Transportation Safety Board of Canada | Bureau de la sécurité des transports du Canada

ENGINEERING BRANCH
ENGINEERING REPORT

DIRECTION D'INGÉNIERIE
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FILE REFERENCE NUMÉRO DE DOSSIER	NUMBER OF PAGES NOMBRE DE PAGES	APPENDICES ANNEXES	1	RELEASE OUTSIDE THE TSB REQUIRES REVIEW BY THE ACCESS TO INFORMATION OFFICER.	YES OUI	NO NON
A05W0148	3	FIGURES CHIFFRES	12	LA PUBLICATION HORS DU BST REQUIERT LA RÉVISION DU (DE LA) COORDONNATEUR(TRICE) DE L'ACCÈS À L'INFORMATION.	X	

ENGINEERING REPORT
RAPPORT TECHNIQUE LP 087/2005

Fuel System Components Examination
VariEze Homebuilt, N914VE
20 July 2005

PREPARED BY - PRÉPARÉ PAR

T.A. Lang Tim Lang
(Senior Materials Engineering Technologist)

REVIEWED BY - RÉVISÉ PAR

M. Mathieu, P.Eng.
(A/Manager, Materials Analysis & Structures)

APPROVED BY - APPROUVÉ PAR

N.G. Cerullo, P.Eng., Director of Engineering

DATE COMPLETED - TERMINÉ LE 31 oct 05

1.0 INTRODUCTION

1.1 An amateur built VariEze aircraft, registration N914VE departed Lethbridge, Alberta on a VFR flight to Airdrie, Alberta. Just after take off, as the aircraft was departing the downwind leg of the circuit the pilot advised Lethbridge FSS that the aircraft was on fire. The aircraft crashed one minute later approximately one mile northwest of the air field. The aircraft was destroyed in the fire and the pilot who was the sole occupant was fatally injured. Witnesses on the ground observed smoke trailing out the back of the aircraft just before it crashed.

1.2 The VariEze aircraft design utilizes an aft mounted pusher engine. The aircraft had recently been modified with the installation of a turbo charged Rotax 914UL engine, serial number V914-4874, which replaced the original Lycoming 0-235 engine. This was reported to be the only VariEze aircraft currently flying with this new engine configuration. The aircraft was also reported to have some additional modifications which included a computerized fuel flow monitoring system that indicated the amount of fuel being consumed by the aircraft.

1.3 The fuel pressure regulator and two carburetors were recovered from the aircraft. Part of a fitting which appeared to be from the fuel system was found on the wreckage trail. The two carburetors, fuel pressure regulator and recovered fitting along with a new fuel pressure regulator for comparison purposes were forwarded to the Engineering Branch Laboratory of the Transportation Safety Board of Canada for examination. The examination would be to determine if the recovered fitting was from the fuel pressure regulator, carburetor or from another component in the fuel system.

2.0 EXAMINATION AND ANALYSIS

2.1 The two carburetors, fuel pressure regulator, recovered fitting and comparison fuel pressure regulator are shown as received in Figure 1. Examination of the components revealed that they had been exposed to excessive heat. The two carburetors and fuel pressure regulator showed evidence of melting. Both are manufactured of an aluminum alloy and the melting point of these alloys is 538 to 593 degrees Celsius (1000 to 1100 degrees Fahrenheit) (refer to Figures 2 and 3). The two carburetors and fuel pressure regulator showed no signs of a failure other than the heat and impact damage.

2.2 The recovered fitting which was found on the wreckage trail still had the rubber hose and clamp attached (refer to Figure 4). The fracture surface was damaged from the fire. Examination did not show any signs of a progressive failure (refer to Figure 5).

The hose and clamp were removed exposing the remaining section of fitting. The hose connection area had no barbs present in this area (refer to Figure 6). A saw cut was performed on the fitting revealing that it was made of plastic (refer to Figure 11). The banjo fitting from the comparison fuel pressure regulator is made from steel and the hose connection area has barbs (refer to Figure 7). The two carburetors also have banjo fittings which are slightly smaller and they also have barbs on the hose connection area (refer to Figure 8).

