



TLC 78/79 SIBS LCV1: RISK ANALYSIS REV-04

Revision Control			
Rev	Released	Change	By
1	02/09/2004	Initial release	AM
2	05/10/2005	Update: Park Brake Lines – leak will cause pump to turn on. Update: Electrical Wiring – all components have min IP65 rating to prevent corrosion	AM
3	21/04/2006	Updated: Hydraulic System (Brake Fluid Level Low; Park Brake Lines Leak; Service Brakes (Piston Seizes ON and OFF); Brake Pads (Worn); Rotor (Excessive Wear); SIBS oil (Incorrect SIBS oil, Excessive Temp of SIBS oil); EMMA Brake (Leaking o-rings, EMMA piston seizing ON & OFF). Refer ECR-205.	AM
4	03/07/2006	Update: EMMA brake: Partially clogged or blocked FILTER ELEMENT/FILTER IN-LINE	MP

COMPONENT	FAILURES/POTENTIAL HAZARD	EFFECT ON SYSTEM	EXISTING RESPONSE	RISK ASSESSMENT			ADDITIONAL CONTROLS
				Likeli hood	Conseq -uence	Risk	
Hydraulic system	Hydraulic lines						
	Front leak	Front brakes not operational	Brake pedal travel increases. Rear brake circuit continues to operate. EMMA brake unaffected.	D	3	M	Maintenance strategy – weekly service (check brake fluid level) SIBS Manual section 10.
	Rear leak	Rear brakes not operational	Brake pedal travel increases. Front brake circuit continues to operate. EMMA brake unaffected.	D	2	L	Maintenance strategy – weekly service (check brake fluid level) SIBS Manual section 10.
	Brake fluid level low	Level near empty: may allow air into system resulting in spongy pedal	None.	C	1	L	Maintenance strategy – weekly service (check brake fluid level) SIBS Manual section 10.
	Brake fluid reservoir empty	Service brake effectiveness falls to zero	None. EMMA brake unaffected.	D	3	M	Maintenance strategy – weekly service (check brake fluid level) SIBS Manual section 10.
	Park brake lines						
	Leak	Pump will switch on to rebuild pressure. Brake will not apply unless leak is severe.	PARK BRAKE ON lamp will illuminate if pressure falls below preset value.	D	2	L	Maintenance strategy – weekly service (check operation of EMMA brake) SIBS Manual section 10.
Service brakes	Callipers						
	Leaking o-ring on pistons	Brake fluid loss. Service brakes will operate but won't hold pressure for extended braking.	Brake pedal travel increases.	C	2	L	Maintenance strategy – weekly service (check brake fluid level) SIBS manual section 10.

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	Piston seizes brakes 'ON'	Brakes bind. 'Brake steer' (for front brake). Possible vapour lock of brake fluid due to overheating, increased pedal travel.	None.	D	2	L	Maintenance strategy – major service (20-50,000 Km) strip down and inspect. SIBS manual section 10
	Piston seizes brake 'OFF'	Reduced braking performance on affected brake; 'Brake steer' (other pistons still operational)	None.	D	2	L	Maintenance strategy – major service (20-50,000 Km) strip down and inspect. SIBS manual section 10
Brake Pads							
	Worn	Gradual reduction in service brake effectiveness.	None.	D	2	L	Maintenance strategy – major service (20-50,000 Km) strip down and inspect. SIBS manual section 10
	Incorrect installation (pad groove – rotation direction incompatibility)	Reduced service brake effectiveness from initial installation	Designed to ensure correct installation only.	E	2	L	SIBS manual section 6.
Rotor							
	Rotor failure (e.g. fatigue cracking)	Major damage to brake. Brake not operational. Remaining brakes unaffected.	Durable design.	E	2	L	Maintenance strategy – major service (20-50,000 Km) strip down and inspect. SIBS manual section 10
	Excessive wear	No significant effect on performance.	None	D	2	L	Maintenance strategy – major service (20-50,000 Km) strip down and inspect. SIBS manual section 10
SIBS oil							
	Excessive SIBS oil	Brakes still operational. Reduced performance. SIBS oil overflow.	Fill plug situation limits volume.	D	2	L	Maintenance strategy – minor service (5-10,000 Km) replace SIBS fluid. SIBS manual section 10
	Lack of SIBS oil	Brake still operational. Increased wear of pads, increased heat generation, increased effectiveness of brakes.	None.	C	2	M	Maintenance strategy - weekly inspection of SIBS fluid level and inspect brake housing for leaks. SIBS manual section 10.
	Incorrect SIBS oil	Possibility of <u>heavily</u> reduced braking performance. Seal degradation. Brake Steer if only in one brake	Installation procedures: (SIBS Manual section 7)	D	3	M	Maintenance strategy: (SIBS manual section 10)
	Excessive SIBS oil temperature.	Oil vapour from brakes. Possibility of transfer of heat to brake fluid leading to vapour lock & spongy pedal.	Low temperature design.	D	3	M	Vapour traps. SOP SIBS Manual section 9.



