel ruler. What is their current thickness in millimeters at their thinnest point?

<table>
<thead>
<tr>
<th>Inner Pad</th>
<th>Varies mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Pad</td>
<td>Varies mm</td>
</tr>
</tbody>
</table>

4) In the spaces provided, indicate the minimum rotor thickness. Give the specifications as they are printed and after unit conversion. If the specifications are given in inches, convert to millimeters. If the specifications are given in millimeters, convert to inches. *Hint: 1 inch = 25.4mm*

<table>
<thead>
<tr>
<th>Minimum Thickness (as printed)</th>
<th>Minimum Thickness (units converted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stamped on Rotor</td>
<td>Varies in / mm (circle one)</td>
</tr>
<tr>
<td>Repair Manual</td>
<td>Varies in / mm (circle one)</td>
</tr>
</tbody>
</table>

5) Measure the rotors and indicate the remaining useable material in *inches* based on the specifications in number 4.

<table>
<thead>
<tr>
<th>Left Rotor</th>
<th>Right Rotor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Thickness</td>
<td>Varies inches</td>
</tr>
<tr>
<td>Useable Material</td>
<td>Varies inches</td>
</tr>
</tbody>
</table>

6) Are these rotors able to be machined? *Answer varies.*

**Instructor’s Note:** Students are instructed that there should be at least 0.030 inch useable material remaining for machining to be an option.

Next, we will machine the rotors using an on-car brake lathe.

Stop here after completing all the related activities and answering the questions. Inform your instructor that you are ready to review this section.

**Instructor Signature:** ________________________________
Brake Lathe Demonstration

Your instructor will demonstrate proper brake lathe set up and operation on your first brake rotor (usually the passenger side). You will then proceed as directed and machine the rotor on the opposite side.

Instructor’s Note: It is a good practice to alternate between pointing out key features of the lathe and asking interrogative questions to make sure students are familiar with the lathe and have taken note of operational characteristics during their review of the instructional video.

Stop here after completing all the related activities and answering the questions. Inform your instructor that you are ready to review this section.

Instructor Signature: ____________________________________
Machine Brake Rotor

Instructor’s Note: The following steps are illustrated here to visually refresh the students after they have witnessed a start-to-finish demonstration of the use of the lathe.

### Choose Hub Adapter

There are a variety of hub adapters for use with the Pro-Cut brake lathe. You will have to find the one that best fits the vehicle you are working on. If you find one that allows all the lug studs through a hole and sits flat against the wheel mounting flange, that’s it!

### Mount Brake Lathe to Hub

Attach hub adapter to hub and secure using lug nuts or nuts supplied with Pro-Cut brake lathe. 

**Note:** Tighten the lug nuts evenly using an open-end wrench.

Instructor’s Note: Pro-Cut does not specify a torque value here most adapters do not provide sufficient clearance for a socket.
Roll the lathe close to the vehicle.

Retract the cutting head as necessary using the manual feed knob.

Attach the drive motor to the hub by carefully adjusting lathe height and rotating hub to align dowel pin.

Tighten attaching screw tightly with one hand.

**Adjust For Run Out**

Turn on main power switch. Lathe motor will start rotating and hub/rotor assembly will rotate with it.

*Note: Be sure vehicle is in neutral!*

Wait 8 or more seconds.

Press “Start.”

A series of clicks will be heard as the unit adjusts itself so the cutting head is laterally stable while the drive motor rotates the hub.

**Prepare Cutting Head**

Loosen locking screw #1 and expand cutting bits wide enough to clear brake rotor.

Loosen locking screw #2 if needed to center cutting head over rotor.

*Tighten immediately after adjustment and do not loosen again!*
Rotate feed knob to bring cutting head approximately half way over the rotor’s friction surface.

Rotate inner cutting head adjustment knob until cutting bit just kisses.

Repeat for outer cutting bit.

Rotate feed knob to until cutting head has moved as far inboard as possible.
Rotate inner cutting head to the desired cutting depth.

Repeat for outer cutting bit.

Lock thumbscrew

Instructor’s Note: Pro-Cut states up to a 0.015” cut is acceptable per pass, per side. It is advisable to instruct your students to use a lesser cut.

