

A320 In-flight thrust reverser deployment

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The in-flight thrust reverser deployment is one of the most feared situation by all pilots. It has always been under the extensive scrutiny of both the engines and airframe manufacturers as well as by the Airworthiness Authorities. This particular attention was even reinforced after the tragic accident which occurred on Lauda Air B767 flight NG004 in May 1991. This has led to the implementation of additional modifications to further decrease the probability of occurrence of such event.

Despite all protective measures in place, the event described hereafter occurred in March 2004 on an A320 aircraft equipped with IAE V2500-A1 engines.

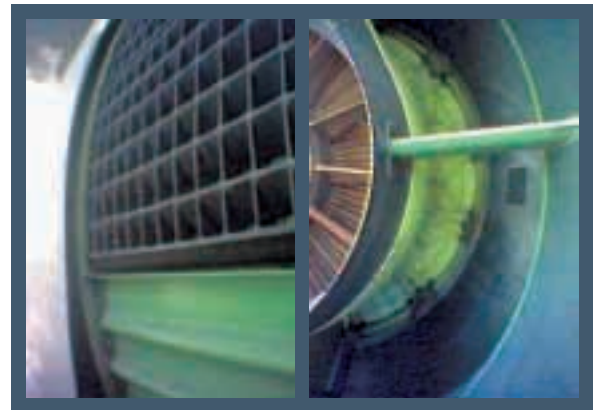
Sequence of events:

- While the aircraft was on a transit check for a scheduled flight, airline's maintenance found an hydraulic leak from the engine N° 1 inboard lower thrust reverser actuator.
- Airline's maintenance deactivated the reverser for an aircraft dispatch under M.E.L.
- In climb phase, approximately 15 nm from the departing airport, engine N° 1 reverser got deployed.
- As per check-list, engine N° 1 was shutdown by the crew

- Crew then made a safe precautionary landing back to departing airport.

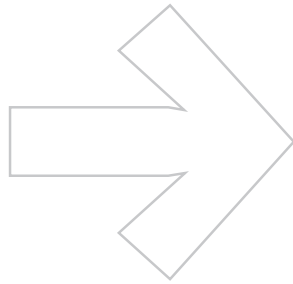
Findings:

- Upon landing, the engine N° 1 reverser was found almost fully deployed.



■ *Figure 1*

- The thrust reverser sleeve locking pins (2) were not found, while the lock-out assembly was intact.
- After opening the fan cowls, both locking actuators were found lock wired in the unlock position. The HCU was properly deactivated.



Flight data analysis:

GMT:14.16.30 A/C takes off TLA are set to TOGA position - EPR reach 1.4 A/THR engages

GMT: 14.17.30 A/P 1 is engaged Altitude is 1,700 ft AGL, TLA are set to CLB

GMT: 14.18.30 SLAT/FLAP conf clean is selected

GMT: 14.20.22 ENG 1 thrust suddenly drops down

ALT is about 6500 ft AGL – CAS = 250kts
The a/c was in a left commanded turn. The roll angle was decreasing from around 10° with a rate of 2°/sec.

EPR actual, EPR command and EPR target decrease from 1.24 to 1.0 in 10 seconds (auto-idle logic activated due to a reverse deployment beyond 10%)

A/THR disengages

Concurrently, VRTG decreases to 0.99g. Roll rate which was about 2°/sec (aircraft was in left turn) reduces to 0.4°/sec ; LATG increases to 0.05g. Rudder moves from 0 to -3DA (right input)

GMT: 14.20.32 ENG 1 TLA increases

When Engine 1 reaches Idle, crew moves TLA1 up to 31DA, ENG1 intends to follow TLA1 position (short thrust increase) but continues to decrease down to Idle (auto-idle logic)

GMT: 14.20.45 ENG 1 TLA decreases

Crew elects to retard TLA1 to Idle and increases TLA2 to 35DA (MCT)

