

Brake System Flushing & Bleeding

Brake Fluid Basics

It is important to become familiar with the various kinds of brake fluids that are available, in order to avoid installing the wrong type. Incorrect brake fluid application may result in degraded braking performance, as well as system component damage.

There are three types of brake fluid: DOT 3, DOT 4, and DOT 5. The more commonly used DOT 3 and 4 brake fluids are of the polyglycol variety, while DOT 5 is silicone-based (Subaru recommends only DOT 3 or 4 brake fluid). Polyglycol-based fluid is hygroscopic, which means it absorbs moisture from the air. This quality allows any moisture absorption to be dispersed throughout the system, thus eliminating any concentration of water which could lead to localized corrosion.

This characteristic, however, has its disadvantages. Over time, the level of moisture absorption may reach as much as 7-8 percent, causing fluid to become contaminated. This condition will drastically reduce the boiling point of the brake fluid, thus lowering the temperature at which it evaporates. Once vapor has formed, pockets of air are created in the hydraulic lines, causing brake pedal travel to increase. This is due to the fact that the air must first be compressed before any fluid starts to move. The minimum boiling point established for DOT 3 fluid is 401 degrees while DOT 4 is 446 degrees.

Silicone brake fluid, classified as DOT 5, can be easily identified by its purple color. Silicone does not absorb water, but rather repels it. This means there is no contamination from moisture absorption and less chance of internal corrosion. In addition, silicone-based brake fluid has a boiling point of over 500 degrees; much higher than polyglycol-based fluids. It would appear then that DOT 5 would be the brake fluid of choice, but there is a catch. In order to realize the benefits of DOT 5 brake fluid, the system must contain 100 percent silicone-based fluid. This means that DOT 5 brake fluid cannot be introduced in a system already using DOT 3 or DOT 4. Because these different types of fluid will not mix, all of the polyglycol-based fluid will be concentrated in one part of the system. At this point, any moisture that is present in the fluid cannot be dispersed through the system. This localized moisture concentration will certainly cause problems.

It is nearly impossible to remove all the brake fluid from a system, and even with power bleeding, 2-3 percent of the old fluid will remain. Since the two types

of brake fluid are not compatible, the safe bet is to stick with the vehicle manufacturer's recommendations.

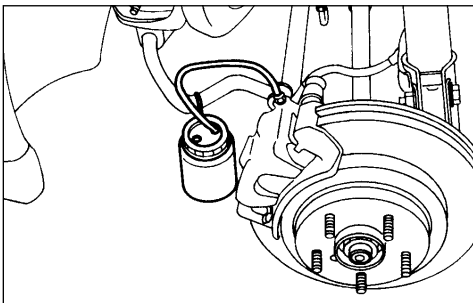
Regular brake fluid changes at 30 month or 30,000 mile intervals are probably the best thing you can do for your customers to provide consistent, safe braking characteristics and to prolong the life of their brake system components. The following pages detail the brake fluid flushing procedures for ABS-, TCS- and non ABS-equipped Subaru vehicles.

General Rules For Effective Bleeding

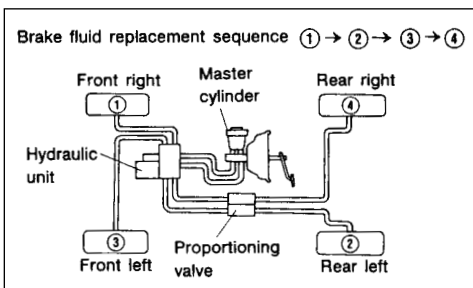
1. Start with the brakes (wheels) connected to the secondary chamber of the master cylinder.
2. The time interval between two brake pedal operations (from the time the pedal is released to the time when it is depressed another time) should be approximately three seconds.
3. The air bleeder on each brake should be opened for one to two seconds.

Bleeding Procedure (Without TCS)

Caution: Fresh DOT 3 or 4 brake fluid must be used. Cover the bleeder with a waste cloth, when loosening it, to prevent brake fluid from being splashed over surrounding parts. Avoid mixing different brands of brake fluid to prevent degrading the quality of the fluid. Be careful not to allow dirt or dust to get into the reservoir tank.



