



Your Ref: SHB 8971P
Our Ref :CI/TP17023247/D

06 December 2017

UK Cool Pte Ltd
23 Changi South Avenue 2
Singapore 486443

TECHNICAL INVESTIGATION REPORT OF FIRE INCIDENT INVOLVING A KIA OPTIMA MOTOR TAXI SHB 8971P ON 21 NOVEMBER 2017

1. I refer to your request dated 22 November 2017 to determine the possible cause of fire to the motor taxi SHB 8971P (herein referred to as "**Motor Taxi**"), and any measures that could be undertaken to prevent similar incident(s) from recurring.
2. Following the request, the Motor Taxi was physically inspected on 24 November 2017 at the premises of Premier Automotive Services Pte Ltd, 23 Changi South Avenue 2 Singapore 486443.

Inspection of the Motor Taxi

3. A static inspection was carried out to the Motor Taxi where the following general information was recorded:-

Vehicle Registration No.	: SHB 8971P
Make / Model	: Kia Optima 1.7(A) Diesel
Chassis No	: KNAGM414ME5462768
Year of Registration	: 2014 (April)
Mileage	: N.A (Battery melted)

4. The Motor Taxi was noted to have sustained severe fire damage that was confined to its frontal portion. Its engine compartment was extensively burnt; its interior compartment was also burnt at its front area.
5. The body parts at the front portion of the Motor Taxi that were observed to have been burnt and/or melted had included its front bumper, front fenders, front bonnet, front headlamps, front grille, front right tyre, right side wing mirror, right side front door, roof panel and front windscreen amongst others. Almost all the parts and components inside the engine compartment were burnt and/or partially melted. Parts towards the front area of the interior compartment, like the dashboard, upholstery and carpet, were also burnt and/or partially melted. See photo 1 – 4 below.



Photo 1 shows a general view of the front left body of the Motor Taxi at the time of inspection. The Motor Taxi was observed to have been severely burnt at its frontal portion. Its front bumper, front bonnet, front grille, front left headlamp, front left fender, roof panel and front windscreen were amongst the body parts that were found to have been affected as a result of the fire.



Photo 2 shows a general view of the front right body of the Motor Taxi at the time of inspection. The Motor Taxi was observed to be severely burnt at its frontal portion. Its front bumper, front bonnet, front right headlamp, front right fender, roof panel and right side wing mirror were amongst the body parts that were found to have been affected as a result of the fire.



Photo 3 shows the engine area of the Motor Taxi at the time of inspection. Almost all the parts inside the engine compartment were observed to be completely burnt and/or melted as a result of the fire. This had included its radiator, cooling fan, engine housing, fuel rail, brake booster and fuse box amongst others.



Photo 4 shows the interior compartment of the Motor Taxi at the time of inspection. Parts towards the front area of the interior compartment were found to be burnt and/or partially melted as a result of the fire. This had included the dashboard, upholstery and carpet amongst others.

6. Apart from the normal standard additional equipment(s) which can be found on a motor taxi, there appears to be no modification(s) and/or additional electronic and/or electrical component(s) fitted on the Motor Taxi.

Investigation and Technical Analysis

7. For this particular case, the fire appears to have originated within the engine compartment of the Motor Taxi, at the rear area, slightly towards the right from the centre of the engine compartment. This can be determined from the high heat intensity burn marks (whitish burn marks) that could be found on the top side of the front bonnet, at the rear right area, and the rust that had developed on the underside of the front bonnet, at the same area.
8. Rust would normally start to develop around areas that were exposed to prolonged heat intensity, soon after a fire, as such exposure usually causes the steel/metal material body parts to be exposed to natural environmental condition. For this case, the rust that had developed on the underside of the front bonnet, around the rear right area, is an indication that the rear right area of the engine compartment was exposed to prolonged high heat intensity. The fire to the Motor Taxi can hence be determined to have originated around the rear right area of its engine compartment. See photo 5 & 6 below.



Photo 5 shows the whitish burn marks (circled) that were found on the top side of the Motor Taxi's front bonnet. Such whitish burn marks are a result of exposure to prolonged heat intensity, which may indicate where the fire had started. Rust would also begin to develop on these areas soon after the fire.



Photo 6 shows the approximate location of where the fire had originated. This was around the rear right area of the engine compartment (circled), as determined from the rust that had developed on the underside of the Motor Taxi's front bonnet (arrowed). The development of rust is a consequence of that area being exposed to prolong high heat intensity, where such exposure usually causes the steel/metal material body parts to be exposed to natural environmental condition.

9. Upon closer examination of the area around the rear right of the engine compartment, which was directly below the area on the underside of the front bonnet where rust was seen, I had found several stretches of wiring burnt internally to its bare copper state. Such condition normally indicate internal heating of copper wires which is a sign of an electrical short circuit occurring. This would then appear to suggest that the cause of fire to the Motor Taxi could have possibly been due to electrical in nature. See photo 7 & 8 below.



