The last slice of the Swiss cheese

SASCON 2011

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Agenda

- How the SMS started.
- One occurrence / What happened.
- First analysis.
- Second analysis and decision.
- Analysis and results of the EMPA : Swiss Federal Laboratories for Materials Science and Technology“.
- Why we think it happends.
- Way we moved.
- References.

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How the SMS started

- 2004, following a discussion with our CEO, a collegue and myself had a wild card to start an SMS.
- 2005, first of january, the CEO published an internal notice to announced the start of the SMS and his commitment to it.
- Since the beginning we had a full support and commitment from the CEO.
- Since the beginning our system was based on a non punitive system.

How the SMS started

- At the beginning the SMS was only based on a reporting system.
- Since then, the SMS has been working and we managed to improve it every year : new publications, training of the SOF (Safety Officers), extension to other services (maintenance – ground ops – etc.), developping a proactiv system, safety goals as well as an emergency response plan.

How the SMS started

- The safety culture is today well implemented within the helicopter department and we continue the work in the other departments.
- Since 2008, we started to work together with our airplane department in order to fulfil the FOCA schedule to implement a full SMS.
- The airplane department had already worked on a safety manual and we decided to produce together one unique manual.

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How the SMS started

- Together with the quality manager we published an SCE (Safety and Compliance Exposure) that we sent to FOCA for approval.
- Today our system is almost completed to match the FOCA requirements but the full implementation thru the complete Air-Glaciers will take some more time.
- AG is : an airplane AOC, an helicopter AOC, a CAMO, a Part 145 ops, an ambulance operator, a heliport owner, a mountain guide service.

How the SMS started

- Since the beginning we were two Safety Officers to manage the SMS.
- Since the beginning we had an SAG (Safety Action Group) to review all our publications and analysis.
- Since the beginning we had different publications like : Safety Notice, Safety Bulletin, External Safety Notice, Immediate informations.

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How the SMS started

- Today the complete system is available on an intranet system. All publications are stored on the web base intranet available to all employees on the different ops and places.
- We are now awaiting the final approval of our SCE (Manual) from FOCA.
- We are working on SPI (Safety Performance Indicators).
- We are implementing the just culture.

What happened

- 23.sept.10, the pilot had to fly 3 workers and the hut keaper as well as a net of tools from the Mutthorn Hut.
- He had attached a 20 meters line to hook up the net.
- The pilot was in a hover position and started to reduce the collective pitch in order to land.
- At that moment, he felt no action on the pedals and the helicopter started to yaw to the left.

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What happened

- One of the most challenging experience to cope with for an helicopter pilot.
- The pilot jettisoned the cable and tried to gain speed again. This occured after 3 to 4 spins.
- As soon as he got speed again, he checked the controls of the helicopter and he confirmed having no more control on the pedals.
- He also noticed that both collective and cyclic were working fine and in the mirror he could see his tail rotor turning.

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What happened

- He established a speed of 60 knots and decided to fly back to Interlaken in order to have a full runway to try a running landing.
- He advises per radio his homebase of his troubles and decisions.
- Another helicopter started immediately and followed him in order to check the situation.
- The 2nd machine could confirmed that the tail rotor was working but could not determine anything else.

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What happened

- Another helicopter crew in the region got the message on the radio and decided to fly to Interlaken to clear up the runway. He also advises per radio the REGA base in Wilderswil and ask them to be ready. (Special thanks to Bohag and Rega Crews).
- Our pilot was now in touch on the radio with all 3 pilots on the ground and could discuss the different options with them.
- The pilot did 2 runway overflights to see the reaction of his helicopter. On the third trial he decided to land on the concrete runway with a speed of around 50 knots.

What happened

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First analysis

- The first analysis showed a broken control wire at about 1 cm after the connector on the winder drum of the tail boom.

