



**Australian Government**

**Australian Transport Safety Bureau**

# Drum stock fuel contamination

Cloncurry Airport, Queensland on 7 September 2016

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#### Addendum

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# Safety summary

## What happened

Since September 2016, the ATSB has received several reports of contaminants being identified in Jet A1 drum stock fuel around Australia. The contaminant was a white, stringy, rubbery substance, varying in size and shape from 10-20 mm to as small as 1-2 mm. An operator first identified the contamination in Queensland through visual inspection of fuel drums. Subsequent fuel pump filter inspections revealed that the filters had trapped further contaminants prior to it entering the aircraft's fuel system. No contaminants were found in any aircraft exposed to the fuel.

Contaminated drums were filled by different refuelling companies but were manufactured by the same company, VIP Packaging. Batch numbers and manufacturing dates on the drums across the incidents did not show any correlation.

## What the ATSB found

The ATSB determined that the contaminant was a sealant used by the drum manufacturer on the lid and base of the drums. The sealant's mechanical properties were found to degrade when exposed to solvents such as Jet A1 fuel. This, in combination with vibration and drum deformation during transport, likely caused pieces of the sealant to enter the fuel within the drum.

Filtration during the refuelling process appeared to be effective in preventing contaminants from reaching the aircraft and there was no evidence that the sealant dissolved in the fuel.

## Safety message

Fuel sourced from drum stock is particularly susceptible to contamination. However, there are a number of ways to minimise the likelihood of using contaminated fuel. These include:

- applying appropriate drum handling and storage methods
- visually inspecting drums for contaminants prior to refuelling activities
- regularly inspecting fuel pump filters
- conducting fuel drains from the aircraft after each refuel for visual inspection.

The following publications provide useful information to pilots, operators, and refuellers regarding the use of drum stock:

- [Civil Aviation Order 20.9](#) titled *Air service operations – precautions in refuelling, engine and ground radar operations*; available from the Federal Register of Legislation.
- [Safety on the ground](#) provides advice on refuelling from a drum, and on the correct way to store a fuel drum; available from the Civil Aviation Safety Authority's website.
- [CASA Safety Video – Drum Refuelling](#) provides an overview of safe refuelling practices using drum stock; available from the Civil Aviation Safety Authority's YouTube channel.

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# The occurrence

## What happened

In September 2016, the ATSB received a report from a helicopter operator regarding contaminated drum stock fuel in Cloncurry, Queensland. One of the operator's pilots observed white particles floating in Jet A1 fuel while inspecting one of several recently arrived drums. The same contaminant was subsequently found in all seven of the drums that were opened and inspected. Similar contaminants were found in the fuel filtration system of the drum transfer pump.

All of the drums appeared to be new, and came from the same manufacturer, VIP Packaging. One of the contaminated drums was manufactured less than a month prior to the incident. The refueller was informed of the contamination and recalled all 50 of the drums that had been recently supplied to the operator.

In October 2016, the same operator reported that it had found four more drums containing the same type of contaminant near McKinlay, Queensland. The contaminants were observed during visual inspection of the drums, and ranged in size from 1-2 mm to 10-20 mm in length (Figure 1). These drums were also manufactured by VIP Packaging. Date stamps on the fuel drums showed that they were all manufactured at different times. The operator noted that the drums had been previously used, cleaned, and refilled by the refuelling company with no evidence of contaminants.

**Figure 1: Contaminant removed from the drum**



Source: Operator

In April 2017, the same operator reported drum stock contamination at two remote airfields in Western Australia. The majority of drums inspected were reported to contain the same sort of contaminant. The contaminant was described as small pieces of white debris and tended to settle at the base of the drum. The contaminant was most easily detected when the fuel was stirred well and then allowed to settle, causing the contaminant to collect at the centre of the drum's base.

The drums in Western Australia were filled by a different refuelling company, but supplied by the same drum manufacturer. The drums had various manufacturing dates, including some produced

less than a month prior to the observed contamination. On 10 June 2019, the same operator reported 20 more VIP drums with various levels of contamination. The filters within the drum transfer pump also contained white contaminants.