Note: During the bleeding operation, keep the brake reserve tank filled with brake fluid to eliminate entry of air. Movement of the brake pedal must be very slow. For convenience and safety, two people should work together to bleed the brakes.



1. Make sure there is no leak from any brake system joints or connections.
2. Fit one end of a vinyl tube onto the air bleeder and put the other end into a brake fluid container.

3. Slowly depress the brake pedal and keep it depressed. Then, open the air bleeder to discharge air together with the fluid.

- Open the bleeder for 1 to 2 seconds.
- Next, with the bleeder closed, slowly release the brake pedal.
- Repeat these steps until there are no more air bubbles in the vinyl tube.
- Allow 3 to 4 seconds between brake pedal operations.

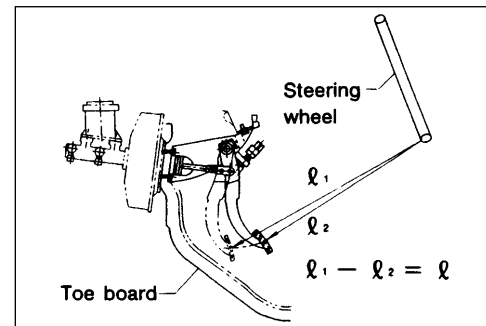
Caution: Cover the bleeder with a waste cloth when loosening it, to prevent brake fluid from being splashed over surrounding parts.

Note: Movement of the brake pedal must be very slow.

4. Tighten the air bleeder securely when no air bubbles are visible in the tube.

Air bleeder tightening torque: $8 \pm 1 \text{ N-m}$ ($0.8 \pm 0.1 \text{ kg-m}$, $5.8 \pm 0.7 \text{ ft-lb}$)

5. Perform these steps for the brakes connecting to the secondary chamber of master cylinder first, and then for the others connecting to the primary chamber. When bleeding has been completed at all four wheels, fully depress the brake pedal and keep it in that position for approximately 20 seconds to make sure there is no leak evident in the entire system.



6. Perform sequence control (With ABS).
7. Check the pedal stroke. While the engine is idling, depress the brake pedal with a 490 N (110 lb) load and measure the distance between the brake pedal and steering wheel. With the brake pedal released, measure the distance between the pedal and steering wheel again. The difference between the two measurements must be greater than the specification.

Brake Noise ... What Is Normal?

"What is normal?" One of the most common things that any vehicle owner perceives as a problem is brake noise when stopping the vehicle. Industry-wide the question pops up "What is considered to be an 'acceptable' level of brake noise?"

The disc brake systems used on vehicles today are designed and developed to meet many different, but very strict requirements. This must be accomplished while providing an optimum level of performance under a wide range of vehicle and environmental operating conditions.

The brake pads used by a manufacturer is ultimately a balanced choice. There is a fine line between a quiet brake pad and one which will provide optimum performance under extreme braking conditions. Consequently, when a change is made in the pad formulation (whether it is meant to provide for longer pad life, shorter stopping distances, noise reduction, or a change in pedal effort), a trade-off must be made in one area or another. An example of pad formulation change would be the industry's switch from asbestos to semi-metallic brake linings due to environmental concerns.

Brake friction materials generate noise and heat in order to dissipate energy, a necessary physical reaction. When this occurs, brake dust and vibration of the brake pad within the caliper is generated. These factors can be changed by other environmental and road conditions such as ambient temperature, moisture, road salt, mud, etc.

It is important to remember that all brakes make noise. The frequency at which the noise becomes audible to us will vary. Any effort to eliminate an intermittent brake noise, which is considered normal, is usually temporary at best. This is not to say, however, that all brake noises should arbitrarily be considered normal. All brake noise should be diagnosed as outlined in the appropriate model year service manual.

Specified pedal stroke:

Without ABS 90 mm (3.54 in)

With ABS 95 mm (3.74 in)

When depressing brake pedal with a 490 N (50 kg, 110 lb) load.