Engage auto-feed.

Most rotors are finished machining in under 3 minutes.

Visually inspect your rotor to determine if the machining process was successful in cleaning up the entire surface on both sides. If it was not, repeat the machining process.

7) Re-measure your rotors and record the following:

<table>
<thead>
<tr>
<th></th>
<th>Left Rotor</th>
<th></th>
<th>Right Rotor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>Varies</td>
<td>inches</td>
<td>Varies</td>
<td>Inches</td>
</tr>
<tr>
<td>Thickness Variation</td>
<td>0.0000</td>
<td>inches</td>
<td>0.0000</td>
<td>Inches</td>
</tr>
<tr>
<td>Runout</td>
<td>Varies</td>
<td>inches</td>
<td>Varies</td>
<td>Inches</td>
</tr>
</tbody>
</table>

Instructor’s Note: Some small, barely distinguishable run out may be present post machining. It should be less than 0.001”.

Stop here after completing all the related activities and answering the questions.
Inform your instructor that you are ready to review this section.

Instructor Signature: ________________________________
Reassemble the Brakes

- Clean the back side of the brake pads as well as the shims and all caliper mounting hardware.

- Apply fresh caliper grease to the back side of the brake pads and re-install shims.

- Apply fresh caliper grease to the brake hardware in areas they will touch the brake pads.

- Many brake pad kits come with their own lubricant/grease.

- Remove the caliper slide pins (if applicable). Clean the pins, apply fresh caliper grease, and re-install.

- Compress the brake caliper piston(s).

Note: As mentioned in the Toyota 553 Technician Handbook, it may be a good idea to loosen the bleeder screw on the caliper before doing this.

If you do not, you will need to remove some brake fluid from the master cylinder reservoir before compressing the caliper.

*Wipe up any spills immediately!*

Re-install the brake pads and torque all fasteners according to the specifications you retrieved before.
Install wheels and torque lug nuts.

Instructor’s Procedure Checklist:

<table>
<thead>
<tr>
<th></th>
<th>Y / N</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1 point)</td>
<td>Y / N</td>
<td>Student has completed all sections of the lab and been signed off to this point</td>
</tr>
<tr>
<td>(5 points)</td>
<td>Y / N</td>
<td>Student measured brake rotors and described condition with 100% accuracy.</td>
</tr>
<tr>
<td>(1 point)</td>
<td>Y / N</td>
<td>Student machined brake rotors on-car and described procedure with 100% accuracy.</td>
</tr>
<tr>
<td></td>
<td>Y / N</td>
<td>Student performed post-machining brake rotor measurements and described results with 100% accuracy.</td>
</tr>
</tbody>
</table>
Practical Procedure 2—Using Off-Car Lathe

Brake Inspection

<table>
<thead>
<tr>
<th>Vehicle Application</th>
<th>Make</th>
<th>Model</th>
<th>Year</th>
<th>Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
</tr>
<tr>
<td>Model</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
</tr>
<tr>
<td>Year</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
</tr>
<tr>
<td>Engine</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
<td>Varies</td>
</tr>
</tbody>
</table>

Transmission  Production Date  Model Code  Build Location
Varies  Varies  Varies  Varies

Obtain reference material. Print and attach the procedure for brake inspection and replacement on the selected axle.

1) In the spaces provided, document caliper slide-pin torque (floating calipers only) and caliper mounting-bolt torque.

<table>
<thead>
<tr>
<th>Caliper Slide Pins</th>
<th>Caliper Mountings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque Specification</td>
<td>Varies</td>
</tr>
<tr>
<td></td>
<td>Varies</td>
</tr>
</tbody>
</table>

2) If applicable, document the specified wheel bearing pre-load torque (tapered roller only). Be sure to note the torque units specified.

<table>
<thead>
<tr>
<th>Bearing Preload</th>
<th>Varies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inch-Pounds</td>
</tr>
</tbody>
</table>

If the vehicle is equipped with hubless ("pop-off") rotors, indicate N/A above.

Remove the brake caliper from one side.

Remove the brake pads.

Remove the caliper mounting bracket, if equipped.
3) Measure the brake pads with your steel ruler. What is their current thickness in millimeters at their thinnest point?

