No: 7/92 **Ref: EW/C92/2/3** **Category: 1c**

Aircraft Type and Registration:	Cessna 172N Skyhawk, N9998E
No & Type of Engines:	1 Lycoming 0-320-H2AD piston engine
Year of Manufacture:	1979
Date & Time (UTC):	15 February 1992 at 1838 hrs
Location:	West Thurrock, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - Serious Passengers - 2 fatal, 1 serious
Nature of Damage:	Aircraft destroyed - minor damage to electricity power lines
Commander's Licence:	Commercial Pilot's Licence (USA)
Commander's Age:	24 years
Commander's Flying Experience:	302 hours (170 on Cessna single engine variants)
Information Source:	AAIB Field Investigation

The Cessna 172N aircraft, registration number N9998E, had been imported into Belgium from the United States of America in May 1991. From that date it had been based at Wevelgem, Belgium, but its registration had not yet been transferred to the Belgian Register of Civil Aircraft. On 15 February 1992 it was planned to fly the aircraft from Wevelgem to Hinton-in-the-Hedges via Kidlington, and thereafter return to Wevelgem on the same day, by the same route. There were the pilot, two adult males and an eight year old boy on board. Prior to departure the aircraft's fuel tanks were reported to have been full. The total useable fuel was 143 litres which, under normal cruise conditions, should have allowed a flight endurance of about four hours and 30 minutes.

The aircraft took-off from Wevelgem at 0828 hrs, but returned and landed some eight minutes later after the pilot had a problem with a VHF radio. He carried out the necessary repair himself, and the aircraft took-off from Wevelgem for the second time at 0945 hrs and subsequently landed at Kidlington at 1221 hrs. The required Customs and Immigration formalities were completed, no extra fuel was loaded and there was no evidence that the engine oil was either checked or topped up. The aircraft took off for Hinton-in-the-Hedges at 1253 hrs. The direct track distance from Kidlington to Hinton-in-the-Hedges is 12½ nm, on a heading of 020°M. The weather was fine with good visibility and the 1000 feet wind was 280°/25 kt.

It has not been possible to establish the aircraft's precise track after it departed Kidlington as the pilot did not request a radar flight information service, or report to any ATC unit. However at 1322 hrs the London Air Traffic Control Distress and Diversion Cell received a radio message from the pilot stating that he was short of fuel, and requesting directions to the nearest airfield. The aircraft's position was established as 12 nm north-east of Silverstone and the pilot was given a heading to take him towards Silverstone airfield. Shortly afterwards the pilot reported that he had an airfield with a grass runway in sight and intended to land. The aircraft then landed at the private airstrip at Buttermilk Farm, near Blisworth, Northamptonshire at about 1330 hrs. The total flight time from the first take-off at Wevelgem to the landing at the private airstrip, was three hours and 21 minutes.

Since no fuel was stored at the farm, arrangements were made for the pilot to purchase 27 litres of four star motor gasoline from a local garage, with which he duly refuelled the aircraft. After the pilot had received specific instructions from the farm owner on the position of Hinton-in-the-Hedges, which is 12 nm to the south-west of Buttermilk Farm, the aircraft took-off and landed at Hinton-in-the-Hedges at about 1500 hrs. There the aircraft was refuelled to full tanks with a total of 119 litres of fuel. There was no evidence as to whether or not the engine oil was checked or topped up at this time.

At about 1630 hrs the aircraft took-off from Hinton-in-the-Hedges and landed at Kidlington, where Customs and Immigration formalities were again completed. A Visual Flight Rules (VFR) flight plan had previously been filed with Kidlington ATC. The planned route was by direct tracks between the VOR beacons at Bovingdon, Brookman's Park, Detling and Dover and thereafter across the Channel to Koksy and direct to Wevelgem. The planned altitude was 2400 feet to Dover, climbing to FL 50 across the channel and into Belgian airspace. Belgian regulations require that flight under Instrument Flight Rules (IFR) is compulsory at night, unless an aircraft remains within 2 nm of an airport.

