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FAST / NUMBER 25
The next A330/A340 Technical Symposium will be held in Cairo from the 23rd to the 26th of May 2000. An operator information telex (OIT) has already been sent and individual invitations are on the way with the preliminary programme.

The symposium will start with a reception on the evening of Monday 22nd of May hosted by Airbus Industrie. The following three and a half days will be devoted to providing operators with a clear view of the technical status of the A330/A340 aircraft in service.

The format for the symposium will be to arrange a mix of formal presentations and Questions and Answers sessions in the main auditorium with more specialised subjects being addressed in parallel. Airlines are encouraged to ensure a suitable level of participation.

Representatives from key vendors will also be invited.

Preparation for the 5th Airbus Training Symposium in Toulouse is in progress. This event will give operators the unique opportunity to be briefed on the status of all Airbus Training programmes, facilities and means for training Flight Crews, Maintenance staff and Cabin attendants.

This is also an excellent occasion for all participants to share their experience by meeting with other training specialists, representatives from the Airworthiness Authorities and the specialised staff from Airbus Industrie.

There will be common sessions for all participants, specialised presentations and workshops. In addition, there will be an exhibition of new training devices and software.

A questionnaire will be sent to all customers to ensure that their topics of interest are covered.
Maintenance cost has always been a major area of interest and investigation for airlines. Due to increased market pressure, this subject is now becoming even more crucial. Many airlines are therefore interested in benchmarking their performance which would provide them with a means to assess their efficiency, to identify high cost areas and to support budget planning.

Airbus Industrie is very active in the maintenance cost field and has long been involved in the direct exchange of data and experience with airlines. In addition, Airbus contributes to IATA (International Air Transport Association) activities within the PPM (Production Performance Measurement) working group, where more than 30 airlines exchange maintenance cost data. This article describes Airbus Industrie’s own direct maintenance cost analysis activities and those related to IATA PPM.
Maintenance cost data published in the press usually shows huge variations, not favorable to meaningful comparisons. Therefore, before launching any benchmarking exercise, maintenance costs must be properly collected, using a precise set of definitions. In addition, these costs must be adjusted to balance the effects of major influencing factors. The result of these adjustments is a reduced scatter of reported maintenance costs, allowing proper comparisons.

Both Airbus and IATA PPM use suitable maintenance cost adjustments to address the following major effects:

- **Fleet age**
  Maintenance costs rise over the first 5 years to reach the mature level which lasts roughly from the 5th to the 15th year. Beyond this, the aircraft enters the ageing period resulting in a regular increase of maintenance cost. Comparisons are performed between mature levels after adjustment.

- **Labour rate and staff efficiency**
  They have a tremendous effect on labour cost. Depending on the analysis performed, airlines may prefer to compare man-hours (effect of difference of staff efficiency) or to compare actual costs (associated with individual airline’s labour rate).

- **Average sector length**
  As an industry standard, maintenance costs are expressed in US$ per flight hour. However, some maintenance costs are directly related to take-offs and landings, for example those caused by wheels, brakes and tyres. For such components, flight sector length has a major influence: an airline flying a sector of three flight hours will experience one third of the cost per flight hour of an airline flying three sectors, each of one flight hour. An appropriate adjustment is therefore required.

- **Subcontracted costs**
  In-house and subcontracted costs can’t be directly compared due to the level of the subcontractors' overheads and profits. For meaningful comparisons, these overheads and profits are removed from the subcontractors’ costs.

Once the reported maintenance costs have been properly adjusted, fair comparison can be performed.

### IATA PPM ACTIVITIES

IATA PPM is the only international maintenance cost databank; its activities have been running for many years. It has different objectives, the major ones being to standardise maintenance cost definitions and to provide means to evaluate efficiency, identify cost drivers and plan budgets. The method is to benchmark costs with the aim to indicate the effectiveness of the airlines’ maintenance divisions. Maintenance cost comparisons are performed within the same operator in different periods and between operators in the same period of time. Much has been done in recent years by both airlines and manufacturers to attract new members and to provide improved data and analyses.

