HQCAA/1901/178/SIB

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CIVIL AVIATION AUTHORITY

AIRCRAFT INCIDENT INVESTIGATION

M/S SCHON AIR CESSNA-172 REG.NO.AP-BDV

WHICH OCCURRED ON

14th. NOV 1994

AT

QUAID-E-AZAM INT'L AIRPORT

NO.HQ.CAA/1901/178/SIB

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CIVIL AVIATION AUTHORITY
KARACHI, PAKISTAN

AIRCRAFT INCIDENT INVESTIGATION

INVESTIGATION REPORT: M/S SCHON AIR (PVT) LTD. CESSNA 172 AIRCRAFT REG NO.AP-BDV WHICH HAD AN INCIDENT ON 14TH NOVEMBER, 1994 AT KARACHI AIRPORT.

Authority:- Director General Civil Aviation Authority Memorandum No. HQ CAA/1901/178/SIB dated 15th November, 1994

COMPOSITION OF INVESTIGATION TEAM

(a)	Air Cdre Jamal Hussain President, SIB CAA	Investigator Incharge
(b)	Wg Cdr (Rtd) Sajjad Ahmed Technical Investigator CAA	Investigator

1. **AIRCRAFT INFORMATION**

1.1.	Registration Marks	:	AP-BDV
1.2.	Aircraft type and maker's S No.	:	Cessna R172K SNo.1723419
1.3.	Engine types, airframe positions and maker's SNo.	:	Continental 10-360KB Fitted front of Cessna R172K SNo. 1723419 Eng. SNo. 356642
1.4	Certificate of Reg No and validity.	:	No.664 Date of issue 08-11-93
1.5.	Certificate of Airworthiness No and date of expiry, and flight manual No.	:	572 Valid from 16-11-93 to 15-11-94
1.6.	Certificate of Safety date and time (GMT) of issue and period of validity.	:	I.E. check - III C of M issued on 03-11-94 Valid upto 2-12-94 or 50:00 hours which ever comes first D.I., on 14-11-94 at 09:20 hours (LT)
1.7.	Date of construction of airframe.	:	1980

1.8	Name and address of Owner	:	Schon Air Ltd QIAP Karachi
1.9	Gross Weights. Maximum permitted by C of A for this flight, at the time of incident	:	1159.09 KGS
1.10	Loading. Centre of gravity limits in C of A and centre of gravity position at the time of incident and commencement of flight.	:	Please refer Pilot Operating Manual
1.11	Airframe history. (Give flying times since manufacture, last overhaul and last periodic check.	:	Since last check III 29:15 hrs
1.12	Engine history. (Give flying time since manufacture, last overhaul and last periodic check.	:	MFR 1982:45 T.S.M/OH 882:20 Total 2865:05 Since last check-III 29:15
1.13	Accessory history. (Operating life and operating time since manufacture and overhaul.	:	Same as engine life
1.14	Defects. (List & remarks upon any technical defects in airframe engines or accessories, discovered during investigation).	:	Under investigation by SIB CAA

2. CREW INFORMATION

2.1 Pilot-in-Command

2.1.1. Name	:	Arshad Ahmad Saeed
2.1.2. Position in the cockpit	:	Captain
2.1.3. Date of Birth	:	12-04-1965
2.1.4. Type of Lic and No	:	CPL 1650
2.1.5. Medical dt with status	:	28-05-1994

2.1.6. **Rating**

2.1.6.1. Type(s) held	:	Cessna-172, C-150/152
2.1.6.2. Type current	:	C-172, C-150/152

2.1.6.3. Flt.Instructor : Two Flight

2.1.7. **Flying Experience**

2.1.7.1. Grand total : 672.00

2.1.7.2. Total -in - Command : 605.45

2.1.8. Where trained : FAA USA/Schon Air

2.2. Co-Pilot

2.2.1. Name : Miss. Naghman Saleem

2.2.2. Position in the cockpit : Student Pilot

2.2.3. Date of Birth : 30-12-1968

2.2.4. Type of Lic and No : PPL No 2002

2.2.5. Medical dt with status : 13-12-1993

2.2.6. **Rating**

2.2.6.1. Type(s) held : C-172

2.2.6.2. Type current : C-172

2.2.7. **Flying Experience**

2.2.7.1. Grand total : 153:05 hours

2.2.7.2. Total - in - Command : 112:20 hours

2.2.8. Where trained : Schon Air

3. SUMMARY OF INCIDENT

3.1. On 14th November, 1994 M/s Schon Air Cessna 172 registration No. AP-BDV operating a training flight from Karachi to Sukkur had an incident at Karachi Airport. Soon after take-off about 600 ft AGL the fuel quantity gauge needles started fluctuating. ATC instructed the pilot to climb to 2000 ft after turning 360 degrees. As the aircraft climbed to a height of 1000 ft the fuel quantity gauge needles fluctuation continued and engine vibrations also started. At this stage the oil pressure started dropping and was followed by drop in engine RPM which soon settled to about 500. The pilot requested for a priority landing and as the aircraft was making an approach the engine RPM dropped further. The aircraft made a successful dead stick landing on the runway. There was no damage to the aircraft or injury to the pilots.

