KAMAN

Specialty Bearings & Engineered Products

UH-1 OPS HAI Brief, EXTEX & KAMATICS

05-MAR-2019

Specialty Bearings & Engineered Products

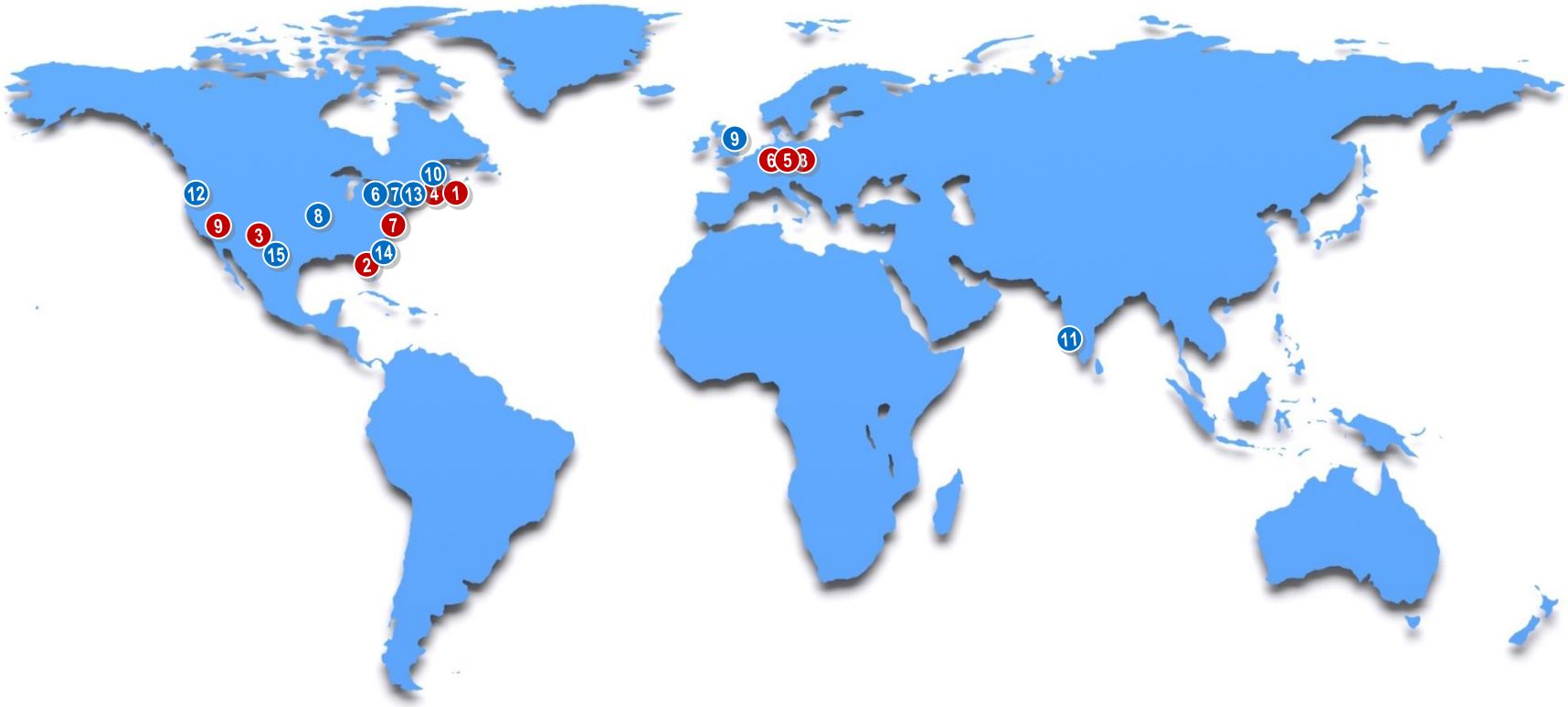
Kamatics Corporation:
- Located in Bloomfield, Connecticut, USA
- Founded in 1966
- 500+ Employees

RWG Germany GmbH:
- Located in Höchstadt, Germany
- Founded in 1943
- Acquired by Kaman in 2002
- 160+ Employees