Second analysis and decision

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Analysis and results (EMPA)

- **2. Investigation**
- The following parts have been received for this investigation.
- The failed tail rotor control cable with a Total Since New (TSN) of 3020 H.
- The winder drum.
- A reference tail rotor control cable for comparison with a TSN of 2153 h and manufactured in the same year (2002) as the failed one.
- The page containing the serviceable limits of the control cable out of the applicable maintenance manual.

Analysis and results (EMPA)

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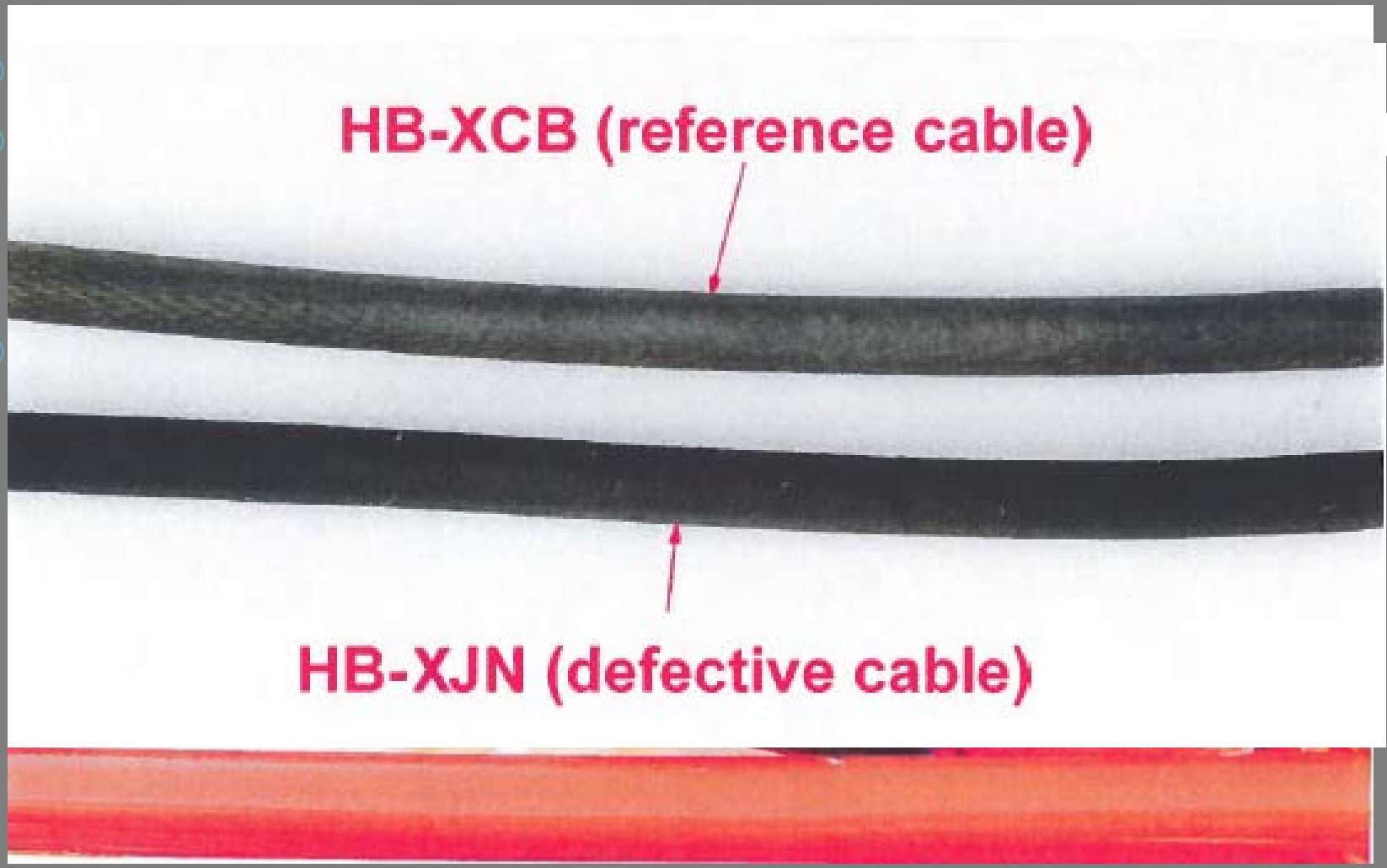
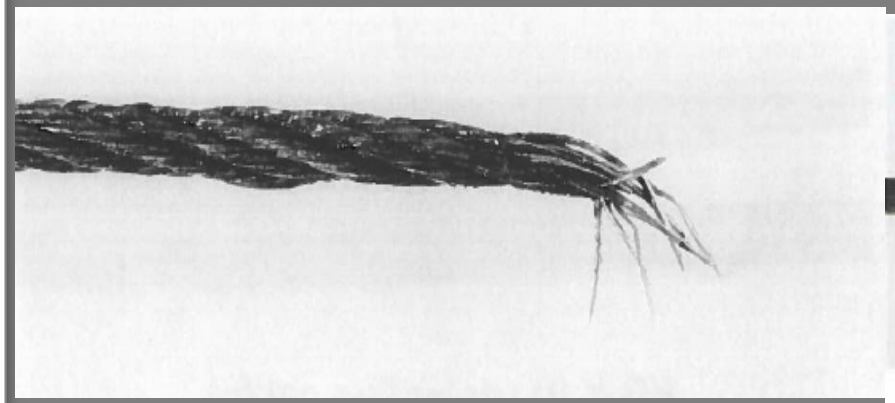
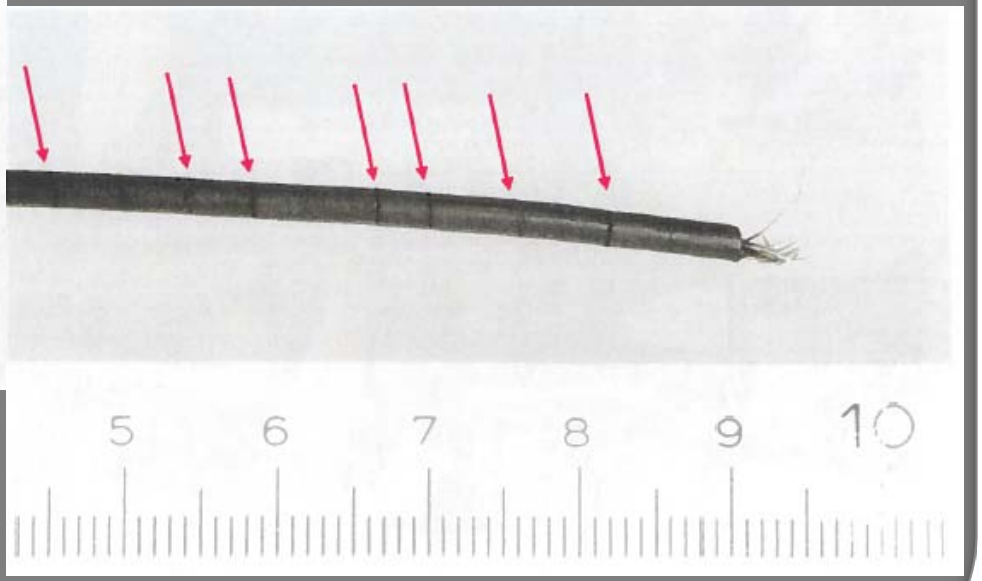
Analysis and results (EMPA)



