Helicopter Maintenance HF Accidents: A Human Centred Design Opportunity

Andy Evans

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The Investigation of Aircraft Accidents

WITH PARTICULAR REFERENCE TO THOSE CAUSED BY MECHANICAL FAILURE, THEIR DIAGNOSIS AND LESSONS LEARNT FROM THEM

E. NEWTON, M.B.E., F.R.Ae.S., M.I.E.I.
Chief Investigating Officer, Accidents Investigation Branch, Ministry of Aviation

8. INCORRECT ASSEMBLIES CAUSING FAILURES AND ACCIDENTS

The number of aircraft accidents due to faulty maintenance has in the past been very few. However, one aspect requires emphasis—the incorrect assembly of vital controls or parts, and the mechanical ability to do this because of the design, has caused serious concern.

It is vitally important in the design stage, therefore, to eliminate such possibilities by careful consideration of design and possible human errors leading to such mistakes in assembly or inspection during the service life of the aircraft.

Paper also mentioned Murphy's Law which originated from rocket sled testing in the US in the late 1940s

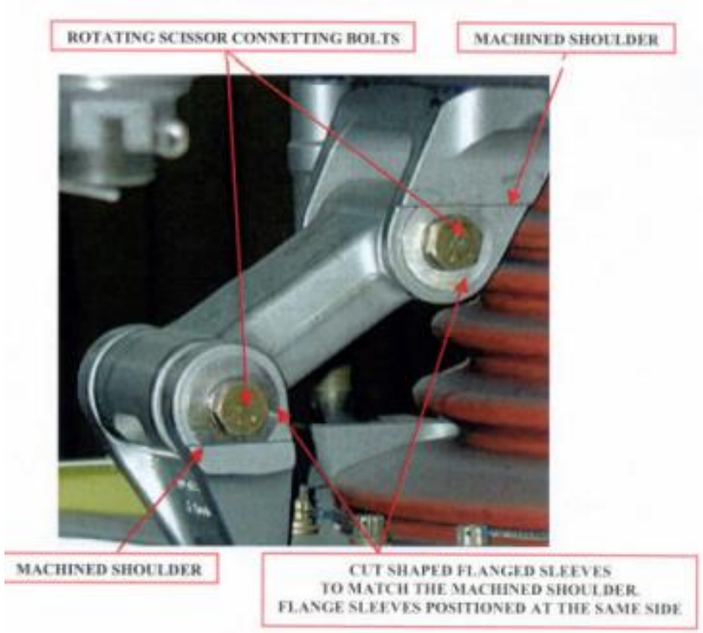
Case Study 1: Vulnerability to Orientation