At the time of publication, every reported instance of this type of contamination involved Jet A1 fuel. Additionally, there have been no reports of the contaminant entering an aircraft's fuel system.

# Context

## Drum fuel filtration

Fuel drums are often used as a means of transporting and storing fuel in remote areas and for smaller operations, where using fuel trucks or bulk storage is not practical.

The requirements for refuelling aircraft using ground stock is outlined in Civil Aviation Order 20.9. With regard to drum stock fuel, the following applies:

All fuel shall be strained or filtered for the removal of free or suspended water and other contaminating matter before entering the aircraft tanks.

There are no other regulations pertaining to the state of the drum, however the following broader guidance is available on safe drum refuelling practices:

- [Safety on the ground](#) provides advice on refuelling from a drum, and on the correct way to store a fuel drum; available from the Civil Aviation Safety Authority's website.
- [The CASA Safety Video – Drum Refuelling](#) provides an overview of safe refuelling practices using drum stock; available from the Civil Aviation Safety Authority's YouTube channel.

Refuelling systems that use fuel drums typically have multiple types of filtration. Refuelling systems used in these occurrences had the following:

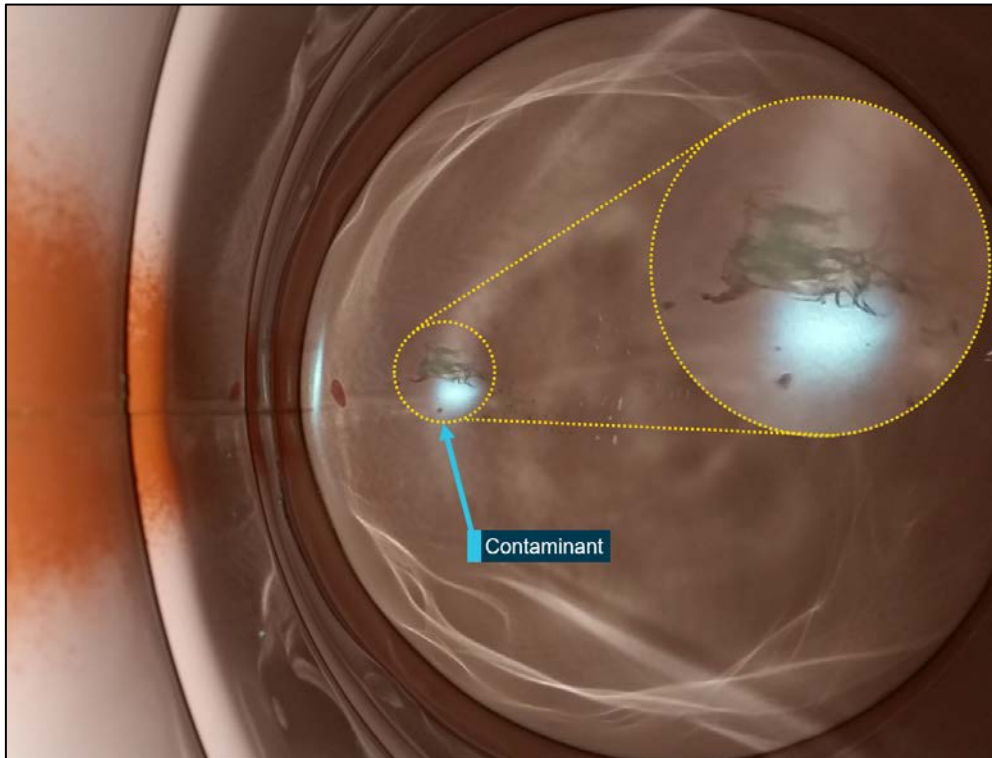
- A coarse 'rock catcher' filter made from rigid wire mesh located immediately downstream of the fuel drum. This removed larger contaminants and protected the refuelling pump.
- A micronic pre-filter – a cylindrical filter made from pleated fabric – prevented fine contaminants and water from being uplifted to the aircraft.

