

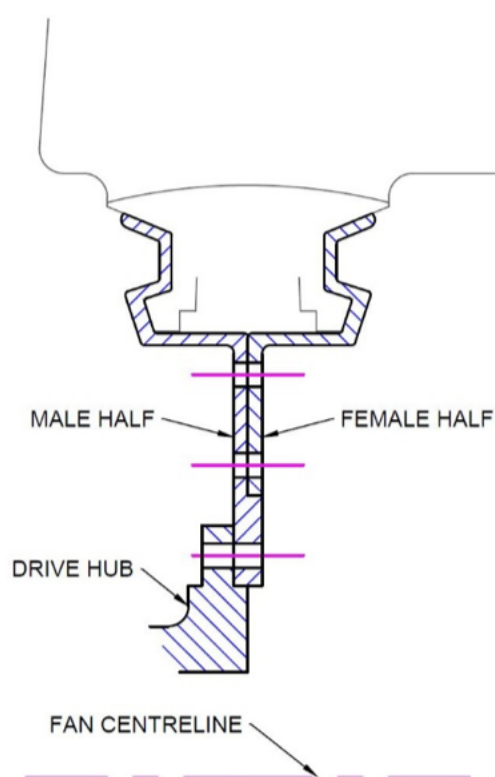
## Annular Fan hub failure

### Fan type – Multiwing 8 blade aluminium cast hub

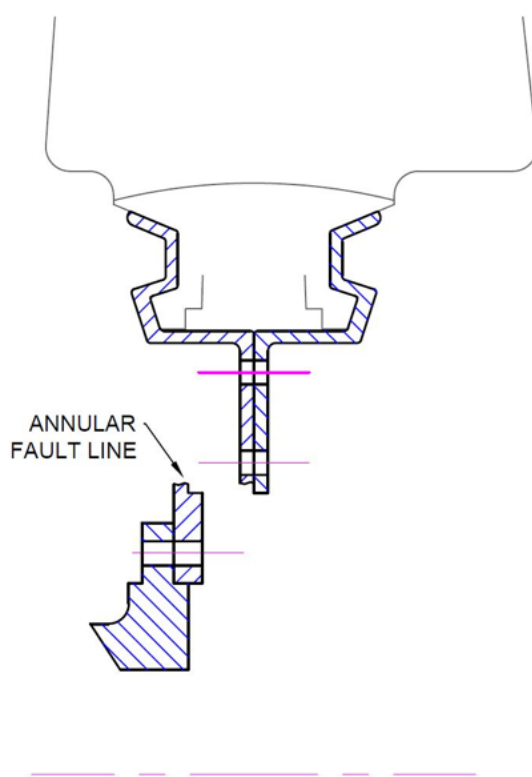


#### Introduction

It has come to the attention of the Scrutineering Committee that during the 2018 racing season, there has been 3 reported similar fan hub safety instances, which have resulted in a fracture line around the circumference just above the male boss near the centre of the hub (see sketches) which led to a structural failure of the hub. All three hubs failed in a very specific way, on the same type of hub. The Multiwing 8 blade male aluminium cast hub.



MULTIWING 8 BLADE HUB  
GENERAL ARRANGEMENT  
ON DRIVE HUB



FAULT LINE AT  
THINNEST POINT

The individual hub histories differ in age and use. One being fairly new. One having a number of fan blade failures which may have compounded residual stresses to the hub. The third I'm not sure of. All were mounted onto standard drive hubs within ducts and ran within the recommended regulation tip speed.



## Inspection

On inspection of the one failed hub available, there is a premature crack around 60mm long showing signs of typical oscillation induced fatigue. Once this had become significantly large enough to overstress the cast material, an annular brittle fracture would soon follow. This can be seen in the coarse granular surface of the break. Unfortunately this kind of fault is almost instantaneous, and no prior evidence or tell tail signs of imminent failure can be seen beforehand



The standard hub pull test which we rely on to approve fan hub strength will not detect this kind of fault.

