

KAMAN

Specialty Bearings & Engineered Products



UH-1 OPS HAI Brief, EXTEX & KAMATICS

07-MAR-2017

Specialty Bearings & Engineered Products



Kamatics Corporation:

- Located in Bloomfield, Connecticut, USA
- Founded in 1966
- 500+ Employees

RWG Germany GmbH:

- Located in Höchststadt, Germany
- Founded in 1943
- Acquired by Kaman in 2002
- 160+ Employees

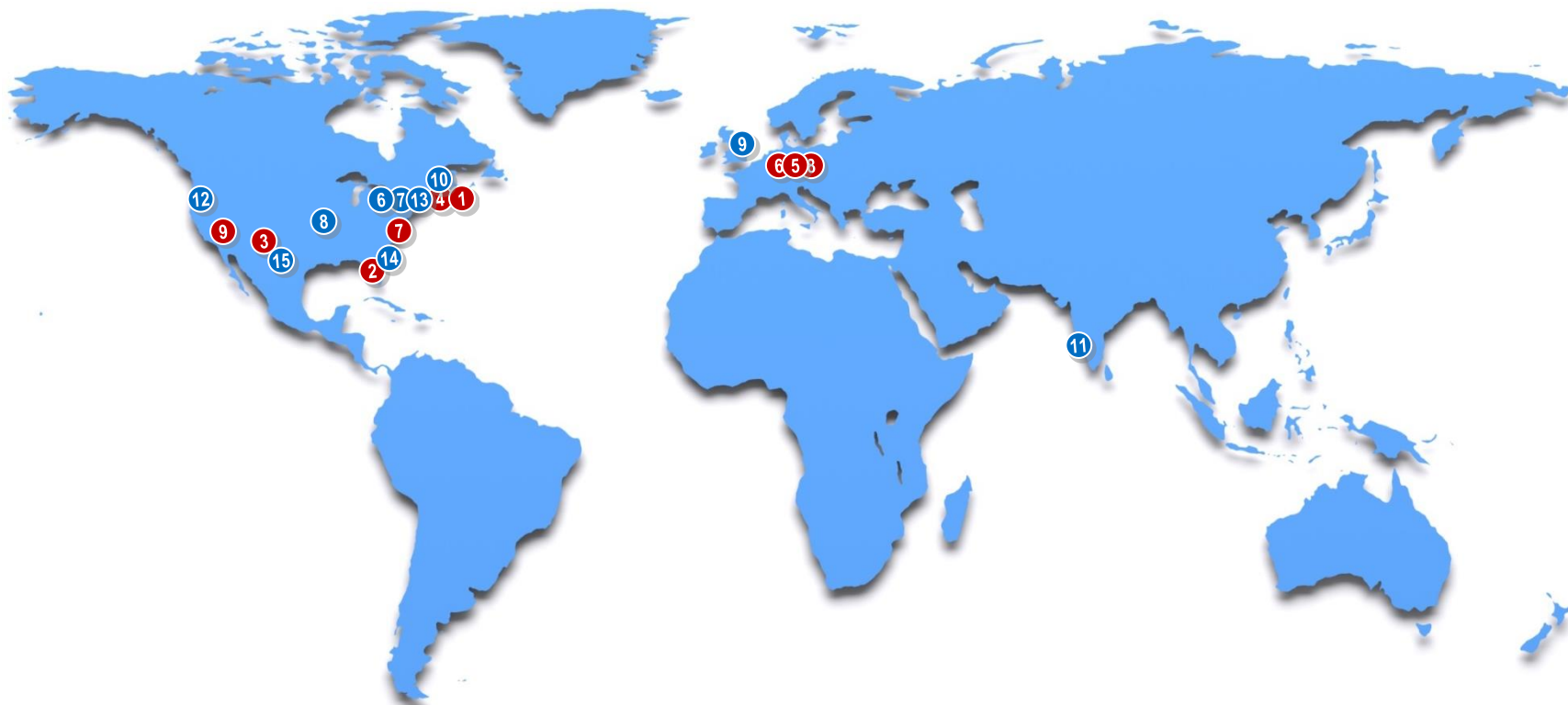
GRW Germany GmbH:

- Headquartered in Rimpf, Germany
- Founded in 1942
- Acquired by Kaman in 2016
- 500+ Employees

EXTEX Engineered Products:

- Located in Mesa, Arizona, USA
- Acquired by Kaman in 2016
- 20+ Employees

Kaman Aerospace Worldwide Locations



Engineered Products

Fuzing & Precision Products

- 1. Middletown, CT
- 2. Orlando, FL
- 3. Tucson, AZ

Specialty Bearings & Engineered Products

- 4. Bloomfield, CT
- 5. Höchststadt, Germany
- 6. Rimpur, Germany
- 7. Sandston, Virginia
- 8. Czech Republic
- 9. Mesa, Arizona

Aerosystems

Air Vehicles & MRO

- 6. Bloomfield, CT

Composite Structures

- 7. Bloomfield, CT
- 8. Wichita, KS
- 9. Lancashire, UK
- 10. Bennington, VT
- 11. Goa, India

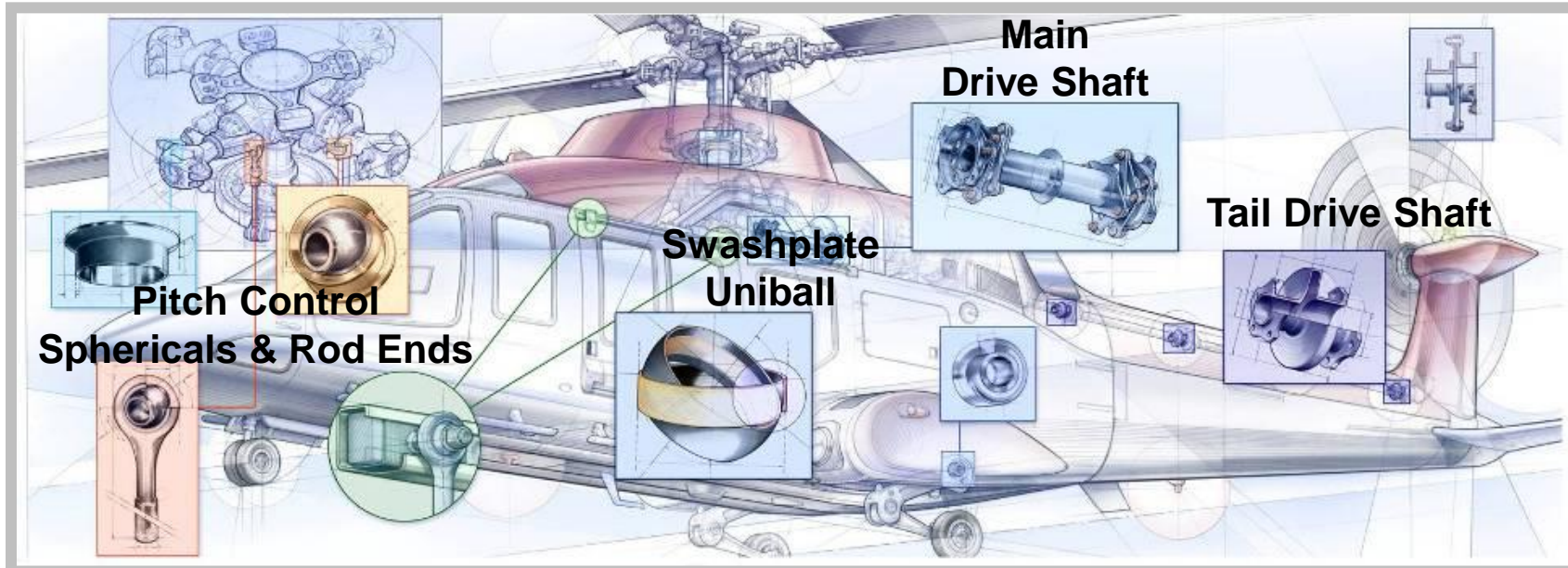
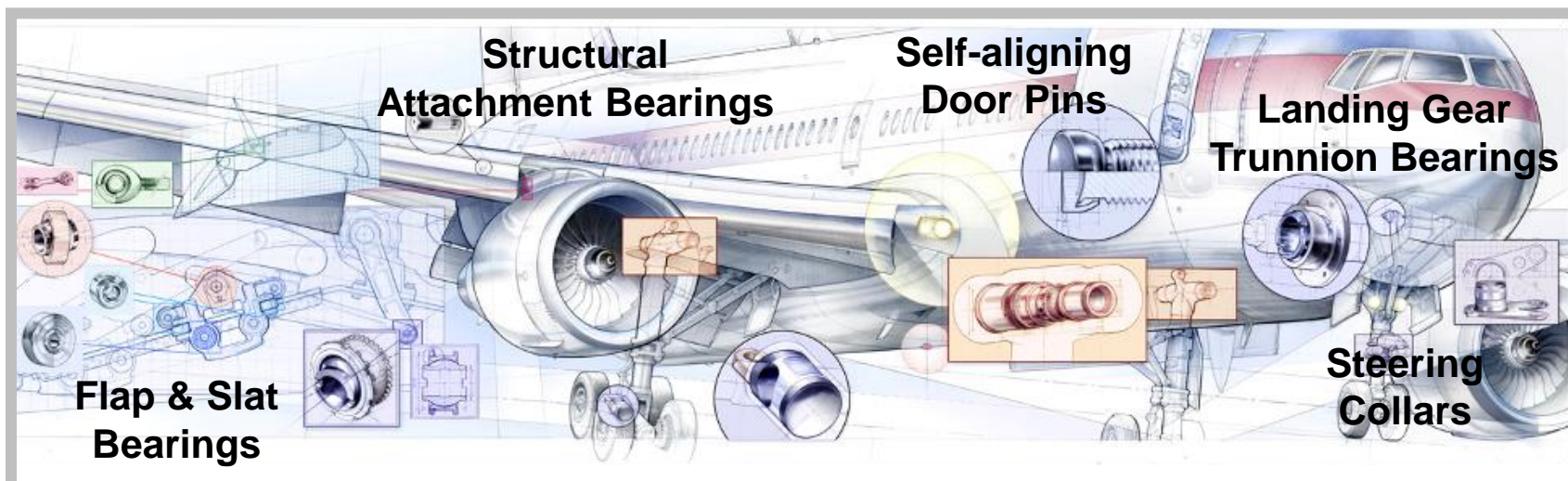
Engineering Services