Photo 7 shows the wirings around the rear right of the engine compartment, which was where the fire to the Motor Taxi had likely started. The wirings (circled) were found to have been burnt internally to its bare copper state, suggesting occurrence of an electrical short circuit.

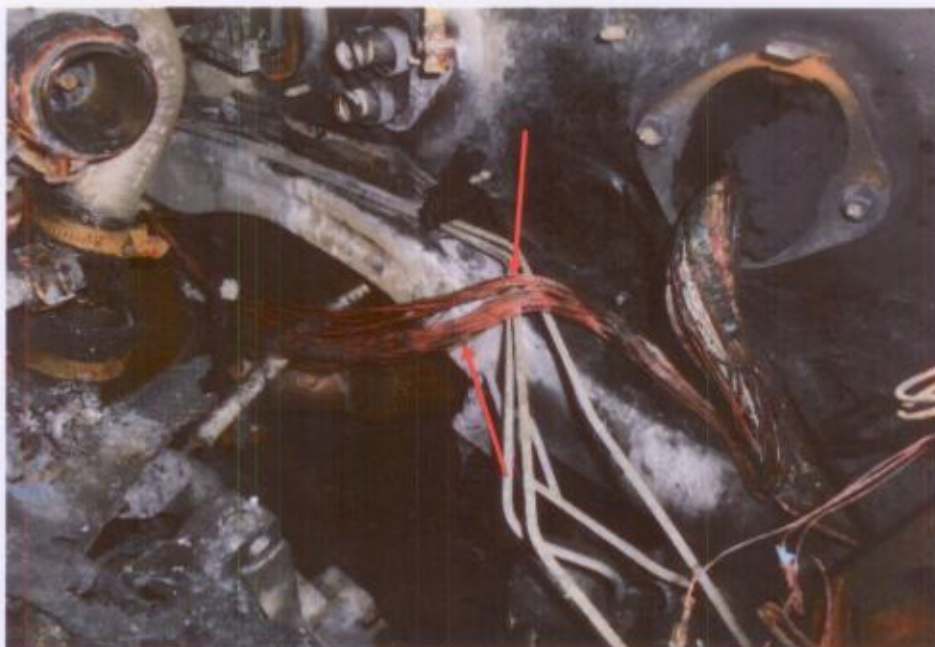


Photo 8 shows another stretch of wirings around the rear of the engine compartment, which was in the immediate vicinity where the fire to the Motor Taxi had likely started. The wirings were found to have been burnt internally to its bare copper state, suggesting occurrence of an electrical short circuit.

10. The hirer of the Motor Taxi had stated in his Police report F/20171121/2216, that the Motor Taxi was stationary at a traffic light junction of Bishan Place and Bishan Street 13 when he noticed smoke coming out from the front bonnet of the Motor Taxi. He then proceeded to make a right turn onto Bishan Street 13 and stopped the Motor Taxi. Upon alighting, he realized fire had started burning at the front portion of the Motor Taxi. SCDF officers subsequently arrived and extinguished the fire.
11. Given the circumstance of incident described by the hirer, the fire had occurred while the Motor Taxi was being driven/engine in operation. Common causes of fire arising from a vehicle that is being driven and/or with its engine in operation include engine overheating, leakage of fluid onto hot surfaces or electrical nature.
12. Fire due to an overheated engine was unlikely as the Motor Taxi was still able to be driven after smoke was first seen coming out from its front bonnet area. In the event if the engine overheated, the mechanical parts inside the engine would first seize causing the engine to stall. The hirer would have unlikely been able to continue driving the Motor Taxi and bring it to a stop after making the right turn into Bishan Street 13.
13. Leakage of fluid within the engine compartment may cause a fire to be ignited when the leaked fluid comes into contact with hot surfaces (usually exhaust pipes). The leaked fluid could possibly reach temperature sufficient for it to self-ignite. For the Motor Taxi, I note that the exhaust manifold and DPF (Diesel Particulate Filter) was located at the rear of the engine compartment, in the immediate vicinity of where the fire to the Motor Taxi had originated. The exterior surfaces of the exhaust manifold and the DPF both did not contain any sign(s) of being exposed to high heat intensity (whitish burn marks) that could have suggested that the DPF was being directly exposed to prolong heat from self-igniting fluid.
14. For this case, maintenance record of the Motor Taxi had indicated that the last work carried out to the Motor Taxi was on 20 November 2017 when it was towed in with issues of vehicle no power, white smoke when idle and moving off, engine check light illuminated. The mileage recorded was 279,790km. From the records provided, the valve seals, head cover gasket, injector gaskets, injector o rings were replaced. Replacement of such items usually indicate that there was engine oil leak and/or diesel leak. I also note that the Motor Taxi was released to the hirer on 21 November 2017 at about 1045hrs. This was less than 3 hours before the fire incident.

