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Our Ref : CI/TP23006033/N 23 June 2023

SATS Maintenance Centre
34 Changi North Crescent
Singapore 499614

TECHNICAL INVESTIGATION REPORT OF FIRE INCIDENT INVOLVING THE MOTOR VEHICLE TR 228 ON 2 JUNE 2023

1. We refer to your letter dated 8 June 2023 and the instructions therein.

2. Our analysis, comments and opinions with respect to the cause of fire to the Motor Vehicle TR 228 (herein referred to as **"Transporter"**) are set out below.

Inspection of the Motor Vehicle

3. The Transporter was physically inspected on 8 June 2023 at the premises of SATS Maintenance Centre (herein referred to as **"SATS"**) located at 34 Changi North Crescent, Singapore 499614.

4. A static inspection was carried out to the Transporter where the following general information was recorded:-

Vehicle Registration No.	: TR 228
Make / Model	: F.M.C. CPT7
Chassis No	: 03013
Year of Registration	: May 2003
Mileage	: N.A (wiring affected)

5. The Transporter was noted to have sustained fire damage that was confined to its instrument cluster. The fire damage was observed to be most severe at its operator control panel. The front exterior portion was unaffected by the fire except for the instrument cluster. The engine compartment was unaffected by the fire. See photos 1 – 4 below.

Photo 1 shows the front view of the Transporter at the time of our inspection. The fire damage to the Transporter was confined to its instrument cluster. Most parts of the front portion were unaffected by the fire except for the instrument cluster.

Photo 2 shows the right body of the Transporter at the time of our inspection. The fire damage to the Transporter was confined to its instrument cluster. The right body was observed to have been unaffected by the fire.

Photo 3 shows the rear portion of the Transporter at the time of our inspection. The fire damage to the Transporter was confined to its instrument cluster. The rear portion was observed to have been unaffected by the fire.

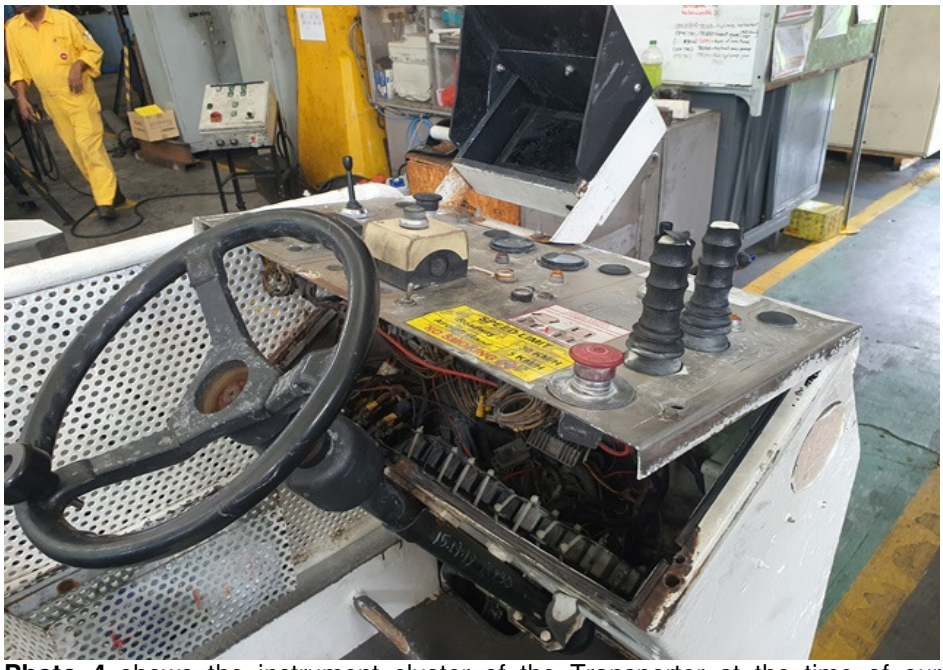


Photo 4 shows the instrument cluster of the Transporter at the time of our inspection. The instrument cluster was significantly affected by the fire.

6. At the time of inspection of the Transporter, we did not find any additionally fitted electronic and/or electrical component(s) on the Transporter. There also appears to be no modification(s) fitted on the Transporter.