GRW Germany GmbH:
- Headquartered in Rimpar, Germany
- Founded in 1942
- Acquired by Kaman in 2016
- 500+ Employees

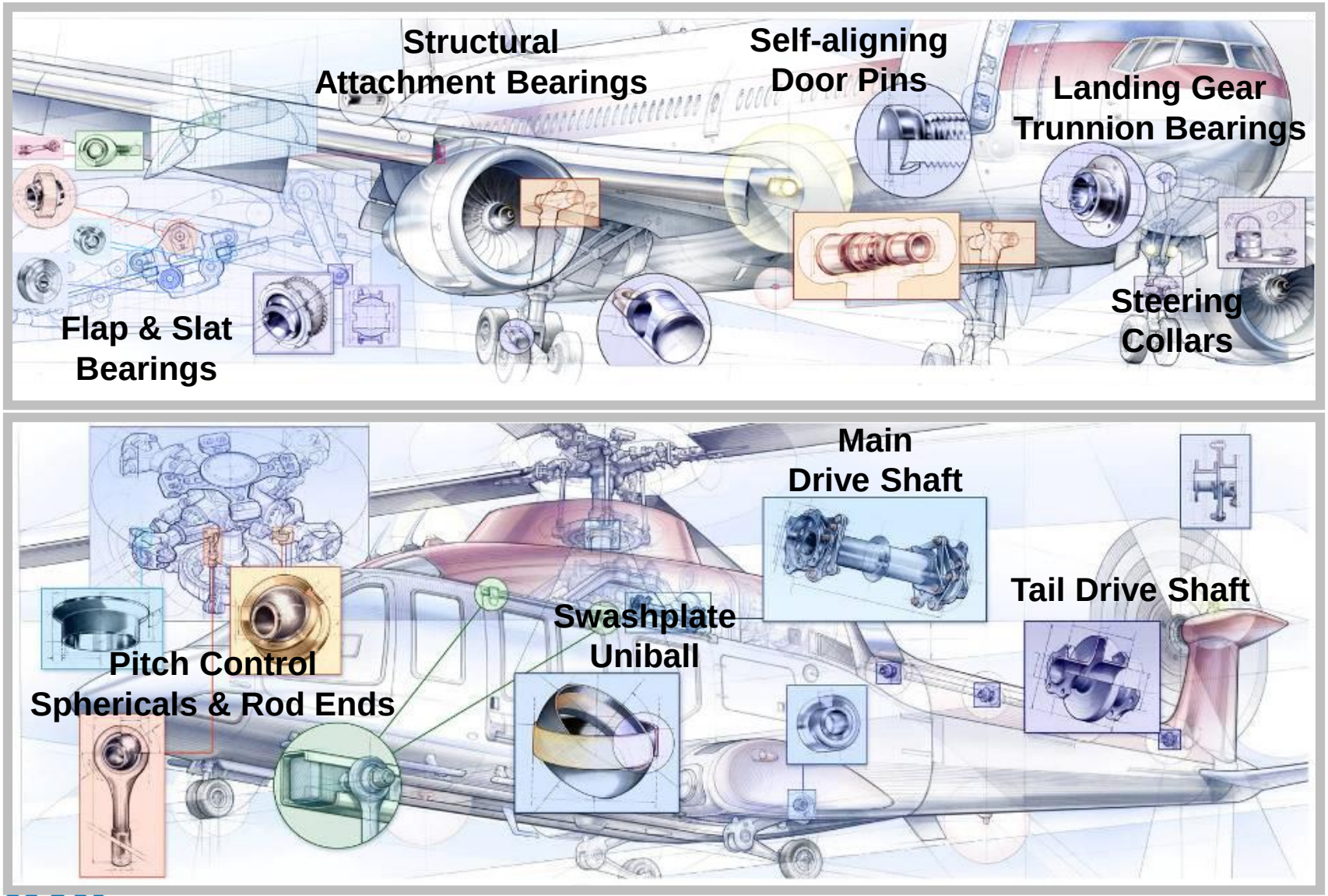
EXTEX Engineered Products:
- Located in Mesa, Arizona, USA
- Acquired by Kaman in 2016
- 20+ Employees