- **Models without ABS:**
If the distance is greater than the specification, there is a possibility that air is still present in the brake lines. Bleed air from the brake lines.
 - **Models with ABS:**
If the distance is greater than the specification, there is a possibility air is inside of the hydraulic unit. Therefore, air must be bled from the the hydraulic unit to the brake pipes in accordance with the bleeding sequence control.
8. Add brake fluid to the required level (MAX level) of the master cylinder reserve tank.
 9. As a final step, test drive the vehicle at low speed and apply the brakes relatively hard two to three times to ensure the brakes provide normal braking action on all four wheels without dragging and uneven braking.

Brake Fluid Replacement

Note: To maintain the brake fluid characteristics, replace the brake fluid according to maintenance schedule or earlier when used in severe condition.

Caution: Fresh DOT 3 or 4 brake fluid must be used.

- *Cover the bleeder with a waste cloth, when loosening it, to prevent brake fluid from being splashed over surrounding parts.*
- *Avoid mixing different brands of brake fluid to prevent degrading the quality of the fluid.*
- *Do not allow dirt or dust to get into the reservoir tank.*

Note: During the bleeding operation, keep the brake reserve tank filled with brake fluid to eliminate entry of air.

- *The amount of brake fluid required is approximately 500 ml (16.9 US fl oz) for the total brake system.*

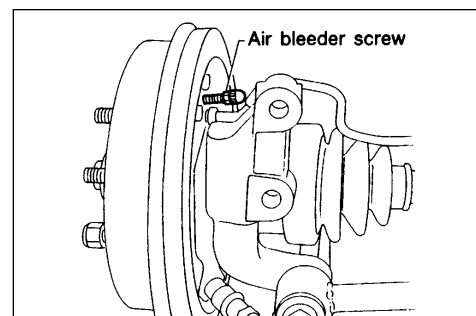
1. Either jack up the vehicle and place safety stands under it, or lift the vehicle.
2. Remove the front and rear wheels.

3. Draw out the brake fluid from the reserve tank with a syringe.
4. Refill the reservoir tank with the recommended brake fluid.

Recommended brake fluid: fresh DOT 3 or 4 brake fluid.

5. Install one end of a vinyl tube over the air bleeder and insert the other end of the tube into a container to collect the brake fluid.
6. Instruct your co-worker to depress the brake pedal slowly two or three times, then hold it depressed.
7. Loosen the bleeder screw approximately 1/4 turn until a small amount of brake fluid drains into the container, then quickly tighten the screw.
8. Repeat steps 6. and 7. until there are no air bubbles in the drained brake fluid and new fluid flows through the vinyl tube.

Caution: Add brake fluid as necessary while performing the air bleed operation, to prevent the tank from running short of brake fluid.



9. After completing the bleeding operation, hold the brake pedal depressed, tighten the screw and install the bleeder cap.

Tightening torque (bleeder screw): 8 ± 1 Nm (5.8 ± 0.7 ft-lb)

10. Bleed air from each wheel cylinder using the same procedures as described in steps 6. through 7. above.
11. Depress the brake pedal with a force of approximately 294 N (30 kg, 66 lb) and hold it there for approximately 20 seconds. At this time check the pedal to see if it shows any unusual movement. Visually inspect the bleeder screws and brake pipe joints to make sure there is no fluid leakage.

12. Install the wheels and drive vehicle for a short distance (1-2 miles) to make sure the brakes are operating properly.

Brake System Air Bleeding (With TCS) Rules For Effective Bleeding

1. Pressure must not be applied to suction pipe by depressing the brake pedal. When any of the following are performed, bleed air from the suction pipe using the air bleeding control operation.

Note: For TCS vehicles, the suction pipe is installed between the master cylinder and hydraulic unit to allow flow of brake fluid between them during ABS and TCS operation.

- When the brake pipe is disconnected from master cylinder.
 - When the brake pipe between the hydraulic unit and master cylinder is disconnected.
 - When fluid is emptied from the reservoir tank.
2. The time interval between two brake pedal operations (from the time when the pedal is released to the time when it is depressed another time) must be approximately 3 seconds.
 3. The air bleeder on each brake must be released for 1 to 2 seconds.

Bleeding Procedure With Air Bleeding Control

Caution:

- Fresh DOT3 or 4 brake fluid must be used.
- Cover the bleeder with a waste cloth, when loosening it, to prevent brake fluid from being splashed over surrounding parts.
- Avoid mixing different brands of brake fluid to prevent degrading the quality of the fluid.
- Be careful not to allow dirt or dust to get into the reservoir tank.
- During the bleeding operation, keep the brake reserve tank filled with brake fluid to eliminate entry of air.

