



## Maintenance Briefing Notes

### Uncommanded Ram Air Turbine (RAT) extensions

#### **Introduction**

The purpose of this Maintenance Briefing Notes note is to summarize the RAT extension logic for the individual Airbus aircraft programs, and then provide a summary as to likely causes of uncommanded RAT extensions.

Uncommanded RAT extensions have the potential to injure maintenance personnel working in the vicinity of the RAT.

Quotes from in-service reports are provided for each aircraft program to explain the scenario under which an uncommanded RAT extension was experienced.



## Uncommanded RAT extension on Airbus A320 Family

### Description

The RAT on the A320 family aircraft can be deployed either manually or automatically, supplying power to either the blue hydraulic system, and to the electrical system via the CSMG (Constant Speed Electrical Generator). For manual RAT deployment, the extension of the RAT is controlled by:

- Manual operation of the pushbutton switch OVRD HYD 2805GE on the HYD section of the overhead panel 40VU, or
- Manual operation of the pushbutton switch OVRD ELEC 24XE on the overhead panel 21VU, or
- A failure of both engines, or
- A failure of one engine together with a failure of the electrical generator of the other engine
- A total electrical system failure.

In addition the airspeed provided by either ADIRU 1 or 3 needs to indicate that the speed of the aircraft is more than 100 kts.

When the RAT receives an automatic or manual command to extend, one of the two deploy solenoids operates and releases the internal lock. Spring pressure causes the RAT actuator to extend, which extends the RAT into the airflow. The RAT compartment doors open with the extension of the RAT. When the RAT extends, the stowed switch operates and sends a signal to the ECAM system where the legend RAT OUT appears.



## Root causes

The identified root causes have been identified as either erroneous operation with respect to flight crew, or in some cases aircraft depowering when the indicated airspeed is greater than 100 kts. These are described in more detail below by reports received from the operator:

### **(a) Human Error:**

Report 1, A320 Fam:

*"It was reported that MPD Task 242400-01-1 "Operational Check of Emergency Generation System" (interval: 36 FH) was being completed in accordance to AMM Subtask 24-24-00-710-001. However the RAT was inadvertently deployed. It appeared that the RAT manual deployment P/B was activated, instead the CSM/G operation P/B. Both P/B are located on panel 21VU. The AMM task was reviewed at this stage, and it was concluded that the AMM procedure and illustration are clear but warning notices were ignored ."*

Report 2, A320 Fam:

*"In this case the operator informed Airbus that the RAT was extended during the Emergency Generator test, with the RAT being extended by mistake."*

Report 3, A320 Fam:

*"The aircraft had 4 returns to stand due to RAT extension. Whilst no detailed information was received from XXX, the internal investigation confirmed that the RAT extensions were identified as being due to Human Error."*

Report 4, A320 Fam:

*"The RAT was reported as being advertently extended during training for new cabin crew and flight crew. The flight crew was requested to push the "Emergency Call" P/BSW to cabin, but instead activated the RAT. The P/BSW is located above the "Emergency Call" P/BSW."*

### **(b) Erroneous Data from ADIRU**

The following in-service reports have been identified as coming from erroneous data from the ADIRU, at the same time as power was removed from the aircraft, which led the RAT to extend on ground:

Report 5, A320 Fam:

*"Refer to ASM 24-24-00 schematic 02. The information relating to the CAS > 100 kts, which is required for RAT deployment, is provided by the ADIRU 1 discrete output (Low Speed Warning Discrete). In this event, the discrete output (pin AA-2F) was shorted to ground, wrongly"*

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*indicating a CAS permanently greater than 100 kts. When the aircraft was powered down, the conditions for RAT extension were met. This failure mode is identified by the ADIRU, and provides a class 2 failure, and triggers maintenance status warning ADR, which is displayed at the end of flight.*

*There is currently one case reported of this failure mode.”*

Report 6, A320 Fam:

*“In this case, performing AMM task Ref. 34-52-00-720-004, XXX input an airspeed of 150kts into the air data test set. During the test, ground power was inadvertently removed from the aircraft, and the RAT immediately extended. The conditions were then set for RAT automatically deployment, which occurs when it detects an aircraft speed >100kts, and a total loss of electrical power. To address this issue, it was proposed that the AMM task 34-52-00-720-004 was modified to pull the circuit breaker 7XE Ref. ASM 24-24-00 Sch2, in the job set-up. This will inhibit RAT extension in the event of erroneous air speed entered, and electrical power removal.*