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EMMA brake	EMMA pistons						
	Leaking o-rings	Loss hydraulic fluid. EMMA brake can still be released until fluid reservoir empty, then Park Brake will apply	PARK BRAKE ON lamp will illuminate if pressure falls below preset value.	D	2	L	Maintenance strategy - weekly inspection of hydraulic fluid level. SIBS Manual section 10.
	EMMA piston seizes OFF	Loss of park brake efficiency in effected brake	None.	D	2	L	Maintenance strategy - weekly performance check of EMMA brake. SIBS Manual section 10.
	EMMA piston seizes ON	Brakes drag. Increased heat build up in effected brake. Possibility of transfer of heat to brake fluid leading to vapour lock & spongy pedal.	None.	D	2	L	Maintenance strategy - weekly performance check of EMMA brake. SIBS Manual section 10.
	Broken Belleville spring	Braking force reduced on affected brake	Maintenance strategy - weekly performance check of EMMA brake. SIBS Manual section 10.	E	2	L	Maintenance strategy – major service (20-50,000 Km) strip down and inspect. SIBS manual section 10
	Partially clogged FILTER ELEMENT OR FILTER IN-LINE	EMMA brake slow to apply.	FILTER IN-LINE replaced by FILTER ELEMENT in the latest design.	C	1	L	Maintenance strategy – weekly performance check of EMMA brake. SIBS manual section 10. Replace filter as per manual.
	Blocked FILTER ELEMENT OR FILTER IN-LINE	The worst case scenario is that the EMMA would not apply.	FILTER IN-LINE replaced by FILTER ELEMENT in the latest design.	E	4	H	Maintenance strategy – weekly performance check of EMMA brake. Clogging of filter a gradual process) SIBS manual section 10. Replace filter every 20,000km or as condition dictates.
EMMA Control unit	Solenoid operated check valve, normally open (SVB)						
	Fails to open EMMA-brake application required	No effect	Not applicable	D	1	L	
	Fails to close EMMA-brake application required	No effect	Not applicable	D	1	L	
	Fails to open EMMA-brake release required	No pressure to EMMA brakes. Will not release	Dashboard "BRAKE ON" warning light continuously ON.	D	1	L	Maintenance strategy - weekly check of EMMA brake operation. SIBS Manual section 10.
	Fails to close EMMA-brake release required	System will not hold pressure. Motor will switch on and off.	Dashboard "BRAKE ON" warning light ON intermittently.	D	1	L	Maintenance strategy - weekly check of EMMA brake operation. SIBS Manual section 10.



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	Partially open/closed	EMMA brakes slow to release. System will not hold pressure. Motor will switch on and off.	Dashboard "BRAKE ON" warning light ON intermittantly.	D	1	L	Maintenance strategy - weekly check of EMMA brake operation. SIBS Manual section 10.
	Pressure switch						
	Failure EMMA-brake application required	Indication ILED's will not work. EMMA brakes will apply	Maintenance strategy - weekly check of EMMA brake operation: SIBS Manual section 10.	D	1	L	
	Failure EMMA-brake release required	EMMA brakes will apply. Indication lamps will not work.	SOP: SIBS Manual section 9 – EMMA piston retractor bolts to release EMMA brake.	D	2	L	
	Stuck closed EMMA-brake application required	Dashboard 'BRAKE ON' warning light always ON.	Not applicable	D	1	L	
	Stuck open EMMA-brake application required	No effect	Not applicable	D	1	L	
	Stuck closed EMMA-brake release required	Continuous operation of hydraulic motor. EMMA brakes will release	Dashboard 'BRAKE ON' warning light ON. Park brake 'OFF' lamp will remain illuminated	D	3	M	Maintenance strategy - weekly check of EMMA brake operation. SIBS Manual section 10.
	Stuck open EMMA-brake release required	Motor will not operate. EMMA brakes will not release.	Park brake 'OFF' lamp will remain illuminated. Dashboard 'BRAKE ON' warning light will NOT be illuminated.	D	1	L	Maintenance strategy - weekly check of EMMA brake operation. SIBS Manual section 10.
	Pressure switch point incorrect – set low	EMMA brakes may not fully release	Initial installation check. SIBS Manual section 7.	D	3	M	Maintenance strategy - weekly check of EMMA brake operation. SIBS Manual section 10.
	Pressure switch point incorrect – set high	Extended operation of motor	Motor may overheat	D	2	L	
	Pressure relief (dump) valve						
	Fails to open EMMA-brake application required	No effect	Not Applicable	D	1	L	
	Fails to close EMMA-brake application required	No effect	Not Applicable	D	1	L	
	Fails to open EMMA-brake release required	No effect	Not Applicable	D	2	L	Maintenance strategy - weekly check of INTERLOCK EMMA brake operation. SIBS Manual section 10.
	Fails to OPEN INTERLOCK EMMA brake application required	Brakes will slowly apply	Neither PARK BRAKE ON nor OFF LED's will be illuminated.	D	3	L	