DMCs reported by IATA PPM airlines are standardised, using precise cost definitions, and adjusted using common parameters as described above. The IATA PPM reported and adjusted DMCs are contained in a Manufacturers Report available to IATA PPM members on a CD-ROM.

Data are accessible through selection of aircraft types, airlines and engine types.
In accordance with IATA PPM definitions, airline DMCs are broken down into labour, material and subcontracted costs and further divided in airframe, component and power plant costs.

A wide range of menus is available to access maintenance costs:
- **Current year report**, including detailed reported and adjusted maintenance costs.
- **10 year report**, including synthetic reported and adjusted maintenance costs. The important variations coming from airframe heavy checks and power plant overhauls are reflected in these costs.
- **Analysis at aircraft version level**, allowing access to maintenance costs of different versions of the aircraft models.
- **Analysis at engine version level**, allowing access to maintenance costs of different versions of the engine models.
- **Engine and maintenance check data**.

With the agreement of the IATA PPM committee, Airbus Industrie has proposed and implemented during the last two years several improvements to provide better access to data and better possibilities for analysis.

As an example, all reported and adjusted data are now contained in a CD ROM. The cost adjustment procedure has also been revised to provide more accurate and comparable DMC. For example, labour rate normalisation has been introduced as an option, to compare either actual costs (reflecting an individual airline’s labour rate) or man-hours (same labour rate applied to all airlines).

Figures 1 and 2, available in the Manufacturers’ Report, show airline maintenance cost data at a global level in their reported and adjusted forms. For confidentiality reasons, airline names, and global and detailed DMC values are not displayed. These data are shared only among IATA PPM members i.e. airlines providing their maintenance cost data.

At its yearly conference, IATA PPM members have the opportunity to exchange experience on cost collection and analysis. Different maintenance cost aspects are addressed by airlines, engine and aircraft manufacturers in dedicated presentations. As an example, Airbus has focused this year on its maintenance cost analysis activities and results; last year its contribution was on material cost reduction.

Regularly, IATA PPM members review the need for additional cost reporting and analysis, the use of reported and adjusted data by the airlines and the accuracy of maintenance cost adjustments.

**Figure 1**
Reported maintenance costs

**Figure 2**
Adjusted maintenance costs
AIRBUS MAINTENANCE COST ANALYSES

Airbus Industrie has for many years performed its own maintenance cost analyses. They are based on data originating from various sources, mainly reports directly from airlines, but also from IATA PPM, repair stations, equipment suppliers and engine shops.

Airbus Industrie pursues two ambitious objectives:
- To ensure through customised recommendations that airlines get the complete benefit of its low maintenance cost design. This is achieved through analysis of airlines’ data, feedback on cost reduction opportunities and also through accurate maintenance cost projections for existing and potential customers.
- To continually lower maintenance costs and improve competitiveness of existing and future Airbus aircraft. This is achieved through actions with all concerned parties to reduce maintenance costs for existing aircraft and also to set up objectives for future projects so as to achieve the lowest possible maintenance and operating costs.

Some years ago Airbus Industrie developed a method placing emphasis on the quality of reported data and on the level of detail of the analyses.

- To ensure accuracy and consistency of airlines’ data, reported DMCs are validated by the airline and Airbus together.
- Airbus Industrie performs cost comparisons following a “top down” approach starting from maintenance cost at aircraft level. The analysis goes into much detail, down to maintenance checks, as shown in Figure 3, individual components and expendable parts. At part number level, Airbus Industrie can provide accurate technical and commercial recommendations to address the most costly items.
- Airbus Industrie also provides a comparison of the evolution of the reported DMC with the customised Airbus DMC projection.
- Finally, a dedicated feedback, highlighting candidates for maintenance cost reduction and associated recommendations, is presented to the airline.

As an example, significant savings have been achieved following comparisons of airlines’ subcontracted costs with the market level. Results and amount of potential savings obviously differ from one airline to the other.

Airbus Industrie supplies this service and data to contributing airlines.