4. INJURY TO PERSON(S)

None

5. DAMAGE TO AIRCRAFT

The aircraft engine was ceased

6. OTHER DAMAGES

None

7. METEOROLOGICAL CONDITION

Not relevant

8. NAVIGATION & LANDING AIDS

Not relevant

9. COMMUNICATION

Not relevant

10. AERODROME & GROUND FACILITIES

Not relevant

11. FLIGHT RECORDERS

Not relevant

12. WRECKAGE & IMPACT INFORMATION

Not relevant

13. FIRE

13.1 No smoke or fire was caused due to the incident.

14. SURVIVAL ASPECTS

14.1 All crews disembarked using the normal exit.

15. TEST & RESEARCH

Nil

16. OBSERVATIONS

16.1 The engine SNo 356642 was overhauled locally at Schon Air Engine Shop under the authority of HQCAA/2206/75/AW dated 14th January, 1993.

16.2 Schon Air Engine Shop does not have facilities for subjecting various engine parts to cleaning process in accordance with Engine Overhaul Manual. Additionally, the Shop has no facilities to carryout crack detection of engine parts in accordance with inspection methods recommended in the engine overhaul manual. As such, both the process of cleaning and crack detection were carried out at PIAC.

16.3 Engine inspection record revealed that the inspection sheets of check II inspections carriedout on 29th September and 21st October, 1994 were missing; however, an entry to that effect was made in the aircraft log book.

16.4 The aircraft journey sheet did not indicate the quantity of oil that was replenished after each flight.

16.5 Whereas the aircraft journey sheet did indicate that 8 quarts of oil was present in the engine but no entry was made regarding the amount of oil replenished after each flight.

16.6 No qualified quality control inspector was deployed in the aircraft or engine maintenance activities.

16.7 No evacuation plan exists for the hangar where presently eight aircraft are parked in close proximity.

17. WITNESS

17.1 Statement of witnesses are given in Exhibits 'S-1 to S-5' to this report.

18. INVESTIGATION

18.1 M/s Schon Air Cessna-172 registration No AP-BDV during a training mission at Karachi Airport had an incident on 14th November, 1994 at about 0910 hours PST. Soon after take-off at about 600 ft AGL the fuel quantity gauge needles started fluctuating. As the aircraft climbed to a height of about 1000ft the engine vibration also started which was followed by continuous drop of oil pressure and the engine RPM came down to 500. The pilot requested for a priority landing and as the aircraft was making an approach the engine lost all power. The aircraft made a successful dead stick landing on the runway.

18.2 Soon after the incident the engine propeller was checked for freedom of rotation and was hard to rotate. The engine was removed and during strip examination following evidence was observed on different engine parts:-

18.2.1 Main Bearings Heavy scoring was observed on No.1 main bearing and No.2/No.3 main bearings were broken. Additionally, the front main bearing had no evidence of deterioration (Ref. Exhibit 'A-1 to A-2 ').

18.2.2 **Connecting Rods** Heavy scoring was observed on No.1,3,4,5 & 6 bearings; whereas, No.2 bearing was partially melted and welded with the connecting rod (Ref Exhibit ' B-1 to B-2').

18.2.3 **Crank Shaft** The crank shaft main bearing had evidence of heavy scoring and overheating. Whereas, No.1,2,3 and 5 bearings were heat affected (Ref. Exhibit ' C-1 to C-2').

18.2.4 **Cam Shaft** The Cam Shaft gear teethes had no evidence of wear on the surface (Ref. Exhibit ' D').

18.2.5 **Pressure Oil Filter** Significant quantity of metal particles were observed in the oil filter element (Ref Exhibit 'E').

18.2.6 **Oil Pressure Relief Valve**. Metal particle was observed in between the spring and body due to which relief valve was stuck in the open position. (Ref. Exhibit 'F').

18.2.7 **Oil Pump** The woodruf key of the oil pump main gear drive was sheared off. Scoring marks were observed on the gear surface and the gear elements were hard to rotate. Additionally, bush of the pressure element was distorted and had evidence of scoring (Ref. Exhibit 'G-1 to G-3').

18.2.8 **Oil Pump Body** Metal particles were observed in the oil pump body and some particles were imbedded in the cavity wall due to stroke of the oil pump gear teeth (Ref. Exhibit 'H').

18.2.9 **Scavenge Oil Filter** The scavenge oil filter element was disintegrated / torn and had deposits of metal particles (Ref Exhibit 'J').

18.2.10 **Tachometer Gen Drive** The tachometer generator drive shaft was sheared off (Ref Exhibit 'K').

18.2.11 **Pistons:** No. 1,2,3,4 & 5 pistons had evidence of scoring and their scrapper oil rings were substantially worn-off and were imbedded in the piston body (Ref. Exhibit 'L-1 to L-11').

18.2.12 **Cylinder Sleeves.** All Cylinder Sleeves except of No 6 cylinder had evidence of scoring on the inner wall at the initial length of the Sleeve (Ref Exhibit 'M-1 to M-2') .

18.2.13 **Oil Passages.** All channels / passages leading to various bearings and other areas requiring lubrication were checked for blockage and were found clear with presence of no evidence of any restriction.

18.2.14 **Oil Sump.** Large deposits of metal particles were observed in the oil sump (Ref Exhibit 'N').

