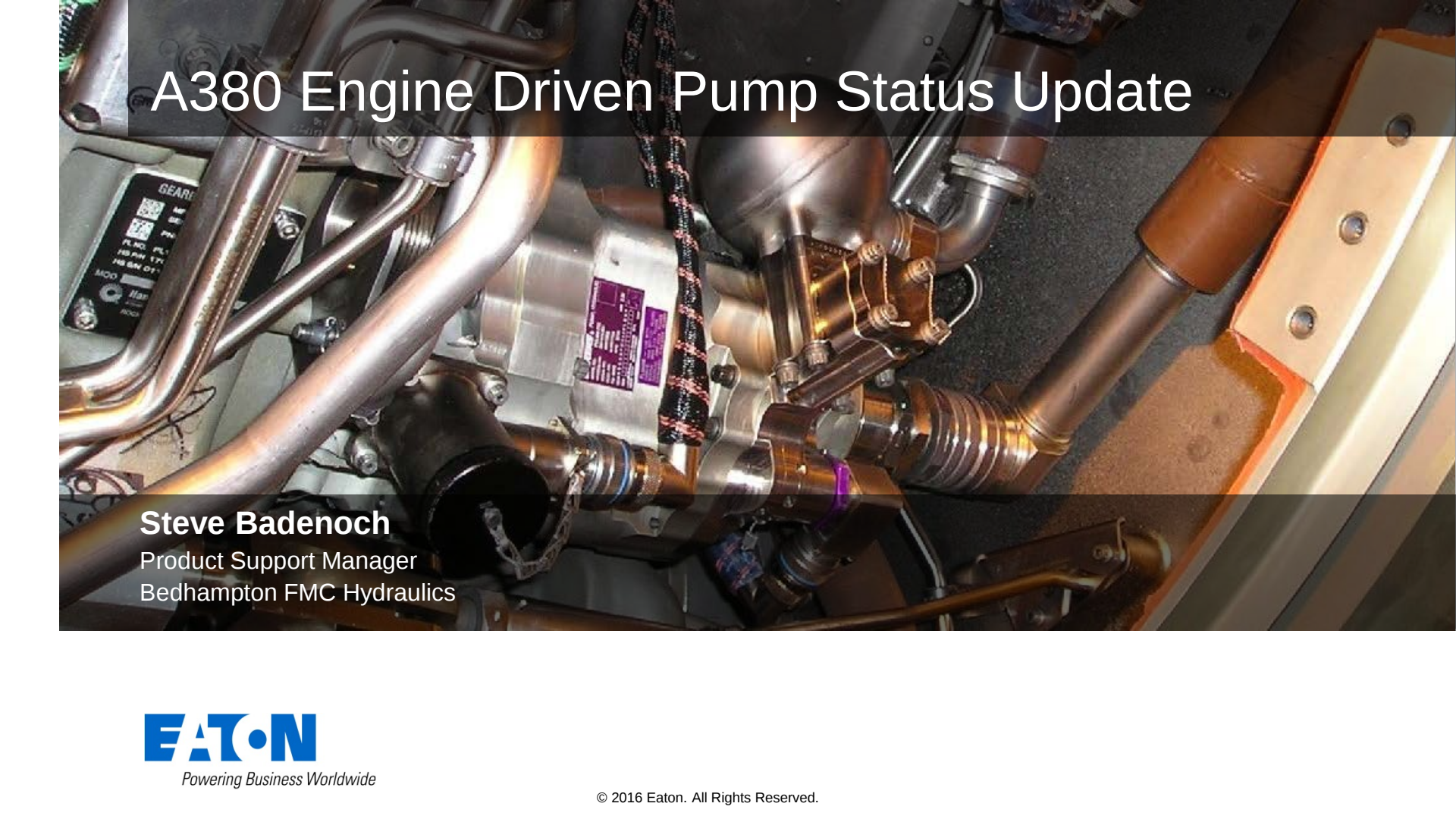


A380 Engine Driven Pump Status Update



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Powering Business Worldwide

A380 Engine Driven Pump Agenda

Historical Background

Equipment Description

Reliability Trends

Manufacturing Issues / Retrofits

Introduction of New Model PV3-300-31P

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Introduction of New Model PV3-300-31P

