Service Bulletin

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Ride Manufacturers: Walt Disney World Co.	**Applicable Date of Mfg:** December, 2000
Ride Name DCA California Screamin'	**Affected Serial Nos:** DCA California Screamin'
Model No: DCA California Screamin'	

Abstract of Issue:

Quick exhaust (QE) valves are often used in air brakes and pneumatic control systems. It has been discovered that under some circumstances, a specific style of QE valve, known as a floating piston valve, may exhibit a failure characteristic when used on mechanically actuated fin brake systems. This condition is not known to exist with "diaphragm" style QE valves or with pneumatic bladder actuated fin brakes.

Reason for Release:

This document is intended to alert Disneyland Resort of a failure characteristic of a specific floating piston style QE valve, and to instruct to replace on the DCA California Screamin' Attraction.

Action to be Taken:

Replace floating piston style quick exhaust valves on DCA California Screamin' brake system with diaphragm style QE valves, under engineering direction.

Details of Issue:

BACKGROUND

Quick exhaust valves are common on roller coaster braking systems. They are typically installed at the air powered actuator at each brake to improve the response time of the brake. A QE valve's function is to vent, allowing quicker exhaust of air directly from the area of an actuator rather than having all of the exhaust air go back through the air lines to the electric solenoid valve.

QE Valves have 3 ports named *pressure*, *exhaust*, and a*ctuator*. Incoming air arrives at the *pressure* port and is directed to the brake through the *actuator* port.

Most QE valves use some sort of diaphragm or piston to "sense" the intended flow of pressure through the valve. When there is pressure at the *pressure* port, the diaphragm/piston shifts position to block the exhaust path in order to direct incoming air to the brake through the *actuator* port. When pressure is removed from the *pressure* port, the diaphragm/piston shifts position again to open the exhaust path, thereby allowing air to exhaust away from the brake quickly (i.e. from the *actuator* port to the *exhaust* port).

Figure 1 - Floating Piston Quick Exhaust Valve

There are many types of QE valves in use on roller coasters The diaphragm style QE valve is designed to hold the diaphragm in place and cannot misalign. Floating piston style QE valves allow the piston to move within the chamber. Figure 1 shows a typical floating piston style QE valve.

FAILURE PHENOMENON

When a vehicle arrives at a closed brake, the vehicle's fin "pushes back" the brake and inserts itself into the brake. This causes a pneumatic shock into the air system; that is, a burst of high pressure backwards towards the air source, causing the QE valve to momentarily vent air out the exhaust, then reseal. This is a normal function of the valve.

Testing indicates a diaphragm style QE valve will release the over pressure and reseal consistently. A floating piston style QE valve may release the pressure and not consistently reseal, allowing supply air to continue leaking through the exhaust. This leak can continue unabated until the valve is cycled again.

Figure 2 - Floating Piston in misaligned position

The floating piston style QE valves are susceptible to this failure when the piston is subjected to the high pressure pulse (pneumatic shock) and becomes misaligned inside the valve chamber. The piston may remain in this misaligned configuration until pressure is removed and reapplied. Figure 2 shows a cutaway view of a piston type QE valve with piston in misaligned position.

TESTING

Tests were conducted on California Screamin's mechanically actuated fin brakes using pressure transducers to measure the actual pressure pulse when a fin enters the brake. Figure 3 is a chart of the pressure pulse. In some cases the pressure pulse (7.5 bar) was 30% higher than the static line pressure (5 bar), and had an extremely high onset rate.

Additional bench testing was performed on various styles of QE valves. Appendix A defines the testing procedure used. The only valves that failed in bench testing were the floating piston style valves as shown in Figures 1 and 2.