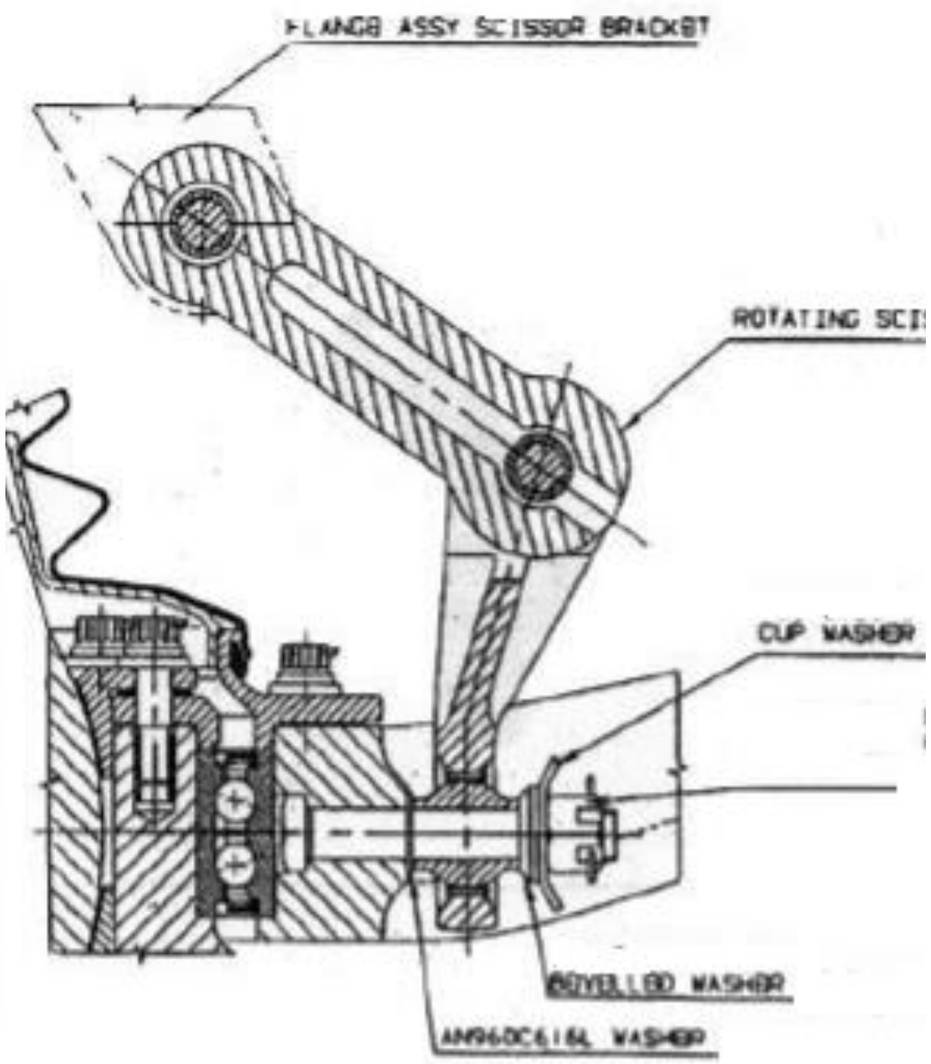
Three accidents:

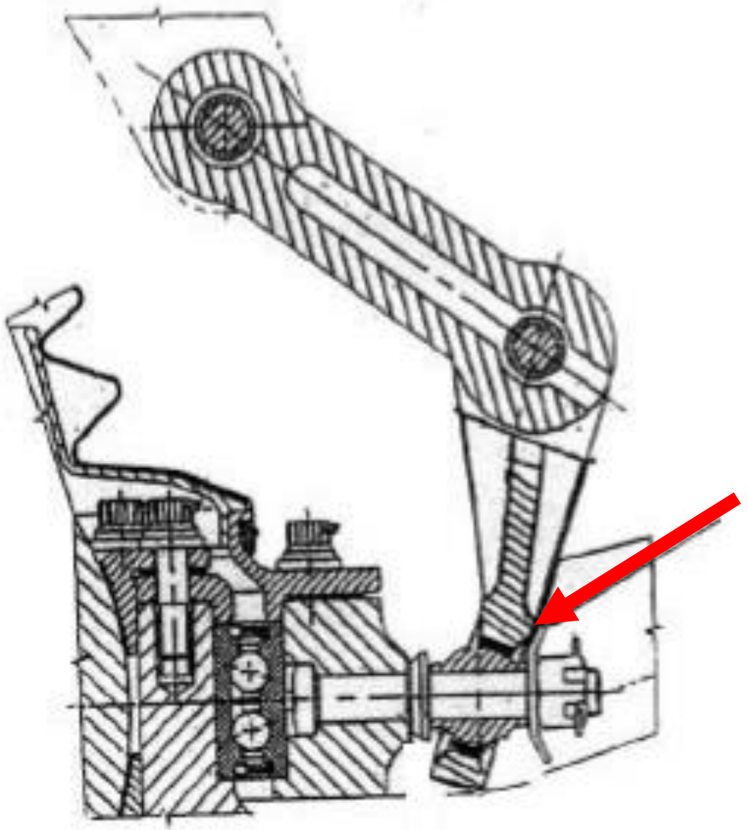
- Spain Jul 1999 1.25FH after maintenance (1 POB: 1 fatality)
- UK Jan 2000 0.75FH after maintenance (3 POB: 2 minor injuries)
- UK Jun 2000 3.15FH after maintenance (3 POB: 3 minor injuries)