Historical Background

- Designed and qualified by Eaton's Jackson facility.
- Manufactured in Eaton's Bedhampton facility,
- First 5000 psi commercial hydraulic EDP application.
- The EDP is unique as it is the only pump supplied by Eaton incorporating a clutch.
- Through a series of product improvements & retrofits the model code has evolved from a PV3-300-31J to PV3-300-31P.
- Rotating group has eleven pistons compared to standard set of nine to meet demanding low pressure pulsation requirement.
- Incorporates an internal vane pump for constant cooling flow from case drain.



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Engine Driven Pump

Equipment Description

Model	PV3-300-31P
Part No	3032793-003
Component Maintenance Manual	29-10-60
Quantity per Aircraft	8
Speed (rated)	3775 rpm
Displacement	47 ml/rev (2.87 cu.in/rev)
Delivery (full flow @ 3775 rpm)	162 l/min (42gpm) minimum
Outlet Pressure @ Rated Speed	345- 0 +/- bars (5000 psi)
Pulsation Level @ Speed range from 60 to 100% and fluid temp from 0 to 95°C	+/- 1%
Port Fittings	
Inlet	Dash 24 per AS4099-24
Outlet	Dash 16 per EN 6123
Case Drain	Dash 8 per AS4099-24



A380 Engine Driven Pump Agenda

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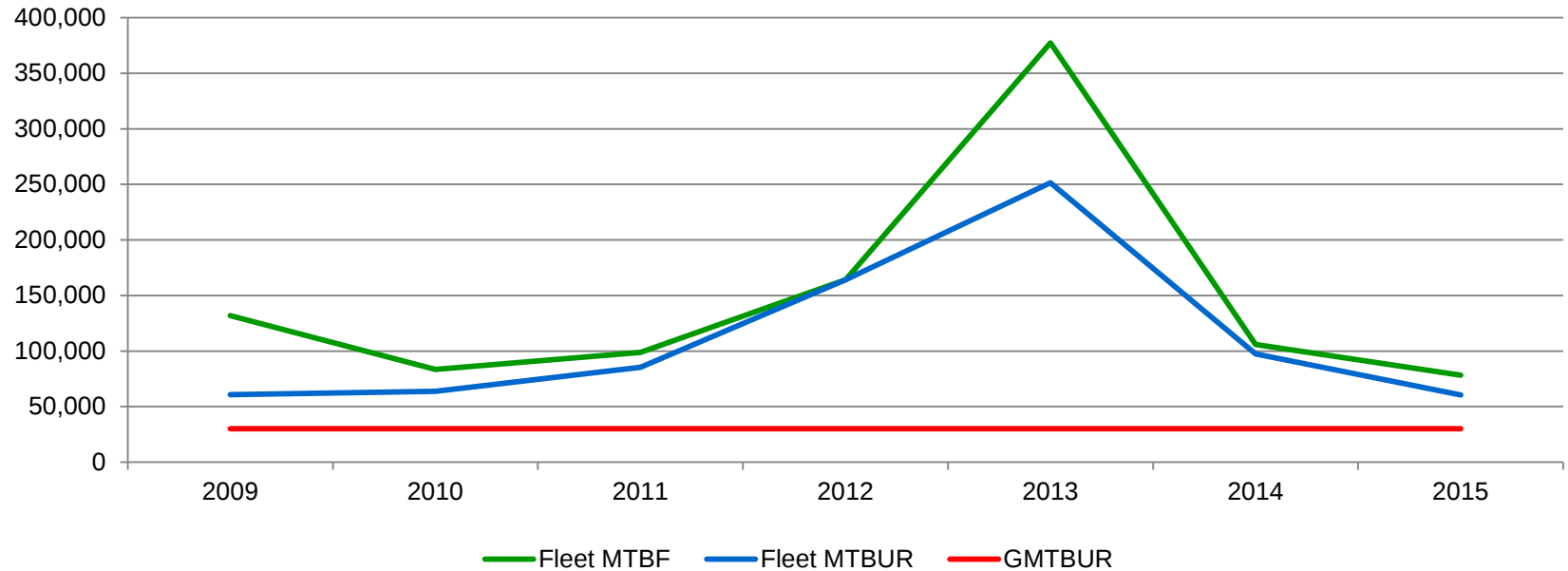
Reliability Trends