## Contaminant description

The white, stringy material was observed in the Jet A1 fuel drums in each instance of contamination. Figure 2 shows the largest of these contaminants.



**Figure 2: A large contaminant observed at the base of a drum of Jet A1 fuel**



Source: Operator, modified by ATSB

On several occasions, contaminants were also found within the fuel filtration system of the pump used for fuelling aircraft. Several pieces of the white contaminant can be seen in the coarse filter shown in Figure 3.

**Figure 3: White contaminants in the ‘rock catcher’ – part of the fuel pump system**



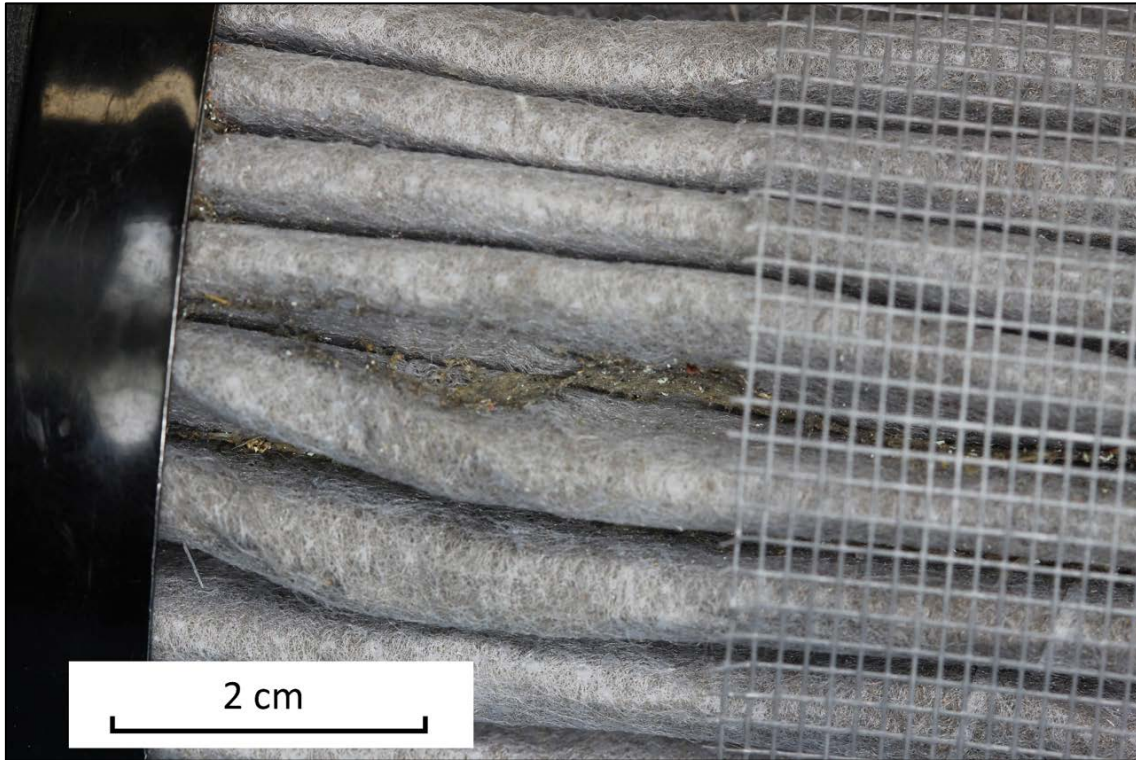
Source: Operator, modified by the ATSB

Contaminants were also found beyond the ‘rock catcher’, such as in the micron pre-filter seen in Figure 4. This filter was from a fuel pump involved in the April 2017 occurrence, and was provided to the ATSB for examination. Figure 5 shows contaminants removed from the same filter. These



rubbery contaminants appeared too large to pass through the upstream coarse filter, as well as the mesh surrounding the filter shown in Figure 4. Assuming the filters were all functioning properly, the large contaminants found in the pre-filter were likely the result of many small pieces (less than 1 mm) coalescing into a larger piece. Other small contaminants (such as dirt and metal) were found within these larger pieces (Figure 5). The smaller pieces were not identified in the fuel drum, most likely because they were too small to be visually observed.