<table>
<thead>
<tr>
<th>Pad Type</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner Pad</td>
<td>Varies mm</td>
</tr>
<tr>
<td>Outer Pad</td>
<td>Varies mm</td>
</tr>
</tbody>
</table>

4) In the spaces provided, indicate the minimum rotor thickness. Give the specifications as they are printed and after unit conversion. If the specifications are given in inches, convert to millimeters. If the specifications are given in millimeters, convert to inches. *Hint: 1 inch = 25.4mm*

<table>
<thead>
<tr>
<th>Source</th>
<th>Minimum Thickness (as printed)</th>
<th>Minimum Thickness (units converted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stamped on Rotor</td>
<td>Varies in / mm (circle one)</td>
<td>Varies in / mm (circle one)</td>
</tr>
<tr>
<td>Repair Manual</td>
<td>Varies in / mm (circle one)</td>
<td>Varies in / mm (circle one)</td>
</tr>
</tbody>
</table>

5) Measure the rotors and indicate the remaining useable material in *inches* based on the specifications in number 4.

<table>
<thead>
<tr>
<th>Rotor Type</th>
<th>Current Thickness</th>
<th>Useable Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Varies inches</td>
<td>Varies inches</td>
</tr>
<tr>
<td>Right</td>
<td>Varies inches</td>
<td>Varies inches</td>
</tr>
</tbody>
</table>

6) Are these rotors able to be machined? Answer varies.

Instructor’s Note: Students are instructed that there should be at least 0.030 inch useable material remaining for machining to be an option.

Next, we will machine the rotors using an off-car brake lathe.

Stop here after completing all the related activities and answering the questions. Inform your instructor that you are ready to review this section.

Instructor Signature: ________________________________
Brake Lathe Demonstration

Your instructor will demonstrate proper brake-lathe setup using a discarded “junk” brake rotor. You will then proceed with the machine work on your rotor. Do not proceed past this point until you have been signed off as indicated below.

Note: For the purposes of this exercise, we will be machining the rotor even if it was out of specifications.

Instructor’s Note: You may decide it is prudent to use a “junk” rotor for the demonstration so the student will be required to machine both of the vehicle’s rotors. Be sure to emphasize the importance of the scratch cut and the need to ensure the rotor is properly set up on the lathe, re-positioning it as necessary.

Stop here after completing all the related activities and answering the questions. Inform your instructor that you are ready to review this section.

Instructor Signature: ________________________________
Instructor’s Note: The following steps are illustrated here to visually refresh the students after they have witnessed a start-to-finish demonstration of the use of the lathe.

For hubless rotors (most of them are) you need:

- Two faceplates
- A spring
- A cone

The inner faceplate should be the largest you can fit that will sit flat against the hub mounting surface.

The cone must fit in the center hole of the rotor.

You will often need more than one spacer.

The last spacer should be the self-aligning type (rubber in the middle).

Note: The attaching nut uses left-hand threads and will have to be rotated “backwards” to tighten.

Once the rotor is secure, and with the cutting bits fully retracted, adjust the position of the cutting head.

Use the cutting bit depth adjustment knobs to perform a scratch cut, one side at a time.
7) Did the scratch cut continue all the way around the friction surface on both sides of the rotor? *Usually the answer will be no. May vary.*

If the scratch cut was uninterrupted all the way around the friction surfaces of the rotor, move on to the next step. If it did not, loosen the nut holding the rotor to the arbor and rotate the face plates 90° each in opposite directions. Re-tighten the nut. Alter the position of the rotor feed one full turn via the manual feed knob and repeat the scratch cut. If the new scratch cut continues all the way around the friction surface of the drum, your setup is correct. If the scratch cut does not continue all the way around, but matches your previous scratch cut, your setup is correct. Otherwise, repeat the above until you achieve one of these outcomes.