Manufacturing Issues / Retrofits

Introduction of New Model PV3-300-31P

Reliability Trend

A380 EDP reliability trend - All models



A380 Engine Driven Pump Agenda

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A380 EDP Manufacturing Issues / Retrofits

In the last year there has been two separate manufacturing issues on the A380 EDP.

- Cylinder sleeve displacement
- Piston and shoe delamination



A380 EDP Cylinder Block Sleeve Displacement

- In 2015 three A380 EDPs were removed for investigation due to reported high in service vibrations
- Following the events damage to hydraulic outlet pipe clamps and pipe leakage were noted on aircraft
- On investigation extracted cylinder block sleeves were discovered
- Further investigation revealed sleeve extraction was due to cracking
- This follows previous similar failures resulting in a fleet wide retrofit campaign



A380 EDP Cylinder Block Sleeve Displacement

Investigation confirmed a new failure mode. The failure mechanism was not the same as previous sleeve displacement incidents.

Cracks were found on outer sleeve diameter and undetectable by NDT post swaging.

Global fleet exposure due to manufacturing issue was determined at 203 units.

The affected cylinder blocks were manufactured between Feb – July 2014.

No material defects were discovered.

Material within drawing limits.

Root cause was linked to a swaging process change where the swaging operation method was changed from a vertical to horizontal method.

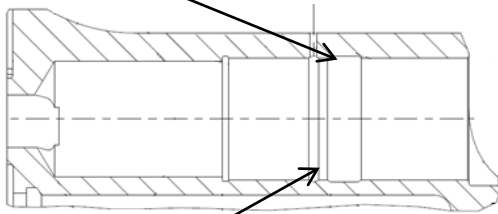
Horizontal swaging resulted in side loading the sleeve due to tool wear.

Side loading can cause the outer sleeve to fracture due to poor alignment.

A380 EDP Cylinder Block Sleeve Displacement – Key Features

Cylinder block bore

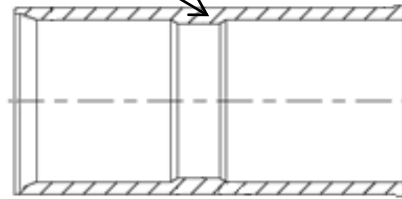
Swage retention groove



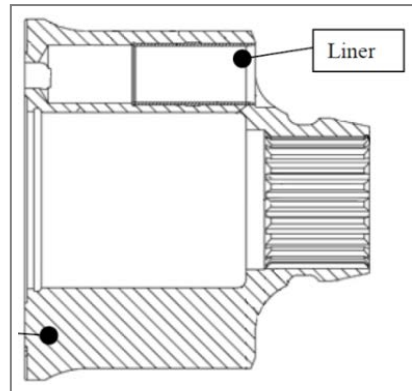
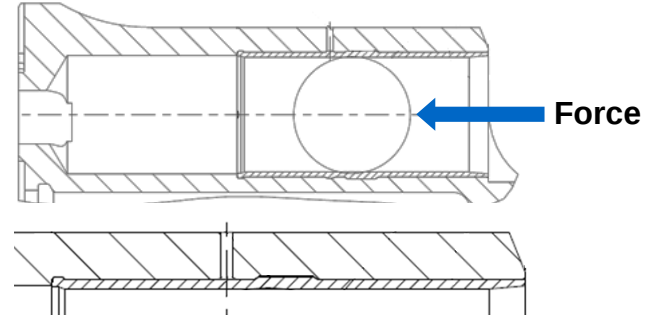
Swage relief groove and hole