2.3 Photographs of the cockpit of the subject aircraft taken four months prior to the accident revealed that a NAVMAN 2100 Fuel Flow Monitor System was installed. This instrument is used to measure the amount of fuel being consumed and is generally used in marine applications. Information provided by the manufacturer revealed that the NAVMAN 2100 system is not designed for use in the aviation industry. It has a published maximum operating temperature of 50 degrees Celsius (122 degrees Fahrenheit) and a component failure temperature of 509 degrees Celsius (948 degrees Fahrenheit). The letter from NAVMAN is attached as Appendix A. A new fuel transducer was obtained from NAVMAN and is shown in Figure 9. The hose connection area on the inlet side of the new fuel transducer is very similar in colour, texture and shape to the recovered fitting. Both fittings have the same circular flat area on the hose connection area and was only located on the inlet side of the new fuel transducer (refer to Figures 10 through 12). Measurements were taken of the inner and outer diameters of the hose connection area on both fittings and they were both 0.26 inch and 0.40 inch respectively. The circular flat area on the hose connection area was measured and both were found to be 0.16 inch in diameter.

3.0 DISCUSSION

3.1 The visual comparison and dimensional results of the recovered fitting and inlet side portion of the new fuel transducer reveal that the recovered fitting is most likely the inlet side of a fuel transducer from a NAVMAN 2100 Fuel Flow Monitor System. Since only a small part of the fuel transducer was recovered, it is not known if it was a factor in the pre-crash fire. The NAVMAN system was not intended or designed for use in aircraft. It has a published maximum operating temperature of 50 degrees Celsius and a reported component failure at a temperature of 509 degrees Celsius. The engine compartment on the subject aircraft could see temperatures of several hundred degrees Celsius during normal operation. The recovered fuel pressure regulator and carburetor had areas of melting, which would occur at a temperature range of 538 to 593 degrees Celsius. If the fuel transducer from the NAVMAN 2100 System was mounted in the engine compartment area it could have been exposed to temperatures that exceeded its maximum designed environmental temperature range.

3.2 The two carburetors and fuel pressure regulator had areas which were melted and deformed indicating that they had been exposed to excessive heat during the accident. Both are manufactured of an aluminum alloy which has a melting point of 538 to 593 degrees Celsius. No failures were observed that might have caused them to be a contributing factor in the fire that was observed to have occurred prior to the aircraft impacting the ground.

4.0 CONCLUSIONS

4.1 The recovered fitting was made of plastic and had no barbs on the hose connection area, and was most likely not from the fuel pressure regulator or either of the two carburetors.

4.2 The fracture surface on the recovered fitting had been exposed to heat, but it did not show any signs of a progressive failure.

4.3 It is highly probable that the recovered fitting was from the inlet side of the fuel transducer which is part of the NAVMAN 2100 Fuel Monitor System. This system was not intended or designed for the use on an aircraft.

4.4 It could not be determined whether the two carburetors, fuel pressure regulator and recovered fitting were a factor in the fire.