*This warning is now included in the job set up paragraph, 34-52-00-865-074 as follows:*

**WARNING:        OPEN CIRCUIT BREAKER 7XE. THIS WILL PREVENT A POSSIBLE DEPLOYMENT OF THE RAT IF THE MAIN AC BUSBARS 1XP AND 2XP BECOME ISOLATED.”**

Report 7, A320 Fam:

*“The aircraft had just come back from painting, with and ADR 1 and ADM 5 faults displayed in the PFR prior to the event. The RAT deployment occurred during troubleshooting of these ADR1 and ADM5 failure messages that occurred during the previous flight.*

*According to maintenance report, further to an unsuccessful reset to clear an ice detection fault and ADR 1 fault, the crew selected OFF Bus Tie pushbutton for 5 seconds. This operation led to the RAT deployment. ADIRU1 and four ADMs (19FP1, 19FP2, 19FP3, 19FP5) were removed. It is highly suspected that ADIRU1 abnormally set speed discrete information. The combination of speed information higher than 100kts, and the temporary loss of AC bus 1 and AC bus 2 induced by crew action on Bus Tie P/B, activated the automatic RAT deployment logic. Due to ADR1 and more specifically ADM5 fault, an erroneous VC could be explained and was maybe due to an ADM pressure spike. “*

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Report 8, A320 Fam:

*“The PITOT tubes had been covered with airtight covers, that trapped total pressure within the total pressure line corresponding to an erroneous airspeed indications, greater than 100 kts. During troubleshooting of this issue, the power was removed from the aircraft, which led to the conditions set for RAT deployment, causing the RAT to be deployed.”*

## **(c) Other Causes**

With respect to the RAT extension, two other cases have been identified. One relates to a relay failure, which put the aircraft into emergency electrical configuration, and the other one was caused by interference between the captains visor and the P/BSW.

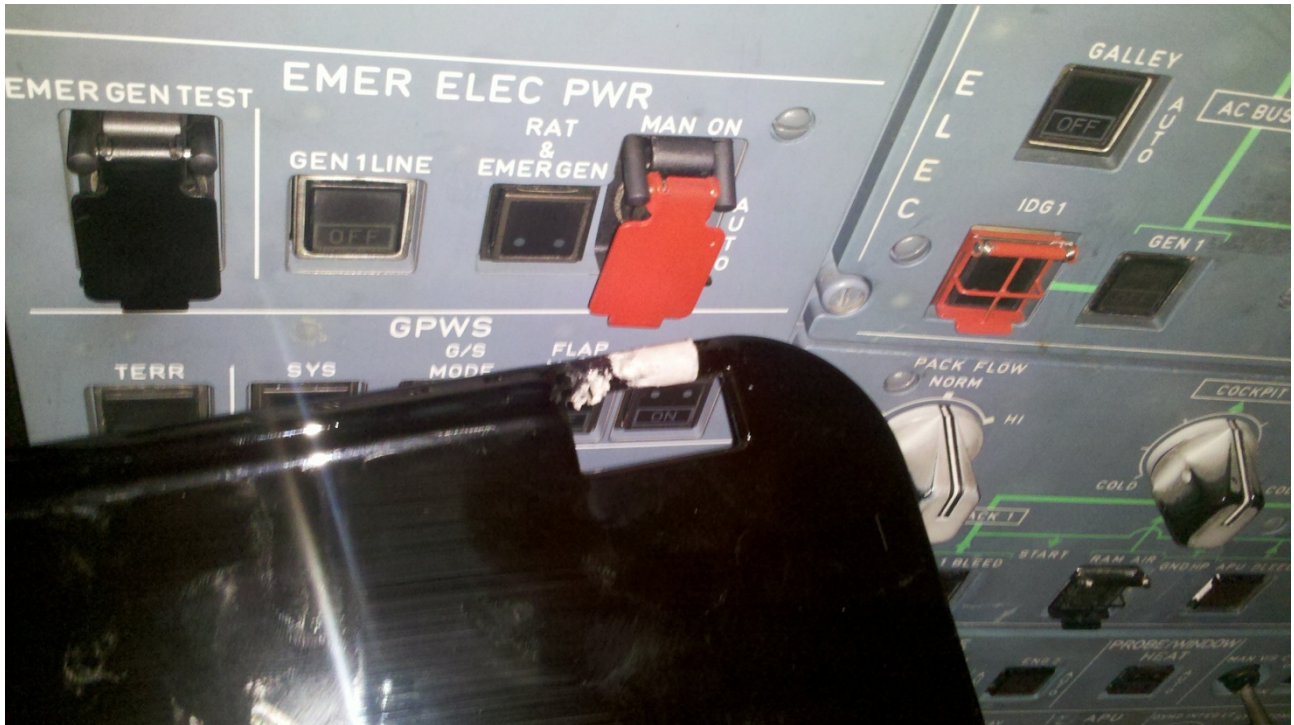
Report 9, A320 Fam:

*“Upon arrival, the engineer found that RAT was deployed on XXX A320. The RAT was restowed, but each time the power was shut down, the RAT re-deployed. The fault was traced to the relay 3PH, and the defect was cleared after relay removal. The relay 3PH is used to control the discrete related to the aircraft speed from the ADIRU. In this even, the relay 3PH had failed in the closed position which indicated a CAS permanently higher than 100 kts.”*

Report 10, A320 Fam:

*“This was an uncommanded extension in flight. XXX reported that while the captain was adjusting the sun visor, the visor caught the cover, and then the button was brushed as visor was moved and was sufficient to deploy RAT. See Figure 1:”*

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**Figure 1: Interference between Visor and RAT MAN P/BSW**

## **(d) Deployment in Flight:**

There are three other reports of uncommanded RAT deployment in flight:

Report 11, A320 Fam:

*"The aircraft suffered a loss of generator #1, then before electrical transfer of network1 from GEN1 TO GEN2, activation of the automatic RAT deployment logic.*

*The GEN2 then supplied the whole aircraft and the CSM/G supplied the essential network. The crew decided to start the APU: APU Gen supplied network1.*

*The aircraft made an in flight turn back, and at landing gear extension, the CSM/G was shut down and the essential network was recovered by the network1. The cause of loss switching between both generators was identified as the relay 18XE failing in the open position."*

Report 12, A320 Fam:

*"The aircraft lost both IDG failed, one because of a failed oil pump, the other for an unknown reason."*

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Report 13, A320 Fam:

*“Uncommanded RAT extension during cruise. During troubleshooting, no identified failures were found, but analysis and XXX investigation led to the suspicion that the crew would have operated by mistake EMER ELEC PWR/MAN ON leading to the reported event.”*

## Consequences

Unexpected RAT deployment on ground has no safety effect on the aircraft. However, maintenance personnel could be injured if in the vicinity of the RAT during deployment.

## Fleet exposure

All A320 Family aircraft are potentially exposed, due to the similarities in the system to deploy the RAT. However no common fault has been identified to identify particular quality or design issues.

## Final fix

AMM tasks have been updated, to ensure that the CB 7XE is pulled to prevent unexpected RAT extension.

## Customer References

| Ref Number   | Type | Title                                 | Issue Date |
|--------------|------|---------------------------------------|------------|
| 24.00.00.014 | TFU  | INADVERTENT RAT DEPLOYMENT IN FLIGHT  | 25 Jun 93  |
| 24-064       | SIL  | FAILURE OF DEUTSCH RELAYS EO245-115BO | 30 Jun 96  |



## Uncommanded RAT extensions on Airbus A330/A340 Family

### Description

The automatic deployment of the long range RAT requires inputs from the LGCIU, giving weight on wheels, the air speed and engine out status.

The RAT extension logic is as follows:

- 1- All engines OFF
- 2- All engines hydraulic pumps low pressure
- 3- Flight condition
- 4- A/C speed > 100kts

### Root causes

There was no one singular root cause identified that has led to the RAT extension. However, in several cases, faults were detected with the input from the ADIRU, which causes the RAT extension logic, to consider that the aircraft is at >100 kts. The root causes identified are explained in the received operator reports as follows :

Report 1, A330/A340 Fam:

