32 – LANDING GEAR WHEELS & BRAKES

WHEELS & BRAKES DESCRIPTION

This L-29 aircraft is equipped with Cleveland Wheels on all three landing gear and hydraulically actuated disk brakes on each main gear. The brakes are used to stop the aircraft on the ground and are normally actuated by the master cylinders connected to the rudder pedals (toe brakes). Hydraulic fluid from the reservoir is supplied to the master cylinders. When the brake pedals are pushed pressurized hydraulic fluid forces the shuttle valve to a position that allows the pressurized fluid to actuate the respective brake assemblies. The left master cylinders are plumbed in series and actuate the left brake. The right master cylinders are also plumbed in series and actuate the right brake.

Figure 32-1 illustrates the front toe brakes being applied. Notice the pressurized fluid flows through the aft master cylinders and positions the shuttle valves so flow is allowed to actuate the brake assemblies from the front toe brakes.

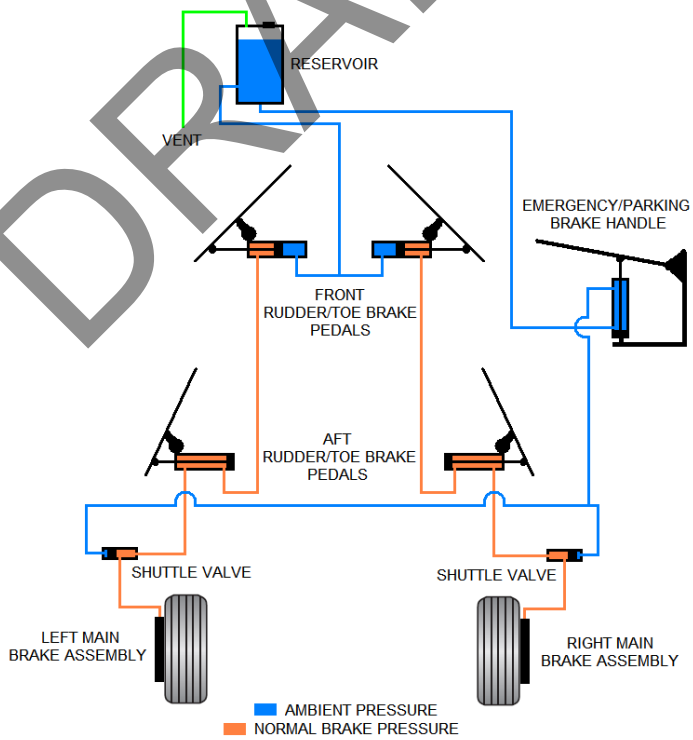

FIGURE 32-1

Figure 32-2 illustrates the aft toe brakes being applied. Notice the fluid from the reservoir is allowed to flow through the front master cylinders to the aft cylinders as necessary. The aft master cylinders supply the pressure to position the shuttle valves so flow is allowed to actuate the brake assemblies from the aft toe brakes.

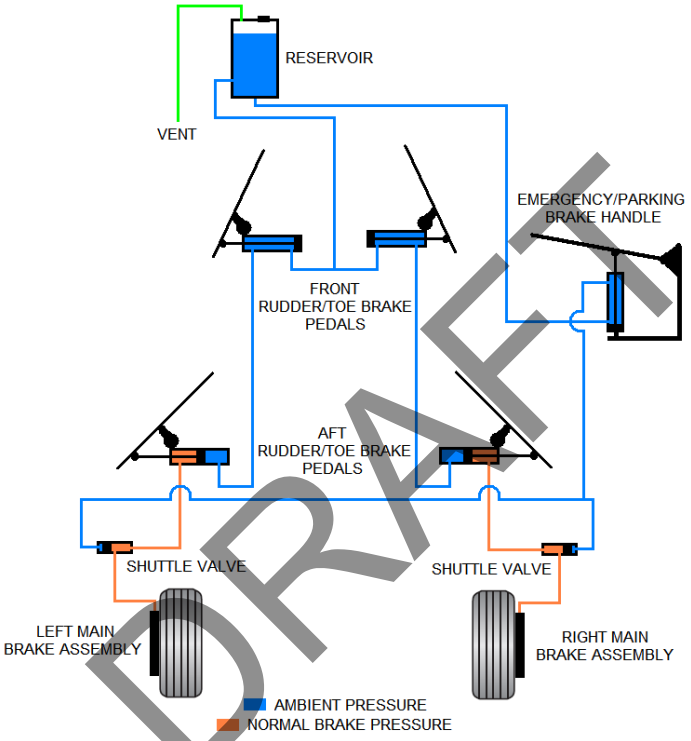

FIGURE 32-2

***** CAUTION *****
THERE IS NO ANTI-SKID SYSTEM INSTALLED ON THIS AIRCRAFT. AGGRESSIVE BRAKING MAY SKID THE TIRES WHICH COULD RESULT IN LOSS OF BRAKING AND DIRECTIONAL CONTROL.