Analysis and results (EMPA)

- **2.2 Fractographic investigation**
- For the fractographic investigation of the initial rupture, a 55 mm long segment has been cut off and the polymer sleeve has been removed.





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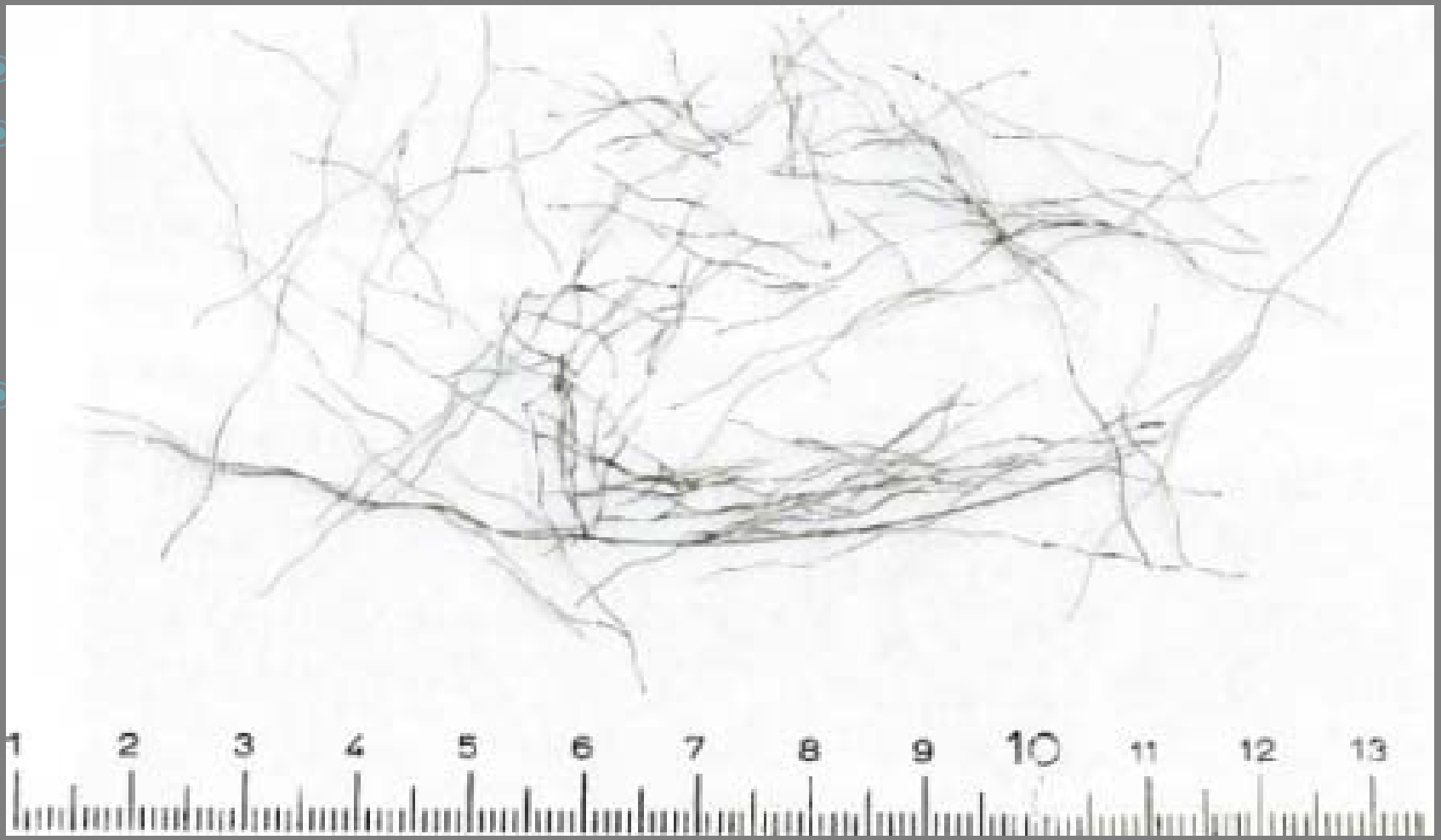
Analysis and results (EMPA)



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Analysis and results (EMPA)

- The investigation of the fracture surfaces revealed, that the wires are thinned by wear and then fail by simple overload.
- **2.2.2 Segment with missing polymer sleeve**
- The segment which was located on the same pulley as the rupture (opposite side) has been investigated to compare the condition of the wires with the rupture area.
- Compared with the ruptured area, the wear effects are less extensive in this area.