Note:

- Brake pedal movement must be very slow.
- For convenience and safety, bleeding should be performed by two persons.

1. Start the air bleeding control operation.
2. Make sure there are no leaks from any joints or connections of the brake system.
3. Bleed air through the front RH caliper by operating the brake pedal.
 - Fit one end of a vinyl tube over the air bleeder and put the other end into a brake fluid container.
 - Slowly depress the brake pedal and keep it depressed. Then, open the air bleeder to discharge air together with the fluid.
 - Release the air bleeder for 1-2 seconds.
 - Next, with the bleeder closed, slowly release the brake pedal.
 - Repeat these steps until there are no more air bubbles in the vinyl tube.
 - Allow 3-4 seconds between two brake pedal operations.

Caution: Cover the bleeder with a waste cloth, when loosening it, to prevent brake fluid from being splashed over surrounding parts.

Note: Brake pedal movement must be very slow.

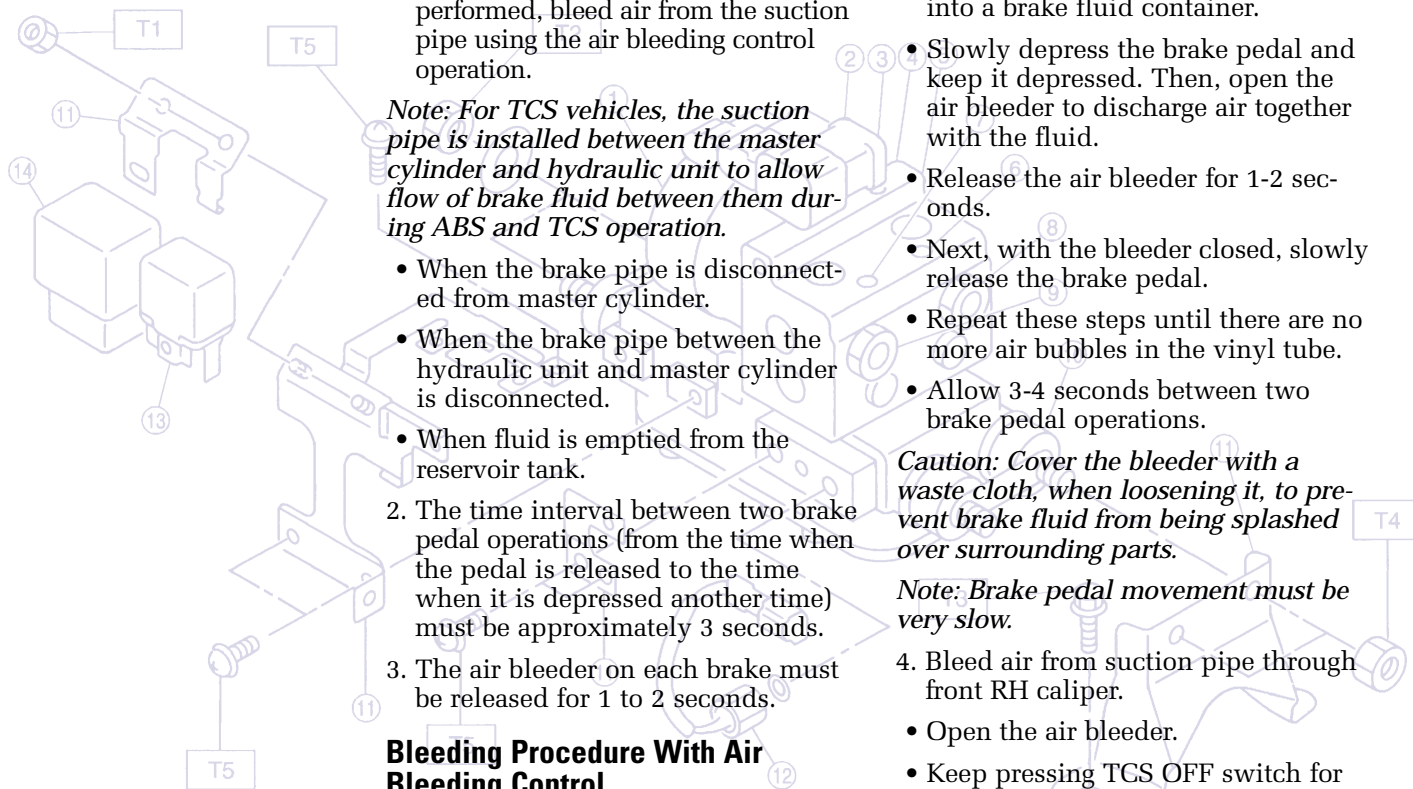
4. Bleed air from suction pipe through front RH caliper.
 - Open the air bleeder.
 - Keep pressing TCS OFF switch for 20 seconds or more.