15. During my comparison of the engine layout of a similar make and model taxi, I had also observed that the fuel rail and fuel injectors were located towards the front area of the engine compartment, away from the hot surfaces of the exhaust manifold and the DPF. The engine oil level of the Motor Taxi was also checked and found to be of sufficient level, indicating no leakage of engine oil. Since the Motor Taxi was able to come to a complete stop after smoke was first seen, it is likely that there is no leak (vacuum or fluid) in the braking system of the Motor Taxi.
16. In general, there appears to be no sign(s) or indication(s) to suggest that the Motor Taxi had experienced fluid leakage prior to the fire incident. Following the discussion in paragraph 13 to paragraph 15, the cause of fire being due to fluid leakage would then be unlikely. See photo 9 - 13 below.

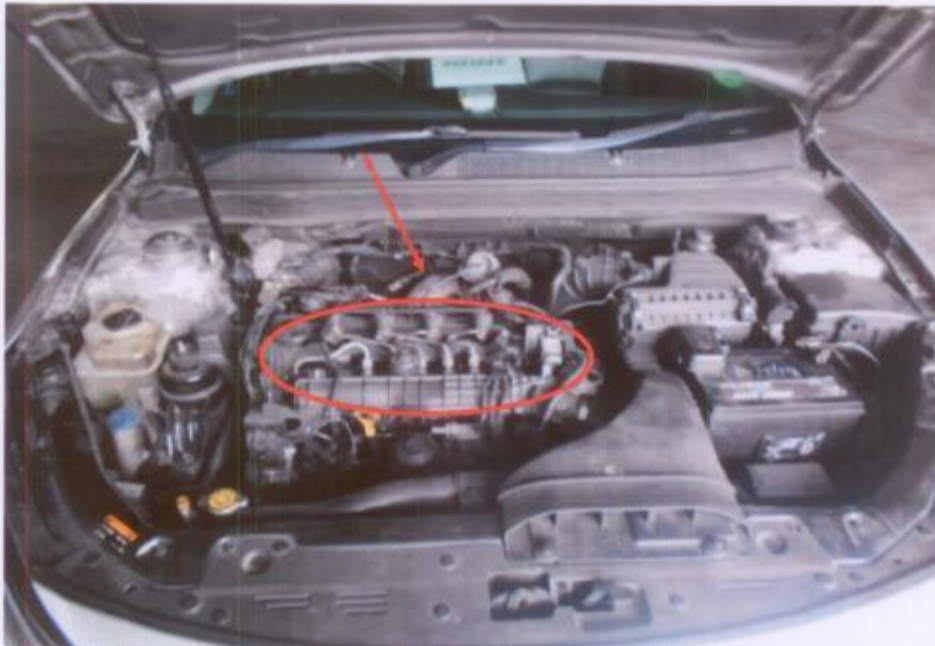


Photo 9 shows the engine layout of a similar make and model motor taxi as the Motor Taxi. The fuel rail and fuel injectors were located towards the front area of the engine compartment (circled), away from the hot surfaces of the exhaust manifold and the DPF, which are both located towards the rear of the engine compartment (arrowed).



Photo 10 shows the engine oil dip stick of the Motor Taxi. The engine oil of the Motor Taxi was found to be of sufficient level (arrowed) for operating purposes, indicating no leakage of engine oil. In general, there appears to be no sign(s) or indication(s) to suggest that the Motor Taxi had experienced fluid leakage prior to the fire incident. Cause of fire being due to fluid leakage would then be unlikely.



Photo 11 shows the DPF (Diesel Particulate Filter) of the Motor Taxi (arrowed). Although the DPF was located in the immediate vicinity of where the fire to the Motor Taxi had originated. The exterior surfaces of the exhaust manifold and the DPF both did not contain any sign(s) of being directly exposed to high heat intensity (whitish burn marks) that could have suggested that fluid had leaked onto the hot surfaces of the exhaust pipes to cause the fluid to self-ignite.



Photo 12 shows the DPF (Diesel Particulate Filter) of the Motor Taxi (arrowed). Although the DPF was located in the immediate vicinity of where the fire to the Motor Taxi had originated. The exterior surfaces of the exhaust manifold and the DPF both did not contain any sign(s) of being exposed to high heat intensity (whitish burn marks) that could have suggested that fluid had leaked onto the hot surfaces of the exhaust pipes to cause the fluid to self-ignite.