Sleeve

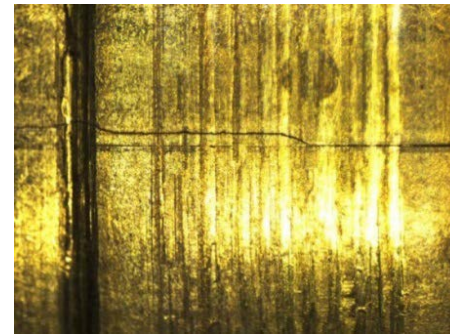
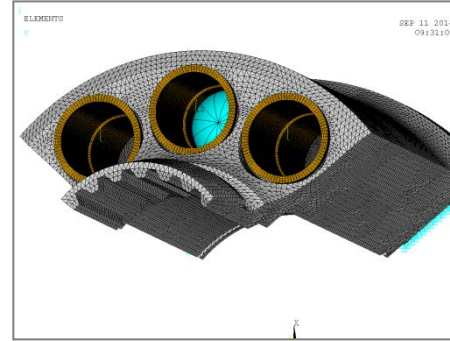
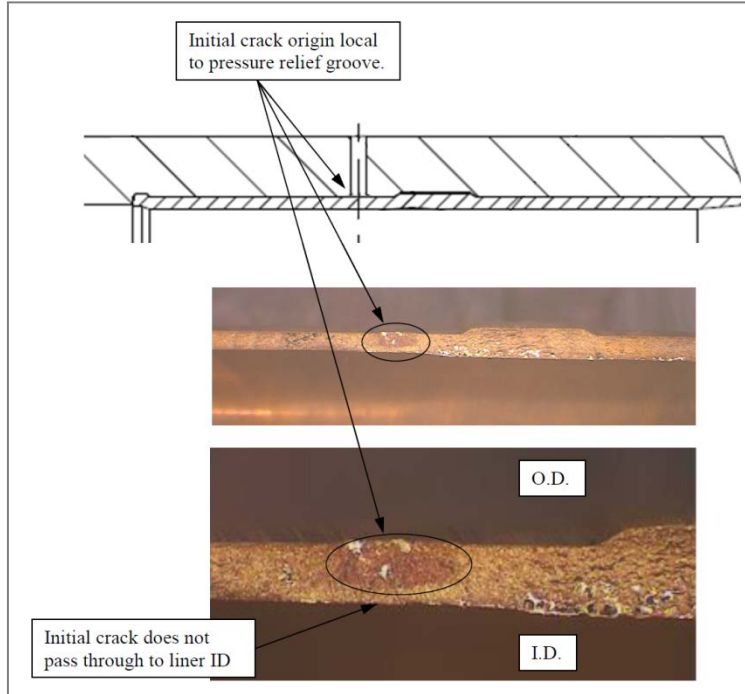
Swage bump volume



Bore and sleeve swaging



A380 EDP Cylinder Block Sleeve Displacement – FEA



A380 EDP Cylinder Block Sleeve Displacement – Conclusions

Root cause has been established.