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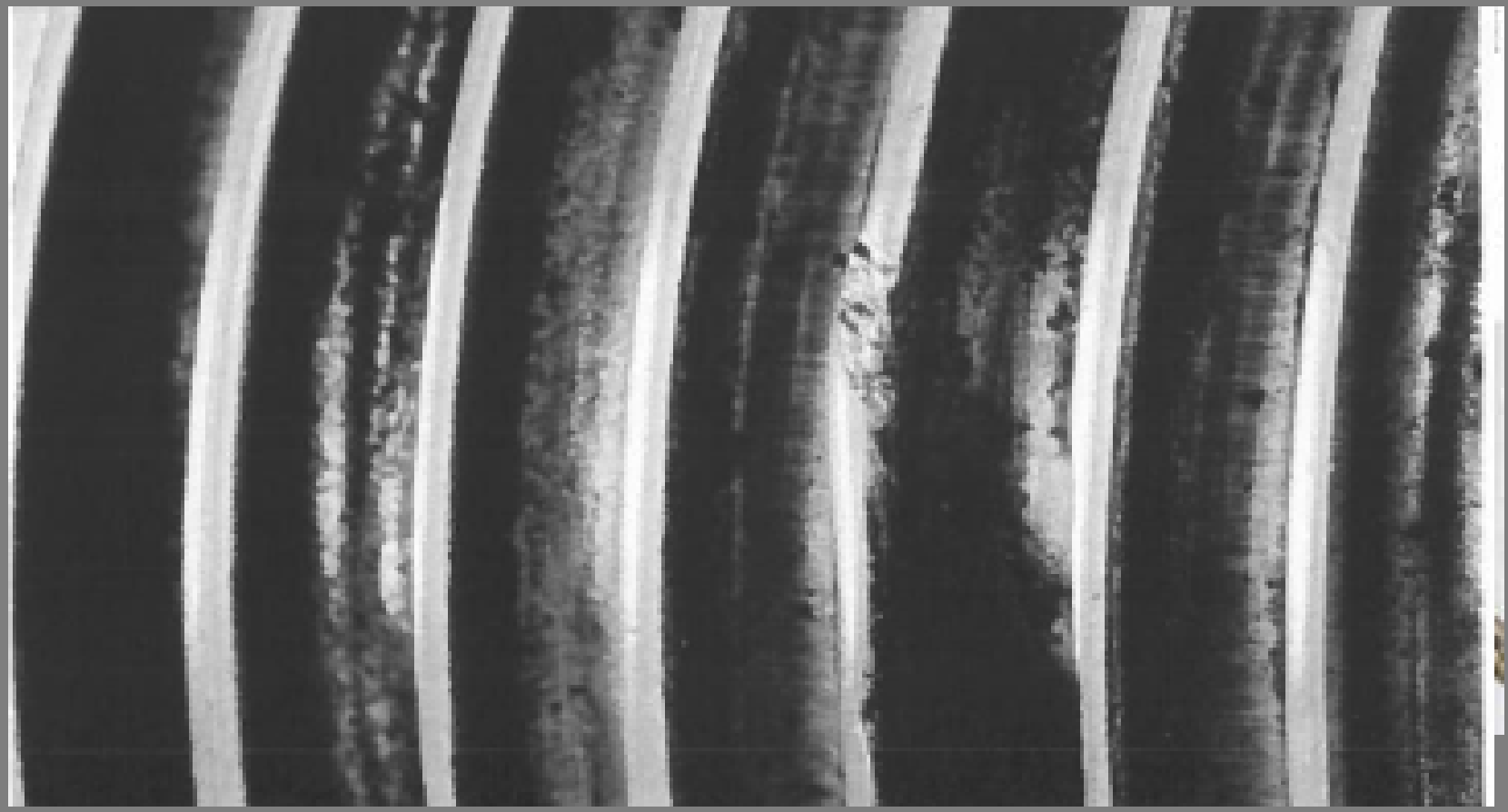
Analysis and results (EMPA)