Credit: CIAIAC

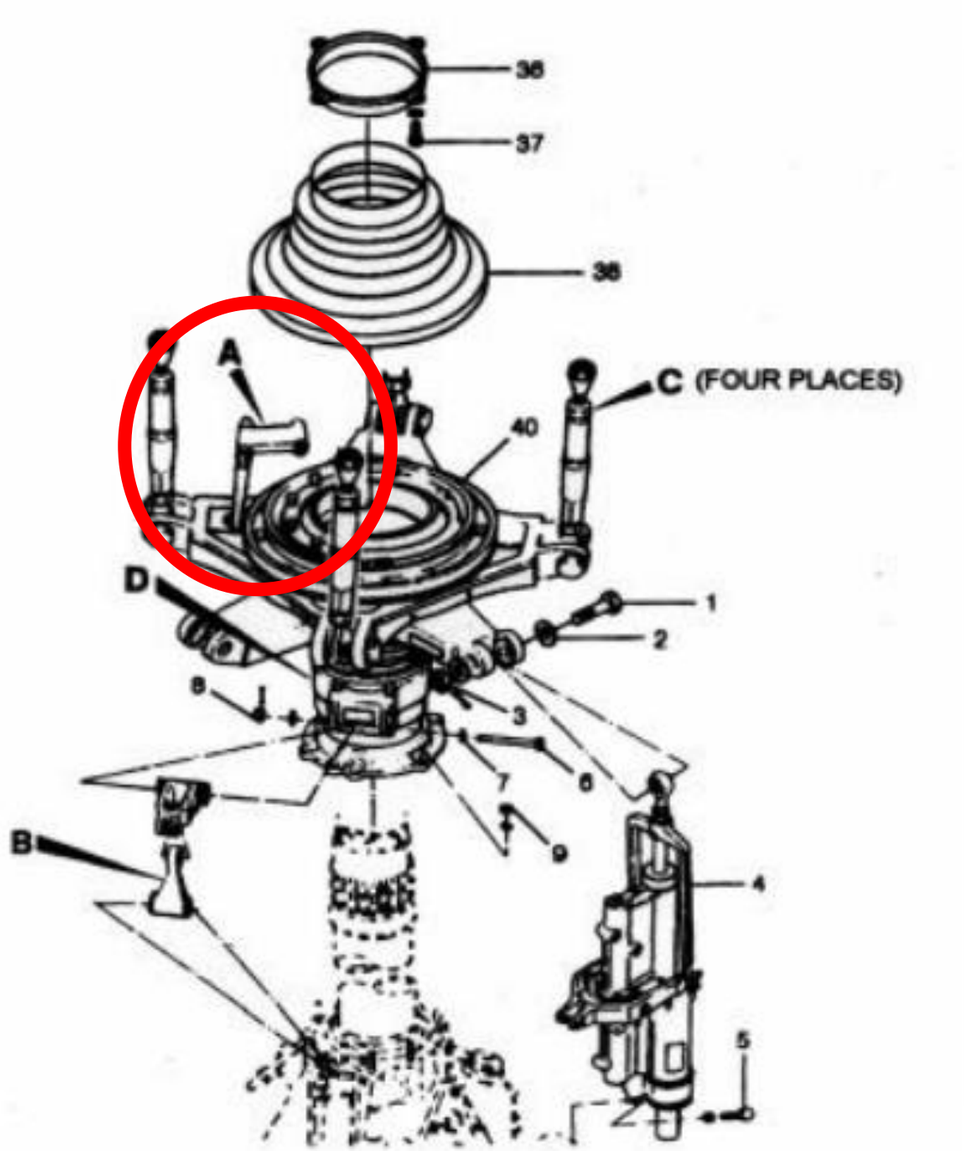
Information sources: CIAIAC & AAIB Final Reports