IF BOTH FRONT AND REAR BRAKES ARE APPLIED AT THE SAME TIME THE MASTER CYLINDER WITH THE HIGHEST PRESSURE WILL OVERRIDE THE OTHER AND WILL BE CONTROLLING.

The brake system also has an Emergency Brake incorporated into the system. This will allow a redundant means to apply brake pressure through dedicated lines from the bottom of the reservoir through a single master cylinder to the shuttle valves. The Emergency Brake may also be used as a parking brake.

Figure 32-3 illustrates the Emergency Brake may still be used if the reservoir level drops below the outlet for normal brakes. Notice that the Emergency Brake master cylinder supplied the pressure to reposition the shuttle valves so flow is allowed to actuate the brake assemblies from the Emergency Brake master cylinder.

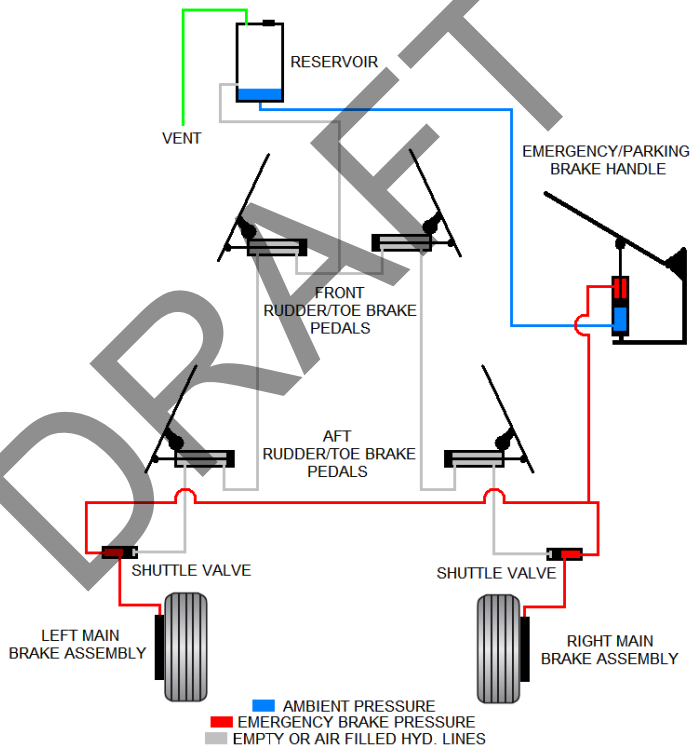

FIGURE 32-3

***** CAUTION *****

USE OF THE EMERGENCY BRAKE SYSTEM TO STOP THE AIRCRAFT DOES NOT ALLOW DIFFERENTIAL BRAKING FOR DIRECTIONAL CONTROL.

DESCRIPTION OF COMPONENTS

BRAKE ASSEMBLIES

Cleveland 30-97 Brake Assemblies installed on this aircraft are single cylinder four piston hydraulically actuated assemblies. These brakes installed on this L-29 meet the requirements of FAR23.735. The calculations are included to provide an enhanced understanding of the factors involved and are for informational purposes only.

REJECTED TAKEOFF (RTO)

FAR part 23.735 item (e)(2) does not apply to this application, however it is felt that it is an important method to determine brake effectiveness and thus have completed the analysis based on the following:

- Aircraft at maximum takeoff gross weight of 7828 pounds.
- $V_R = V_{S1} = 86$KTS

The rejected takeoff brake kinetic energy absorption requirement for each main wheel brake assembly was derived from the following formula.

$$KE = \frac{.0443 * W * V^2}{N} \qquad 1{,}282{,}394 \text{ ft.-lbs.} = \frac{.0443 * 7828 * 86^2}{2}$$

Where,

KE = Kinetic energy per wheel (ft.-lbs.)
W = Design takeoff weight (lbs.)
V = Ground speed, in knots.
N = Number of main wheels with brakes.

The RTO kinetic energy capacity for each Cleveland 30-97 brake assembly is 2,365,800 ft-lbs.