Kaman Aerospace Worldwide Locations



Engineered Products		Aerosystems			
Fuzing & Precision Products	Specialty Bearings & Engineered Products	Air Vehicles & MRO	Composite Structures	Engineering Services	Integrated Structures & Metallics
1. Middletown, CT 2. Orlando, FL 3. Tucson, AZ	4. Bloomfield, CT 5. Höchstadt, Germany 6. Rimpar, Germany 7. Sandston, Virginia 8. Czech Republic 9. Mesa, Arizona	6. Bloomfield, CT	7. Bloomfield, CT 8. Wichita, KS 9. Lancashire, UK 10. Bennington, VT 11. Goa, India	12. Everett, WA 13. Bloomfield, CT	14. Jacksonville, FL 15. Chihuahua, Mexico

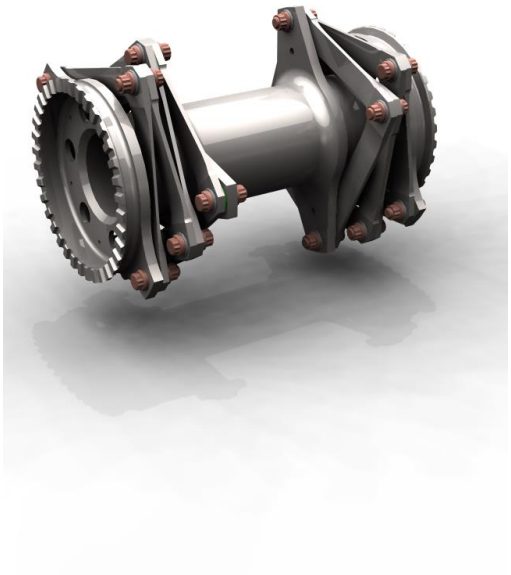
Various Aerospace Applications



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…..Until recently**

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-yrs 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 corrosion of substrate**

UH-1H Drive Shaft; Reported 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; Reported 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

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

Garlick Helicopters, Inc. UH-1H; N462CC, Operated by Elkhorn Aviation, Inc.

- **31-MAY-2015 – Emergency hard landing near Cove, OR; Accident Number WPR15LA178**
  - **Low altitude log lift; Pilot felt vibration and heard "howling sound" coming from transmission area**
  - **NTSB final report Probable Cause and Findings; "*The failure of the engine to transmission driveshaft coupling due to a fatigue fracture of one of its attachment bolts, which resulted in a loss of power to the main rotor*."**
  - **Pilot not injured; Aircraft had significant damage**
  - **Shaft serial number 3734 was assembled and shipped in April, 1984**
    - **KAMATICS has no knowledge of accumulated flight hours however, length of time in service is over 3X greater than that of all other KAflex shaft applications**