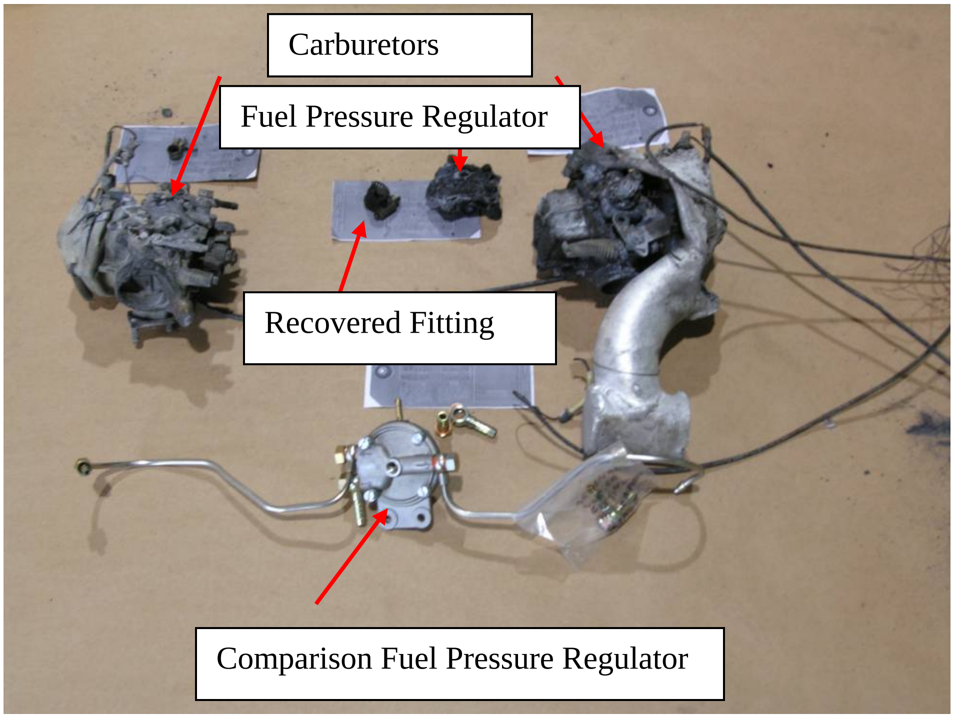

Figure 1 - Photograph showing the two carburetors, fuel pressure regulator, banjo fitting and comparison fuel pressure regulator as received.

Figure 2 - Photograph showing one of the carburetors. Arrow points to the heat deformed area.

Figure 3 - Photograph showing the excessive heat damage to the fuel pressure regulator. Arrow points to area on the regulator where the aluminum has drooped.

Figure 4 - Photograph showing the recovered fitting with the hose and clamp still attached.

Figure 5 - Photograph showing the fracture surface on the recovered fitting. Rubber hose and clamp are still attached.

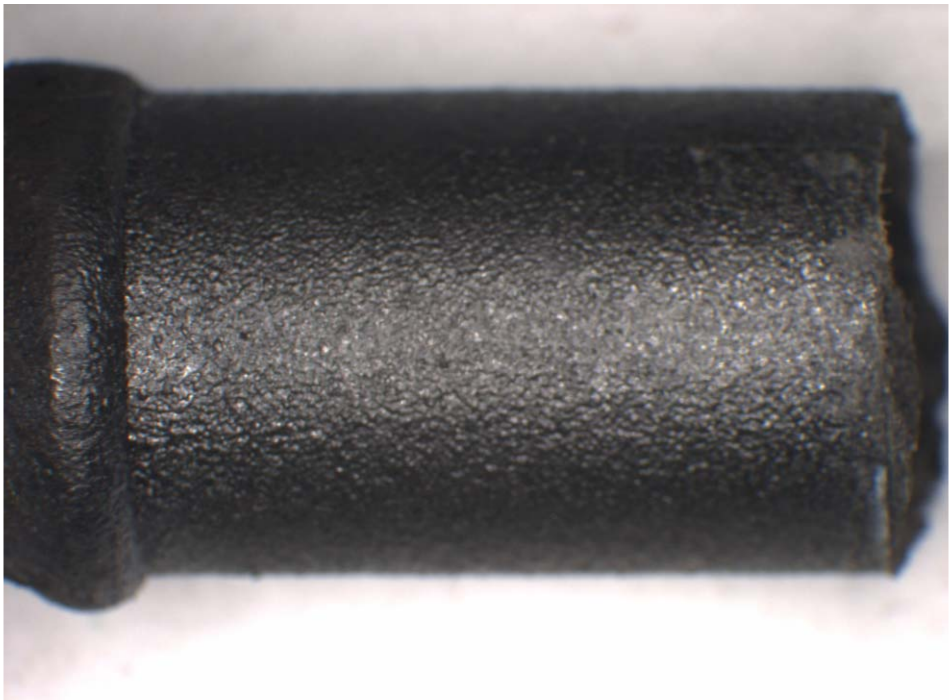

Figure 6 - Photograph showing the hose connection area of the recovered fitting, note there are no barbs on the hose connection area.

Figure 7 - Photograph showing a banjo fitting from the comparison fuel pressure regulator. Note the barbs on the hose connection area (arrow)

Figure 8 - Photograph showing a banjo fitting from the carburetor. Note the barbs on the hose connection surface (arrow).

Figure 9 - Photograph showing the new fuel transducer obtained from NAVMAN.