**Figure 4: Micronic pre-filter containing contaminants from April 2017**



Source: ATSB

**Figure 5: Contaminants removed from a pre-filter involved in the April 2017 occurrence**



Source: ATSB

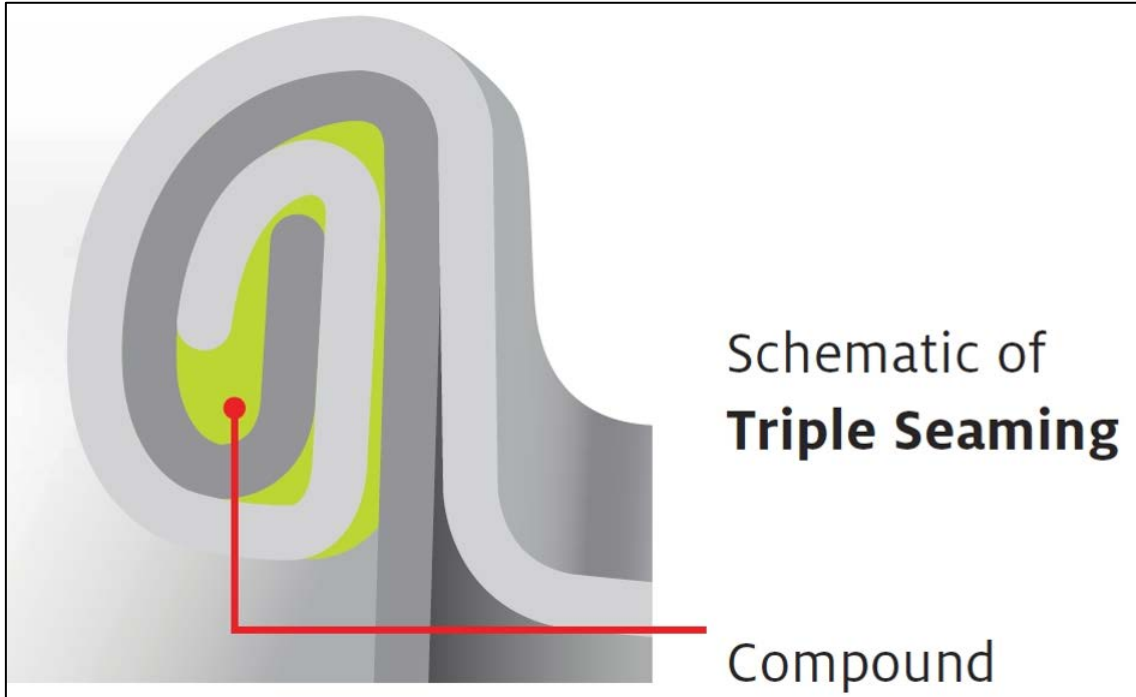
### Drum manufacturing

VIP Packaging is the only Australian manufacturer of fuel drums. All of the drums in the occurrence were the same type – a stainless steel drum with rolled seams on the lid and base.

The drum parts were manufactured in Victoria, but the drums were assembled at different facilities in Queensland and Western Australia. A bead of sealant was added onto the lids and bases of each drum before being transported for assembly.

The assembly process involved rolling the lid/base and the barrel of the drum together to create a sealed vessel with a cylindrical lip on the top and bottom to add rigidity (Figure 6).