Figure 3
A320 heavy check
man hours

CONCLUSION

Controlling maintenance costs is a crucial issue for airlines. Accurate cost reporting and proper cost adjustments are essential to have fair comparisons and analyses. Airbus operators benefit from the considerable ability available within Airbus Industrie to analyse and predict maintenance cost. Airlines also have the advantage of exchanging data and experience directly with Airbus Industrie and through IATA PPM activities.
Airbus Industrie has introduced new features in the Illustrated Parts Catalog (IPC) to further improve the Airbus data quality, to optimise the airlines spares investment and improve their maintenance efficiency.

NEW FEATURES
IN THE ILLUSTRATED PARTS CATALOG
INCLUDING CONDITIONAL INTERCHANGEABILITY DATA

A major airline aim is to avoid any shortage of spare parts which may lead to having an aircraft on the ground (AOG), something all operators wish to avoid. In some cases an AOG situation can be avoided by judicious use of alternative parts. Therefore Airbus Industrie in compliance with ATA (Air Transport Association) Specification 2000 (SPEC 2000) recommendations, provide its customers with IPC and provisioning files which include an exhaustive list of line replaceable parts fitted on production aircraft as well as many possible alternative parts and sources of supply.
IPC part number change data already includes all parts which are “one way” (coded INC1) or “two way” (coded INC2) interchangeable as well as optional part numbers, preferred part numbers and associated possible sources of supply from optional vendors or distributors.

In addition to this information the IPC will indicate possible alternative part numbers which could be installed under certain conditions.

For those familiar with ATA SPEC 2000, this particular information is codified as Interchangeability codes (INC), for example INC4 defines parts “interchangeable as a set” and INC5 represents parts with “qualified interchangeability”. Basically these two definitions require some additional concrete information in order to be analysed by mechanics and engineers.

To cover this particular relationship, the related part numbers in the IPC, provisioning files (S and V file) and Recommended Spare Parts Lists (RSPL) will be identified.

The introduction dates are as follows:
- July 1999 for the A330 and the A340,
- August 1999 for the A319, the A320 and the A321,
- December 1999 for the A300-600
- and March 2000 for the A300.

ANNOUNCING PART NUMBER CHANGES

In the case of a part number change, the basic and new part numbers are shown in the part number column with their related applicability expressed in Fleet Serial Number (FSN) in the USAGE FROM TO COLUMN) in addition to the part number relationship indicated in the nomenclature column as follows: RPLS (RePLACE part number), RPLD BY (RePLACE BY part number) (see Figure 1).

The ICD (Interchangeability Condition Document) is included in a new section of the Additional Cross Reference Table (ACRT).

IMPORTANT: The effectivity noted in the “usage from to” column will not be modified.
THE NEW IPC FEATURES ARE INCLUDED IN THE FOLLOWING DOCUMENTS

In the Additional Cross Reference Table

The ACRT which supplements the IPC is supplied with each revision of the IPC. All ACRT information is valid for a given aircraft model (e.g. A319/A320/A321, A330 or A340).

The ACRT contains:
- The standard cross reference table (of non international standards)
- The list of Functional Item Numbers (FIN)
- Local manufacture cross reference table (X file)
- Identification of lamps and fuses on A319/A320/A321, A330 and A340 film only
- and, in addition, the new section called “Interchangeability Condition Document” (ICD).

This ICD contains (Figure 3) the following information:
- The basic part number and its associated CAGE code indicating the part number that the operator wants to replace.
- The related Functional Identification Numbers (FIN).
- The IPC Catalog Sequence Numbers (CSN) including IPC figure and item numbers.
- The conditions/actions/information to be considered for installation of the replacing part number.
- The replacing part number and its associated CAGE code indicates the part number which can be installed under the mentioned conditions, instead of the previous part number.

![Figure 3](Example of Interchangeability Condition Document (ICD))
In the provisioning files (S, V, T)

In compliance with the ATA SPEC 2000, conditional interchangeability between two part numbers will be codified in the “S” file with the related Explanation Code (EC 06 or 07) and in the “V” file with the related Interchangeability Code (INC 4 or 5).

The “S” and “V” file users have to refer to the IPC data to get the Interchangeability Condition Text (ICT).

The ICT has proven too complex to manage electronically within the scope of the SPEC 2000 provisioning files.

No conditional interchangeability codes will be managed for “T” File components.