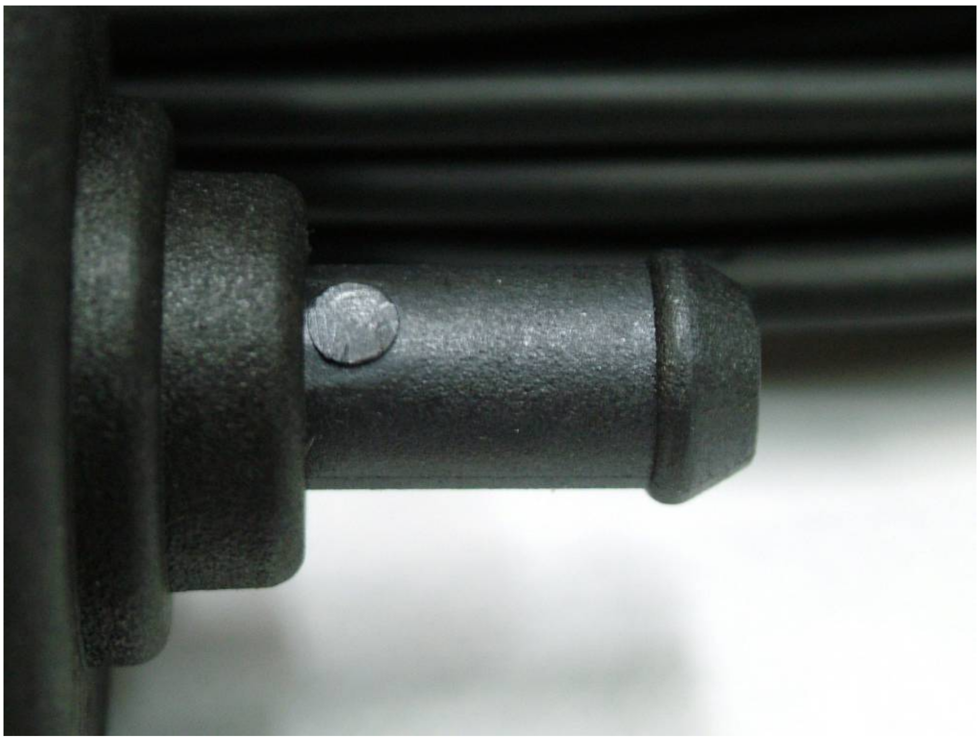

Figure 10 - Close-up photograph showing the hose connection area on the inlet side of the new fuel transducer.

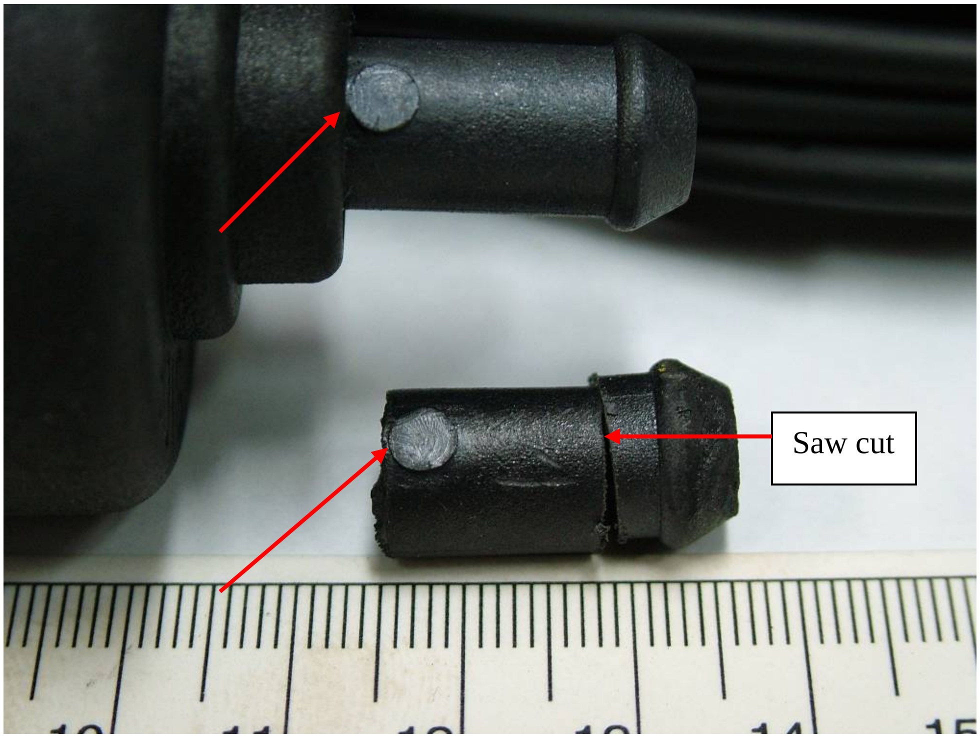

Figure 11 - Photograph showing the recovered fitting (bottom) with the hose connection area from the inlet side of the new fuel transducer. Note both have the same circular flat spot (arrows).