The precise time of take-off from Kidlington could not be established, since the ATC service had closed down. However there was a subsequent eye-witness report that the aircraft had been stationary at the runway threshold for some time, before it took-off without either its navigation or anti-collision lights illuminated. At 1758 hrs the pilot contacted Brize Norton radar, passed his flight details and requested a radar service. This was provided and the Brize Norton radar controller advised headings which assisted the pilot in navigating to the Bovingdon VOR. There was some confusion and difficulty in identifying the aircraft at this stage since, although the pilot reported that he was flying at 2400 feet, his transponder return was displaying 1400 feet. The error was corrected and, after the aircraft had climbed to 2400 feet, radar service was transferred to Luton at 1811 hrs. Between 1811 hrs and 1828 hrs the aircraft transitted the Luton and Stansted zones without incident and, when the radar service was transferred to Thames radar, the pilot correctly reported his position as inbound to the Detling VOR, at a range of 26 nm.

Radar recordings showed that at the moment of transfer to Thames radar, the aircraft was close to the planned track and flying level at 2400 feet. It continued in this manner until 1832 hrs, when the pilot transmitted the emergency message: "MAYDAY MAYDAY MAYDAY, - NOVEMBER NINE EIGHT ECHO IS LOSING HIS ENGINE REQUEST RADAR VECTOR FOR AN AIRPORT." The background noise recorded on this, and subsequent transmissions, indicated that the aircraft was suffering severe vibration. The Thames radar controller advised that Biggin Hill was ahead of the aircraft on a course of 210° and a range of 18 nm. The ensuing exchange of messages indicated that the pilot was not receiving the radar controller's advice clearly, and that the vibration was such that he was unable to read his flight instruments. The radar recording also showed that, from shortly before the emergency call, the aircraft had been in a continuous descent. The radar controller continued to give advice on the position of airports in the vicinity, including London City and the unlit grass airfield at Thurrock, but none of these could be reached in the gliding distance available.

At 1836.30 hrs the pilot's last radio transmission was that he was looking for a place to land. He has since stated that he advised his passengers of an imminent crash landing and ensured that their restraint harnesses were tightened. He attempted to direct the aircraft towards a 'dark area' and ground eye-witnesses subsequently confirmed seeing the aircraft at very low level, in a right turn towards an area of quarries situated close to the service station at the interchange of the M25 and A13 roads. Finally, when the aircraft was still in a right turn, its right wing struck a power cable and the aircraft then impacted steeply with the ground. The two adult passengers, who were seated on the right side of the aircraft, were killed by the impact. Emergency services arrived quickly at the scene and the pilot and the eight year old boy were released from the wreckage and transferred to hospital. Both had suffered serious injuries. In order to gain access to the cabin to release the victims, it was necessary for emergency services personnel to cut away the right wing at its root.

Initial on site examination of the wreckage distribution and ground marks indicated that the aircraft had been inverted and substantially structurally intact when it first struck the ground. The engine and its cowling had then detached. After the initial impact, the main part of the structure had slid about 11 metres in the direction of 050°M, across an earth track, before coming to rest near the top of an earth bank, which separated the site from a steep slope into a water-filled dis-used quarry. The fuselage, tailplane and left wing had remained as a unit with considerable structural disruption of the cabin area and a partial tearing separation of the rear fuselage, just aft of the cabin. No significant damage had been suffered by any of the three landing gears, although the nose gear had been displaced as a result of distortion of the engine firewall bulkhead.

The inboard/major part of the right wing, which had been cut away, was lying behind the main wreckage on the bank. However the outboard one metre of the right wing was found beneath electric power distribution lines, and close to a pylon which was positioned about 100 metres due south of the ground impact position. Examination of the damage in the zone of the right wing separation,

particularly that evident on the leading edges of both portions of this wing, showed it to be consistent with that to be expected following collision with a power cable. The absence of any significant damage to, or disruption of, the aircraft's landing gear indicated that this had not contacted the power lines and implied that, at the moment of contact with the cable, the aircraft had been banked at least 30° to the right. An examination of the power cables by an Electricity Board inspector confirmed that there was evidence that the topmost (Earth Return) cable had been struck by a white painted object; the strike mark was about two metres to the west of the pylon, at a height of about 150 feet above ground level.

The underside of the aircraft was largely covered in an oil film, of even thickness, which appeared to have flowed aft from the lower/right corner of the engine firewall bulkhead. This oil film had spread to cover the full width of the underside of the aircraft at the main landing gear and had continued along the full underside width back to the tailplane. This film appeared to consist of fairly clean oil. Inspection of the engine revealed a large hole in the crankcase below the No. 2 cylinder, but the engine was not generally 'oily' externally.

The aircraft wreckage was removed from the accident site and transported to the Air Accidents Investigation Branch facility, at Farnborough, for detailed examination.