Note: Ensure no air comes out from the air bleeder.

- Close the air bleeder.
5. Bleed air through the front LH caliper by operating the brake pedal. This is the same procedure as step 3.
 6. Bleed air from the suction pipe through the front LH caliper. This is the same procedure as step 4.
 7. Bleed air through the front RH and LH calipers by operating the brake pedal. This is the same procedure as step 3. Repeat steps 3. to 7. until air no longer comes out.
 8. Tighten the air bleeders securely when bubbles are visible.

Air bleeder tightening torque: 8 ± 1 N-m (0.8 ± 0.1 kg-m, 5.8 ± 0.7 ft-lb)

9. Bleed air through the rear LH and RH



Conditions For Air Bleeding Control

	Stop light switch	TCS OFF switch	Pump motor	TCS valve	FRO RLO	FLO RRO	TCS operating indicator light	ABS warning light	TCS warning light
Air bleeding control is operating	OFF	ON	ON	Close	Close	Close	ON	ON	ON
	ON	ON	OFF	Open	Open	Close	ON	ON	OFF
	ON	ON	OFF	Open	Close	Open	ON	OFF	ON
	ON or OFF	OFF	OFF	Open	Close	Close	ON	OFF	OFF
Stops temporarily	—	—	OFF	Open	Close	Close	OFF	OFF	OFF
Prohibited	—	—	OFF	Open	Close	Close	OFF	ON	ON

*When brake fluid level switch detects brake fluid in LOW level, control operation stops temporarily. After refilling brake fluid, operation restarts.

caliper by operating the brake pedal. This is the same procedure as step 3.

10. Tighten the air bleeders securely when bubbles are visible.

Air bleeder tightening torque: 8 ± 1 N-m (0.8 ± 0.1 kg-m, 5.8 ± 0.7 ft-lb)

Air Bleeding (With TCS)

11. Operate the FRO (Front Right Outlet) valve and RLO (Rear Left Outlet) valve to bleed air from the hydraulic unit outlet circuit.

- Press the TCS OFF switch while depressing brake pedal.
- Make sure the ABS warning light illuminates.
- Repeatedly depress and release the brake pedal 10 times or more while pressing the TCS OFF switch.

NOTE: Air comes out from the reservoir tank.

12. Operate the FLO (Front Left Outlet) valve and RRO (Rear Right Outlet) valve to bleed air from the hydraulic unit outlet circuit.

- Press the TCS OFF switch while depressing the brake pedal.
- Make sure the TCS warning light illuminates.
- Repeatedly depress and release the brake pedal 10 times or more while pressing the TCS OFF switch.

Note: Air comes out from the reservoir tank. The operations in steps 11. and 12. above can be switched with each other by operating the brake pedal (stop light switch) while pressing the TCS OFF switch. Repeat procedures 11. and 12. until air no longer comes out of the reservoir tank.

13. Perform these steps for the brakes connecting to the secondary chamber of master cylinder, first, then for those connected to the primary chamber. When bleeding of all four brake circuits has been completed, depress the brake pedal and keep it in that position for approximately 20 seconds to make sure no leaks are evident in the entire system.

14. Turn the ignition switch OFF.

15. Perform the TCS sequence control.

16. Check the pedal stroke. While the engine is idling, depress the brake pedal with a 490 N (50 kg, 110 lb) load and measure the distance between the brake pedal and steering wheel. With the brake pedal released, measure the distance between the pedal and steering wheel again. The difference between the two measurements must be less than specified.