In the Recommended Spare Parts List (RSPL)

Conditional interchangeability will be processed in the RSPL. The conditions allowing the replacement of one or a set of components by another will be documented in the ICD that will be part of the Line Replaceable Units (LRU) RSPL folder. Airbus Industrie will not modify the math model logic to process these particular conditions.

The recommendations will be processed with the basic interchangeability codes (INC 1 or 3) without taking the conditions into consideration.

The airlines will then be able to organize their inventory according to the options available.

In IPC SGML format

The SGML (Standard Generalized Mark-up Language) format (governed by the ATA specification 2100), is used for the interchange of IPC textual information.

The conditions will also be provided in IPC SGML format to our customers using this particular data retrieval facility.

In the Component Evolution List (CEL)

The CEL part three “PART NUMBER CHANGE DATA” will also make reference to the ICD.

In CD-ROM IPC (ADRES)

ADRES (Aircraft Documentation Retrieval System on CD-ROM) allows the retrieval of the Aircraft Maintenance Manual (AMM) and the IPC on a PC/Windows environment.

Airbus Industrie is offering its customers the CD-ROM for the whole Airbus new generation family of “fly-by-wire” aircraft, A319/A320/A321/A330/A340. When an alternative part number exists, “SEE PN CHANGE” appears in the nomenclature column. Double-clicking on this gives access to the following interchangeability data (see examples in figure 4):

- The basic part number and its associated CAGE code
- The Interchangeability code
  - “1” for ONE WAY,
  - “2” for TWO WAY,
  - “3” for NOT INTERCHANGEABLE
- The replacing part number and its associated CAGE code.

If a Conditional Interchangeability exists, the Interchangeability code will be highlighted in grey. Double-clicking on this will give access to the related conditions or ICT.

Another major advantage of this new information is the possibility to clearly show different interchangeability data depending on the location in the aircraft. As an example, a part with the same part number installed in the cabin and near the engine may be fully interchangeable in the cabin, but not interchangeable near the engine area (perhaps due to high temperature).

The ICT is only related to a given aircraft model applicability:

- A310 or
- A300-600 or
- A319/A320/A321 or
- A330 or A340.
Figure 4

PN 3957900613 CAN REPLACE PN 3957900613 ON A320 CFM56-5A ONLY PROVIDED FROM TR107 IS APPLIED.

THE APU CAN ONLY BE EXCHANGED IN CONJUNCTION WITH THE RELATED ECD. THE WIRE HARNESS AND FUEL LINE MUST BE REROUTED.
PRACTICAL EXAMPLE FOR LINE MAINTENANCE

To illustrate the advantage of these new IPC features, let us take a practical example for line maintenance mechanics:

You must replace a piece of equipment from the cockpit

STEP 1

✓ Locate this equipment and find the related part number by using the ACRT (Additional Cross Reference Table)

FIN 3XX1 ==> PN A1 IPC CSN 34-21-10 FIG 01 ITEM 120

To identify the reference of the part which was removed, you have two solutions:
1. Either note the part number (PN A1) from the removed unit
2. Or note the Functional Identification Number (FIN 3XX1) – label stuck close to the equipment.

Using the IPC alpha numerical index in the first case, or the Additional Cross Reference Table (ACRT) FIN to part number in the second case, you will be able to determine the part number and the Catalog Sequence Number (CSN 34-21-10 including the figure FIG 01 and item number (ITEM 120) of the removed equipment.

STEP 2

✓ Select in ADRES the CSN 34-21-19-01-120 from your customized IPC

With this information you will be able to consult all related data in this particular figure, and more particularly to check the spares availability with regards to the alternative parts mentioned in the IPC.

LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>ABBREVIATIONS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACRT</td>
<td>Additional Cross Reference Table</td>
</tr>
<tr>
<td>CAGE</td>
<td>Commercial And Governmental Entity</td>
</tr>
<tr>
<td>FSCM</td>
<td>Federal Supplier Code of the Manufacturer</td>
</tr>
<tr>
<td>ICD</td>
<td>Interchangeability Condition Document</td>
</tr>
<tr>
<td>ICT</td>
<td>Interchangeability Condition Text</td>
</tr>
<tr>
<td>INC</td>
<td>Interchangeability Code</td>
</tr>
<tr>
<td>IPC</td>
<td>Illustrated Parts Catalog</td>
</tr>
<tr>
<td>RSPL</td>
<td>Recommended Spare Parts List</td>
</tr>
<tr>
<td>SAV &amp; T files</td>
<td>Provisioning files including spares parts recommendation in compliance with ATA requirements</td>
</tr>
</tbody>
</table>
**STEP 3**

✔ Check the Spares availability

- **Spares availability check list:**
  1. The removed part number (same PN)
  2. The optional part numbers (OPT TO PN - Fully interchangeable-)
  3. The preferred part number (“BUY PN”)

- **In IPC on film:**
  4. The replacing part numbers
    (RPLD BY stands for Replaced By – one way interchangeable)
  5. The replacing part numbers
    (I/W stands for Interchangeable With – Fully interchangeable)
  6. Should you find the mention “SEE ICD FOR PNxxxx” denotes that interchangeable parts under certain condition exists.
  7. Refer to the Additional Cross reference Table ICD (Interchangeability Condition document) section and check with your Engineering department whether the replacing PN proposed by Airbus Industrie can be acceptable for your particular aircraft.

- **Using ADRES:**
  8. The mention “SEE PN CHANGE” denotes that interchangeable Part Numbers (One way or two way) are proposed
  9. The highlighted INC (interchangeability code) indicates that conditions are linked to this particular PN change.
  10. In this case check with your Engineering department whether the replacing part number proposed by Airbus Industrie can be acceptable for your particular aircraft.

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**IPC data**

<table>
<thead>
<tr>
<th>Basic PN</th>
<th>Opt PN</th>
<th>Buy PN</th>
<th>Action</th>
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</thead>
<tbody>
<tr>
<td>PN A1</td>
<td>PN A2</td>
<td>PN B3</td>
<td></td>
</tr>
</tbody>
</table>

**Spares on hand?**

- Yes
- No

**SEE PN CHANGE**

<table>
<thead>
<tr>
<th>Basic PN</th>
<th>INC</th>
<th>Replacing PN</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN A1</td>
<td>2</td>
<td>PN C1</td>
<td></td>
</tr>
<tr>
<td>PN C1</td>
<td>3</td>
<td>PN C2</td>
<td></td>
</tr>
</tbody>
</table>

**Check the condition**

**Condition**

PN C1 can be replaced by PN C2. However, MMR function will be lost.

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**Conclusion**

Through the dialogue with the engineering department, the line maintenance mechanic will have a wider choice of alternative spares for his maintenance activity. Furthermore, with the incorporation of conditional interchangeability data in the spares documentation and in the provisioning files Airbus Industrie helps airlines to optimise the spares selection while maintaining and even improving their aircraft dispatch reliability.
A stage-by-stage guide

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Engineering
Single Aisle MLG

The A319, A320 and A321 Aircraft Maintenance Manuals (AMM) subtask 12-14-32-614-080 (*) provide a detailed procedure for replenishment of the nitrogen in the main landing gear (MLG) shock absorber when the aircraft weight is on the wheels. This procedure may appear to be somewhat complex and time consuming. The purpose of this article is to explain the underlying reasons for some of the procedure’s steps and why the procedure must be followed as prescribed.

This article is intended for those who are directly involved in the maintenance and servicing of MLGs in the A320 family of aircraft and have access to the AMM sub-task.

(*) Aug 01/99 revision
The A319, A320 and A321 Main Landing Gears all have two stage shock absorbers, which were chosen very early in the life of the A320 following comments from the operators regarding what they perceived as over-firm landings.

The procedure for servicing the main landing gears of each aircraft is identical, with the exception of the nitrogen pressures. These pressures vary depending upon the aircraft (A319/A320 and A321) to which the MLGs are fitted, creating a shock absorber spring curve characteristic that is best suited to that aircraft.

The two-stage shock absorber comprises two nitrogen chambers, whose charging valves are referred to in the AMM as the “top charging valve” and the “bottom charging valve”.

In this article the upper chamber will be referred to as the 1st stage and the lower chamber as the 2nd stage.
The 1st stage is separated from the 2nd stage by a floating piston contained in the 2nd stage cylinder as shown in figure 1.