*"A330 MSNnnnn was carrying out a leak test of main static and pressure lines (CAPT and F/O) as per AMM 34-11-00-790-801 and -802. During task -801, as airspeed and altitude was increased to 320 knots and 20,000 ft, master warning came on with repetitive chime and ECAM warning Green, Blue and Yellow hydraulic low level messages. 'CONSIDER RAT USE' cyan message appeared. Few seconds later, RAT was automatically deployed. The ground condition was not met, which subsequently led to the RAT extension conditions, as follows: (ENG1 N2<50% AND ENG2 N2<50%) AND (ADIRU1 VC >100 KT OR ADIRU3 VC >100KT) AND (LGCIU1:'FLIGHT' OR LGCIU2:'FLIGHT')."*

Report 2, A330/A340 Fam:

*"In this case, the aircraft experienced two unexpected RAT auto extension on ground during APU GEN/Ext power transfer. Analysis showed that this on-ground RAT deployment is due to a combination of GAPCU failure during APU Gen/Ext power transfer and an ADM3 misbehavior. As per design, the RAT extension logic has been met : Engines OFF, Flight information sent by LGCIU due to reset following power transfer, and Vc > 100Kts from ADIRU3."*

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Report 3, A330/A340 Fam:

*"During the accomplishment of the functional check of landing gear safety valve (FIN85GA) closure at 280 knots as per AMM Task 32-31-00-720-802, the Ram Air Turbine (RAT) automatically deployed. Despite the recommendation given in AMM Task 32-00-00-860-804 (called by AMM 32-31-00-720-802), the operator seems to not have opened/safety and tag circuit breakers FIN 5JR & 2JR. This leads the RAT to meet its auto deployment conditions; i.e. aircraft speed more than 100 kts, flight condition and N2 speed of the engines 1 and 2 less than 50% N2."*

Report 4, A330/A340 Fam:

*"During transit stop, and trouble shooting activities through the CIDS, the flight crew was required to make an a/c power reset. At the time of resetting, the a/c was powered by the APU generator. The flight crew made the power "off" then "on" by pushing the P/B of APU GEN. Once the power reset done, E/W indicated that the RAT was extended, and confirmed extended by ground mechanics. At the time of occurrence, the a/c had the ADR 1 fault. The a/c was being operated under MEL of the ADR 1 Fault. Likely cause of the RAT extension in this case was that the ADIRU 1 rotary switch was not correctly selected in the OFF position. Unless the ADIRU is no longer supplied, the ADR maintains all low speed discrete (including the >100 knots logic) in their state previous to the fault to ensure a fail-safe mechanism for the RAT deployment logic. Furthermore, the aircraft power down does not remove power to the ADIRU1 since this one is connected to battery. As a consequence, the ADIRU1 output discrete Low speed Warning#1 remained to the "Ground" state meaning a "Flight" condition (CAS > 100kts) thus allowing a RAT deployment."*

Report 5, A330/A340 Fam:

*"It was reported that during power transfer from APU to EXT power, the RAT had been extended and APU extinguisher was found discharged. There was a power transfer failure, during this period some of the signals fall back into their initial position (because they are temporarily non-power). For example, from the ADIRU, if there was a previous failure of speed > 100 kts, and the LGCIU becoming FLIGHT mode, hence letting the HSMU "think" there is an emergency case. This leads the HSMU to send out the deployment signal."*

Report 6, A330/A340 Fam:

*"Troubleshooting was being performed on ADM (ADIRU 1 confirmed faulty) when the RAT deployed. On replacement of the Pitot Supply tube the airspeed indicated dropped from 100 kts – 80 kts – zero. It is believed that during the troubleshooting, the condition of landing gear not compressed was transiently met, which led to the RAT deployment. Further investigations confirmed that the following conditions were met:*

- 1) At the time of the event, during maintenance operation, Engines were shut off, so the first condition has been satisfied.*

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- 2) *According to the operator, while removing the ADM, CAS increased from 0 to 100 kts. This CAS inconsistency may be attributed to a pressure spike in the ADM. However, ADM 19FP1 shop finding didn't reveal any fault (ADM 87232329V07, SIN 500) and pressure spikes have not been reproduced during investigations. According to Tech Log Report, during ADM removal, maintenance operator found a hose from ADM 19FP1 damaged, and was replaced. But a damaged hose cannot fully explain such pressure spikes. It is highly suspected that the pressure spikes occurred during the handling of this hose.*
- 3) *Regarding the third condition, Flight condition is sent by default by both LGCIU when not powered. A transient loss of electrical power may have occurred during the maintenance proceedings, leading to LGCIU reset. "*

## Consequences

For the A330/A340 Family aircraft, inadvertent RAT extension can cause injury to maintenance personnel operating in the RAT deployment area. However, the risk is limited because the RAT deployment area is outside the usual maintenance operation zone because of the height between the ground and the RAT located under the wing.