GMT: 14.21.25 Aircraft levels off Altitude is 8000ft ; CAS increases to 262kts (maximum reached during this flight)

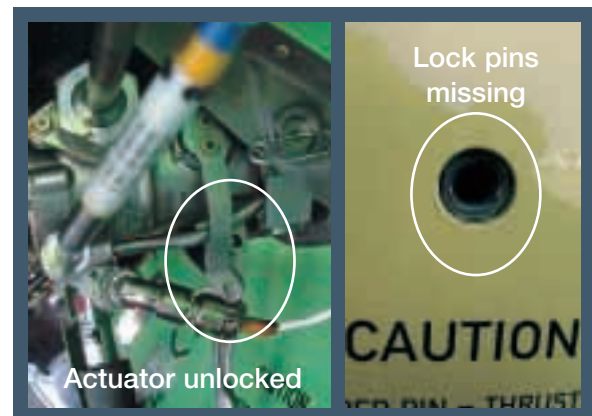
GMT: 14.21.59 ENG1 shut down Main ENG1 parameters start to toggle, NCD parameters

GMT: 14.22.27 Auto thrust is reactivated

GMT: 14.42.25 Crew performs a manual single engine landing

Maintenance actions analysis:

- The HCU deactivation was done properly following the AMM procedure:
 - “A. Deactivation of the Thrust Reverser HCU” procedure.
- The following AMM procedure steps were not performed , because it was not possible to do so while the thrust reverser actuators were lock wired in the unlocked position:
 - “B. Manually move the translating sleeves to the fully retracted position”
 - “C. Lock the Left and the Right Translating sleeves”
- Finally the last AMM procedure step was not done.
 - “D. Put the locking actuators in the locked position”



Due to the combination of having:

- The HCU deactivated (leading to no hydraulic power to the actuators)
- And the actuators not locked
- And the lock-out bolts not properly installed on the translating sleeves,

the translating sleeves were not locked and were free to move under aerodynamic loads.



Operational aspect analysis:

Prior to engine start, the ECAM warning “ENGX REVERSE UNLOCKED” was annunciated.

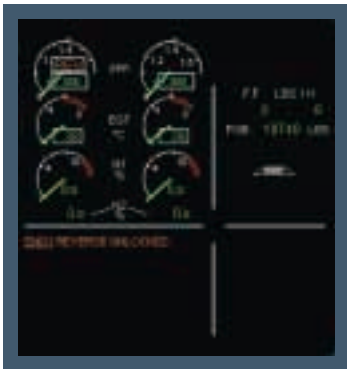


Figure 2

According to information received, maintenance personnel cancelled the “ENGX REVERSE UNLOCKED” message through the “EMER/CAN” button.

Upon engine start, the “ENGX REVERSE UNLOCKED” warning was then displayed under cancelled cautions, while the ECAM showed “REV” Amber in EPR gauge and “STS” indication.



Figure 3

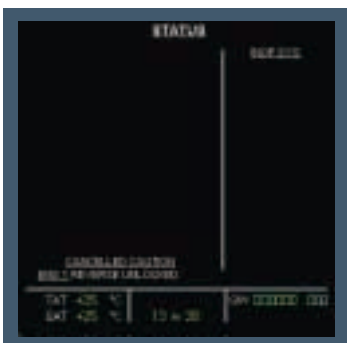


Figure 4

However, the aircraft was dispatched with the thrust reverser unlocked and free to move under aerodynamic forces.

Less than 4 minutes after take-off, the engine N°1 auto-idle was activated. It activates once there is more than 10% opening of the reverser, and brings down the TRA to idle based on the initial TRA position. This reverser opening detection also triggered the Auto thrust disconnection. The Auto re-stow which is also normally triggered was not effective since there was no hydraulic power due to the proper de-activation of the HCU.