**Figure 6: Cross section of a drum's triple seam**



Source: Henkel

### Previous instances of fuel contamination

In 2015, a refueller in Western Australia reported an instance of fuel contamination to the Civil Aviation Safety Authority. The contamination was discovered by an operator in the Kimberley region. The drums were also supplied by the same manufacturer. Contaminants were found in drums as well as filters in the refuelling system. The refueller arranged to have the material tested, and found that the contaminant was consistent with the sealant used on the lids and bases of the fuel drums manufactured by VIP Packaging. The refueller published a customer alert identifying the contaminant as drum sealant, and urged customers to inspect their drums, filters, and strainers for any evidence of the contaminant. Figure 7 shows a comparison of the contaminant found in the 'rock catcher' filters in 2015 and the most recent occurrence in 2017.



Figure 7: A comparison of the white contaminant found in 2015 and in April 2017



Source: Refueller, Operator

The refueller reportedly brought the issue to the attention of the drum manufacturer, who sent them a batch of new drums manufactured in a different factory. However, the refueller found the new drums had the same contamination present.

### Drum manufacturer’s response

As a result of the 2015 occurrence, the drum manufacturer reportedly increased their inspections of the fabricated drums, and acquired a probe to check inside the empty barrels before sale. This check was meant to ensure that no sealant was visible within the drum, since it should all be trapped in the seam between the barrel and lid/base. The bead of sealant was also moved closer to the edge of the lid/base to reduce the likelihood of any sealant entering the drum. It was also reported that instead of shipping the lids, bases and barrel of the drum to be assembled at other facilities, the manufacturer started shipping some drums fully fabricated from their manufacturing facility in Victoria.

The manufacturer reported being unsure how the contaminant, whether it was drum sealant or otherwise, was entering the drum. They suggested that contamination by drum sealant could be caused or exacerbated by drum handling, and noted that transport to remote airports could cause drum damage from high temperatures as well as rough and corrugated roads. One of the refuelling companies involved also believed that the contaminants might be associated with the forces resulting from transport. One drum that had been returned to VIP with reported contaminants showed signs of physical deformation consistent with mishandling. A cross section of the drum revealed that the gap had opened up between the base and sidewall.

## Sealant interaction with fuel

The ATSB sought to determine whether the sealant interacted physically and/or chemically with Jet A1, and whether a combination of handling and temperature could degrade the sealant.

A drum base was provided by the manufacturer in order to test the behaviour of the sealant in Jet A1. The base had a bead of sealant applied around its circumference, which was removed for testing. The removed sealant exhibited the behaviour of a piece of thin, elastic tape (Figure 8).

**Figure 8: A section of sealant removed from a drum base.**



Source: ATSB

Pieces of sealant were taken from the base, immersed in Jet A1, and exposed to:

- room temperature without agitation
- periodic heating to 50°C without agitation
- periodic heating to 50°C and agitation by a magnetic stirrer bar
- an ultrasonic bath for one hour.

A sample of the sealant was also immersed in water, as an experimental control.