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	Fails to close normal EMMA-brake release required	No effect	Not Applicable	D	1	L	Maintenance strategy - weekly check of INTERLOCK EMMA brake operation. SIBS Manual section 10.
	Pressure relief valve incorrectly set – set low	INTERLOCK brake application will be rapid	Neither PARK BRAKE ON nor OFF LED's will be illuminated	D	2	L	Maintenance strategy - weekly check of INTERLOCK EMMA brake operation. SIBS Manual section 10.
	Pressure relief valve incorrectly set – set high	INTERLOCK brake application will be slow.	Neither PARK BRAKE ON nor OFF LED's will be illuminated	D	2	L	
Solenoid operated valve, normally closed (SVA) (not used in the new design, assembly no. 02-1007-0)							
	Fails to open EMMA-brake application required	Brake application will be at same rate as INTERLOCK.		D	2	L	
	Fails to close EMMA-brake release required	EMMA brake can not be released	Buzzer will sound continuously. SOP: SIBS Manual section 9.	D	1	L	SIBS Manual section 9 – EMMA piston retractor bolts to release EMMA brake.
	Solenoid failure	Valve will fail to open	SOP: SIBS Manual section 9.	D	2	L	Maintenance strategy - weekly check of EMMA brake operation. SIBS Manual section 10.
EMMA brake operation and feedback	Control switch						
	Failure	Brakes will remain released if released.	Brakes can be applied by turning ignition OFF or by operating INTERLOCKING device	C	2	M	Maintenance strategy - weekly check of EMMA brake operation: SIBS Manual section 10. SIBS Manual section 9 – EMMA piston retractor bolts to release EMMA brake
	EMMA brake operation indication						
	Dashboard PARK BRAKE WARNING lamp failure	Operator may not be aware EMMA brakes are engaged and attempt to drive.	PARK BRAKE OFF lamp,.	D	1	L	Maintenance strategy - weekly check of EMMA brake operation: SIBS Manual section 10.
	PARK BRAKE OFF & ON LED failure	None	PARK BRAKE ON lamp	D	1	L	Maintenance strategy - weekly check of EMMA brake operation: SIBS Manual section 10.
EMMA general	Attempting to drive when EMMA brakes are applied	Drive-away difficult.	Dashboard "BRAKE ON" warning light ON.	C	2	M	SOP: SIBS Manual section 9.
	Electrical wiring						



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faults	Physical damage	EMMA brakes will apply	SOP: SIBS Manual section 9.	D	2	L	All components have minimum IP rating of IP65 to prevent corrosion.
	High current drawn	Fuse protection. EMMA brakes may apply	SOP: SIBS Manual section 9.	D	2	L	
	Earthing failure	EMMA brakes will apply	SOP: SIBS Manual section 9.	D	2	L	
	Relay						
	Failure	Motor will not operate.	EMMA brakes will not release	D	1	L	Reliable component selected. Maintenance strategy - weekly check of EMMA brake operation:
	Stuck open	Motor will not operate.	EMMA brakes will not release	D	1	L	Reliable component selected. Maintenance strategy - weekly check of EMMA brake operation:
	Stuck closed	Motor will continually operate, exceeding duty cycle and eventually failing No effect on brake operation.	Audible motor operation.	D	3	M	Reliable component selected. Maintenance strategy - weekly check of EMMA brake operation:
	Power supply						
	Failure	EMMA brakes will apply	Replace battery	C	2	M	Maintenance strategy - weekly check of EMMA brake operation: SIBS Manual section 10.
	Over voltage supply	No effect	None	C	1	L	
	Under voltage supply	Motor speed reduced. EMMA brake release slow. Solenoid may open causing EMMA brakes to apply	Maintenance strategy - weekly check of EMMA brake operation: SIBS Manual section 10.	C	2	M	
	Electric Motor						
	Motor Failure	No pressure generation. Brakes will not release.	SIBS Manual section 9 – EMMA piston retractor bolts to release EMMA brake	D	1	L	
	Extended operation	Overheating and failure	Dashboard "BRAKE ON" warning light ON	D	1	L	Maintenance strategy - weekly check of EMMA brake operation: SIBS Manual section 10.
	Hydraulic Pump						
	Motor Coupling Failure	No pressure generation. Brakes will not release.	Durable design	E	1	L	SIBS Manual section 9 – EMMA piston retractor bolts to release EMMA brake



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	Pump seizure	No pressure generation. Brakes will not release.	Durable design	E	1	L	SIBS Manual section 9 – EMMA piston retractor bolts to release EMMA brake
	Internal seal failure	Reduced pressure generation. Brakes may not release.	Durable design	D	1	L	SIBS Manual section 9 – EMMA piston retractor bolts to release EMMA brake
	Hydraulic fluid reservoir empty	EMMA brakes cannot be released.	Maintenance strategy - weekly check of EMMA brake operation: SIBS Manual section 10.	C	1	L	
	Incorrect hydraulic fluid	High viscous fluid will reduce EMMA brake release time. Hydraulic leaks possible with fluid-seal incompatibility	Installation procedures: SIBS Manual section 7. Maintenance strategy: SIBS Manual section 10.	D	2	L	