<table>
<thead>
<tr>
<th>DAMPER</th>
<th>DISC ROTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once you are satisfied with the scratch cut, it's time to machine the rotor.</td>
<td></td>
</tr>
<tr>
<td>Wrap the rotor with the anti-chatter belt. This helps absorb vibration ensuring the smoothest cut possible.</td>
<td></td>
</tr>
<tr>
<td>When the belt is in place, start the lathe motor and manually rotate the feed knob until the cutting head reaches as far inward as possible.</td>
<td></td>
</tr>
<tr>
<td>Once the cutting head has been positioned all the way inward, establish the cutting depth by adjusting cutting depth knobs no more than three notches each.</td>
<td></td>
</tr>
<tr>
<td>Note: Each notch represents a cutting depth increase of 0.002 inches.</td>
<td></td>
</tr>
<tr>
<td>8) If we cut three notches, how deep a cut is that? <strong>0.006 inches.</strong></td>
<td></td>
</tr>
<tr>
<td>9) If we do this on both sides, how much thinner will the rotor be when we are done? <strong>0.012 inches.</strong></td>
<td></td>
</tr>
</tbody>
</table>
Be sure to lock the cutting bits in place using the thumbscrews before continuing!

Engage the auto feed by moving the switch to the “fast” position.

The manual feed knob will begin rotating on its own.

Observe the rotor as it is cut on the lathe.

*Do not leave the rotor unattended!*

When the rotor is finished machining, disengage the auto feed and turn the lathe motor off.

Carefully examine the friction surface of the rotor.

10) Did the entire surface of the rotor clean up? *Answer varies. In most cases, it will need another pass.*

If the rotor has been machined all the way around on both sides, you are almost done. If not, repeat the cutting procedure by rotating the feed knob until you are all the way inward again and set a new cutting depth that is no more than three notches deep on the cutting depth knob. Re-start the auto feed on “fast.”

Once the rotor is completely cleaned up, repeat your cut with a depth of one notch (0.002) on both sides and engage the auto-feed on “slow.”
Lightly sand the friction surface while the lathe motor rotates the rotor.

Remove the rotor from the lathe.

11) Measure the rotor. What is the thickness of the rotor? **Answer varies.**

12) What is the current thickness variation of the rotor? **0.000 inches.**

When you have completed the above for both rotors, it is time to reinstall and check run-out.

13) Attach rotors to hubs with uniformly tightened lug nuts and measure run-out on both rotors and record below.

<table>
<thead>
<tr>
<th>Left Rotor</th>
<th>Right Rotor</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIR (inches)</td>
<td>TIR (inches)</td>
</tr>
</tbody>
</table>

14) Is the above acceptable? **Answer Varies. With hubless rotors there will usually be a fair amount of run-out; usually more than the allowable maximum (0.002”).**

Rotors benefit from having the least possible of run-out when placed in service. Perform phase-matching procedure (same procedure from 553 TW01) and place rotor in service in the position where it has the least run-out.

**Brake Rotor Phase Matching Procedure**

Mark one wheel stud and its position on the rotor for indexing purposes. Install lug nuts and torque them evenly.

15) Measure the rotor run-out in the first position and record run-out in box #1 below.

16) Reposition rotor in a clockwise direction to the next stud and re-measure run-out and record the value in the next cell. Repeat for all wheel stud positions.

<table>
<thead>
<tr>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
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<td></td>
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</table>

Place rotor in the position in which you measured the least run-out before continuing.

Stop here after completing all the related activities and answering the questions. Inform your instructor that you are ready to review this section.

**Instructor Signature:** ________________________________
Reassemble the Brakes

| **•** Clean the back side of the brake pads as well as the shims and all caliper mounting hardware. |
| **•** Apply fresh caliper grease to the back side of the brake pads and re-install shims. |
| **•** Apply fresh caliper grease to the brake hardware in areas they will touch the brake pads. |
| **•** Many brake pad kits come with their own lubricant/grease. |
| **•** Remove the caliper slide pins (if applicable). Clean the pins, apply fresh caliper grease, and re-install. |
| **•** Compress the brake caliper piston(s). |

Note: As mentioned in the Toyota 553 Technician Handbook, it may be a good idea to loosen the bleeder screw on the caliper before doing this.

If you do not, you will need to remove some brake fluid from the master cylinder reservoir before compressing the caliper.

*Wipe up any spills immediately!*

Re-install the brake pads and torque all fasteners according to the specifications you retrieved before.
Install wheels and torque lug nuts.