Subsequent strip examination of the engine, performed in co-operation with a representative from its American manufacturer, revealed that it had suffered catastrophic internal failure. Whilst the primary mechanical failure was considered to have occurred to the No. 3 big end bearing, the characteristics of the associated damage were consistent with there having been insufficient lubrication of the bearing, leading to local overheating and seizure. Inspection of the oil pump showed it to have been in reasonable condition, with its drive intact.

The relatively good condition of the other three big-end bearings, and their associated crankpins, indicated that the lubrication problem was most likely to have been related to a reduced lubricant level in the sump. This situation can lead to intermittent lubrication of all bearings as a result of the mouth of the oil intake pipe being occasionally uncovered and air being entrained into the pressurised oil feed as the aircraft attitude changes sightly during flight. Service experience has shown that, in this situation, the lubrication of the No. 3 crankpin (of a 4 cylinder Lycoming engine) is usually more seriously affected than that of any of the other bearings in the engine, causing the No. 3 big-end bearings to overheat and fail before any of the others shows overt signs of distress.

Examination of the engine oil filter (which was of the 'spin-on', disposable type) revealed that an oil seal gasket on the filter mounting had 'split'. Since this seal is designed to contain the pressurised oil, this split would have allowed the oil to leak away steadily. Close examination of the engine cowling and firewall bulkhead showed that there was a greater, though not severe, 'oiliness' of the structure and components in the area of the filter and immediately below it. The filter, as installed on the engine,

is positioned at the aft/upper right side of the engine compartment, immediately above the apparent source of the oil film on the underside of the aircraft .

An inspection was made of the area at Kidlington airport in which the aircraft was reported to have held position, with its engine running, before its last take-off. However, no evidence was found of any significant oil spillage. This indicated that the split in the seal had not developed sufficiently, at that time, for any appreciable oil loss to have occurred by this mechanism. This in turn implied that the final rupture of the seal, leading to the loss of oil which resulted in the engine failure, had probably occurred during the accident flight.

Detailed examination of this sealing gasket revealed evidence that it had been fitted as a replacement for a previous seal at some time during the aircraft's life. It could be identified as a replacement by the presence of a dye marking on the inner rim, and it should have been bonded to the converter plate before being fitted to the engine. On disassembly of the filter there was no evidence of a bonding agent having being used to attach the gasket to the converter plate.

If the gasket is fitted without being bonded to the plate, gravity will tend to distort the gasket into an 'oval shape' because of the orientation of the filter housing. Witness impressions on the seal showed that it was incorrectly positioned at the time of the accident and that the way in which it was seated had not altered since it had been installed (see illustrations). This error in the way in which the seal had been fitted would not have been visible immediately after its installation had been completed; nor would it have resulted in an oil leak, the accepted indicator of satisfactory fitting. Subsequently, the error would not have been visible without dismantling the filter mounting assembly, which is not a normal procedure whilst changing the oil filter.

The result of this incorrect assembly had been to 'pinch' the seal between a sharp lip, normally used to locate the seal radially whilst bonding it to the converter plate, and the body of the filter mounting (see illustrations). This pinching had induced local tears in the seal which had been extended, by a mechanism with characteristics consistent with fatigue driven by the variations of oil pressure resulting from the engine being started and stopped, until one tear reached the free edge of the seal.

Once the tear had reached the edge, a restricted passage for oil leakage would have been present. However such low leakage would have been unlikely to have caused a reduction of oil pressure. In this context, it has been observed during tests performed by the engine manufacturer that the type of oil pressure gauge fitted to this (and many other light aircraft types) appeared to be heavily 'damped' and, therefore, insensitive to the short term pressure fluctuations which may result from operation with a low engine oil level.