Investigation and Technical Analysis

7. For this particular case, the fire appears to have originated within the operator control panel of the Transporter, somewhere around the right portion. This can be determined from the circumstances of the incident where the driver had reported seeing white smoke emitting from the right portion of the operator control panel of the Transporter.

8. Upon closer examination of the right portion of the operator control panel, which was where the fire to the Transporter had likely started, we had found greenish residue on the wirings leading from an electrical relay. The wirings were original factory fitted wirings. The presence of greenish residue indicates internal heating of copper wires, a sign of an electrical short circuit occurring. The greenish residue is normally left behind from oxidation as a result of chemical reaction involving the copper wires. This physical evidence would then appear to suggest that the cause of fire to the Transporter could have possibly been due to electrical in nature. See photos 5 - 8 below.

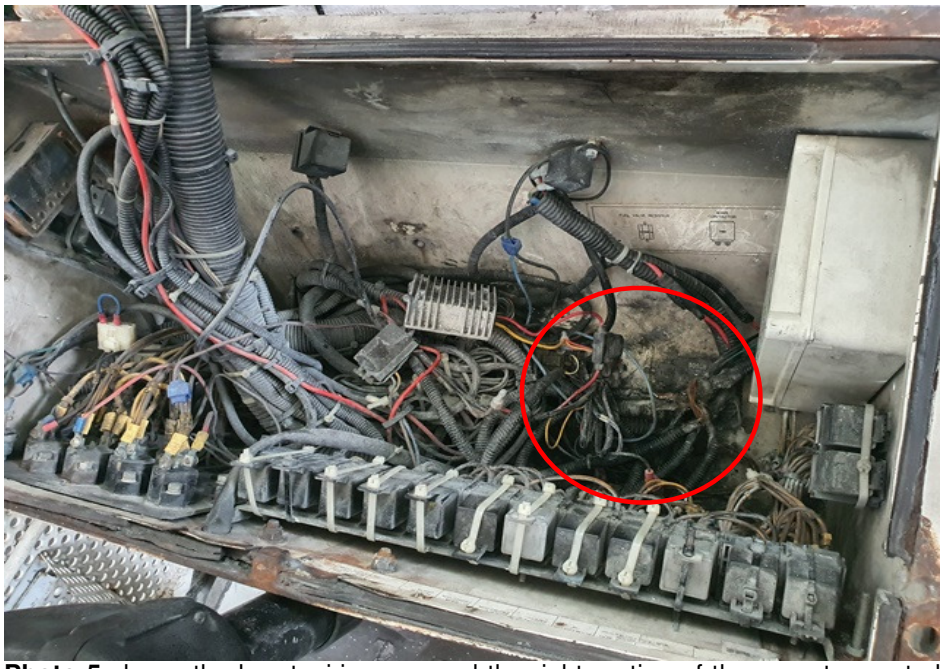


Photo 5 shows the burnt wirings around the right portion of the operator control panel, which was where the fire to the Transporter had likely started (circled).