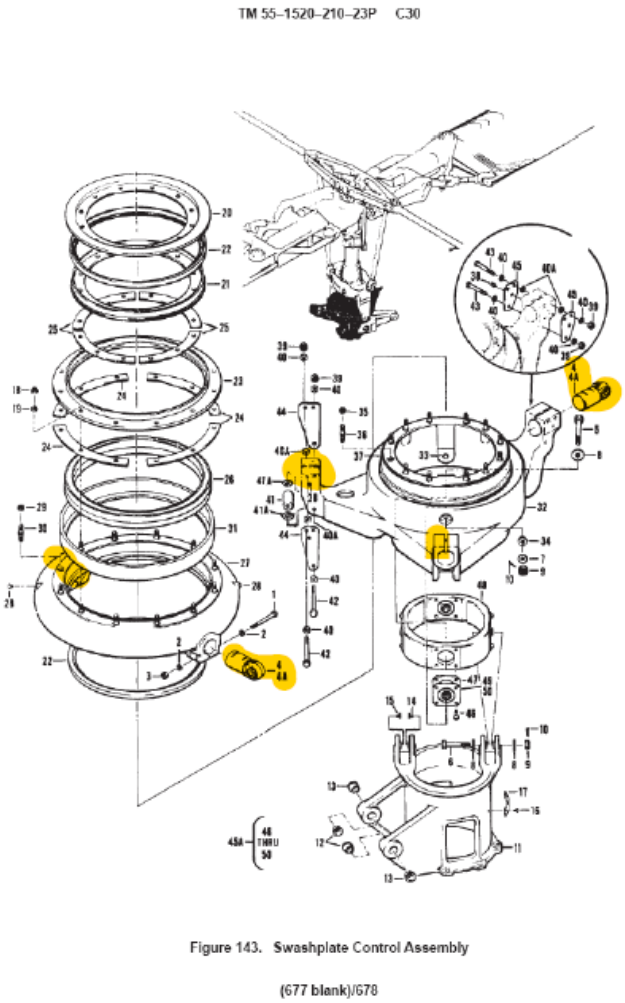
Next Steps

- 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
  - Added solid moly spacer/washer between frame joints; replaced moly-coated steel washer. Better & longer lasting anti-fretting properties
  - 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
  - Shaft is now fully FAA-PMA approved and available through EXTEX
    - Existing shafts in operation are eligible for re-build, provided they pass rigorous inspection at KAMATICS
    - Once rebuilt, shafts can be operated for 5,000-hours, at which time they are to be removed and replaced with a serviceable unit. Shaft can then be re-built again.

UH-1H Trunnion Bearing

KAMATICS Part Number KSP9001-5

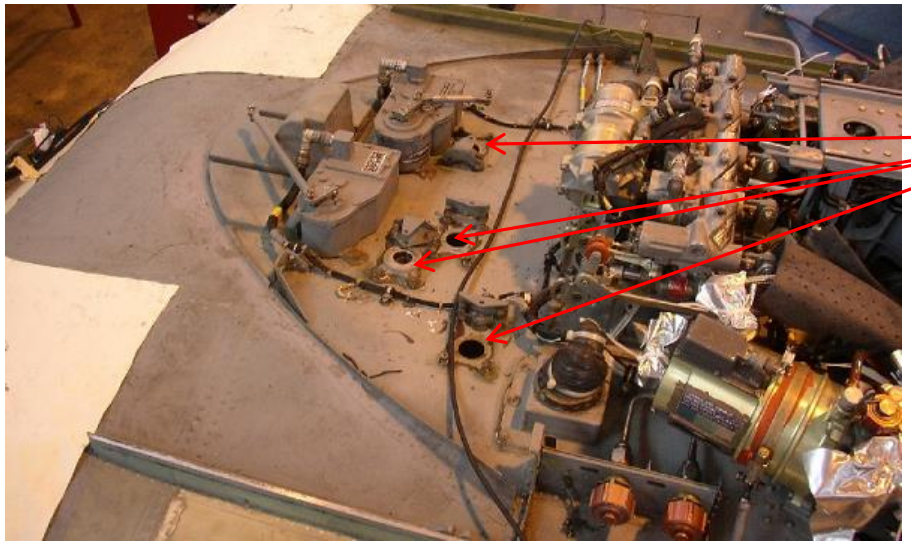
- **Direct replacement for Bell part number 204-011-451-001**
- **FAA PMA Approved**
- **Available through EXTEX; Roughly at roughly half the cost of the Bell list price**



H-60 Applications

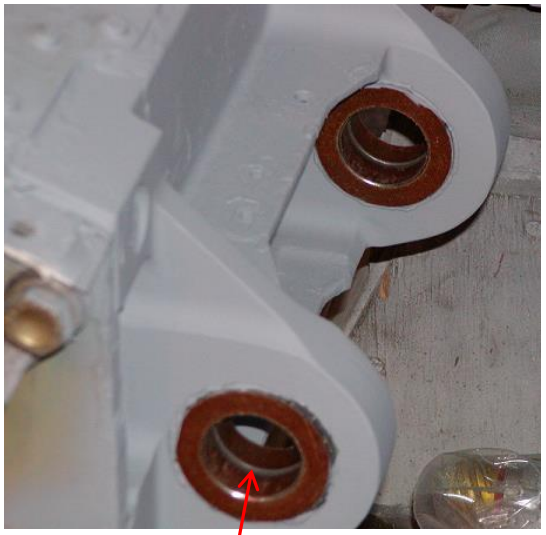
- **Collective, Pitch, Yaw & Roll Torque Shaft Bearings**
  - **Three KAron spherical bearings, one misalignment roller; Roller eliminates scoring of the torque shaft, while the sphericals eliminate excessive play in the controls**