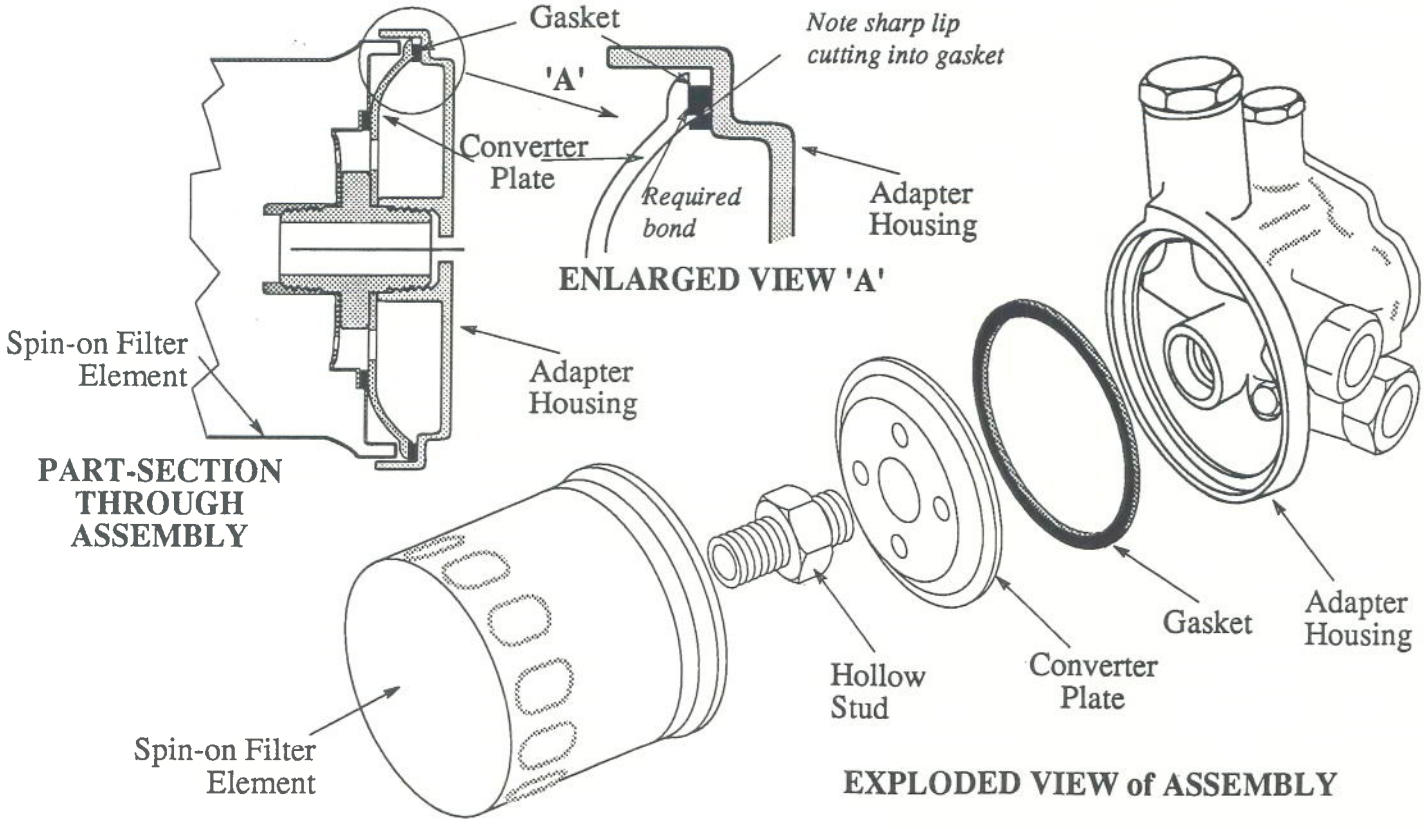
The gasket was not available as an individual spare part until fairly recently and so it had previously to be obtained already bonded to the converter plate. However, after it had been made available as a single part, service experience led the engine manufacturer to suspect that the bonding of the gasket to the converter plate was not always performed. The engine manufacturer therefore issued (in May 1991, when this aircraft was also in transit to Belgium from the USA) a Service Instruction, No. 1453, reiterating the required procedure for fitting a replacement gasket and recommending replacement of the oil converter plate at overhaul.