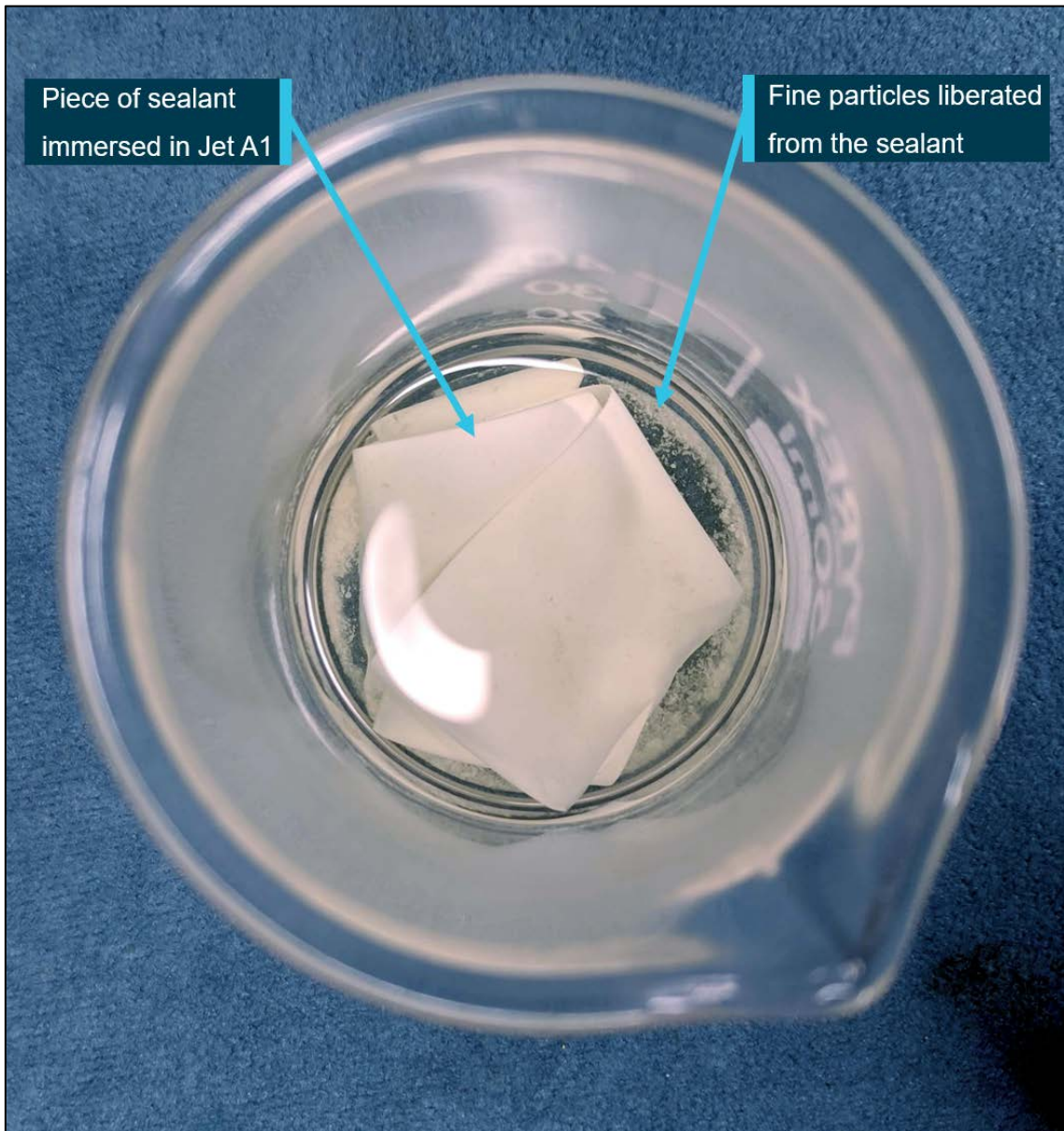
It was found that after 24 hours of immersion in Jet A1, the appearance and properties of the sealant changed noticeably. Specifically the:

- width of the sealant increased by approximately 50 per cent
- extension to failure dropped from ~250 per cent of original length down to less than 20 percent
- sealant became friable when held.

Temperature had no noticeable effect on the sealant, but agitation by the stirrer and the ultrasonic bath both caused the sealant to degrade. The stirrer caused the sealant to break into pieces of varying sizes, while the ultrasonic bath liberated very fine particles from the single piece of sealant (Figure 9). When the sealant was removed from the Jet A1 and dried, the appearance and properties appeared to return to normal. There was insufficient evidence to suggest the sealant dissolved in Jet A1. When immersed in water, the sealant did not appear to change properties or appearance at all.



**Figure 9: A piece of sealant after immersion in Jet A1 fuel and ultrasonic agitation**



Source: ATSB

Once properly dried, the sealant's properties returned to normal. Therefore, it was concluded that the interaction between sealant and Jet A1 was primarily physical rather than chemical. The substantial change in the width of the sealant suggested that Jet A1 was being temporarily absorbed into the material, causing the change in properties.

In response to these findings, the sealant manufacturer stated the following:

Drum and can sealants are designed to be tightly bound within a metal seam of the drum. This keeps them largely protected from drum contents... Can sealants are not designed for direct exposure to solvents and must be incorporated into a correctly formed drum seam.

