

# Safety of Rotorcraft Drivetrains

Assessment, testing, improvement, monitoring, and teaching

The research unit known as 'Transmissions for Aviation' at TU Wien, the largest technical university in Austria, was established by Prof. Michael Weigand in 2008. It follows the basic principle that the operational safety as well as certification and design regulations of the EASA and FAA are to be taken into account from the very beginning of every technical improvement or innovation.



The unit collaborates closely with the Tribology research unit in developing new lubricant additives and materials.

The aim is to develop innovative, primarily mechanical drive train solutions that offer superior safety, as well as innovative lubricants and improved loss-of-lubrication concepts for novel rotorcraft and engines.

## EASA Rotorcraft Safety Roadmap

In 2018, EASA released the Rotorcraft Safety Roadmap, with the goal to reduce rotorcraft accidents by 50% by 2028, but with the aim to see clear improvements achieved by 2023.

TU Wien addresses key topics of the EASA Rotorcraft Safety Roadmap in its research and teaching, and TU Wien contributed to the EASA Rotorcraft Symposium in 2012, 2016 and 2018.

## Integrity improvement of MGB

The research unit has developed a systematic research approach to improve the integrity of rotorcraft main gearboxes (MGB). This concept echoed the corresponding EASA call (Publication Reference: EASA.2019.HVP.17). TU Wien and its partners proposed alternative approaches for detection of the degradation of critical parts. This approach is suitable for all transmissions for aviation.

## Safety assessment & FMECA

EASA started the Notice of Proposed Amendment 2021 – 11 in October 2021 (NPA 2021-11) 'Enhancement of



the safety assessment processes for rotorcraft designs'. TU Wien intends to contribute actively to the objectives of the proposed amendment.

Based on an accident report which was made public, TU Wien defined and tested a concept for a modular and software-based Failure Mode Effects and Criticality Analysis (FMECA). It could be shown that the FMECA can be integrated fully into the design process, especially for continuing airworthiness.

## Detection of abrasion & status monitoring

The rulemaking task RMT.0725 was initiated by the EASA to improve chip detection in rotorcraft gearboxes. TU Wien offers its scientific findings and independent expertise to these working groups.

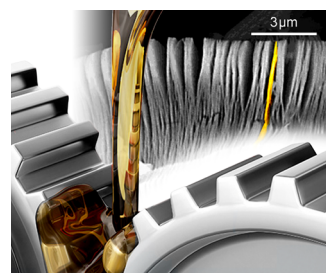
INMOX, a startup company based in Vienna, has developed a new concept for the smart detection of dangerous metal chips and particles, including the proof of concept. This innovation is closely linked to the RMT.0725 and to the research unit Transmissions for Aviation at TU Wien (see separate INMOX flyer). TU Wien is testing these new chip detectors on its transmission test stands.

A catastrophic incident occurred in 2016 that was not caused by abraded chips or particles. This provided evidence that critical parts like gears and bearings can also de grade to a catastrophic degree without the involvement of abraded particles, which must be further investigated.

## Lubricants & loss of lubrication

Prof. Weigand has experience in improving lubricants for rotorcraft gearboxes (esp. MGB) to increase the protection of gears and bearings, thus increasing overall safety. His expertise stems from co-operating with Eurocopter (now Airbus Helicopters Germany) during his work for ZF Luftfahrttechnik.

Together with Prof. Carsten Gachot and his research group Tribology at TU Wien existing lubricants were characterized and new additives (ionic liquids) were developed and tested successfully on FZG and tribological test benches in combination with FVA-reference



Advanced lubrication and new 2D-materials

oils. Now these additives are about to be tested and tried in combination with certified oils (like oils acc. to MIL-PRF 23699) using original rotorcraft gearboxes. Also new 2D and 3D materials as well as advanced surface structures for improved lubrication are being developed.

The rule making task RMT.0608 regarding loss of lubrication was initiated by EASA following misinterpretations of Certification Specifications CS-29 for Large Rotorcraft, especially § 29.927(c). TU Wien is willing to supply independent scientific expertise to these discussion and working groups.

The research units 'Transmissions for Aviation' and 'Tribology' at TU Wien are co-operating closely to improve the loss-of-lubrication performance of rotorcraft gearboxes and to develop design tools to predict loss-of-lubrication behaviour in early stages of design.

## Freewheel operation

Freewheel clutches have proven to be very sensitive transmission components. TU Wien has compiled and analysed the information available on details of mechanical components, operational experience and reported incidents involving freewheel clutches.



Unique test stand at TU Wien

TU Wien elaborated a concept for theoretical and experimental investigations including a dedicated test rig to analyse the engagement and disengagement of freewheel clutches, and the effect of longer over-running phases e.g. in intended single engine operation (ISEO).

Freewheel clutches in drivetrains powered by piston engines, and their specific demands can also be investigated.

## Teaching

The research unit offers several courses on Transmissions for Aviation, comprising lectures, practical calculation and design as well as laboratory exercises involving work with transmission test stands, alignment and balancing, and typical tests on FZG test benches.

EASA's regulatory framework, in particularly CS-VLR, CS-27 and CS-29, and its associated guidance material is covered in class. Accident and incident reports also are discussed and evaluated to make sure that students are familiar with all the pertinent regulations, organisations and authorities from a very early stage on.

## Unbiased expertise

TU Wien is an independent and neutral research institution which contributes to aviation safety.

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