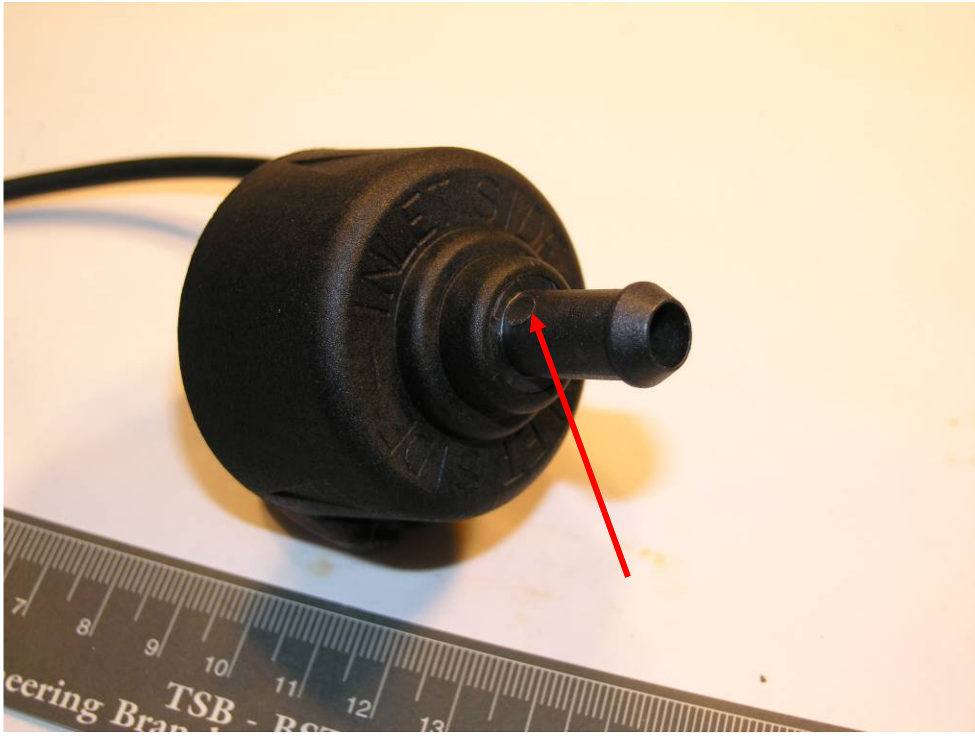

Figure 12 - Photograph showing the inlet side of the new fuel transducer. Arrow points to the circular flat spot on the hose connection area.

Mr. Bill Kemp,
Senior Investigator,
Transportation Safety Board of Canada,
Edmonton,
Alberta,
Canada.
Phone: +1-780-495-2003

NAVMAN

Navman NZ Limited
7 — 21 Kawana Street, Northcote
PO Box 68 155 Newton
Auckland, New Zealand
Tel: +64 9 481 0500
Fax: +64 9 480 3176
www.navman.com

Monday September 26, 2005

RE : A05W0148: REQUEST FOR INFORMATION ON NAVMAN FUEL 2100 FUEL FLOW TRANSDUCER

Dear Mr. Kemp,

Thank you for your email detailing the events surrounding the unfortunate air-accident of 20 July 2005, at Lethbridge, Alberta, Canada.

Before I answer the specific questions that you raised in the email, please let me give you a brief background on Navman and Navman fuel instruments.

Navman has never sold any instruments -- directly or indirectly -- into the aviation market. Navman has no intention of entering the aviation market. We have, on occasion, received enquiries from potential customers asking if our instruments would be suitable for use in a particular aircraft application, but on all occasions we have vehemently informed these customers that Navman instruments are not appropriate for aviation use.

Navman has a proud safety record in the marine industry. All of our products are thoroughly tested using both our stringent in-house test regimes and the industry standards relevant to the intended application.