The manufacturer also stated that the drum sealant it supplied had been used in Australia for approximately 45 years without issue.

## Safety analysis

There have been several occurrences of white contaminants found in refuelling systems' fuel pump filters and fuel drums, all involving drums from the same manufacturer. Photos and descriptions of the contaminants indicated that they were all a similar material and also similar to instances of drum contamination identified in 2015. At that time, the contaminant was tested and found to be sealant from the base and/or lid of the drums.

Experiments carried out by the ATSB demonstrated that the presence of Jet A1 fuel adversely affects the sealant used in the drums. The sealant manufacturer confirmed that the sealant is not designed for exposure to solvents such as Jet A1, and must remain in the drum seam to be effective. After being immersed in Jet A1, vibrations caused the sealant to break down into very fine particles. This result is consistent with the contaminants reported in the fuel transfer pumps' coarse ('rock catcher') and micronic pre-filters. Large pieces were caught by the 'rock catchers', while very small pieces passed through and coalesced on the pre-filter. There was no evidence to suggest that the sealant was dissolving in Jet A1, so the properties of the fuel should not be affected by the sealant.

VIP Packaging believed transport on rough roads could lead to deformation of the drums. In particular, a gap can open up between the barrel and base/lid of a drum. Coupled with vibrations associated with transport, this deformation may have allowed pieces of sealant to escape the seam and enter the fuel.

There have been no reported instances of this contaminant affecting the performance of an aircraft, or entering an aircraft's fuel system. In every instance of contaminated fuel, adequate fuel filtration caught the contaminant. It is possible that the sealant may break down into small enough pieces to pass through the micronic pre-filter and reach the aircraft's fuel tank, and from there pass through the aircraft's fuel filtration system and enter the engine. However, if that was to occur, the particles would be in minor quantities and too small to affect engine operation. As long as fuel is filtered as required under the regulations, and in accordance with best practice, harmful contaminants should not be able to reach the aircraft.

# Findings

From the evidence available, the following findings are made with respect to the fuel contamination issues observed at Cloncurry Airport, Queensland and in Western Australia in 2016. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

## Contributing factors

- Interaction with Jet A1 and rough handling likely caused pieces of drum sealant to detach and enter the fuel stock, increasing the risk of contaminants entering an aircraft's fuel system.

## Other findings

- Adequate fuel filtration in accordance with regulations and best practice should prevent contaminants from entering aircraft.
- There have been no reported occurrences of this contaminant entering an aircraft's fuel system or affecting the performance of an aircraft.



# General details

## Occurrence details

Date and time:	7 September 2016, 08:00 Eastern Standard Time	
Occurrence category:	Incident	
Primary occurrence type:	Fuel Contamination	
Location:	near Cloncurry Airport, Queensland	
	Latitude: 20° 40.1220' S	Longitude: 140° 30.2700' E

# Sources and submissions

## Sources of information

The sources of information during the investigation included:

- a number of helicopter operators and refuelling companies
- the fuel drum manufacturer
- the Civil Aviation Safety Authority.

## Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the fuel drum manufacturer, the sealant manufacturer, the involved operators, refuelling companies and the Civil Aviation Safety Authority.

A submission was received from the sealant manufacturer, which was reviewed and, where considered appropriate, the report was amended accordingly.

# Australian Transport Safety Bureau

The ATSB is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within the ATSB's jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to operations involving the travelling public.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

## Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

## Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

## Terminology used in this report

**Occurrence:** accident or incident.

**Safety factor:** an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

**Contributing factor:** a factor that, had it not occurred or existed at the time of an occurrence, then either:

- (a) the occurrence would probably not have occurred; or
- (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or
- (c) another contributing factor would probably not have occurred or existed.

**Other factors that increased risk:** a safety factor identified during an occurrence investigation, which did not meet the definition of contributing factor but was still considered to be important to communicate in an investigation report in the interest of improved transport safety.

**Other findings:** any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which ‘saved the day’ or played an important role in reducing the risk associated with an occurrence.