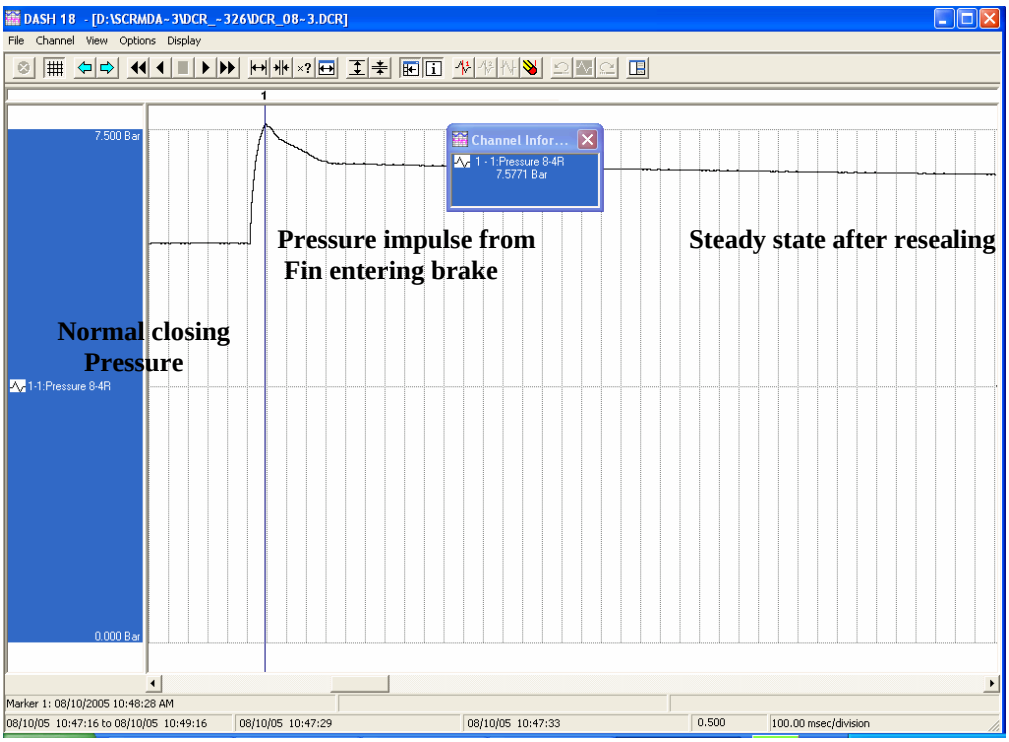


Figure 3. Chart of Pressure Pulse

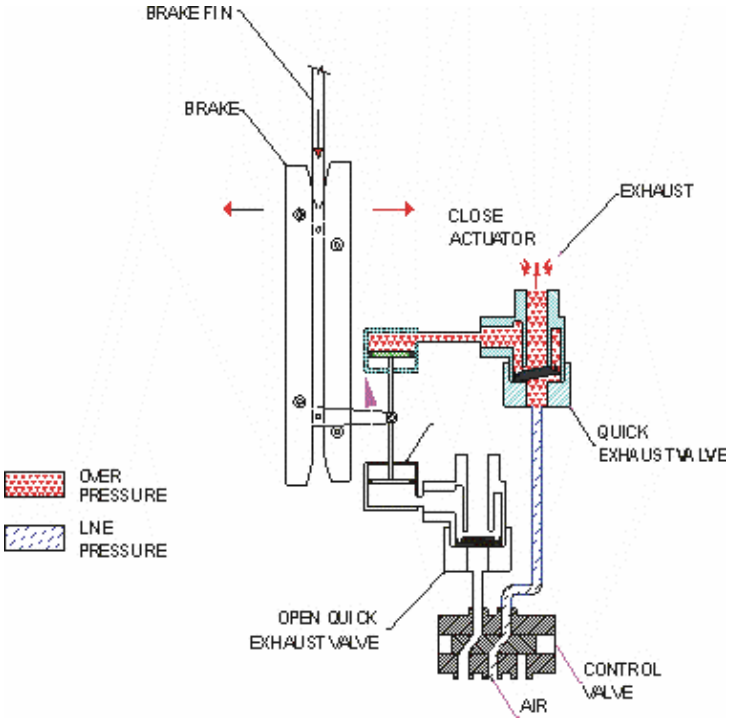


Figure 4 – Quick Exhaust Valve Failure Mode

Figure 4 illustrates the QE valve failure mode. As the fin from a high speed train enters a brake, a pressure pulse is created, causing rapid displacement of the floating piston on the QE valve. This rapid displacement may misalign the floating piston, preventing the QE valve from reseating. If this occurs, the QE valve will continue to leak, lowering the system pressure at the brakes.