18.3 **Engine History.** Engine SNo 356842 was overhauled locally at Schon Air Engine Shop under CAA authority No HQCAA/ 2206 /75/ AW dated 14th January, 1993 and was installed on the aircraft on 16th November, 1993. The engine had logged 882 hours at the time incident occurred. No engine defect pertaining to engine oil system or Cylinder Head Temperature was reported in the last 100 hours of operation prior to the incident. Complete documentary record of engine overhaul work sheets were checked and all record was found in order. Various processes involved in different stages of overhaul starting from disassembly, cleaning, inspection to final assembly were carried out in accordance with the Overhaul Manual 10-360 of Teledyne Continental Motors. While the Schon Air engine Shop does not have facilities for cleaning and magnaflux inspection the same were carried out at PIAC as per the requirements stipulated in the overhaul manual. Additionally, certain deficiencies in terms of engine test bed and special tools were observed the details of which are given

in Exhibit 'O' to this report. However subject deficiencies were satisfactorily covered up by borrowing tools from PIAC and accomplishing engine test run on the aircraft. Additionally, the technicians who carried out overhaul of subject engine were adequately trained and possessed requisite experience of piston engine overhaul. Furthermore, no discrepancy pertaining to engine vibration, low oil pressure, high CHT was reported during 882 hours of engine operation since overhaul. As such, a very low probability can be attributed to the local overhaul factor in the subject case.

18.4 **Propeller History.** The propeller installed on subject engine was also overhauled locally at Schon Engine Shop under the CAA Authority No HQ CAA/ 2221/58/AW dated 19th January, 1992. The overhaul record revealed that propeller SNo 805022 was overhauled in accordance with MacCauly Overhaul Manual No 780630 and all functions involved in the process of overhaul were carried out satisfactorily. The shop is adequately equipped to carryout prop balancing and blade angle checks. Additionally, no major discrepancy in terms of engine vibration at different propeller pitch settings was reported during 882 hours of operation since overhaul.

18.5 **Fuel Quantity System.** The fuel quantity indicating system was checked for serviceability and its operation was found satisfactory.

18.6 **Post Flight Evidence.** Soon after the incident during external examination of the engine it was observed that the propeller was hard to rotate and the quantity of engine oil was satisfactory. Subsequently, all the cylinder heads were removed and all pistons and cylinder sleeves except No 6 had evidence of scoring and dry running. As such, it is established beyond doubt that engine was completely ceased in the air.

18.7 **Engine Strip Examination.** During strip examination of the engine large quantity of metal particles were observed both in the oil sump and pressure oil filter. logically, such a large amount of metal particles could not have accumulated in last few minutes of engine operation from start-up to the time when incident occurred. Additionally, the spectrometric oil analysis reports of sump and pressure filter oil samples indicate that concentration of iron, aluminum, copper, nickels and chromium was different in the two samples. While the concentration of iron was comparatively high in pressure oil filter sample the sump oil sample had the highest concentration of aluminum particles. It should be appreciated that oil after passing through the scavenge screen is transferred by oil pump into the pressure oil filter (Ref Exhibit 'P'). Logically the concentration of various metal particles in the two oil samples should be same. However, this was not true. The oil sample analysis reports (Ref Exhibit 'Q') indicate that there was negligible difference in the concentration of various metal particles like Magnesium, Copper, Nickel and Chromium except Iron and Aluminum. In the two samples metal particles concentration difference in parts per million was as follows:-

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SNo.	SUMP OIL SAMPLE	FILTER OIL SAMPLE	DIFFERENCE
Aluminum	46	33	13
Iron	56	76	20

A reference to the metallic composition of various engine parts (Ref Exhibit 'R') indicate that pistons have large quantity of aluminum beside Iron and carbon. The scoring marks on all the pistons indicate that substantial amount of piston surface weared-off as the crank shaft revolved in an unbalance state in dry condition when oil pressure was lost due to oil pump faihure. As such, it is logically inferred that large quantity of aluminum was deposited in the sump during last stages of engine ceasure. Additionally, from the composition table of various engine parts it can be seen that Iron

formed an essential ingredient of main moving parts which shows that the wearing of various moving parts was taking place gradually and these particles initially were so small in size that they went through the scavenge filter screen and were deposited on the micronic pressure filter element after passing through the oil pump. Naturally, no substantial damage was caused to the oil pump by these particles due to their size.

18.8 **Metal Particles and Oil Circulation.** It must be appreciated that metal particles would not get deposited on the pressure oil filter if the circulation of oil is not taking place and this condition will only occur when the oil pump will stop functioning. As such, the engine parts were wearing off and were deposited on the pressure oil filter much before the oil pump failed and engine dry running condition was initiated before engine ceasure. From the foregoing discussion it is concluded that engine parts were wearing off much before the incident occurred.

18.9 **Engine Parts Wearing Process.** During the wearing process of engine parts the metal particles were initially so small that they went unchecked through the scavenge filter screen which is not micronic type. These metal particles were deposited on the pressure filter element. As the wearing process continued size of the metal particles increased and a stage came when the scavenge filter screen was choked. Under this condition the scavenge filter was exposed to a considerable high suction pressure of the oil pump. Under this high pressure the scavenge filter screen was ruptured and allowed a free passage for the trapped metal particles into the oil pump. The oil pump is gear type and has two elements which are driven in an enclosed space with very fine tolerances. As such, the passage between the gear element and pump body is very small. The metal particles which came into the oil pump body after scavenge filter element was ruptured, were comparatively large in size. Evidence in the oil pump cavity wall indicate that some metal particles were imbedded in the wall-surface under the stroking action of the oil pump gear teeth. Under this situation as unchecked flow of large

metal particles continued into the oil pump body, thereby restricting free movement of oil pump gear element. At one time the restriction went so high that the woodruf key (Ref Exhibit 'G-1') which provides drive to the oil pump was sheared off and the oil pressure dropped. After some time, the tachometer drive which is connected on the other side of the gear also sheared-off due to dry running of engine and the pilot observed drop in engine RPM after the oil pressure had dropped.