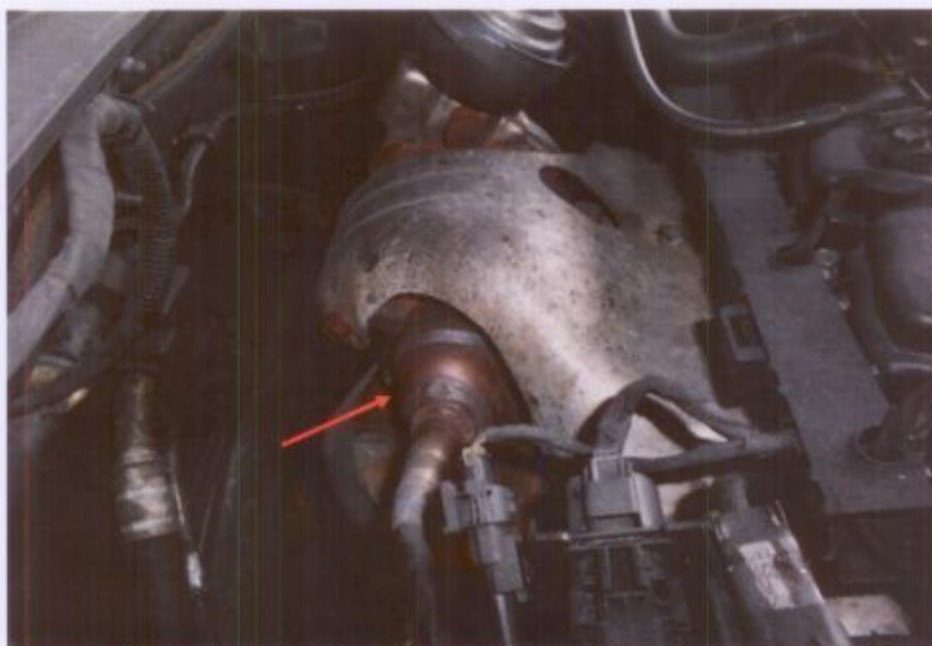


Photo 13 shows the DPF (Diesel Particulate Filter) of a similar make and model motor taxi as the Motor Taxi (arrowed) for comparison of its exterior surfaces. I also note that there was no fluid carrying pipe/hose directly above the area where the DPF is located.

17. Since engine overheating and leakage of fluid were both unlikely the cause of fire, the most probable cause would then be electrical in nature. This appears to be supported by the condition of the wiring (burnt to its copper state) found at the rear right area of the engine compartment, which was where the fire to the Motor Taxi had originated. Refer to photograph 7 and photograph 8 above.
18. My review of the maintenance record of the Motor Taxi for the period 14 May 2014 to 20 November 2017 revealed that the Motor Taxi was regularly maintained with the last servicing carried out to the Motor Taxi was on 19 October 2017. During this servicing, the front brake pad, engine oil filter, engine oil and transmission fluid were replaced. The mileage of the Motor Taxi during this servicing was 267,647km. I also note that there was no recurring electronic and/or electrical issues recorded.

Preventive Measure(s)

19. Modern day vehicles are equipped with numerous sensors, actuators and radars that are all linked to the various control modules as part of a vehicle's operation aspect and safety aspect. These sensors, actuators, radars and control modules communicate electronically through wires and/or wiring harness. There are therefore numerous wires and/or wiring harness located within the engine compartment.
20. Heat from engine operation could possibly cause the rubber insulation of these wires and/or wiring harness to lose its flexibility and become hardened after a prolong period of time. The hardened rubber insulation may then become brittle and break off bits by bits, exposing live wires that may come into contact with each other and/or the metal body of the vehicle, creating sparks that could ignite a fire.
21. Unlike countries with different seasons, the hot local climate increases the heat within the engine compartment of locally used vehicles. This enhances the deterioration of any rubber material parts or components contained within the engine compartment.
22. Although the Motor Taxi was regularly maintained, such deterioration of rubber material parts or components are difficult to be visually detected and hence are usually unnoticed during the periodic maintenance of a vehicle. If detected, the entire wire harness would have to be replaced and this would involve costly rectification and long periods of downtime.

Conclusion

23. Basing on my inspection of the Motor Taxi, I am of the view that the fire had originated around the rear right area of the Motor Taxi's engine compartment. The cause of fire was likely to be of electrical in nature, where deterioration of rubber wire insulators could have caused live wires to come into contact with each other and/or the metal body of the vehicle, creating sparks that had ignited the fire.
24. This deterioration of rubber wire insulators are difficult to be visually detected and tend to be unnoticed during the periodic maintenance of a vehicle. If detected, the entire wire harness of the vehicle would have to be replaced in order to eliminate any possible fire risk. This would involve costly rectification and long periods of downtime.
25. For this case, I did not find any evidence which had suggested that the cause of fire was due to poor maintenance and/or recurring electrical problem.
26. There appears to be also no modification(s) and/or additional electronic and/or electrical component(s) fitted on the Motor Taxi apart from the standard equipment(s) found on a normal motor taxi.

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