In addition the airframe manufacturer has a brake limitation which prohibits maximum braking with certain fuel loads above predetermined speeds. Basically this chart indicates the maximum speed you could safely perform a RTO with a specific fuel load. This table is listed below and also shows the percent of brake capacity that is used by the Cleveland brakes to meet this requirement. This was determined utilizing the same formula as above using a ZFW of 5470lbs. which includes two pilots.

Fuel Qty. (total)	Max. Braking Speed	% Cleveland Capacity
1300L (2,317lbs.)	76kts	42.1%
1000L (1,782lbs.)	78kts	41.3%
700L (1,162lbs.)	81kts	40.7%
400L (713lbs.)	86kts	42.8%

The Cleveland brakes meet the RTO requirement of FAR 23.735 item (e)(2) utilizing just 54% of their rated capacity. The ***aircraft manufacturers*** brake limitations no longer apply and shall be disregarded.

LANDING

The landing brake kinetic energy absorption requirement per FAR 23.735 item (a)(2) was derived from the following formula:

$$KE = \frac{.0443 * W * V^2}{N} \qquad 1{,}026{,}768 \text{ ft.-lbs.} = \frac{.0443 * 7243 * 80^2}{2}$$

where,

KE = Kinetic energy per wheel (ft.-lbs).
W = Design landing weight (lbs.).
V = Airplane speed in knots, not less than Vso.
N = number of main wheels with brakes.

The landing brake kinetic energy capacity for each Cleveland 30-97 brake assembly is 1,194,200 ft.-lbs.

The normal takeoff weight for the L-29 is 7252lbs. which includes two pilots and full internal fuel (1000L.). If the aircraft made an immediate return the landing weight would be 6896lbs, normal landing weight is 6183lbs, which includes approximately 45 minutes of fuel (400L.).

A takeoff made at maximum gross weight of 7828lbs would include two pilots and 1300L of fuel. If an immediate return were made the landing weight would be 7472lbs. Using the same formula as above; the brake assemblies would be required to absorb 1,085,877 ft-lbs. of torque, still less than the capacity of the brake assemblies.

Note:
Exceeding the aircraft manufactures maximum landing weight of 7243lbs should only be done if an emergency situation exists that requires an immediate landing.

From these analyses, it may be concluded that, the Cleveland brake assembly part number 30-97, when installed on an L-29:

- Have a greater kinetic energy absorption capacity than the brakes originally installed on the L-29.
- Exceed the requirements of FAR 23.735 item (a)(2)(LAND).
- Exceed the requirements of FAR 23.735 item (e)(2)(RTO).
- The airframe manufacturers brake limitations no longer apply and shall be disregarded.

EMERGENCY/PARKING BRAKE HANDLE ASSEMBLY
A handle assembly, fabricated from 4130 steel, is positioned on the right side of the front pilot seat. Pulling of the handle will actuate a single master cylinder (Cleveland 10-23F). This will allow a redundant means to apply brake pressure thru dedicated lines from the bottom of the reservoir through the shuttle valves. This Emergency brake may be used as an emergency means to stop the aircraft or as a parking brake.

MASTER CYLINDERS
Five master cylinders are used to supply pressurized hydraulic fluid for brake activation. Four of the cylinders are pedal mounted and the other is mounted on the emergency/parking brake assembly.

RESERVOIR
A brake reservoir is mounted on the forward pressure bulkhead. It is filled through an opening on top, has a capacity of 16 ounces and is vented to the atmosphere. The outlet for normal brakes is located approximately 3 ounces from the bottom. This will allow the emergency brakes access to the remaining hydraulic fluid from the outlet on the bottom of the reservoir.

RUDDER/TOE BRAKE PEDAL ASSEMBLIES
The rudder/toe brake pedal assemblies facilitate simultaneous or independent inputs for yaw/directional control and aircraft braking. For rudder input apply pressure to the lower half of the pedal. For brake application apply pressure to the top half of the pedal.

SHUTTLE VALVE, BRAKE
A shuttle valve is located on each main gear just prior to the brake assemblies. The purpose of the shuttle valve is to isolate an unused brake pressure supply line. This will facilitate the option of applying brake pressure from multiple sources.

TIRE, MAIN
A 6.50-10 10 ply Bias Type III tire is installed on each main wheel. This tire meets the requirements of FAR23.733 when installed on the mains of an L-29.