18.10 **Oil Pump Failure.** Soon after the oil pump failed the engine operated in dry condition which resulted in generation of intense amount of heat and excessive wearing of various engine parts specially the bearings and piston rings. The scrapper rings of all pistons except No 6 were excessively worn off and were welded with the piston body. Additionally, No 2 connecting rod big end bearing was welded with the rod end (Ref Exhibit 'B-2'). The crank shaft bearings which are fitted on the crank case body were forced to leave their seat under the intense frictional force created due to dry running. At this stage the crank shaft lost it balance and piston outer surface started rubbing with the sleeve walls and crank case body where cylinder sleeves are installed. Chunk of worn metal particles were thrown in the oil sump and engine was completely ceased. It should be noted that sump oil sample indicated presence of large shining metal particles which could be seen without use of magnifying glass.

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18.11 **Engine Oil Change.** During the process of investigation it was observed that engine oil is changed during check II inspection. The aircraft log book indicate that check II inspection were carried out on 6th September, 1st October, 23rd October and 3rd November, 1994. However, corresponding inspection sheet record revealed that no record of check II inspections carried out on 1st and 23rd October, 1994 was held in the inspection sheet folder. In the absence of inspection sheets it can be logically presumed that engine oil was not

changed between 6th September and 3rd November, 1994 and during this period the engine logged 117 hours. However, engine oil was changed on 3rd November, 1994 and the engine logged 29 hours till 14th November, 1994 the day when the incident occurred. Naturally, not changing engine oil will definitely cause operation of engine with poor viscosity oil which deteriorates with the passage of time. In such a case the engine parts would wear off due to friction and heat. The circumstantial evidence support the presumption that engine parts were wearing off much before the date of occurrence. Additionally, the aircraft journey log book does indicate that 8 qrts of oil was there in the engine prior to each flight but it does not indicate how much oil was serviced during post flight inspections.

18.12 **Conclusion.** In the absence of engine oil change record, discrepancies observed in engine oil replenishing record and the fact that engine parts had worn over a period of time, it is concluded that engine was run under poor viscosity oil condition which ultimately resulted in engine ceasure.

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19. FINDINGS

19.1 Documentation of the aircraft was in order.

19.2 The license of Instructor and Student pilots were appropriate and valid.

19.3 The Instructor and student pilot had logged 604: 45 and 153 hours respectively.

19.4 The weather was fair and there was no rain or wet runway condition at the time of occurrence.

19.5 Captain Arshad Ahmed was on the controls at the time incident occurred.

19.6 Engine SNo 356842 was overhauled locally at Schon Air Engine Shop under CAA authority No HQ CAA /2206/75/AW dated 14th January, 1993 and was installed on the aircraft on 16th November, 1993. At the time of incident the engine had logged 882 hours.

19.7 No engine defect pertaining to engine vibration, engine oil system or cylinder head temperature was reported in last 100 hours of operation prior to the incident.

19.8 The engine overhaul documentary record was found in order and all processes involved in different stages of overhaul starting from disassembly, cleaning, inspection to final assembly were satisfactorily carried out in accordance with overhaul Manual IO-360 of Teledyne Continental Motors.

19.9 Propeller SNo 805022 installed on the subject engine was also overhauled at Schon Engine Shop under CAA authority No HQ CAA / 2221/58/AW dated 19th January, 1992.

19.10 All process involved in the propeller overhaul as per MacCauly overhaul Manual No 780630 were carriedout satisfactorily.

19.11 Soon after the incident the propeller was hard to rotate and all cylinders sleeves except No 6 had evidence of scoring and dry running which indicate that the engine had completely ceased in air.

19.12 Soon after take-off the pilot observed fuel quantity gauge needles fluctuating which was followed by engine vibration, continuous drop of oil pressure and engine RMP.

19.13 Substantial quantity of metal particles both in oil sump and pressure oil filter indicate that engine parts were wearing off much before the time incident occurred.

19.14 The difference in concentration of Magnesium, Copper, Nickel and Chromium in sump oil and pressure oil filter sample was negligible except of Iron and Aluminum.

19.15 The concentration of aluminum in sump oil sample was 13 PPM (parts per million) higher than filter oil sample.

19.16 The concentration of Iron in filter oil sample was 20 PPM higher than sump oil sample.

19.17 Engine oil is changed during check II inspections and no record for the subject inspections carriedout on Ist and 23rd October, 1994 was held in the inspection sheet folder.

19.18 The journey log book record for last 200 hours of operation didn't indicate how much oil was serviced.

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19.19 The engine operated for 117 hours without change of engine oil.

19.20 No quality control inspector is deployed either in the line maintenance or engine/propeller overhaul shop.

19.21 The Pilot handled a serious in-flight emergency very professionally and executed a safe dead stick landing following an engine ceasure.

20. CAUSES

The following are the causes of the incident:-

(a) Not changing engine oil on Ist and 23rd October, 1994 during which the engine operated for 115 hours with poor viscosity oil.

(b) Non deployment of Quality Control Inspectors in the line maintenance activities area.

21. RECOMMENDATIONS

21.1 All Work sheets pertaining to different inspection processes should be checked for accuracy by the Chief Engineer prior to release of aircraft for operation.

21.2 Quantity of oil service during post flight inspection should be entered in the aircraft journey log book.

21.3 Qualified quality control inspectors should be deployed in line maintenance and engine/propeller overhaul shops and all work carriedout during different stages of overhaul process should be certified by the inspector.