As further discussed below, we believe it is highly unlikely that the F2100 instrument contributed to this unfortunate accident. But, as you can gather from what I have stated above, we remain concerned that it is being used in aviation applications. In that regard, we would appreciate any information that you may develop regarding the supply chain that led to this installation.

In regard to the specific questions and information you have requested by your email, here are Navman's answers:

1. *What type of plastic is used in the construction of the Fuel 2100 transducer housing and posts/nipples?*

   The main flow path for fuel in the F2100 transducer is a single component, our part number is TD000090D "TDX FUEL FLOW BODY GLASS FORTRON" as shown here:

   This component is molded from FORTRON 1140A1 which has resistance to the following chemicals and more, as listed in Table 3-11 of the manufacturers data sheet (attached):

   Toluene
   Acetone
   Diethyl ether
   Methanol
   Gasoline
   Gasohol
   Light oil
   Kerosene
   Motor oil
   Break fluid

   The outer casing is also moulded from the same FORTRON 1140A1 material.

2. *What is the maximum compartment/environmental temperature for installation of this fuel flow transducer (i.e. what is the maximum ambient temperature that this component can be exposed to in situ, during normal operation?)*

   The maximum operating temperature, as published by Navman, is 50ºC (122ºF). This figure is based on the maximum temperature to which the transducer electronics will operate without error. The maximum environmental temperature before mechanical failure will be much higher than this. For example, the principal load bearing component of the transducer is the main flow body (described above) which has a temperature of deflection under load of 265ºC (509ºF).

Related to these maximum temperature specifications are two other standards with which the transducer complies. These are ISO10088 and ISO8846 Ignition protection and external surface temperature tests (copy attached). These tests require fire testing (pictured) in accordance with ISO7840:1994 Annex A.

3. *What is the maximum fuel pressure rating for this transducer?*

   The transducer is not designed to be used under pressure. It must be installed on the suction side of the fuel pump. Therefore, we have not done any maximum fuel pressure tests. However, the maximum flow rate that the transducer can read without error is 150 litres per hour. We have tested the transducer thoroughly at this flow rate. The backpressure generated by the transducer (i.e. the extra pressure on the fuel line seen by the fuel pump) at this flow rate is 1.0" of mercury.

4. *We are aware that this transducer is designed for marine applications. The aircraft was fuelled with 100 LL aviation fuel. Would you consider this transducer to be completely compatible with 100 LL aviation fuel?*

   We have tested the transducer with several high severity premium commercial grades of gasoline and diesel. These tests involved soaking the transducer in the fuel for periods up to 100 days before removing and testing for any reduction in mechanical strength (both tensile and compression). The tests were carried out by an independent and certified test laboratory in accordance with AS/NZS 2906 and the transducer passed in all cases. The test results are attached. Given that the units are intended, designed and marketed for marine use only, we have not tested specifically with Avgas or 100 LL aviation fuel. But the certification under AS/NZS 2906, together with the chemical resistance of FORTRON 1140A1 described in question 1 above (especially the Kerosene resistance), suggests that normal operation of the transducer with these fuels is possible.

5. *Aside from there being no approval for aircraft use, are there any design or operating parameters/limitations/characteristics that would render this transducer incompatible for use in an experimental/amateur built aircraft application?*

   As noted above, since these transducers are intended, designed and marketed solely for the marine market, Navman has not analyzed whether there might be design or operating parameters/limitations/characteristics that would render them incompatible for use in an experimental/amateur built aircraft application. Navman is not aware, therefore, of any compatibility or incompatibility with such an aircraft application

In summary, even though our transducer is not intended and has not been designed, approved or recommended for use in the aircraft applications, we believe that it is unlikely to have failed in the application that you have detailed.

We are, however, concerned that it is being used in such applications. As noted above, if you become aware of the circumstances that led to the installation of the Navman product in this aircraft, we would appreciate learning about them.

We would also appreciate being advised in advance if you anticipate either reporting any significant connection between the Navman fuel transducer and the crash in your analysis or changing the classification of the occurrence where the reason for the change relates in any way to the performance of the Navman fuel transducer.

I hope this letter addresses all of your questions in the detail that you need, but please do not hesitate to contact me directly should you need further expansion on any of the points.

Darren Coneybear Navman Customer Support Manager