DETECTION:

Detection of this phenomenon is difficult. Most roller coaster brake zones have multiple brakes and corresponding QE valves. Occasional leakage from a single QE valve can typically be tolerated by multiple brake systems, and still allow a vehicle to be stopped by the brake. However, leakage by a number of QE valves occurring at one time may result in pressure drops that do not provide sufficient force to completely stop a fully loaded train. To further complicate the issue, systems with several leaking QE valves may properly stop an empty train, which could pass a typical brake penetration test. Further obscuring the detection of this failure characteristic is that the valves do not leak when manually cycling the brakes, such as during maintenance checks. Also, a QE valve that is leaking due to the pressure pulse created by a brake fin may reseal after the brakes cycle.

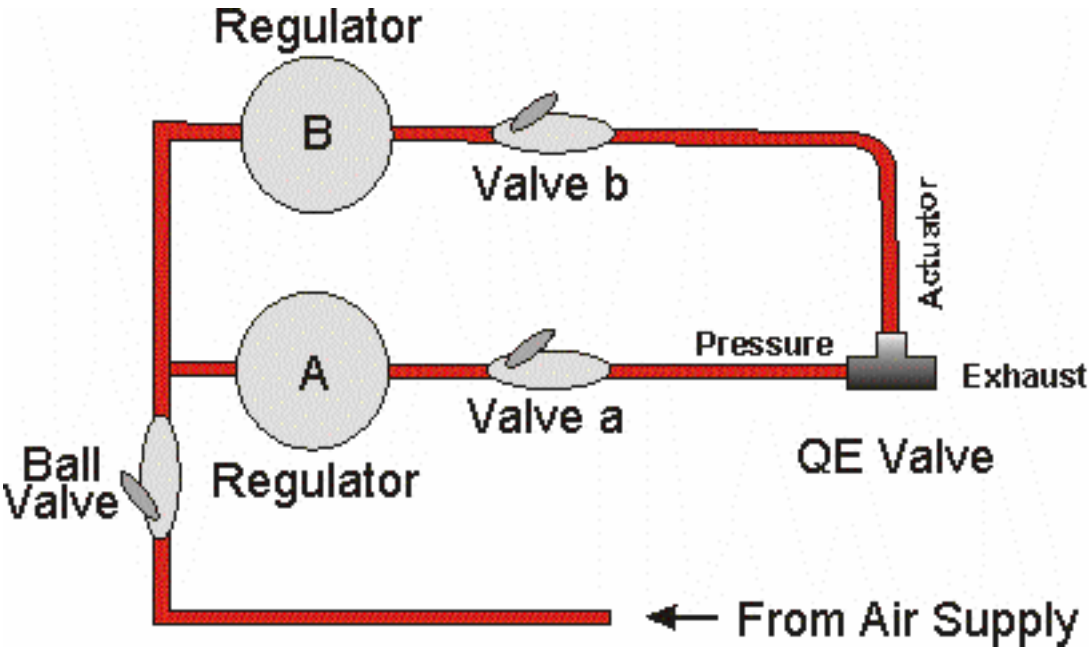
CONCLUSIONS:

The unexpected leaking of the floating piston style QE valves may be caused by a high pressure pulse precipitated by the coaster brake fin entering a closed mechanically actuated brake.

It should be noted that not all applications have such a severe high pressure pulse and floating piston style QE valves may perform satisfactorily without incident. For example, coaster brakes that use an inflatable bladder to close, rather than a mechanically actuated brake, may dampen the pressure pulse so that it is not a factor. Also, diaphragm style QE valves do not appear to be susceptible to this failure characteristic.

APPENDIX A

QUICK EXHAUST VALVE BENCH TEST PROCEDURE



1. Turn on air supply to regulators A and B
2. Adjust regulator A to approximately 4 bar
3. Adjust regulator B to approximately 6-7 bar
4. Turn on valve A with valve B closed. QE valve should seal.
5. Rapidly open and close valve B at various frequencies and magnitudes. A passing QE valve will not leak at all after valve B is closed and exhaust vents a little. A failing QE valve will continue to leak after valve B is closed.
6. Note which QE valves either:
    - do not leak at all, or
    - continue to leak after valve B is closed

Notes:

- A rapid pulse from Regulator B is required.
- Various regulator pressures should be used throughout the test (remember: B must always be higher than A).
- This test was used to replicate a specific leaking condition and may not replicate all failure modes.