Instructor’s Procedure Checklist:

- **Y / N** Student has completed all sections of the lab and been signed off to this point
  
  **(1 point)** **Y / N** Student measured brake rotors and described condition with 100% accuracy.
  
  **(3 points)** **Y / N** Student machined brake rotors using an off-car lathe and described procedures with 100% accuracy.
  
  **(1 point)** **Y / N** Student performed post-machining brake rotor measurement and described results with 100% accuracy.
Knowledge Assessment

1) Brake rotors are checked for wear and serviceability by measuring:
   a) Inside diameter
   b) Outside diameter
   c) **Thickness**
   d) None of these

2) Technician A says any brake lathe will remove thickness variation from rotors. Tech B says it is better to use an off-car brake lathe when machining hubless rotors. Who is right?
   a) Technician A
   b) Technician B
   c) Both
   d) Neither

3) Technician A says disc brake run out, over time, leads to thickness variation. Technician B says thickness variation is the immediate cause of brake pulsation. Who is right?
   a) Technician A
   b) Technician B
   c) **Both**
   d) Neither

4) As a brake rotor wears out, or is repeatedly machined, we would expect its __________ to decrease.
   a) Outside diameter
   b) **Thickness**
   c) Inside diameter
   d) None of these
5) Technician A says disc brakes require more hydraulic pressure to operate than drum brakes. Technician B says disc brake calipers amplify output force using a piston(s) with a larger surface area than those of the master cylinder. Who is right?

a) Technician A  
b) Technician B  
c) Both  
d) Neither

6) A rubber belt (chatter belt) is wrapped around the rotor while machining on an off-car lathe to absorb:

a) Vibration  
b) Heat  
c) Metal particles  
d) None of these

7) Technician A says vehicles with hubless rotors may leave the factory with more run-out than desired due to tolerance stacking. Technician B says wheel hub should be machined before machining the rotor. Who is right?

a) Technician A  
b) Technician B  
c) Both  
d) Neither

8) Technician A says run-out is the root cause of brake pulsation. Technician B says run out can best be eliminated using an on-car lathe. Who is right?

a) Technician A  
b) Technician B  
c) Both  
d) Neither

9) Technician A says the Pro-Cut on-car brake lathe will adjust itself for lateral run out. Technician B says the “ready to cut” and “optimum” lights should both be illuminated before beginning the machining process. Who is right?

a) Technician A  
b) Technician B  
c) Both  
d) Neither
10) Technician A says caliper slide pins should be cleaned and lubricated during brake service. Technician B says only high-temperature caliper grease should be used for this purpose. Who is right?

a) Technician A
b) Technician B
c) Both
d) Neither

11) If the rotor/lathe makes excessive noise during the machining process, it may be necessary to replace the __________ on the brake lathe.

a) Arbor
b) Drive belt
c) Cutting bit(s)
d) Feed control

12) Technician A says the Pro-Cut on-car brake lathe will exhibit a slight in and out (radial) motion at the cutting head during the machining operation. Technician B says this is to ensure a directional finish. Who is right?

a) Technician A
b) Technician B
c) Both
d) Neither

13) Technician A says if one rotor is worn excessively and cannot be machined, both rotors need to be replaced. Technician B says the brake caliper should be inspected and/or replaced any time the brake pads are replaced. Who is right?

a) Technician A
b) Technician B
c) Both
d) Neither

14) Technician A says excessive rotor run-out leads to thickness variation. Technician B says thickness variation causes vibration and brake pedal pulsation. Who is right?

a) Technician A
b) Technician B
c) Both
d) Neither
15) How much thickness variation is considered to be the allowable maximum?

a) 0.0800 inch
b) 0.0080 inch
c) **0.0008 inch**
d) None of these

16) How much run-out is considered to be the allowable maximum?

a) 0.0200 inch
b) **0.0020 inch**
c) 0.0002 inch
d) None of these

17) Technician A says it is appropriate to lightly sand the brake rotor friction surface after machining. Technician B says the brake rotor friction surface should be lightly coated with petroleum-based lubricant after machining. Who is right?

a) **Technician A**
b) Technician B
c) Both
d) Neither

STOP

Stop here after completing all the related activities and answering the questions. Inform your instructor that you are ready to review this section.

**Instructor Signature:** ________________________________