21.4 Test bed for engine run-up after engine overhaul should be established on priority.

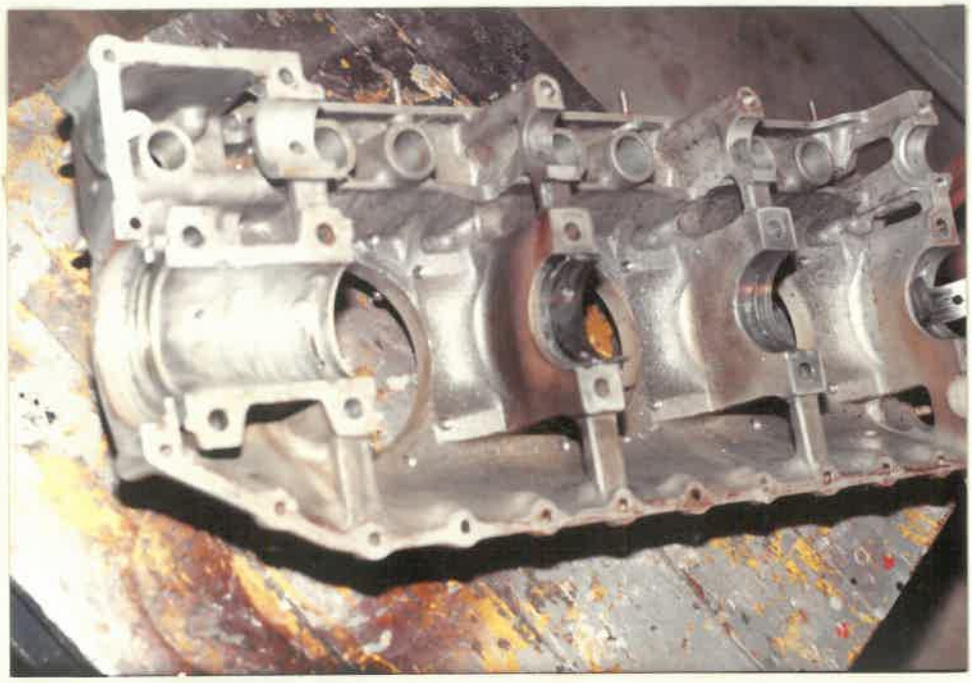
21.5 All tools found deficient as per Exhibit 'O' be procured at the earliest.

16

MAIN BEARINGS.

NOTE:- HEAVY SCORINGS

EXHIBIT - A



MAIN BEARINGS.

NOTE:- HEAVY SCORINGS

EXHIBIT -B

B-1

CONNECTING RODS.

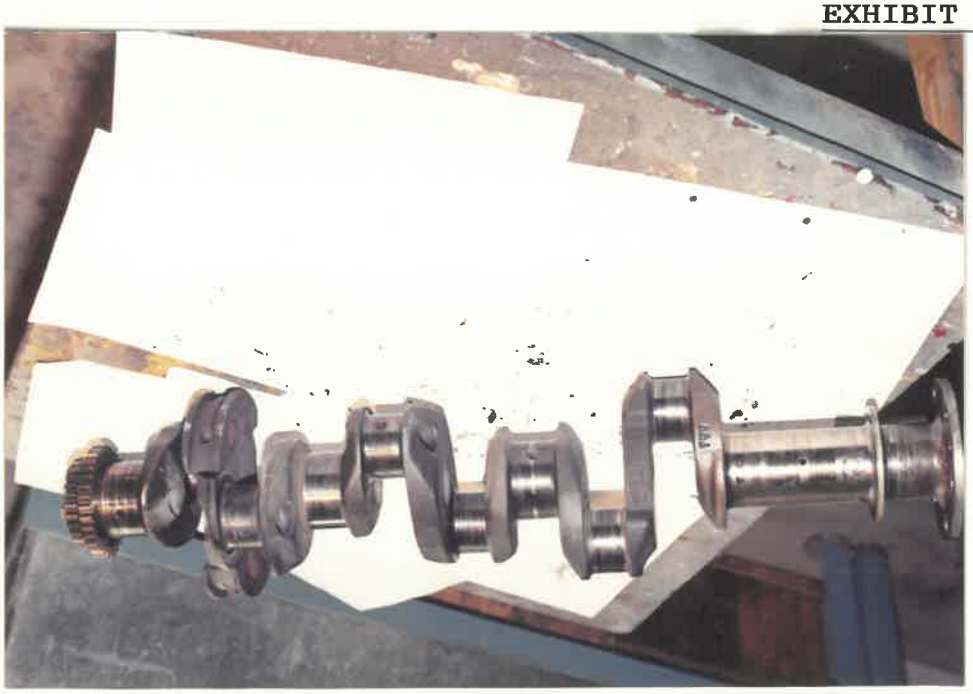
NOTE:- HEAVY SCORING.

B-2

NO.2 CONNECTING ROD. NOTE:- WELDED BEARING.

5

EXHIBIT - C



C-1

CRANK SHAFT. NOTE:- SCORING ON THE SURFACE.