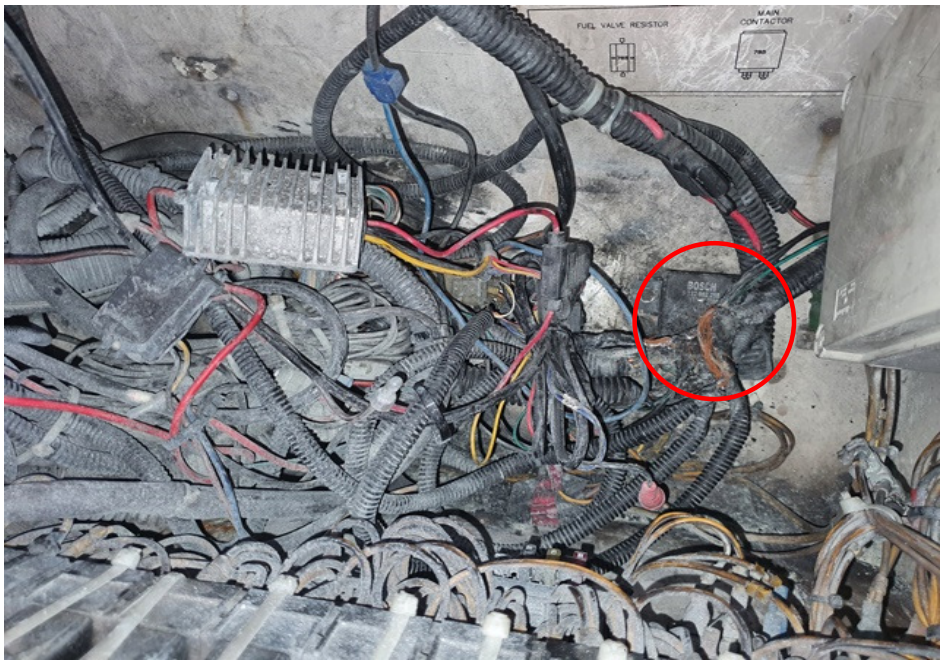


Photo 6 shows the right portion of the operator control panel of the Transporter. We found greenish residue on some of the burnt wirings leading from an electrical relay (circled). The presence of such greenish residue suggests occurrence of an electrical short circuit.

Photo 7 shows a closer view of the greenish residue found on some of the burnt wirings leading from an electrical relay (red arrows). The presence of such greenish residue suggests occurrence of an electrical short circuit. The greenish residue is normally left behind from oxidation as a result of chemical reaction involving the copper wires.

Photo 8 shows a close up view of the greenish residue found on some of the burnt wirings leading from an electrical relay (red arrows).The presence of such greenish residue suggests occurrence of an electrical short circuit.

9. From the Incident Report which was made by Mr Lau who was the assigned driver of the Transporter at the time of incident, we note that the fire to the Transporter had started at a time when he was driving. Mr Lau was first alerted of the fire when he saw white smoke emitting from within the operator control panel.

10. According to Mr Lau, at about 1507 hours on 2 June 2023, he had driven the Transporter from F41 and was proceeding to F56 to service SQ875. Along the way, he detected a burning smell coming from the instrument cluster of the Transporter. He stated that the engine was cut off abruptly and white smoke could be seen emitting from the right portion of the operator control panel.

11. Mr Lau immediately grabbed a fire extinguisher, loosened a bolt on the instrument cluster and put out the flames in the operator control panel. Airport Emergency Service (AES) and SCDF were activated and arrived at the incident scene shortly after. Changi Airport Group (CAG) was informed of the incident.

12. Mr Lau is the assigned driver of the Transporter on the day of the incident. To the best of his recollection, there has not been any major mechanical problem and/or electrical problem with the Transporter on the day that he was driving it.

13. With regards to the history of the Transporter, we were able to gather from Mr S Saravanan (herein referred to as **"Mr Saravanan"**) who is the maintenance assistant manager of SATS that the Transporter was purchased new in 2003.

14. Pertaining to the maintenance aspect, Mr Saravanan informed us that the Transporter was sent for periodical servicing in- house at the SATS Maintenance Centre for every 200 work hours, 400 work hours and 2000 work hours respectively.

15. During the course of our investigations, we were able to obtain from Mr Saravanan the latest servicing and repair records of the Transporter. The last servicing before the incident was done on 20 April 2023 which included the changing of engine oil, oil filter and engine oil drain plug 'O' ring. Checks on the electrical system were also conducted. Everything was in working order and no electrical components were replaced. See Invoices 1 & 2 below.

SATS GATEWAY

SATS MAINTENANCE CENTRE
TRANSPORTER (FMC)
PREVENTIVE MAINTENANCE CHECKLIST

Equipment No. : TP778 ← | Job No. : 0686
Hourmeter Reading : 327 | Date : 20/4/23 ←

Mechanical Checks By : Lim Jia Yong / Lai Zhengyang | S/No. : 731 / 736 | Sign:
Electrical Checks By : Ng Yuan Ang | S/No. : 738 | Sign:
Quality Check / Tested By : Andre / Bob | S/No. : 730 / 05 | Sign:

S/No.	SYSTEM / SERVICE		200HRS	400HRS	2000HRS	REMARKS
A	ENGINE					
1	Valve Clearance	Check & adjust if necessary		✓		
2	Rocker & Cover	Check for leaks & security		✓		
3	Timing Cover Gasket / Oil Seal	Check for leaks		✓		
4	Engine Oil	Drain, flush & replenish to the correct level		✓		Replaced oil ←
5	Engine Oil Filter	Replace element (carried out every 400 hrs)		✓		Replaced element ←
6	Oil Cooler	Clean with dry air and check for cracks & leaks				
7	Oil Sump Gasket & Bolt	Check for leaks & security		✓		
8	Drain Plug	Check for leaks & security		✓		Replaced 'O' ring ←
9	Engine Mounting (Front & Rear)	Check for cracks & security		✓		
10	Flywheel Housing	Check for wear & security		✓		
11	Engine Belt	Check Tension of belt (carried out every 200hrs)		✓		
12	Engine Support Bolts & Nuts	Check for wear & security		✓		
B	ENGINE FUEL SYSTEM					
1	Fuel Tank	Check for leaks & security		✓		
2	Fuel Tank Cap	Check condition & security (Rubber Seal)		✓		
3	Tank Drain Plug	Check for security & leaks		✓		
4	Hoses / Pipes / Unions	Check for damages, leaks & chafing Replace the hose every 4 years **Last Change :** 25/6/18		✓		
5	Sediment Bowl	Check condition & clean (carried out every 400 hrs)		✓		Clean bowl
6	Fuel Filter (Fuel Tank, Fuel Pump)	Replace element (carried out every 400 hrs)		✓		
7	Fuel Injectors	Check, clean and calibrate injectors. Replace any that are faulty				
8	Fuel Injector Pump	Check for leaks & operation				
9	Fuel Lift Pump	Check for leaks & operation		✓		
10	Throttle Linkage & Pipes	Check for bend, leaks & security		✓		
11	Fuel Solenoid	Examine for cracks, damages, security & check for ohms		✓		
12	Accelerator Pedal	Examine for cracks, damages & security		✓		
13	Fuel level	Check fuel & refill if necessary		✓		

Invoice 1 shows the last servicing package done on the Transporter in- house at the SATS Maintenance Centre on 20 April 2023 (red arrows) which included the changing of engine oil, oil filter and engine oil drain plug 'O' ring (black arrows).

	SYSTEM / SERVICE		200HRS	400HRS	2000HRS	REMARKS
	ELECTRICAL SYSTEM					
1	Battery	Check for electrolyte level, connection, insulation, battery holding charge, master switch & replace battery yearly		✓		
2	Battery Terminals & Wire	Clean terminal, examine for cuts, abrasion, proper connection & security		✓		
3	Battery Terminal Cover	Check for cracks & security		✓		
4	Electrical Wiring / Connection* (All Junction Box)	Examine for cuts, abrasion, proper connection & security		✓		
5	Starter Motor*	Check for security, damages, operation & replace yearly (condition check every 2000hrs)		✓		
6	Starter Motor Solenoid	Check for the mounting & electrical wire for security		✓		
7	Alternator Belt	Examine for intersecting cracks / fray		✓		
8	Alternator*	Check for correct charging rates, security, connection, insulation & replace yearly (condition check 2000 hrly) Last Change: 17/1/13		✓		
9	Proximity Switches	Check for security, damages & operation		✓		
10	Foot Pedal Micro Switch	Check for security, damages & operation		✓		
11	Hour Meter	Check for security, damages & operation		✓		
12	Battery Charging Meter & Charging	Check for security, damages & operation		✓		
13	Fuel Gauge	Check for security, damages & operation		✓		
14	Dashboard Lights*	Check for security, damages & operation (check every 100 hours)		✓		
15	Ignition Switch	Check for security, damages & operation		✓		
16	I-Button	Check for security, damages & operation		✓		
17	Bypass Switch	Check for security, damages & operation		✓		
18	Headlights	Check for security, damages & operation		✓		
19	Tail Lights	Check for security, damages & operation		✓		
20	Signal Lights	Check for security, damages & operation		✓		
21	Apron Light	Check for security, damages & operation		✓		
22	Spotlight	Check for security, damages & operation		✓		
23	Reverse Alarm	Check for security, damages & operation		✓		
24	Reverse Amber Blinker Light	Check for security, damages & operation		✓		
25	Horn	Check for security, damages & operation		✓		
26	Joy Sticks	Check for security, damages & operation		✓		
27	Parking Brake Switch	Check for security, damages & operation		✓		
28	High Temperature Engine Shut Down	Check for security, damages & operation		✓		
29	Circuit Switch	Check for security, damages, operation & every 2 years		✓		
30	Solenoid Coil	Check for security, damages, operation & every 2 years		✓		