## Operational impact

The uncommanded extension of the RAT is not considered to have any additional operational impact. The RAT is able to be extended in all flight envelope conditions. If there is an uncommanded RAT extension, then this is indicated to the flight crew, and hence the appropriate maintenance action, i.e. the resetting of the RAT, can be performed.

## Final fix

Since one single failure mode has not been fully identified, there is no final fix recommendation. However several of the cases have been linked to erroneous ADR values, causing too high airspeed to be indicated, and coupled with removal of electrical power from the aircraft, e.g. during troubleshooting.



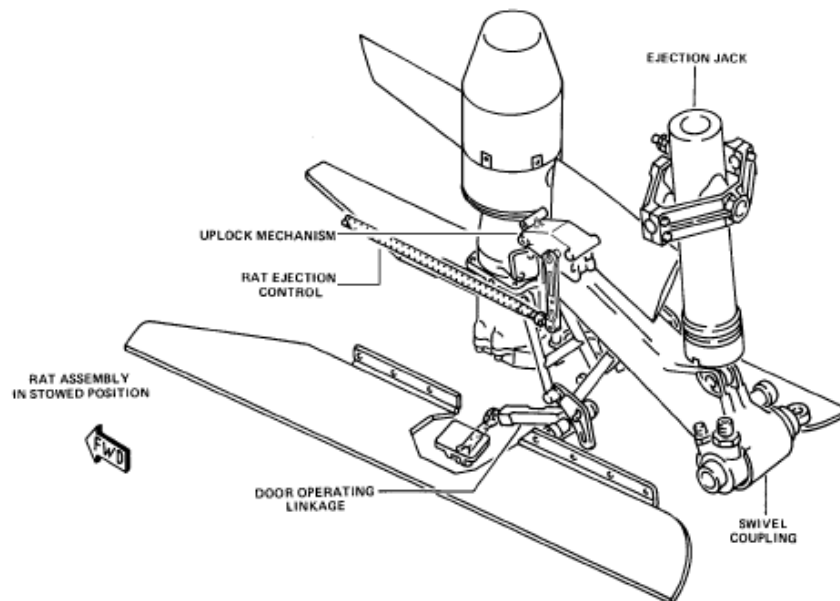
## Uncommanded RAT extensions on Airbus Wide Body aircraft

### Description

The uncommanded RAT extensions were usually discovered at the end of flight. On the WB family aircraft, the RAT supplies emergency hydraulic power to the primary flight controls. The ejection of the RAT is initiated by mechanical release of the uplock mechanism, followed by mechanical RAT extension. Stowage of the RAT in its compartment is achieved manually on the ground.

An uplock mechanism holds the RAT in a stowed position. The RAT deployment is initiated from the flight compartment. The rotation of an uplock input shaft moves an internal locking cam in order to unlock the uplock hook. Release of this uplock hook allows the ejection jack to push the RAT into the airstream.

The diagram below shows the RAT in the retracted position:

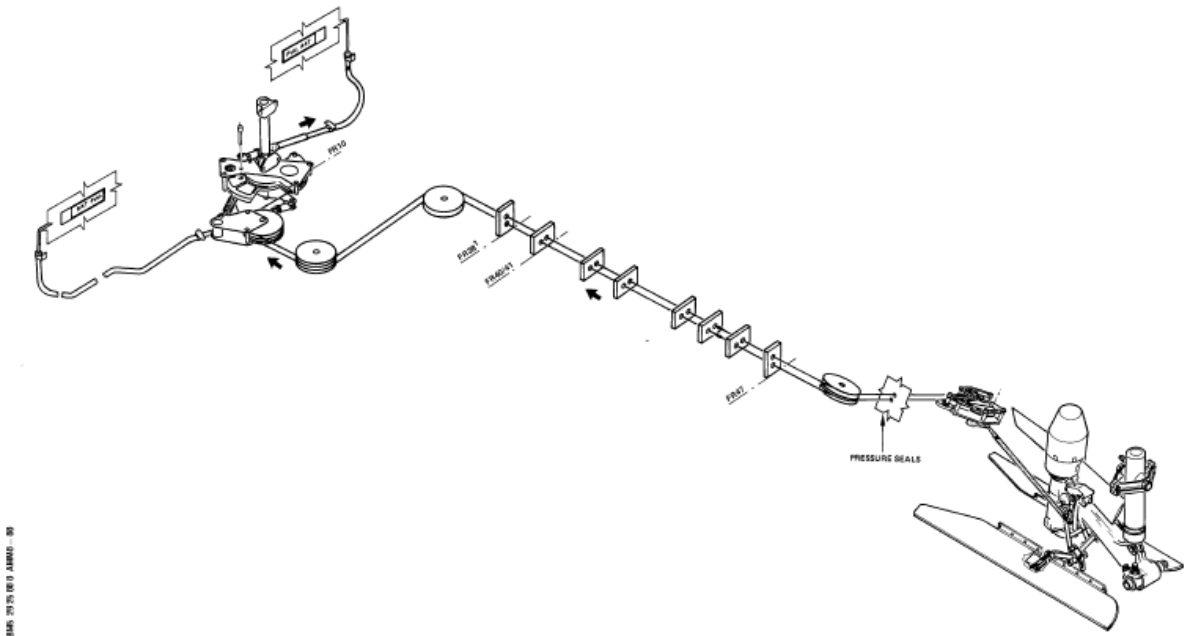


**Figure 2: A300 Family RAT in retracted Position**

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The RAT ejection jack consists of an oil damped, spring powered actuator. Helical compression springs initiate the RAT deployment against the compartment doors. Once caught by the airstream, the RAT is forced to the fully deployed position. As the RAT approaches the fully deployed position, oil is forced through various sized internal orifices causing a dampening effect. The dampening effect prevents high shock loads from being transmitted into the RAT and into the aircraft structure.



**Figure 3: A300 Family RAT Extension Mechanism**

To extend the RAT, the handle at the Captains station, or a second handle at the First Officers station has to be pulled. Each handle drives a control system connected to the uplock mechanism release system to extend the RAT.

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## Root causes

The reported cases of uncommanded RAT extension are described below:

Report 1, WB Fam:

*"Upon touchdown, the RAT extended without any cockpit selection. Trouble shooting confirmed that the UPLOCK P/N: 730822B, IPC 29-25-03-3A-90 was weak and could be released by manual effort, with no obvious damage in cables/ control linkages detected. A new uplock was ordered to replace the suspected one. Investigation of the uplock confirmed that the uplock (which was >20 years old) would not lock, and therefore could lead to the uncommanded RAT extension. "*

Report 2, WB Fam:

*"During a transit check , the RAT was found deployed. It was confirmed that the Flight crew/mechanic didn't operate RAT control handle, and the mechanic confirmed that there was no deployment of the RAT when the aircraft arrived at the gate just before this RAT deployment. It was suspected that the uncommanded deployment of the RAT occurred during the ground stay time. The RAT was correctly reset. In addition, the AMM task "Operation of RAT Uplock Mechanism" (AMM 29-25-00, PB 301: interval 10 months) was performed 17days before the uncommanded extension. It was concluded that this un-commanded extension is due to an incorrectly stowed RAT further to a previous extension."*

Report 3, WB Fam:

*" The operator reported that during a transit check, the RAT was found unexpectedly deployed. The aircraft was released after retracting the RAT, and performed a successful SYS test. The uplock was subsequently replaced during night check. The uplock PN was PN:730822B and SN:0492. The aircraft itself was in the effectivity of the Inspection SB A300-29-6053, which inspects for correct locking of the uplock assembly."*

Report 4, WB Fam:

*"Uncommanded RAT extension at arrival. The crew had no indication of the RAT extension. ISB A310-29-2034 was reported not applicable, as the Mod 05161 was not embodied on this fleet. The ISB was issued in October 1992 and is requesting to check the RAT uplock unit minimum unlocking angle. The uplock was removed, and tested in shop, which revealed no fault on uplock mechanism PN 730822B SN 0478. Vvisual inspection was normal and all locking and unlocking parameters were within limits as described in CMM 29-21-24 tests. Therefore it was concluded that the cause of the RAT deployment is associated with RAT incorrectly stowed during previous retraction performed at the opportunity of SB 29-2090 application 23 days before the event."*

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From the above cases, the likely root cause of the RAT extensions is associated to the weakening of the uplock, or the incorrect stowing of the uplock after performing the test of the uplock, in accordance with the SB associated to this task. Note that it is also recommended to remove the uplock after 20 years for an overhaul.