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Analysis and results (EMPA)

- **3.1 Initial rupture**
- The investigation showed that the initial rupture of the tail rotor control cable has been a result of excessive wear between the wires themselves.
- Wear within steel cables is the result of movement between the individual wires. The observed wear occurs underneath the polymer sleeve and is therefore not directly visible by the performed inspections (only by secondary indication as discoloration of the sleeve).

Analysis and results (EMPA)

- The different amount of wear of the failed cable on the same pulley indicates the following :
- In the rupture area either atypical torsion momentum was present or some kind of « relaxing effect » due to the altered polymer sleeve allowed excessive movement between the wires (or a combination of both).

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Analysis and results (EMPA)

- Since on the opposite side of the pulley the cable is in relatively good condition local circumstances on the same pulley must have been different for at least a certain amount of time.
- **3.2 In service time and inspection criteria**
- The defective cable has been installed since April 2002. The wear along the cable's wires, which finally lead to the failure, is a continuously but slow progressing degradation that starts which the installation of the cable. The wear products together with other factors (as aging) affect the colour and transparency of the polymer sleeve in time.

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Analysis and results (EMPA)

- The corresponding maintenance manual instructs to exchange a cable if one of the following criteria is met :
- If wear or missing pieces of the polymer sleeve lay steel-cable free
- If wires penetrate the polymer sleeve
- If the discoloration of the polymer sleeve is intense (no longer transparent) and uniform around the circumference over the length of more than 10mm.
- The 3rd requirement has been reached by the failed cable and it should therefore not have been in-service anymore.

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Analysis and results (EMPA)

- **4 Conclusions**
- The failure of the tail rotor control cable has been the result of a too long in-service time, beyond serviceable limits (according to the applicable maintenance manual).
- Since the affected helicopter has been undertaken very frequent checks, the failure of the control cable indicates that the awareness of the maintenance staff (regarding the condition of this particular part) has been insufficient.

Analysis and results (EMPA)

- **4 Conclusions**
- Several (daily and scheduled) checks must have been performed while the cable was already in an unserviceable condition.
- A more restrictive compliance to the OEM recommendations in exchanging such cables should diminish the risk of such an incident greatly.

Why we think it happends

- The helicopter was involved until the 15th of august in spraying.
- The urgent need of helicopter in the normal transport department forced the maintenance to postpone the heavy maintenance work after season to a later stage.
- The helicopter was used in 3 different bases.
- At the second base, the engineer requested a spare tail rotor control cable as he thought he needed to be replaced.