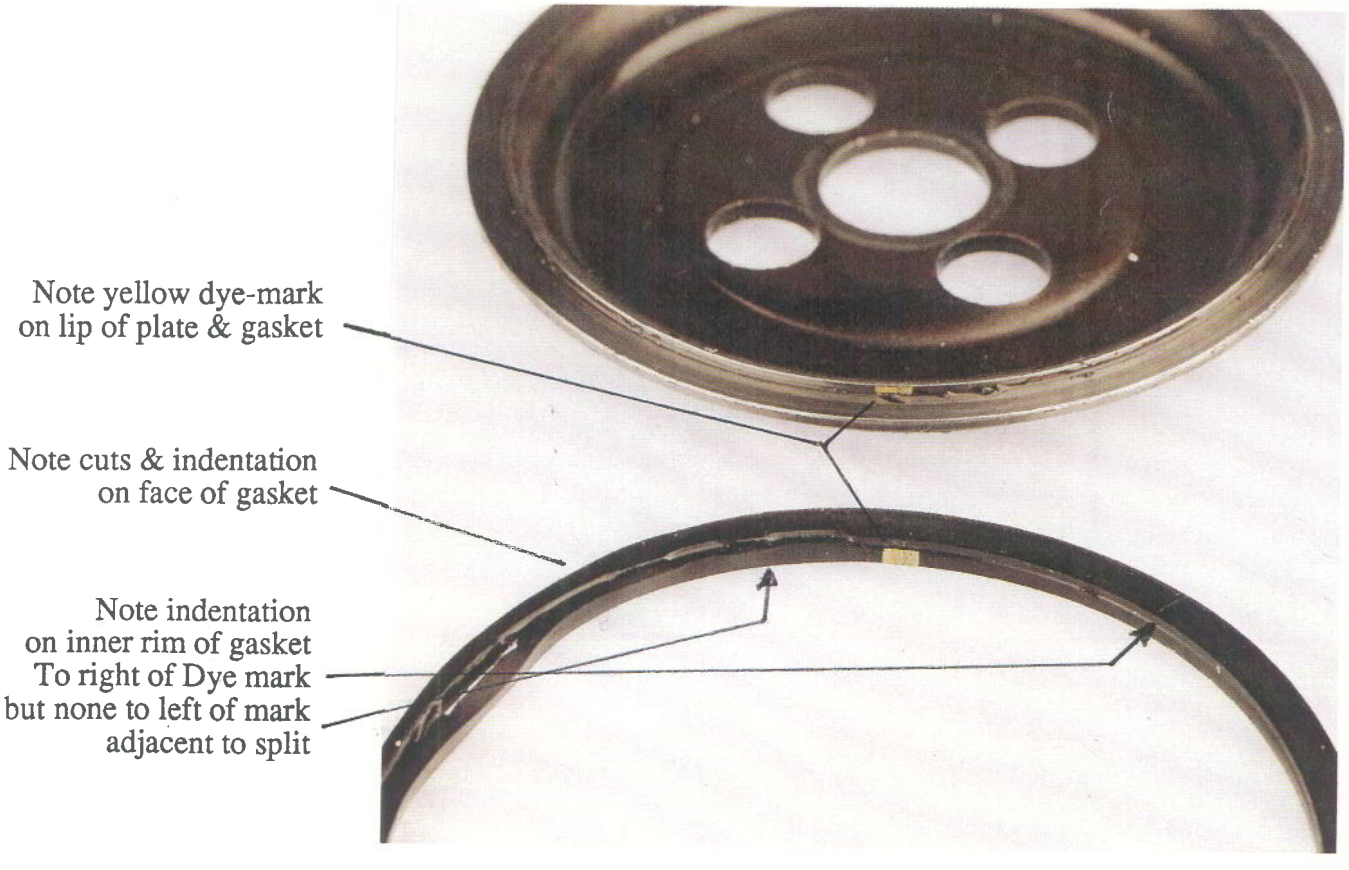
The need to change this gasket could arise as a result of the converter plate moving relative to the adaptor housing during removal of the oil filter. Such relative movement could damage the gasket and give rise to oil leaks. The most likely cause of the converter plate moving during filter removal would be as a result of the filter having been overtightened during installation. Overtightening of the filter during fitment with the addition of the 'binding' of the filter to the converter plate which will occur during operation, could give rise to the need to apply such torque at filter removal that the clamping of the converter plate to the adaptor housing would be overcome.

The aircraft had been operated in the USA until May 1991 when it was sold and ferried to its new owner in Belgium. During the period that the aircraft had been operating in Belgium, the oil filter had been changed twice, but the maintenance organisation involved has stated that on neither occasion had this gasket been disturbed, or changed. The maintenance records available from the aircraft's operation in the USA were insufficiently detailed to permit a determination of when, or where, the gasket was changed.

Examination of the aircraft's documentation revealed that the legal status of the aircraft was, due to an administrative shortcoming, uncertain although it appears to have remained on the American Register of Aircraft and therefore subject to FAA certification and operational rules. The maintenance documentation indicated that the aircraft had been regularly maintained by duly licensed personnel whilst it had operated in the USA and that the maintenance performed since the aircraft had been in Belgium was of an equivalent standard.

Oil Filter Assembly





CONVERTER PLATE & GASKET