CRANK SHAFT. NOTE: SCORING

EXHIBIT - "D"

D-1

CAM SHAFT

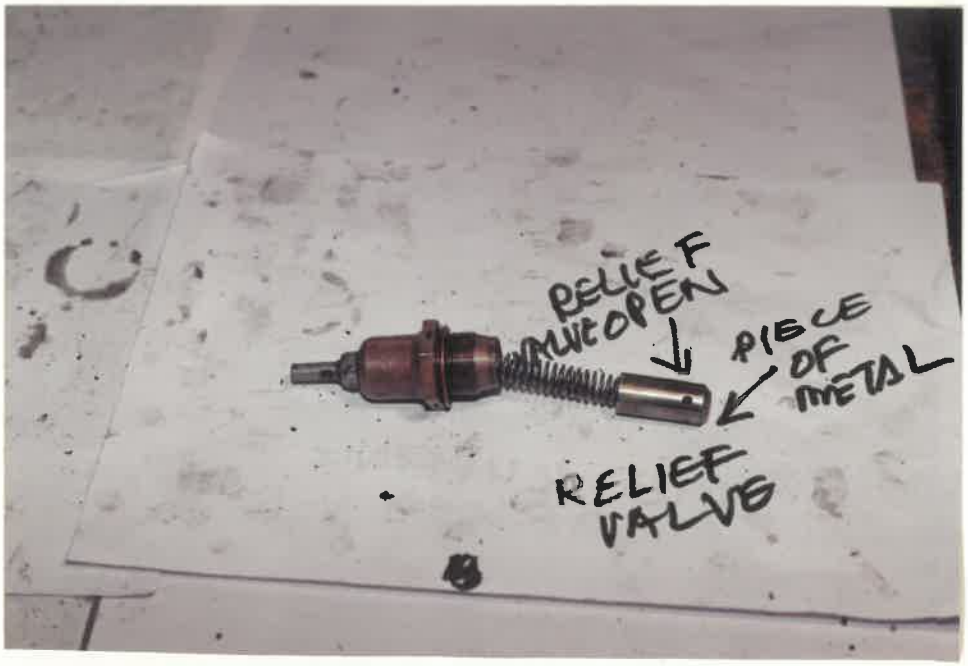
D-2

CAM SHAFT

EXHIBIT -E

PRESSURE OIL FILTER. NOTE:- METAL DEPOSITS OF PARTICLES.

EXHIBIT - F



PRESSURE RELIEF VALVE. IT WAS FOUND STUCK IN OPEN POSITION.

G-1

OIL PUMP GEARS. NOTE:- SCRATCH MARKS.

19

G-2

OIL PUMP GEARS. NOTE:- SCORING AND SCRTCH MARKS.

EXHIBIT - H

OIL PUMP BODY. NOTE:- SCRATCH MARKS.

10

EXHIBIT - J

SCAVENGE OIL FILTER. NOTE:- DISINTEGRATED ELEMENT.

EXHIBIT - K

TACHOMETER GEN DRIVE. NOTE:- SHEARED SHAFT.

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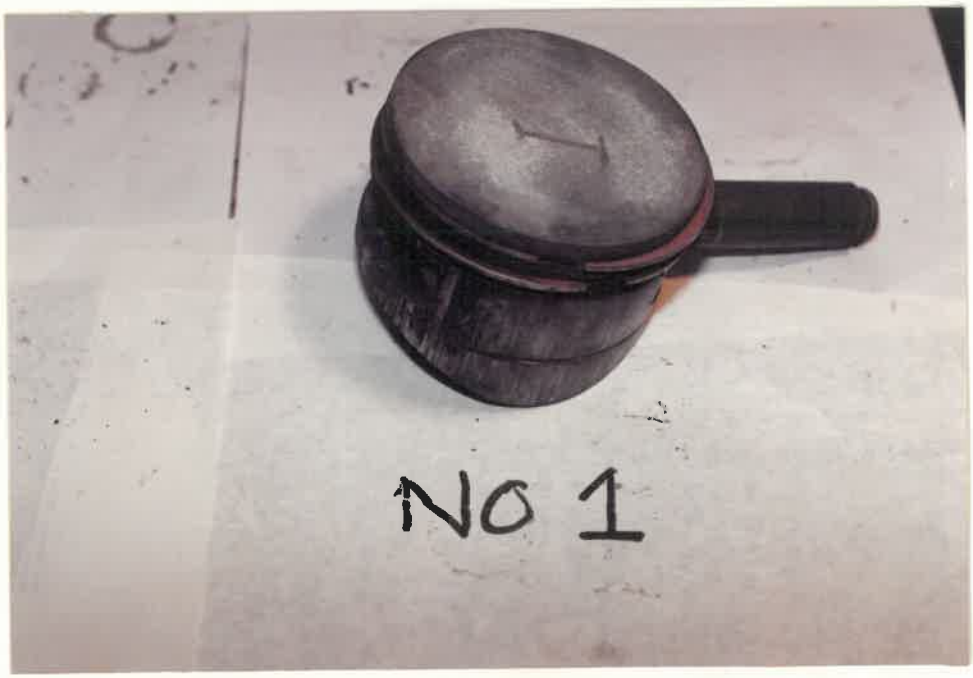
EXHIBIT - L