Typically with a MLG temperature of 20°C and with no load on the shock absorber the 1st stage is inflated to 7.6 bar (110 psi) and the 2nd stage is inflated to 78 bar (1132 psi) (A320-200 pressures). Initially, as the load on the shock absorber is applied, it is only the nitrogen pressure in the 1st stage that increases. With increasing load the 1st stage pressure will reach a value equal to the initial charge pressure of the 2nd stage (78 bar). Further increase in shock absorber load, from this point onwards, causes the floating piston to start moving down the 2nd stage cylinder and the pressures in both to equalize and remain equal for all further compression of the shock absorber. Figure 1 illustrates this sequence and a typical pressure vs shock absorber closure curve is shown in figure 2. The portion of the curve A-B represents the 1st stage compression and the portion of the curve B-C represents the combined compression of the 1st and 2nd stages. A set of curves like this are presented in the AMM for maintenance at different MLG temperatures.

In the AMM these curves are called DIAGRAM 1 and are shown in figure 3. The first part of the procedure in the AMM provides a check to establish whether the shock absorber closure (compression) is within acceptable limits for the measured temperature and 1st stage pressure. (Shock absorber closure is referred to in the AMM as the ‘H’ dimension). For any combination of MLG temperature and 1st stage nitrogen pressure the corresponding ‘H’ dimension is given a tolerance of ±15mm. The ±15mm tolerance on the ‘H’ dimension applies only at this stage in the check procedure. When adding or removing nitrogen, during the procedure to correct the ‘H’ dimension, the required ‘H’ dimension is to be achieved within a tolerance of ±2mm.

Before launching into the explanation of the servicing procedure it is worth defining what is meant by “MLG temperature”, “measured temperature”, etc. The AMM states that the temperature at the ‘top charging valve’ is to be measured. Therefore the temperature should be measured using a thermometer whose sensing element can be placed in contact with the top charging valve, such as a probe type digital thermometer. This will provide a sufficiently accurate temperature to use in conjunction with the diagrams in the AMM. It is important to understand that it is not the ambient air temperature that is to be measured.
It is important to bear in mind that the pressure relates to the 1st stage (upper chamber) pressure.

**Practical tip**
Tape the temperature probe to leg at the start of the charging operation and allow temperature to stabilise.
When the ‘H’ dimension is found to be outside the ±15mm tolerance, replenishment of the nitrogen is required. The replenishment procedure is not as simple as just adding or removing nitrogen from one nitrogen chamber or the other.

If this were to be done it would change the ‘H’ dimension to give the appearance of a correctly charged shock absorber but with no certainty that this was the case. In fact all that may have been achieved is a new spring curve characteristic that has just one pressure/‘H’ dimension co-ordinate that lies on the true spring curve.

When a shock absorber requires replenishment, and it is not convenient to jack the aircraft, what must be done? The answer is that each nitrogen chamber must be serviced independently. The procedure in the AMM is structured accordingly: Subtask 12-14-32-614-080 para B (9) through para (26) deals with the correction of the 1st stage and para (27) through para (36) deals with the correction of the 2nd stage. Both parts of the procedure MUST be completed. There are no short cuts.

The 1st stage nitrogen chamber is serviced first. But before this can be done the 2nd stage must be isolated and made inactive. The 2nd stage is made inactive by adding nitrogen at the bottom charging valve to move the floating piston to the top of the 2nd stage cylinder. This condition is achieved when sufficient nitrogen has been added to make the pressure in the 2nd stage cylinder 18 bar (260 psi) greater than the 1st stage nitrogen pressure (para (17)). This effectively converts the leg into a single-stage shock absorber whose spring curve is shown in figure 3 by the curve A-B-D, which is simply an extrapolation of the curve A-B. A set of curves like this are presented in the AMM for maintenance at different MLG temperatures. In the AMM these curves are referred to as DIAGRAM 2 and are shown in figure 4.

Subtask para (18) starts the part of the procedure that corrects the nitrogen volume in the 1st stage chamber.