- 12. Everett, WA
- 13. Bloomfield, CT

Integrated Structures & Metallics

- 14. Jacksonville, FL
- 15. Chihuahua, Mexico

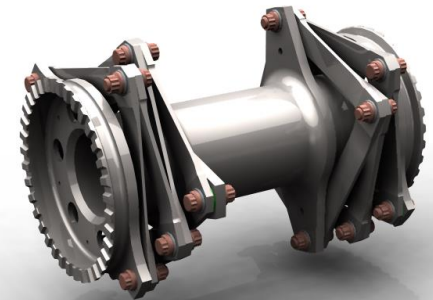
Various Aerospace Applications



UH-1H Drive Shaft History

- Began service in U.S. Army UH-1 Jan 1976, followed by fleet retrofit.
- German, Australian, and New Zealand UH-1 fleet retrofits - June 1980.
- Total number of KAflex® drive shafts delivered for UH-1 fleet is 6,500 units worldwide.
- Total number of hours on UH-1 fleet in excess of 16,000,000 flight hours.
- UH-1 KAflex® lead the fleet aircraft approaching 25,000 flight hours.
- No reported accidents due to KAflex® UH-1 Driveshafts in 40 years of operation.

Just one problem.....The shafts have never been overhauled!



Typical KAflex Overhaul/Retirement Overview

Manufacturer	Model	Overhaul/Retirement
Agusta	AW101 - Tail	1,200-hour TBO
Bell	UH-1N - Main	4,800-hour Retirement
Bell	407 - Main	2,500-hour TBO
Bell	206 A/B - Main	6,000-hour TBO
Bell	LongRanger LI/LIII - Main	4,500-hour TBO
Bell	204/205/AH-1	5,000-hour Retirement
MD	500 – Main & Tail	10-ysr from delivery date TBO

UH-1H Drive Shaft Present Day

- The Huey Shaft, SKCP2281, is the only KAMATICS driveshaft program in which there is no prescribed overhaul or life limit
 - *The Army did implement its own overhaul program (DMWR 55-1615-278) but, it proved to be too complex and difficult to manage. Although a number of units were overhauled, hard-cards are usually absent from the shafts that are still flying today*
- Although the shafts are designed and tested for “Infinite Life”, there are environmental and operational influences that may limit long-term operational viability
 - Aluminum-Ceramic Protective Coating – A self-sacrificing coating designed to protect the base metal via galvanic reaction in the coating itself; works like a zinc block on a boat in salt water. Ultimately, it becomes less effective and corrosion can set in, leading to stress corrosion cracking
 - Tool Damage – Although not too common, should a slight “nick” in the coating go unnoticed, it can lead to SCC

UH-1H Drive Shaft; Recent Failure



Orange County Sheriff's Office

- Frame broke on approach, failsafe engaged and aircraft landed without incident
- Post mortem revealed that the crack propagated from a corrosion point
 - Thorough inspection showed signs of excessive fretting wear between frames and hardware
- Bell hard card arrived with the shaft
 - Card indicated only 4,352 hours on the shaft and that the Army had installed it on the aircraft with zero hours.
 - No installation date
 - Shaft was shipped to the Army in April of 1979; High probability that this shaft had four-times the number of hours indicated

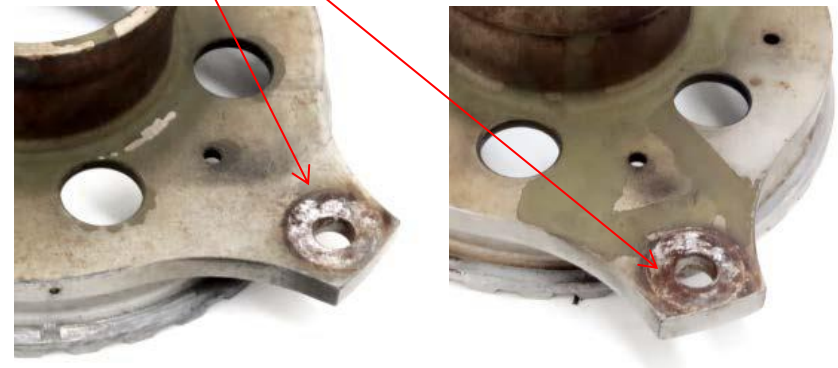
UH-1H Drive Shaft; Recent Failure, *continued*



Indications of fretting debris and wear

After stripping of protective coating and performing MPI, KAMATICS engineering determined;

- All components passed MPI
 - No cracks (other than the broken frame), though we would have scrapped the entire shaft due to pitting and fretting wear of major components