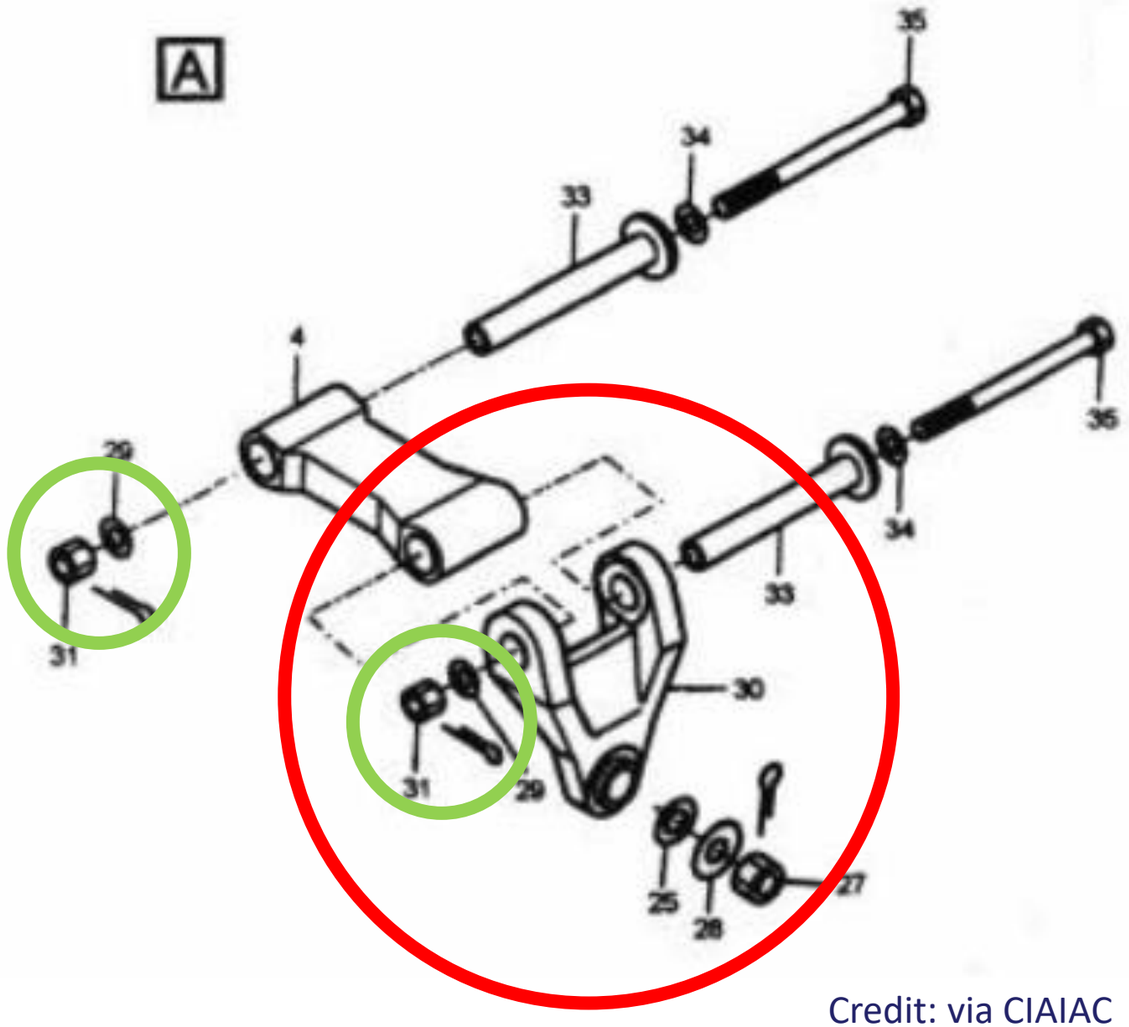






Credit: via CIAIAC





Credit: via CIAIAC

- Is the MM clear?: ☑ nuts ☒ lower link ☒ washers
- The component could be reversed (*unlike the 'A'!)* ☒
- No discussion on MR changes in differences course ☒
- 'A' model had lower link p/n marked on the other side ☒

- *If* it *made sense* on assembly it *can* make sense in a II
- Functional / full and free checks completed?