Reasons for the failure are many and all compound towards the end result -

1. The initial failure occurred at the root of the male shoulder of the mating surfaces of the two hub halves. Any sharp internal edge is a stress concentration point, both in use and also from the casting process.
2. The material flange thickness was 3.3mm. This is the thinnest I have seen, with equivalent hubs ranging from 3.5 to 4mm thick.
3. The male boss is only 140mm dia compared with the 12 blade hub at closer to 190mm. this increases the torque loading at that smaller diameter and also reduces the circumference cross sectional area at the weak fault line
4. The drive hub is only connected to one half of the fan hub (male half)
5. The operation factor of safety for a fan in a hovercraft is far beyond that which the Multiwing fan system is designed for. The combination of vibrational harmonics, flexing under load, acceleration up to full speed and torque from the fan blade resistance all combine to induce stress into a relatively brittle material.

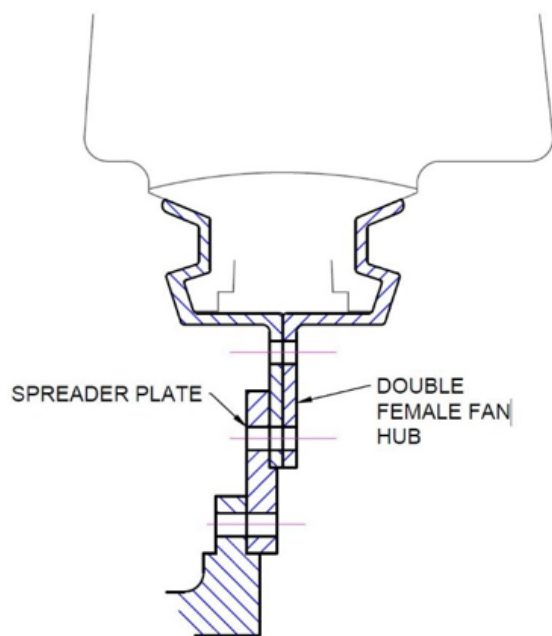
Just as important to consider is the manufacturing process and the unavoidable characteristics of the cast material properties. High precision die cast products suffer from micro porosity due to the quick cooling of the metal causing contraction. This can become particularly prevalent in areas of sudden differing thickness as the rate of cooling can be uneven. The male boss step is such an area of material thickness change. This can cause a ring of porosity which acts like a perforation line. Evidence of such porosity can be seen in the photos



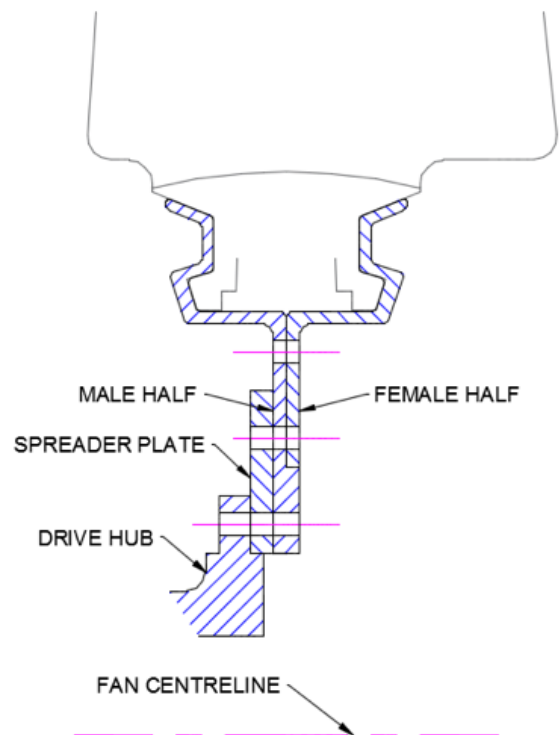
## Recommendations

To reduce the repeat probability of such a fault occurrence –

1. Only use a double female fan hub configuration. With both halves bolting directly onto the drive hub
2. Install a spreader plate (min thickness 5mm 6082T6 or equivalent) which would connect up to the holes on the outer fan flange. With both halves bolting directly onto the plate



POSSIBLE SOLUTION



POSSIBLE SOLUTION 2



## Conclusion

Due to the similarity of failures in quick succession. The HCGB scrutineering Committee has no choice but to postpone the approval of this particular fan hub male female configuration, until further evidence deems them fit for use, or additional measures as suggested above, are put in place.

Further investigation will be carried out with wider diameter fan hubs during this season by a team of scrutineers.

Check the integrity of your hub and if you have any concerns then please contact us with details and photos on [hoeverdory@outlook.com](mailto:hoeverdory@outlook.com) so we can carry out necessary tests.

At anytime you can ask us questions