Next Steps

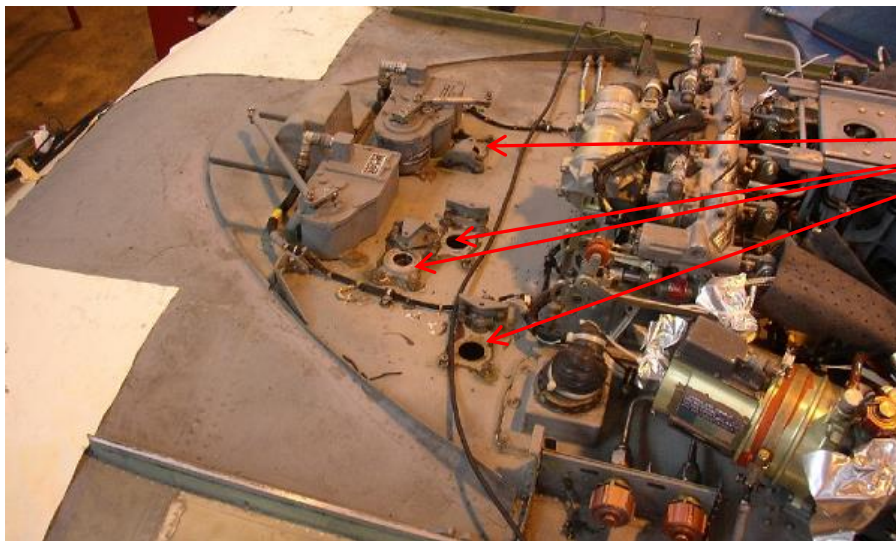
- In 2007, KAMATICS worked with the Army to roll the SKCP2281-103 part number to SKCP3303-1
 - Added high visibility torque stripes to bolted joints
 - Classified the new part number as “Safety Critical”
 - Intent was to keep aged, surplus parts with no paperwork/improper paperwork from getting into the FMS supply system
 - Currently, KAMATICS is able to supply this new part number with C of C, only;
 - PMA application has been submitted to FAA; Once PMA has been granted, we will add the part number to our FAA Repair Station Capabilities List
 - Though overhaul cannot be mandated, operators will be encouraged to have an overhaul performed
 - *Your safety is our concern!*

H-60 Applications

▪ Collective, Pitch, Yaw & Roll Torque Shaft Bearings

- Three Karon spherical bearings, one misalignment roller; Roller eliminates scoring of the torque shaft, while the sphericals eliminate excessive play in the controls

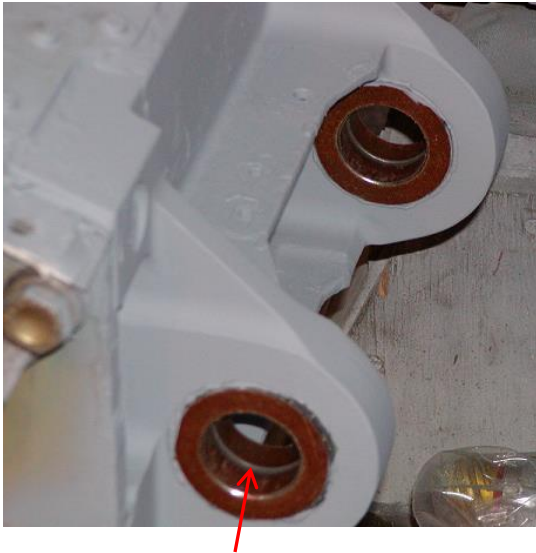
Kamatics Bearings	Acft Quantity
KRP203321V	8
KSC312504V	24
KSC347504V	12
KSC346704V	12



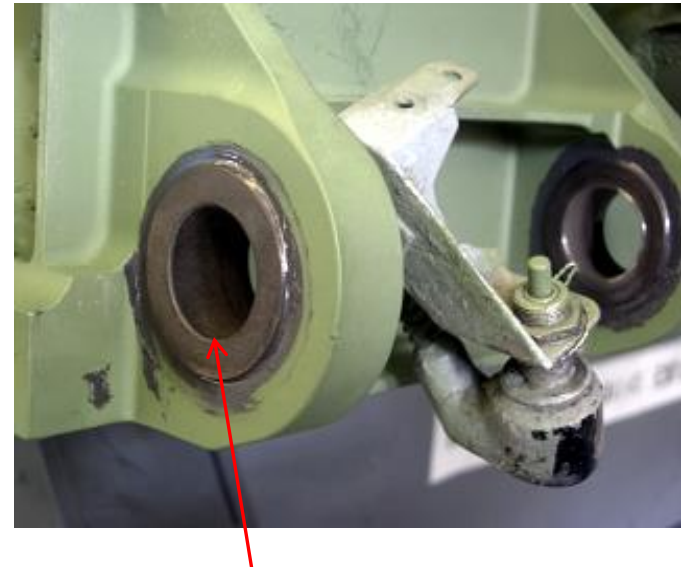
H-60 Applications, *Continued*

▪ MLG Drag Beam

- Karon bushing with washer; Eliminates corrosion inside of the beam lug
- Cost to replace fitting due to corrosion in excess of \$24K (As calculated by the Navy)
- *Navy has not replaced a single fitting since switching to the KAMATICS bearings*