- Information Leaflet issued after the 3rd accident

Certification Requirements (1964 on)

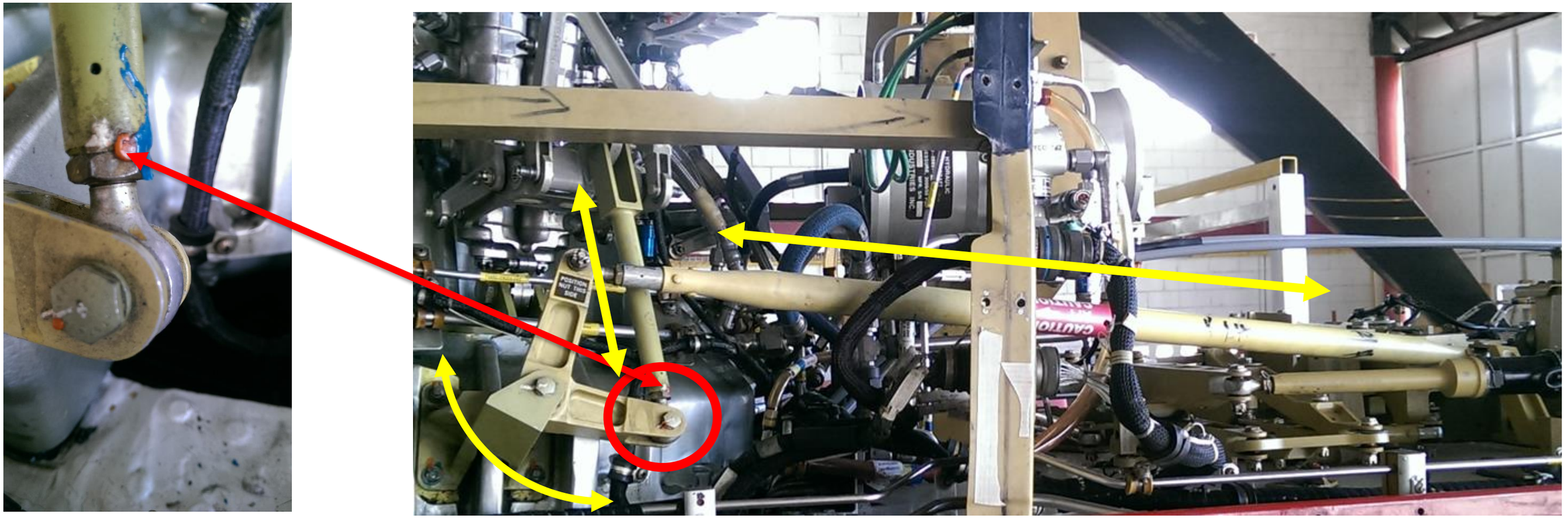
The "Federal Aviation Regulations" FAR 27 airworthiness requirements applied to normal category helicopters, in paragraph 27.671 b), state:

"Each element of each flight control system must be designed, or distinctively and permanently marked, to minimise the probability of any incorrect assembly that could result in the malfunction of the system"

The Advisory Circular of the Federal Aviation Administration AC 27-1B "Certification of Normal Category Rotorcraft" provides on page D-31 guides and additional information on compliance with this paragraph FAR 27.671 b), as follows:

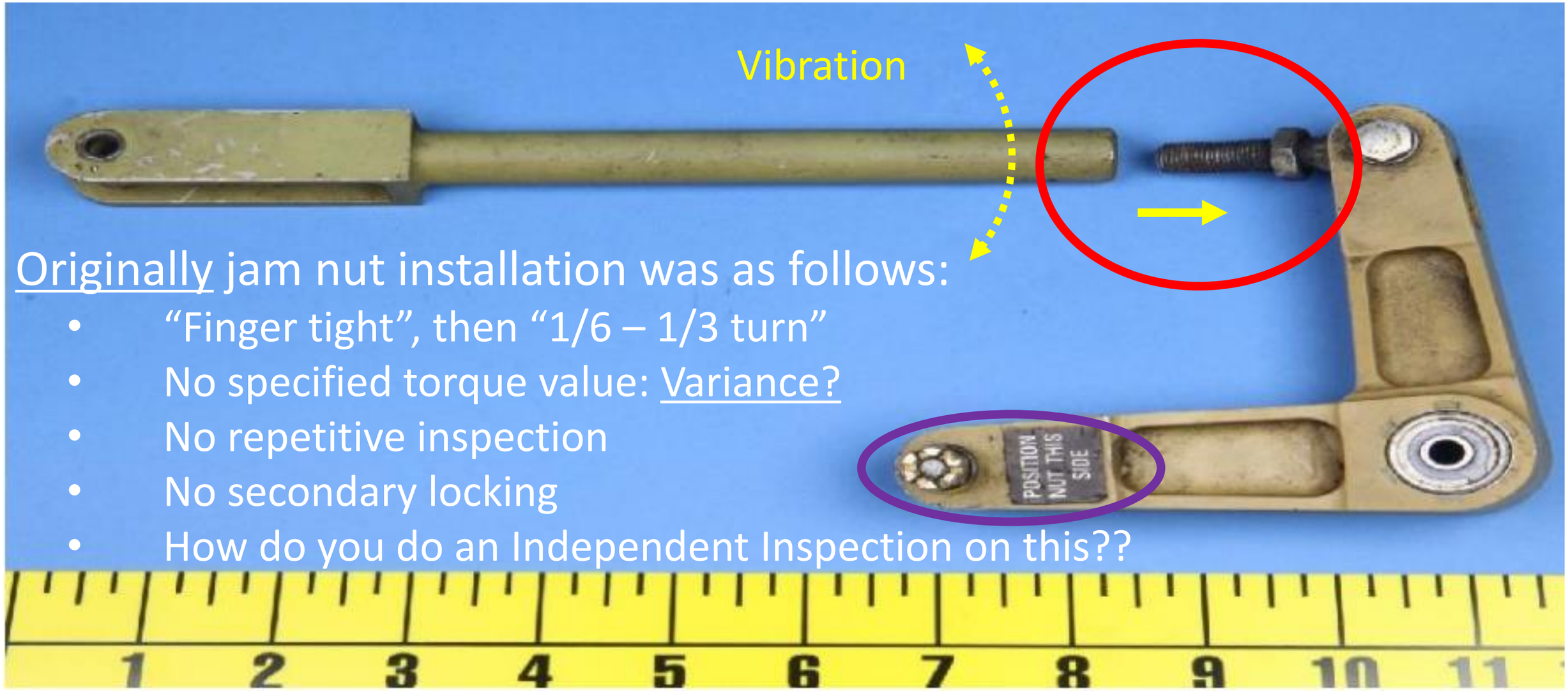
"To meet the requirement that incorrect assembly be prevented, the preferred method is providing design features which make incorrect assembly impossible. Typical design features which can be used are different lug thicknesses, different member lengths, or significantly different configurations for each system component. In the event that incorrect assembly is physically possible (because of other considerations), the rule may be met by the use of permanent, obvious, and simple markings. Permanent (durable) decals or stencils may be used".

Case Study 2: Variability / Inspectability



Credit: Aerossurance
Note fixed structure removed during base maintenance

Accident 2015



Originally jam nut installation was as follows:

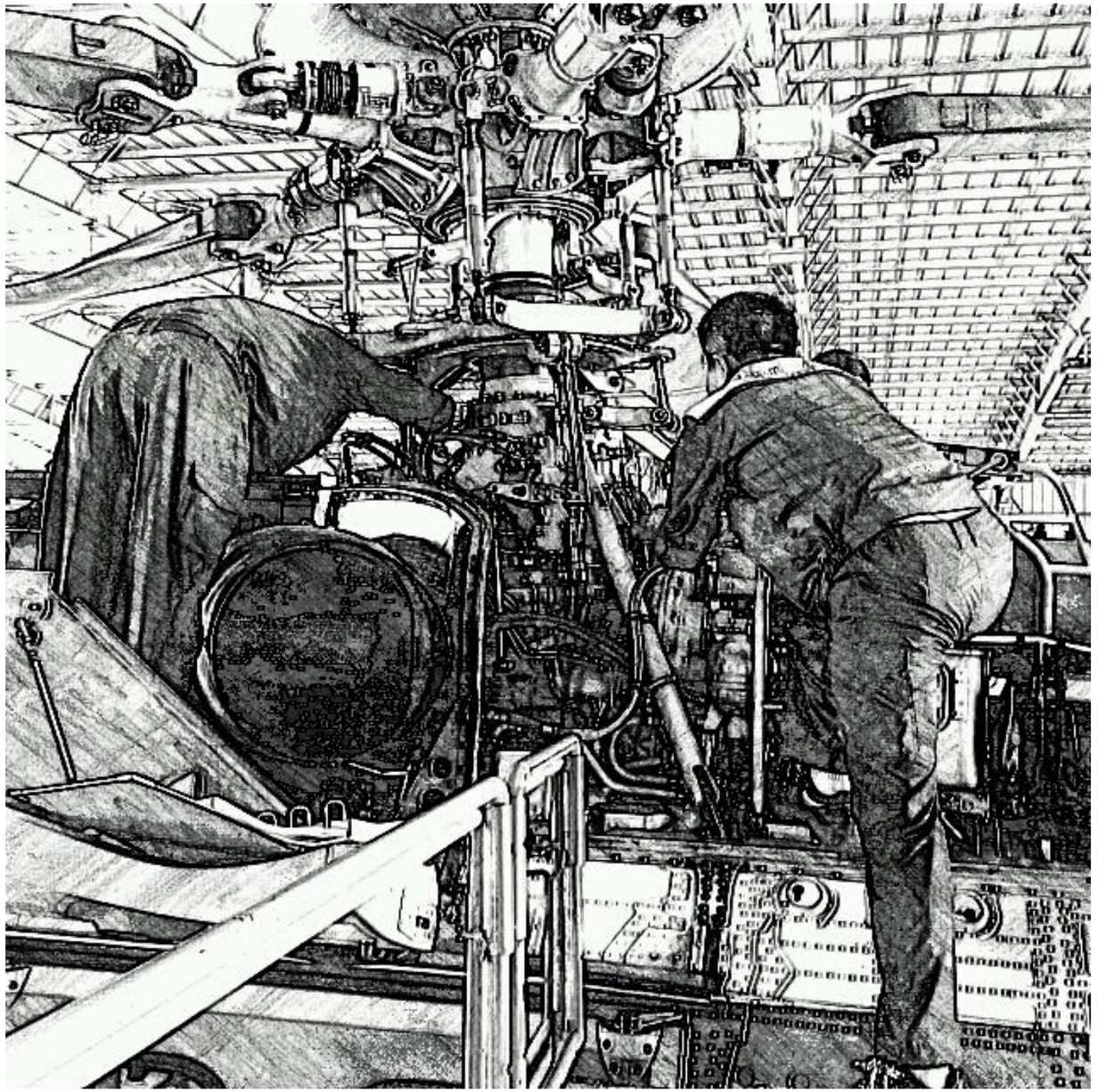
- "Finger tight", then "1/6 – 1/3 turn"
- No specified torque value: Variance?
- No repetitive inspection
- No secondary locking
- How do you do an Independent Inspection on this??

Credit: AIBN Information sources: AIBN *Preliminary* Report and AD (*investigation is ongoing*).

Conclusions

- Certification requirements have a loop hole
  - Focused on orientation not ‘adjustment’
  - Has the approach to compliance been variable?
- Human error design assessment techniques have been demonstrated but are not widely used *(yet)*
- Opportunity for smarter HCD requirements?
  - *RMT.0712 Enhancement of the safety assessment processes for rotorcraft designs*
  - *RMT.0713 Reduction in HF-caused rotorcraft accidents that are attributed to the rotorcraft design*
- **Maintenance HF is not just a maintenance problem**

Questions?



andy.evans@aerossurance.com

@Aerossurance