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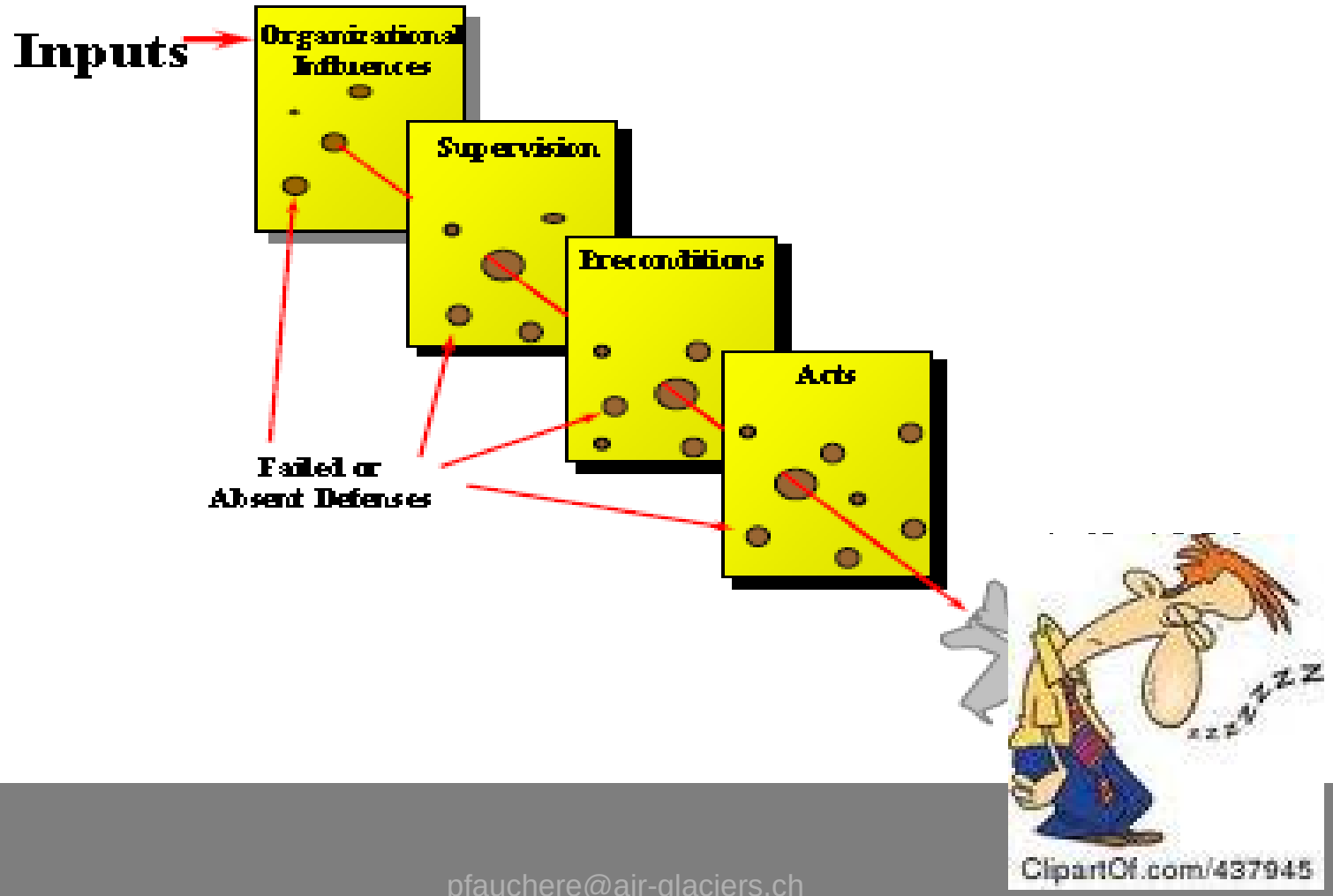
Why we think it happends

- As the cable had to come from the home base, the technician released the helicopter to service, mentionning that the control cable has been ordered and needed to be exchanged at the next 25 hours maintenance scheduled around 17 hours later.

Why we think it happends



Way we moved

- The occurrence was reported to Rega from the pilot and then transmitted to the Flight Safety Officer and forwarded to FOCA SRM.
- The maintenance department did the first analysis and transmitted the results.
  Together with the CAMO, the decision was taken to ask for a deeper analysis by EMPA.
- The non punitive system worked as desired. No sanctions, nothing.
- Since the beginning of the occurrence we had an open dialog with all departments and authorities.

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Way we moved

- Following the very good EMPA report, a copy of the full report was sent to FOCA SRM as well as the Manufacturer Eurocopter.
- FOCA then published a lesson's learned on the subject.
- EUROCOPTER published a Safety letter.
- Internal : we exchanged all cable according to the OEM criterias.
- We share the case at the SASCON 2011.

References

- EMPA report
- FOCA lesson’s learned
- Eurocopter Safety letter
- Aircraft Flight Manual – Maintenance manual
- Pilot’s occurrence report
- Safety bulletin Air Glaciers

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Questions ?

- Thank you !

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