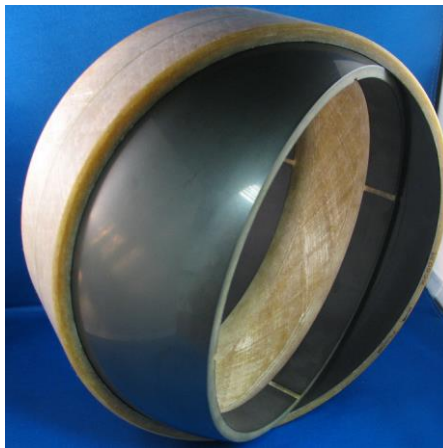
From this configuration with a gap in the middle; *Two flanged bushings pressed in from either side*



To this configuration with no gap; *Flanged bushing on one side, Karon-coated washer on the other*

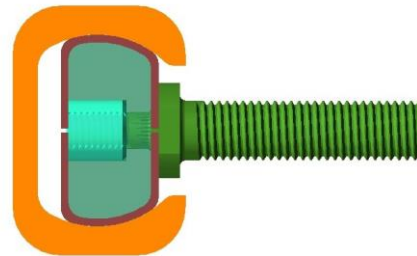
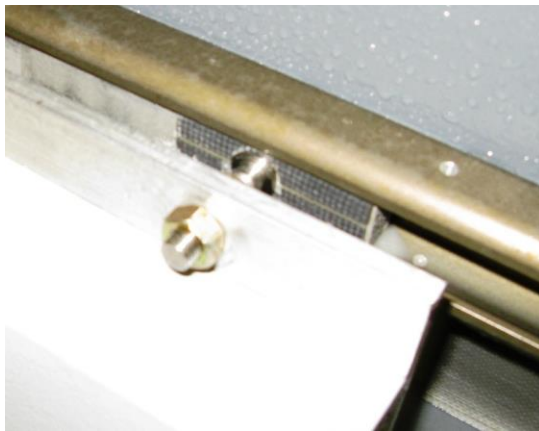
■ Swashplate Uniball

- Full testing regime completed under contract with Sikorsky & Army
- Considered “Approved” by Sikorsky, though they are looking for \$\$ in order to add KAMATICS as a source of supply
 - All-composite construction; No chance of corrosion
 - 2.3-lb weight savings over current design
 - Machineable self-lube liner; No chance of liner disbonding
 - Roughly the same price as the current, sole-source design
 - Potential for PMA, depending on level of interest from RU operators



■ Cargo Door Sliding Track

- Approved and in use on the Navy Hotel-model Gunner Window
 - Eliminates ball bearings, which are subject to corrosion and pose a FOD hazard
 - Mounts to existing brackets, using existing hardware
 - Self-cleaning; Sweeps debris out of the wear path
- Working on a kit design for the main cargo door for the Coast Guard
 - Potential for PMA, depending on level of interest from RU operators



CH-47 Applications

- KAMATICS manufactures a limited number of parts for the CH-47

KAMATICS Part No	Boeing Part No	NSN
KJB416352V	423RS271-10	3120-01-361-2977
KJB961408V-1	423CS751-1	3120-01-566-7665



- There are additional over-size configurations manufactured for repair and overhaul, though they are proprietary to the contractor and not recognized through DLA
- We are able and willing to evaluate additional applications for the restricted use operators and can provide;
 - Reverse engineering
 - Test and computation
 - PMA application

Questions?

Thank you for your time!