- Due to manufacturing process change to a CNC horizontal swaging operation
- The horizontal swaging method does not permit self centering of the swaging tool causing side loading
- Sleeves not always correctly aligned, scratching the outer sleeve, raising a burr and this can create stress raisers
- FEA computations confirm significant stresses are large enough to rupture material when stress raisers are present combined with tool offset



A380 EDP Cylinder Block Sleeve Displacement – Solution

- The key contributor is directly related to using the horizontal CNC milling machine to swage the sleeves causing mis-alignment
- This is eliminated by returning the swaging operation to a vertical press.
- Vertical swaging self aligns naturally to each bore and there is no opportunity for side loading to occur
- Worth mentioning is the fact that the vertical swaging operation used to retrofit the global fleet to the PV3-300-31N standard is a well proven and robust manufacturing process. There are no recorded incidents of sleeve displacements with 1000+ PV3-300-31N EDPs produced.
- All 203 affected units will be retrofitted with a new cylinder block– SIL 3032793-002-29-01 applies, retrofitted EDPs identified by S/N Suffix A. A total of 154 retrofits completed to date.



A380 EDP Piston Shoe Delamination

- A manufacturing piston shoe plating process issue has been identified affecting a specific batch of piston and shoe subassemblies
- The problem was revealed following a test failure in Eaton's Jackson facility where a portion of piston shoe bronze had separated from 1 piston & shoe subassembly
- Additional metallurgical tests of the suspect population revealed an issue with piston shoe adhesion, the non conforming product failed to meet the minimal requirement for shoe bronze adhesion
- The affected material was used to produce 3 piston & shoe subassembly P/Ns for different pump applications. For the A380 EDP piston & shoe subassembly P/N 3031310-001 a total of 41 EDPs were shipped with material from the affected batch
- Due to slow return rate 6 retrofits completed to date.



A380 EDP Piston Shoe Delamination

- Root cause investigation determined excessive amperage was applied during the plating operation at sub-contractor
- All affected units have been identified
- All affected material has been scrapped
- Corrective actions have been put in place:
 - New work instructions
 - Additional training
 - More material sampling
 - Process control review
- All 41 affected units to be retrofitted – SIL 3032793-002-29-02 applies, retrofitted EDPs identified by S/N Suffix B.



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Introduction of New Model PV3-300-31P

Introduction of New Model PV3-300-31P

Model Code : PV3-300-31P

P/N : 3032793-003

Incorporates new thermal barrier

Reduce heat transfer to the EDP clutch cavity from the Accessory Gear Box (AGB)

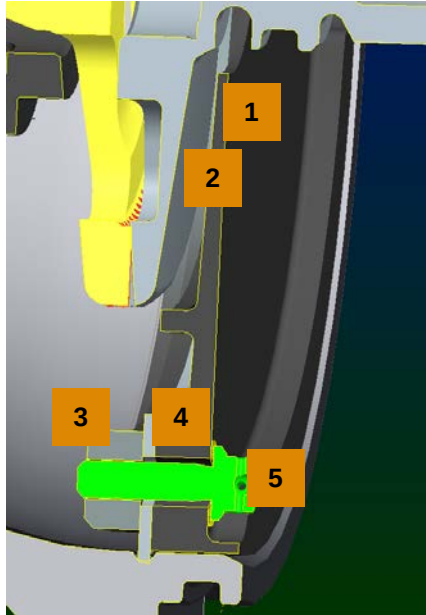
The thermal barrier is intended to resist high temperature blown air from the AGB

Combat the formation of thermally stressed fluid inside the mounting flange cavity



PV3-300-31P Thermal Heat Guard

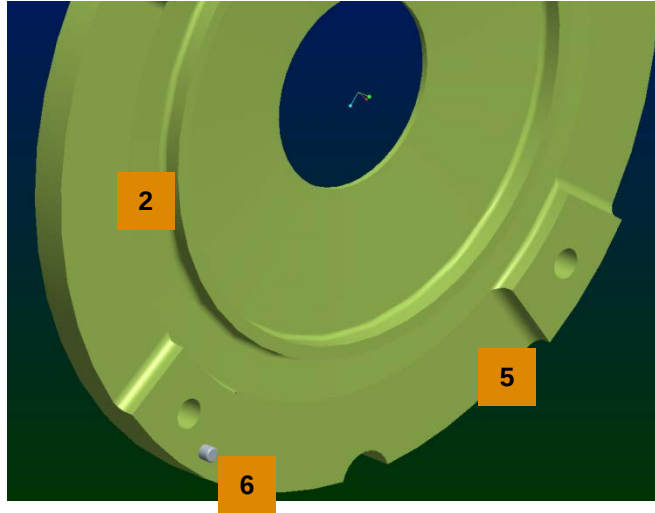
Thermal Barrier Heat Guard Kit 3022090-521