S/No.	SYSTEM / SERVICE					
J	ELECTRICAL SYSTEM (CONT'D)					
31	Emergency Kill Switch Button	Check for security, damages & operation				
32	Engine Oil Pressure Switch	Check wiring, insulation & continuity		✓		
33	Water Temperature Switch	Check wiring, insulation & continuity		✓		
34	Main Service Coil	Check wiring, insulation, reading of not more than 22 ohms & not less than 18 ohms		✓		
35	Height Cylinder Coil	Check wiring, insulation, reading of not more than 22 ohms & not less than 18 ohms		✓		
36	Parking Brake Coil	Check wiring, insulation, reading of not more than 22 ohms & not less than 18 ohms		✓		
37	Battery Fluid Level	Check clamps &connectors (Liquid must cover battery plates) (check every 50 hours)		✓		
38	Solenoid Valve	Check the correct solenoid valve feeding		✓		
39	Dash Panel	Check components & connections		✓		
40	Seat Sensor	Check for security, damages & operation		✓		
41	Front Monitor	Check for security, damages & operation		✓		
42	Rear Camera	Check for security, damages & operation		✓		
43	Reverse LED Blinking Light	Check for security, damages & operation		✓		

Invoice 2 shows the checks done on the electrical system of the Transporter during the last periodic servicing. Everything was in working order and no electrical component was replaced.

16. Based on the vehicle service record invoices provided, we are of the opinion that it is unlikely that the fire could have been caused by poor maintenance of the Transporter.

17. Given the circumstances of incident as reported, the possibility of the cause of fire to the Transporter being due to engine overheating would seem unlikely as Mr Lau had mentioned to us there were no indications of abnormally high temperatures on the Transporter when he drove the Transporter on the day of the incident.

18. The possibility of the fire being due to external factors (foreign material(s) stuck on hot surfaces, arson and sabotage amongst others) would also seem unlikely given that the location of where the Transporter was positioned was also observed to be not at a secluded location.

19. The possibility of the fire being due to electrical in nature would then seem more likely given that engine overheating and external factors would both seem unlikely. The fire being due to electrical nature is also supported by the condition of the wirings that were found inside the right portion of the operator control panel of the Transporter, which was earlier discussed in paragraph 8 above.

20. Our checks with both local and international bodies and associations had revealed that at the time of writing this report, there is no manufacturer recall of electrical nature to similar make and model vehicle as the Transporter that may possibly be related to this incident. See search result from LTA below.

Land Transport Authority

Vehicle Recall Details

ONLY INFORMATION ON VEHICLE RECALLS SUBMITTED FROM 9 APRIL 2007 IS AVAILABLE

Owner ID Type	*Owner ID*
Company	**561R** ←
Vehicle No.	*Make/Model*
WB8526P ←	**F.M.C./ CPT7**

Engine No.:	Chassis No.:
AR36924U306163K	03013

Recall Details:

No Recall Detail records ←

Conclusion

21. Having investigated and technically analysed the damages of burnt nature to the Transporter, we are of the view that the cause of fire to the Transporter was of electrical in nature. For this particular case, the fire had originated from the wirings within the operator control panel of the Transporter. The wirings were original factory wirings leading from one of the electrical relays of the Transporter. We are given to understand that the particular relay is part of the wiring system for the camera of the Transporter.

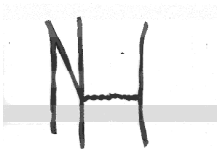
22. Electrical relays are exposed to both high electrical load and low electrical load, hence replacement of electric relays periodically is suggested in order to maintain integrity of the pins and inner coils. Rust or corrosion on the pins and inner coils can cause resistance, which in turn will lead to build up of heat from the electrical current passing through, potentially igniting an electrical fire. The cost of such electrical relays is not expensive.

23. We did not find any evidence which had suggested that the cause of fire to the Transporter was due to poor maintenance and/or recurring electrical problem.

24. We suggest that the company perform physical checks of wirings for loose connections and frayed wires should also be part of a regular maintenance checklist especially when our hot weather climate can accelerate the deterioration of wire insulations.

25. There were no modification(s) or additional electronic and/or electrical component(s) fitted on the Transporter at the time of our inspection of the Transporter.

26. Our investigations had also revealed that at the time of writing this report, there is no manufacturer recall of electrical nature to similar make and model vehicle as the Transporter that may possibly be related to this incident.



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