- The maximum load rating for the tire is 4750lbs at 100psi per TSO-C62.
- At maximum gross weight of 7828lbs. with the center of gravity at its most ***rearward*** limit the static load per wheel is 3680lbs.

In this application the tire meets the requirements of FAR23.733 item (a)(1)&(c).

TIRE, NOSE

A 15x6.0-6 6 ply Bias Type VII tire is installed on the nose wheel. This tire meets the requirements of FAR23.733 when installed on the nose of an L-29.

- The maximum load rating for the tire is 1950lbs at 68psi per TSO-C62.
- At maximum gross weight of 7828lbs, with the center of gravity at its most ***forward*** limit, the static load on the nose wheel is 673lbs.

In this application the tire meets the requirements of FAR23.733 item (a)(2)&(c).

WHEEL ASSEMBLIES, MAIN

The 40-132 Cleveland wheel assemblies, installed on the mains of this L-29, meet the requirements of FAR23.731.

- The static load rating for the 40-132 wheel is 3900lbs per TSO-C26b.
- At maximum gross weight of 7828lbs, with the center of gravity at its most ***rearward*** limit, the static load for each wheel is 3680lbs.

In this application the wheel meets the requirements of FAR23.731 item (a)(1&2).

WHEEL ASSEMBLY, NOSE

The 40-76B Cleveland wheel assembly, installed on the nose of this L-29, meets the requirements of FAR23.731.

- The static load rating for the 40-76B wheel is 2500lbs per TSO-C26b.
- At maximum gross weight of 7828lbs, with the center of gravity at its most ***forward*** limit, the static load on the nose wheel is 673lbs.

In this application the wheel meets the requirements of FAR23.731 item (a)(1&2).

CONTROLS AND INDICATORS

NORMAL BRAKES

A master cylinder is connected to each rudder/toe brake pedal in both cockpits. To apply the brakes simply apply pressure to the top of the rudder/toe brake pedal. The left pedal applies pressure to the left brake and the right pedal applies pressure to the right brake. Differential braking may be used for directional control on the ground. Simultaneous application of brakes from both cockpits should be avoided. The pilot applying the highest pressure to the brake pedal will override the other and will be controlling.

Brake systems typically give poor feedback and are hard to manage when heavy braking is required, especially under high pilot workload conditions. This aircraft is no exception and has no brake indicators nor does it have an anti-skid system install. As a result braking technique is of critical importance to prevent tire skidding. Tire friction must be considered, especially at higher speeds. If poor tire friction is a possibility or at higher speeds, slowly apply brake pressure to prevent tire skids and as the tire friction increases (higher tire loading at slower speeds) additional brake pressure can be applied. If a skid is detected, immediately release the brakes and then reapply slowly, repeat until the aircraft is stopped or slowed to the desired speed.

***** CAUTION *****

THERE IS NO ANTI-SKID SYSTEM INSTALLED ON THIS AIRCRAFT. AGGRESSIVE BRAKING MAY SKID THE TIRES WHICH COULD RESULT IN LOSS OF BRAKING AND DIRECTIONAL CONTROL.

IF BOTH FRONT AND REAR BRAKES ARE APPLIED AT THE SAME TIME THE MASTER CYLINDER WITH THE HIGHEST PRESSURE WILL OVERRIDE THE OTHER AND WILL BE CONTROLLING.

EMERGENCY/PARKING BRAKES

An emergency brake handle is positioned on the right side of the front pilot seat. Pulling the handle upward applies pressure to both brakes from a single master cylinder. This will allow brake pressure, through dedicated lines from the bottom of the reservoir to the shuttle valves, to flow to each brake assembly. To release the emergency brake push the button on the end of the handle while pulling up then relax the pressure on the handle and allow it to lower to the stop and release the button. Using the emergency brake applies equal brake pressure to each brake thus preventing differential braking for directional control.

***** CAUTION *****
USE OF THE EMERGENCY BRAKE SYSTEM TO STOP THE AIRCRAFT DOES NOT ALLOW DIFFERENTIAL BRAKING FOR DIRECTIONAL CONTROL.

Because of the lack of directional control, while using the emergency brake, it is recommended to stop the aircraft using normal brakes whenever possible.

To use the emergency brake as a parking brake, pull the handle upward until the desired pressure is achieved. The locking mechanism will engage as the handle is pulled up preventing the handle to stow. To release the parking brake push in the spring loaded button on the end of the handle, while pulling up slightly if necessary, then relax the pressure on the handle and allow it to stow.

INTENTIONALY LEFT BLANK