Specified pedal stroke with TCS:
95 mm (3.74 in) when depressing brake pedal with a 490 N (50 kg, 110 lb) load. If the distance is more than specifications, there is a possibility that air is in the brake line. Bleed air from the brake line.

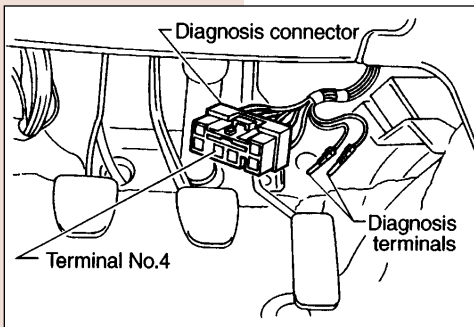
17. Turn the ignition switch OFF.
18. Disconnect the Select Monitor or diagnosis terminal.
19. Add brake fluid to the required level (MAX level) of the reserve tank.
20. As a final step, test drive the vehicle at low speed and apply the brakes relatively hard 2-3 times to ensure the brakes provide normal braking action on all four wheels without dragging or uneven braking.

Conditions For Completion Of Air Bleeding Control

When any of the following conditions occurs, the ABS and TCS warning lights illuminate. Air bleeding control stops, while the ABS and TCS function will then stop. The brake system functions as a conventional brake system.

1. When the speed of at least one wheel reaches 10 km/h (6 MPH).
2. When terminal No. 4 is separated from the diagnosis terminal. (When Select Monitor is not used.)
3. When the pump motor remains ON for two minutes.
4. When the TCS valve remains open for two minutes.
5. When the outlet valve remains closed for two minutes.
6. When a malfunction is detected.

Note: When a malfunction is detected the air bleeding operation stops and the trouble codes are stored in memory.



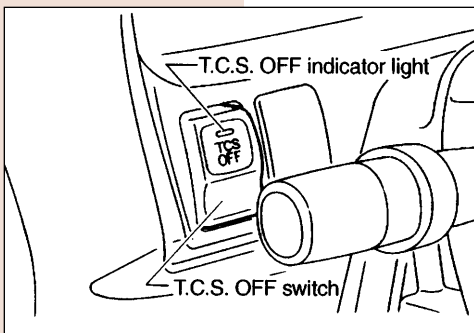
Air Bleeding Control With Diagnosis Connector

1. Connect diagnosis terminals to terminal No. 4 of the diagnosis connector beside driver's seat heater unit.
2. Start the engine while pushing the TCS OFF switch.

Note: Keep the TCS OFF switch depressed even after the engine has started.

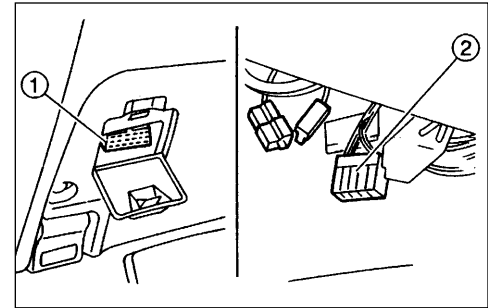
3. After the ABS and TCS warning lights go out, depress the brake pedal within 0.5 seconds.
4. After ensuring the TCS ON indicator illuminates, release the TCS OFF switch and brake pedal.

5. Air bleeding control operation starts.



Air Bleeding With Select Monitor

1. Connect the Select Monitor to the data link connector beside the driver's seat instrument panel lower.



Left Figure: Data link connector (for Subaru Select Monitor and OBD-II generic scan tool)

Right Figure: Data link connector (for Subaru Select Monitor).

Note: When using data link connector 1. above, use ST 498357200 Adapter Cable.

2. Start the engine.
3. Change the Select Monitor to TCS mode by pressing the function key.
4. Press the FD3 ENT key.
5. When the message is displayed, press the ENT key.
6. Air bleeding control operation starts.
7. The Select Monitor indicates that air bleeding control is now operating.
8. When air bleeding control cannot be started (by system malfunction, etc.), the message "Function Start Unable" will be displayed.

Note: Read the trouble codes. Repair faulty parts.