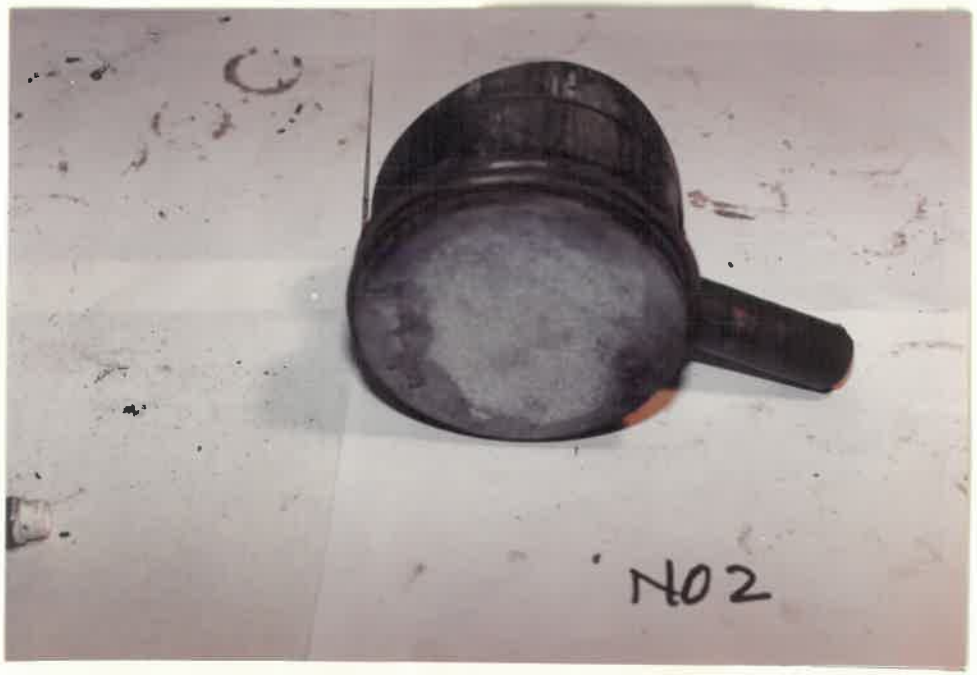
L-1

NO.1 PISTON NOTE:- RUBBING MARKS.

L-2

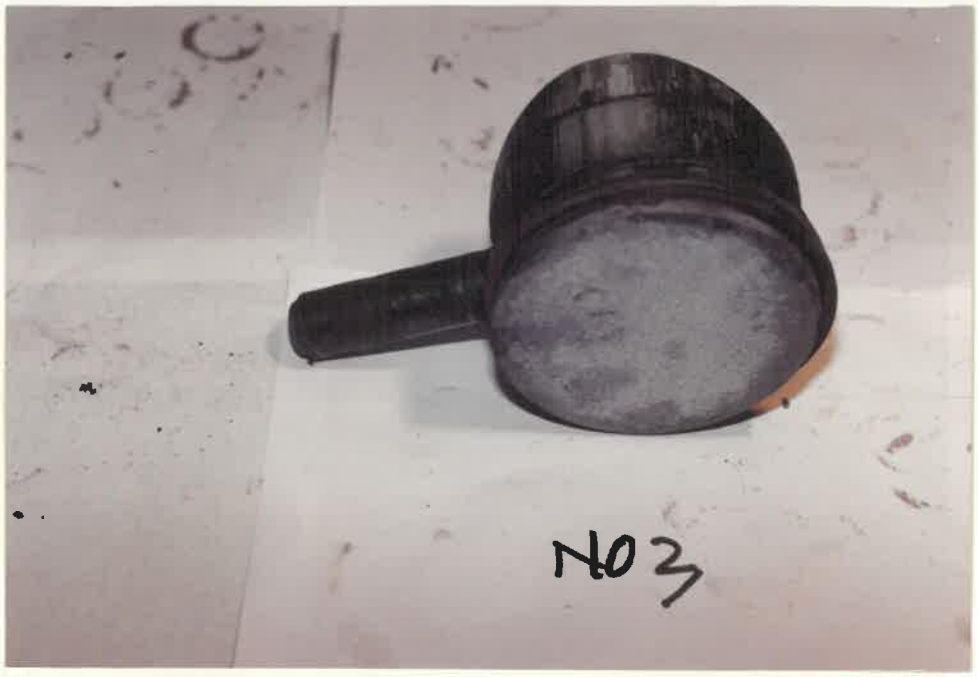
NO.1 PISTON NOTE:- SCORING MARKS.

12



L-3

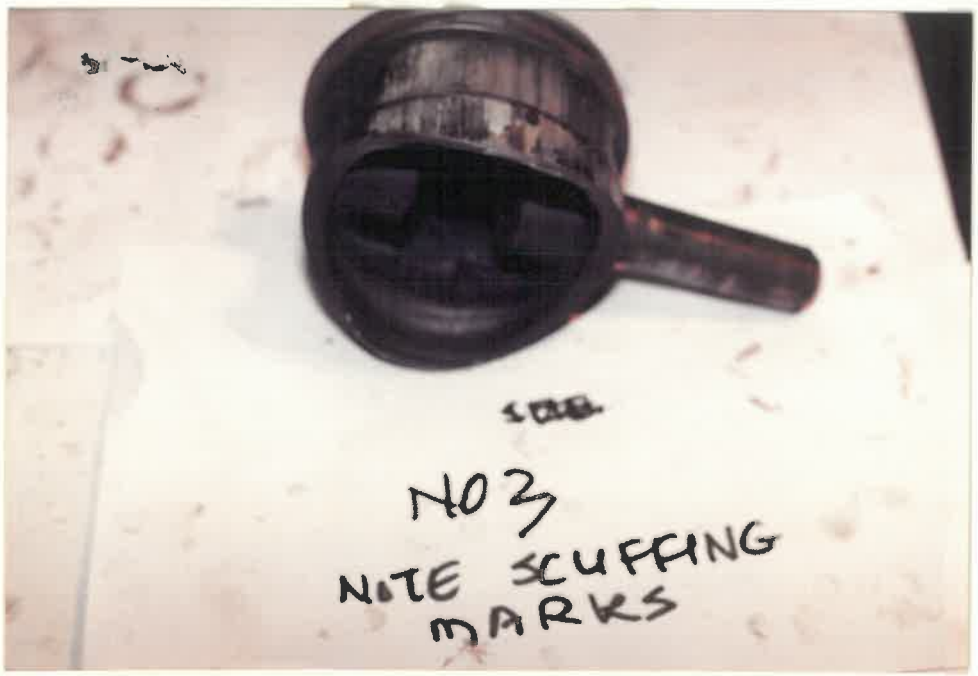
NO.2 PISTON. NOTE:- SCORING MARKS.