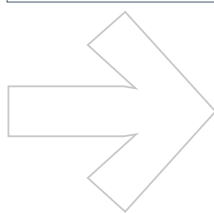
As described in the Flight data analysis, there was very little changes on aircraft flight characteristics. Based on the flight parameters evolution it is assumed that the thrust reverser deployed slowly due to the aerodynamic forces (there was no hydraulic power due to HCU de-activation).

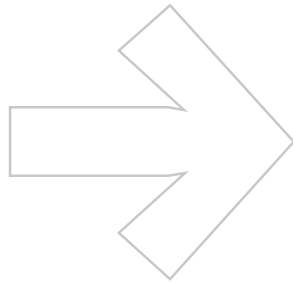
The aircraft maintained control with no upset throughout the event.

The engine was shut-down, then the Auto thrust was re-engage, and an IFTB was made followed by an uneventful single engine landing.

Per FCOM Standard Operating Procedure “cockpit preparation”, the ECAM control panel STS page must be checked to ensure that INOP SYS display is compatible with MEL.

In this case for ENGX REVERSE UNLOCKED, the MEL says “NO DISPATCH”.





Maintenance recommendations:

It is absolutely necessary to strictly follow all steps of the relevant AMM Thrust reverser de-activation procedure.

Furthermore, only the required tooling must be used (appropriate locking pins,...)

Finally, "ENG X REVERSE UNLOCKED" warning should not be displayed following reverser deactivation.