## Consequences

The RAT uncommanded extension does not lead to any system consequence.

Moreover, the RAT is designed for operation within the entire flight envelope (flight phases and aircraft speeds).

## Final fix

It was identified that the uplocks could be affected over time, and therefore corrective maintenance actions were defined:

- The MPD Task 292500-06-1 (10 month) was added to "Extend RAT and check for correct adjustment of locking rod".
- A 20 year overhaul interval of the up lock was added.

## Customer References

| Ref Number   | Type | Title                                                                                                                     | Issue Date |
|--------------|------|---------------------------------------------------------------------------------------------------------------------------|------------|
|              |      |                                                                                                                           |            |
| A300-29-6053 | SB   | HYDRAULIC POWER - YELLOW AUXILIARY POWER (R.A.T.) - RAT NON DEPLOYEMENT DUE TO BLOCKED UPLOCK UNIT, INSPECTION            | 19 Feb 08  |
| A300-29-6055 | SB   | HYDRAULIC POWER - YELLOW AUXILIARY POWER (RAM AIR TURBINE) - REMOVAL AND OVERHAUL OF THE RAM AIR TURBINE UPLOCK MECHANISM | 19 Feb 08  |
| A300-29-9005 | SB   | HYDRAULIC POWER - YELLOW AUXILIARY POWER (R.A.T.) - RAT NON DEPLOYEMENT DUE TO BLOCKED UPLOCK UNIT, INSPECTION            | 19 Feb 08  |
| A300-29-9006 | SB   | HYDRAULIC POWER - YELLOW AUXILIARY POWER (RAM AIR TURBINE) - REMOVAL AND OVERHAUL OF THE RAM AIR TURBINE UPLOCK MECHANISM | 19 Feb 08  |
| A310-29-2090 | SB   | HYDRAULIC POWER - YELLOW AUXILIARY POWER (R.A.T.) - RAT NON DEPLOYEMENT                                                   | 19 Feb 08  |

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|              |     |                                                                                                                           |           |
|--------------|-----|---------------------------------------------------------------------------------------------------------------------------|-----------|
|              |     | DUE TO BLOCKED UPLOCK UNIT, INSPECTION                                                                                    |           |
| A310-29-2092 | SB  | HYDRAULIC POWER - YELLOW AUXILIARY POWER (RAM AIR TURBINE) - REMOVAL AND OVERHAUL OF THE RAM AIR TURBINE UPLOCK MECHANISM | 19 Feb 08 |
|              |     |                                                                                                                           |           |
| A310-29-2034 | SB  | RAM AIR TURBINE - TO CHECK FOR THE RAT UPLOCK MINIMUM UNLOCKING ANGLE                                                     | 08 Oct 92 |
| 999.0072/08  | OIT | NOTICE OF REVISION OF SPECIFIC MPD TASK SOURCE INFORMATION                                                                | 12 Sep 08 |
| 292500-06-1  | MPD | RAM AIR TURBINE EXTEND RAM AIR TURBINE AND CHECK FOR CORRECT ADJUSTMENT OF LOCKING ROD                                    |           |
|              |     |                                                                                                                           |           |

## Conclusion

The conclusion drawn from the reported events on the A320 and A330/A340 Family aircraft is that there is no single root cause leading to uncommanded RAT extension. They can be explained by either erroneous operation by flight or maintenance crews, or from data received from the ADIRU simulating a condition for which the RAT is to extend.

For the Airbus Wide Body aircraft, the uncommanded RAT extensions are likely associated to weakening of the uplock mechanism, or incorrect stowing of the RAT. Maintenance and inspection recommendations are listed in this Maintenance Briefing Note.

The quoted in-service reports can help to raise awareness for maintenance to avoid similar cases, and that it is imperative to follow the Airbus procedures.

We appreciate receiving feedback to this issue of the Maintenance Briefing Notes.

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# Maintenance Briefing Notes



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