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

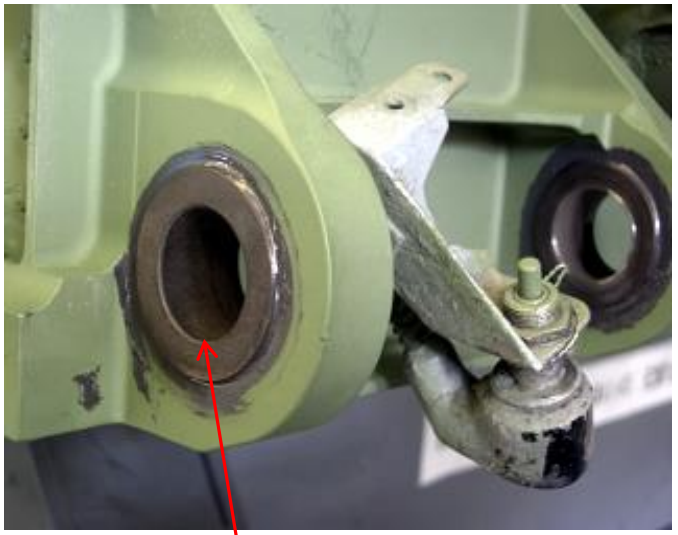


H-60 Applications, *Continued*

- **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***



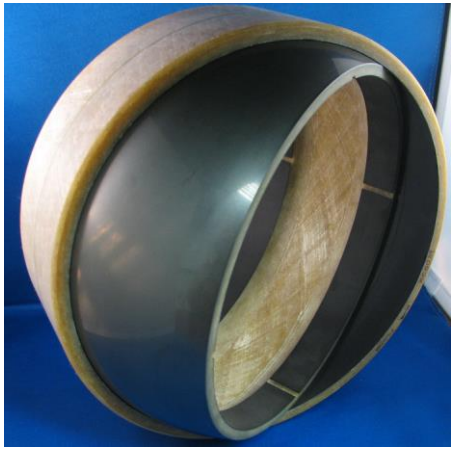
From this configuration with a gap in the middle; *Two flanged bushings pressed in from either side*



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

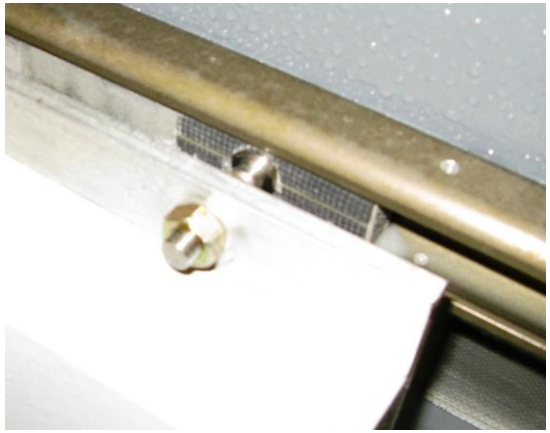
H-60 Applications, *Continued*

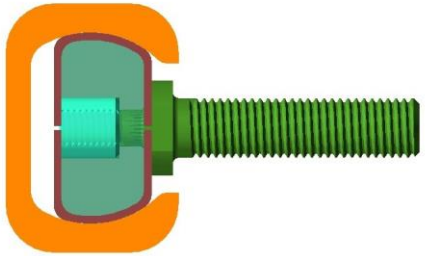
- **Swashplate Uniball**
  - **Full testing regime completed under contract with Sikorsky & Army**
  - **Considered "Approved" by Sikorsky, though they are looking for $$ in order to add KAMATICS as a source of supply**
    - **All-composite construction; No chance of corrosion**
    - **2.3-lb weight 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**



H-60 Applications, *Continued*

- **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!