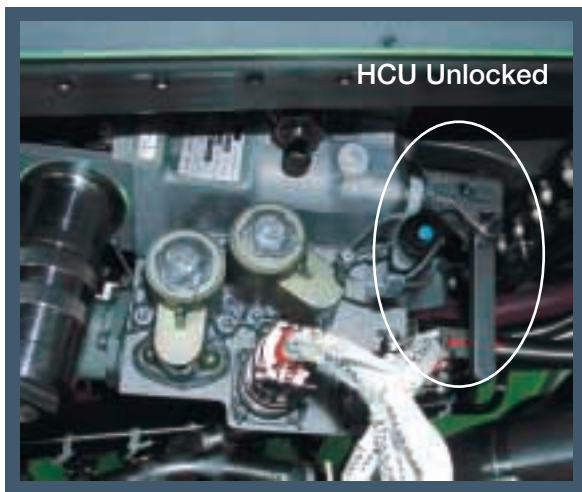


Figure 5: Normal Flight Condition

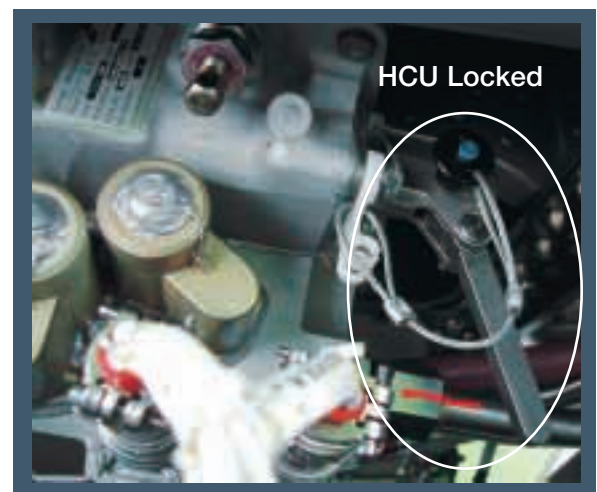


Figure 6: Deactivated Flight Condition

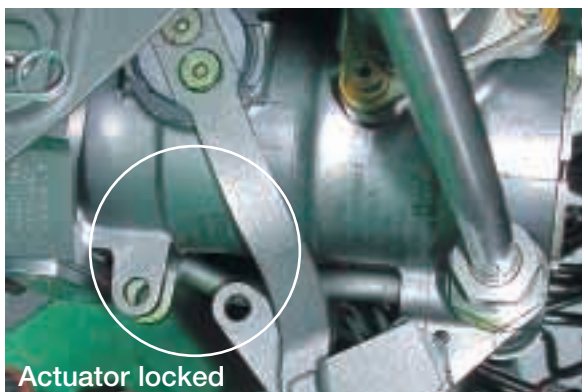


Figure 7: Normal Flight Condition & Deactivated Flight Condition

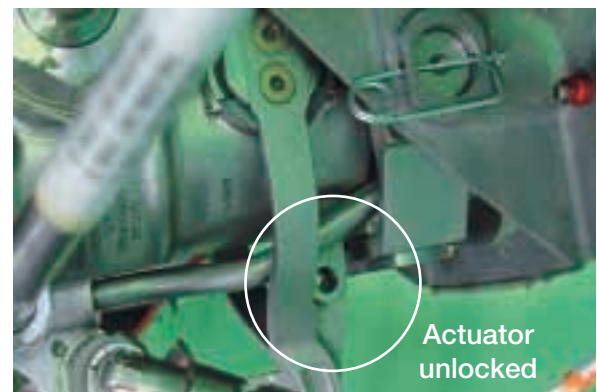


Figure 8: Maintenance Condition Only

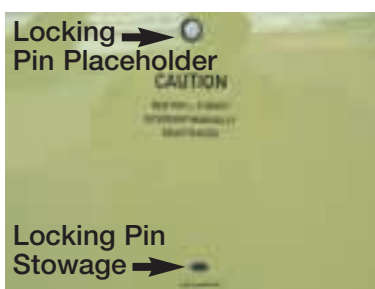


Figure 9: Normal Flight Condition

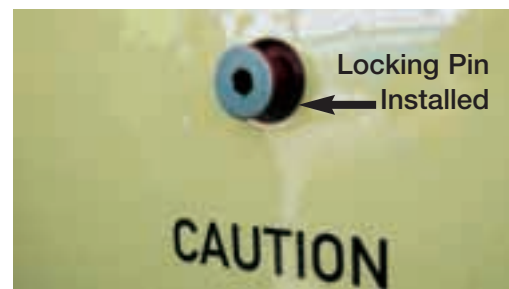


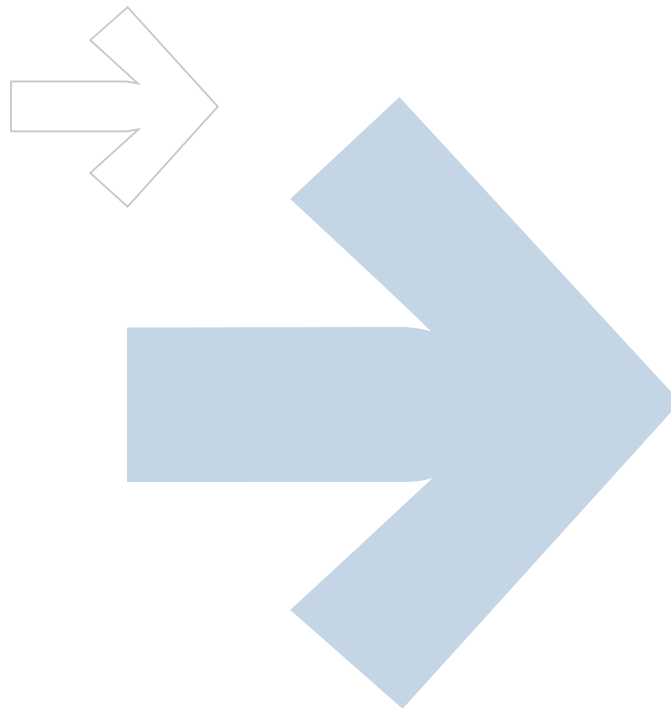
Figure 10: Deactivated Flight Condition



Operational recommendations:

The “**ENGX REVERSE UNLOCKED**” and the “**REV**” Amber messages should not be present on ECAM following a proper thrust reverser deactivation. **They are both NO DISPATCH warnings.**

In addition, the “EMER/CANC” button should only be utilized to kill a permanent spurious warning.





SAFETY FIRST

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