- | | |
|---|---------------------|
| 1 | Thermal barrier |
| 2 | Coupling shaft S/A |
| 3 | Guard retainer S/A |
| 4 | Sprung retainer |
| 5 | Fasteners & washers |

PV3-300-31P Thermal Barrier - Detail

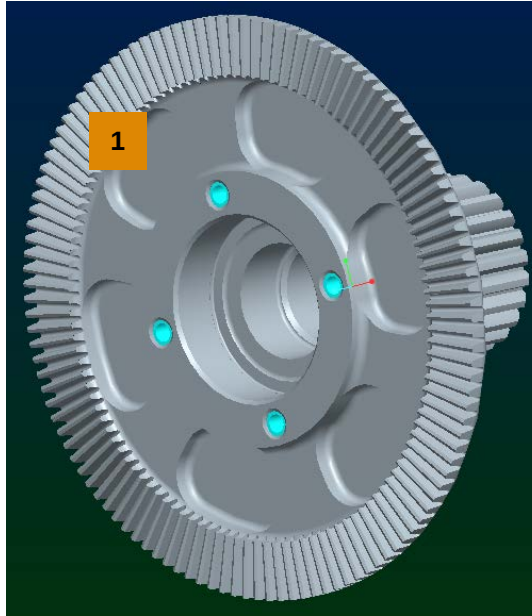
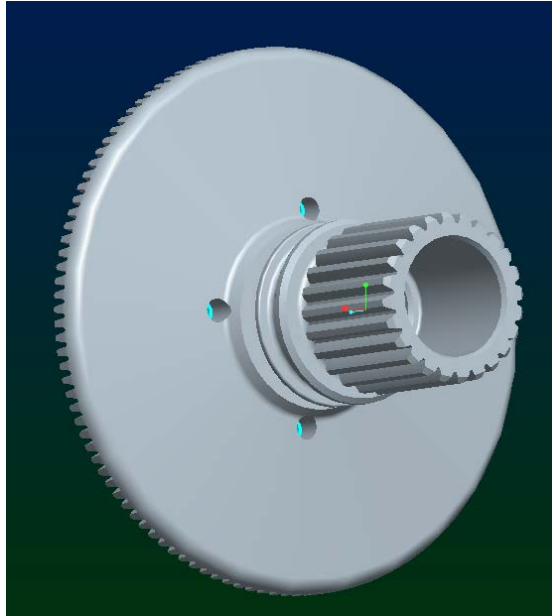
1. Thermal barrier S/A (3022148-205)



1	Material (30% GF filled PAI)
2	Boss (stiffens and reduces air flow)
3	Single drainage hole
4	Alignment groove feature (visual checking aid)
5	Weight saving cut outs
6	Pin to Poka-Yoke assembly