L-4

NO.3 PISTON. NOTE:- SCORING MARKS.

13



L-5

NO.3 PISTON. NOTE:- SCORING MARKS.

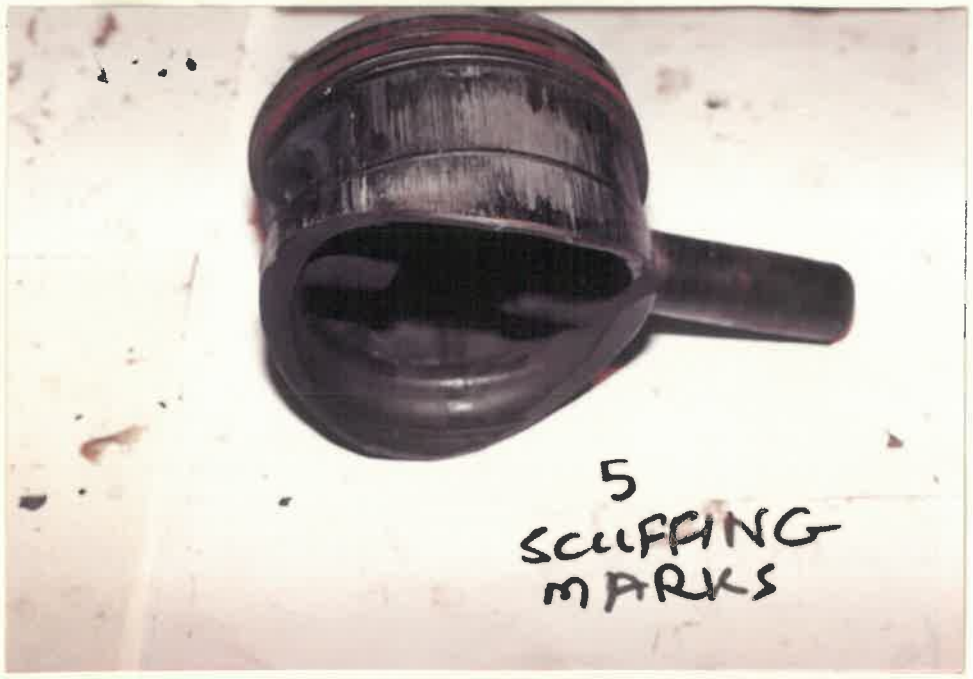
L-6

NO.4 PISTON. NOTE:- SCORING MARKS.

14

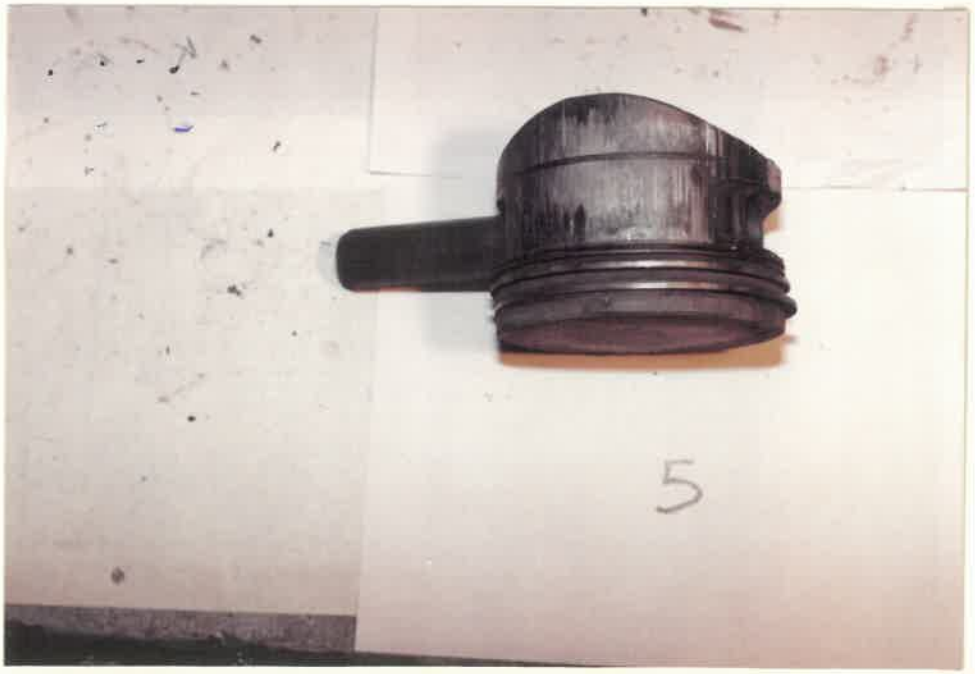
L-7

NO.4 PISTON. NOTE:- SCORING MARKS.



L-8

NO.5 PISTON. NOTE:- SCORING MARKS.



L-9

NO.5 PISTON. NOTE:- SCORING MARKS.

L-10

NO.6 PISTON. NOTE:- SCORING MARKS.

16

L-11

NO.6 PISTON. NOTE:- SCORING MARKS.

M-1

NO.1 CYLINDER. NOTE:- INTERNAL SCORING.

M-2

CYLINDER SLEEVE. NOTE:- INTERNAL SCORING.

18

CYLINDER SLEEVE. NOTE: INNER WALL SCORING

OIL SUMP. NOTE:- METAL DEPOSITS.