PV3-300-31P Coupling Shaft - Detail

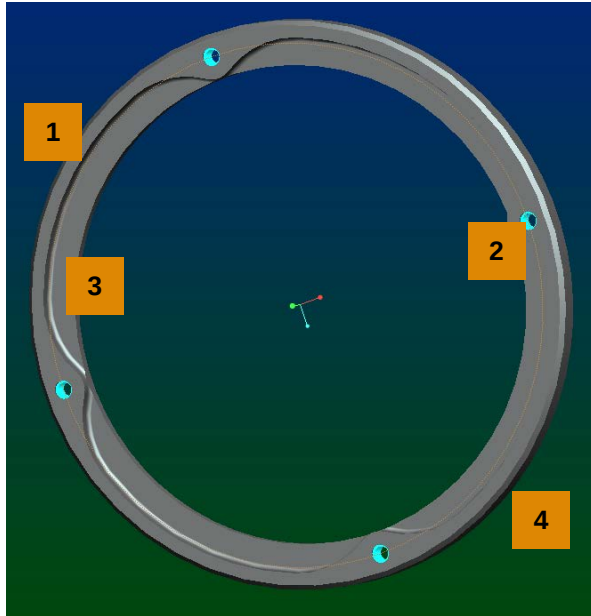
2. Coupling shaft S/A (3022148-204)



- 1** Through holes now pocketed
(reduces air flow into clutch cavity)

PV3-300-31P Guard Retainer - Detail

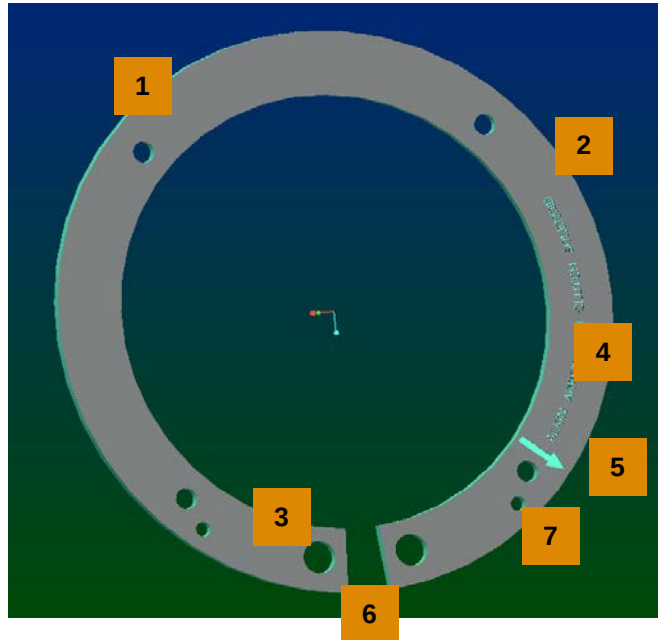
3. Guard retainer S/A (3022148-203)



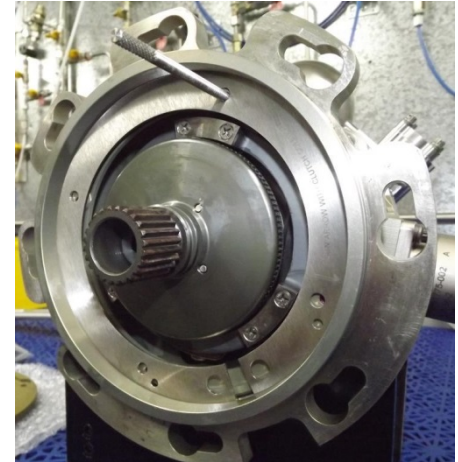
- | | |
|---|--|
| 1 | Hard anodized aluminum |
| 2 | Locking type inserts
(part of secondary locking) |
| 3 | Weight saving machining |
| 4 | Inner and Outer diameter optimized
to reduce weight |

PV3-300-31P Sprung Retainer - Detail

4. Sprung retainer (3022148-308)



- | | |
|---|--|
| 1 | Stainless steel |
| 2 | Design similar to existing “snap-fit” type finger guard |
| 3 | Tooling holes for installation |
| 4 | Alignment arrow and text to aid installation |
| 5 | Outer diameter engages with existing groove in mounting flange |
| 6 | Gap acts as fluid drain path |
| 7 | Pin Hole to Poka-Yoke assembly |



Installed Thermal Heat Guard





Questions/Comments



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