At this point in the procedure it is worth explaining that the pressure in the 1st stage chamber is directly related to aircraft weight (i.e. the load on the shock absorber). Adding or removing nitrogen from the 1st stage chamber is not intended to change this pressure; rather it is to change the volume of nitrogen. For instance, adding nitrogen will increase the ‘H’ dimension which increases the volume in the 1st stage chamber whilst keeping the pressure constant and consistent with the aircraft weight.

The new nitrogen pressure thus generated is the pressure that must be used in conjunction with AMM DIAGRAM 2. This determines the correct ‘H’ dimension to be achieved when the addition or removal of nitrogen is recommenced. When the addition or removal of nitrogen is recommenced the ‘H’ dimension will smoothly change at constant 1st
Stage pressure. The reason why the friction forces and the nitrogen pressure generated forces need to be balanced is further explained in figure 5.

This first part of the procedure, to correct the 1st stage nitrogen volume, is interspersed with check readings of pressure, temperature and ‘H’ dimension. These checks are to ensure that previously achieved conditions have remained unchanged and that a sufficiently-high pressure-differential between the 1st and 2nd stage pressures has been maintained. This will ensure that the floating piston is still at the top of the cylinder, i.e. the pressure in the 1st stage is at least 11 bars lower than the pressure in the 2nd stage.

**Figure 5**

- **H1** - Measured ‘H’ dimension at the pressure P1 showing an error in ‘H’ equal to (H2-H1).
- **H3** - ‘H’ dimension to be achieved obtained from curve AFTER measuring new pressure P2.

1. 1st stage pressure (P1) and H dimension (H1) measured and found not to lie on curve at P1/H2.

2. Nitrogen added. Shock absorber does not move. Pressure increases from P1 to P2.

3. Point at which shock absorber starts to move. Stop adding nitrogen. Measure new pressure P2.

4. **This is where you want to be**...

5. ... but you will finish at this point if the new pressure (P2) is not measured to obtain the new dimension (H3).
On completion of subtask para (25) the 1st stage nitrogen volume is correct. BUT remember that the 2nd stage must now be corrected.

The next part of the procedure is to correct the 2nd stage. How this is achieved is dependent on the weight of the aircraft, because at the end of the 2nd stage charging procedure it is possible for one of two conditions to exist:

- **Condition (a)**
  
  The weight of the aircraft is such that the shock absorber will be operating on the 1st stage of the spring curve – somewhere along the curve A-B of figure 2. The floating piston is still at the top of the 2nd stage cylinder. (The aircraft is relatively light)

- **Condition (b)**
  
  The weight of the aircraft is such that the shock absorber will be operating on the 2nd stage of the spring curve – somewhere along the curve B-C of figure 2. The floating piston is at some intermediate position within the 2nd stage cylinder. (The aircraft is relatively heavy)

The AMM deals with these conditions separately. Subtask para (27) is the procedure for condition (a) and subtask para (28) is the procedure for condition (b). It is not necessary to know the actual aircraft weight because the procedure that is used is determined by the 1st stage pressure and its position relative to the line on ‘DIAGRAM 3’ in the AMM. It is shown in figure 6 and shows the relationship between the 2nd stage pressure and temperature when the floating piston is at the top of the cylinder.

If the 1st stage pressure is such that it is below the line on diagram 3 it means that the aircraft weight has generated a 1st stage pressure that is not great enough to cause the floating piston to move down from its position at the top of the cylinder. Therefore all that needs to be done in this case, is to remove nitrogen from the 2nd stage cylinder to make the pressure agree with the line on DIAGRAM 3. It is important that this final step is performed even though there will be no change in the ‘H’ dimension. If it is not done the 2nd stage will remain overpressurised. For condition (a) the procedure is now complete.

If the 1st stage pressure is such that it is above the line on DIAGRAM 3, it means that the aircraft weight has generated a sufficiently high 1st stage pressure to overcome the initial charge pressure of the 2nd stage cylinder and has moved the floating piston away from its stop at the top of the cylinder. In this case it is necessary to adjust the volume of nitrogen in the 2nd stage to obtain the final correct ‘H’ dimension. As the shock absorber will be operating on the 2nd stage of the spring curve refer now to DIAGRAM 1 in the AMM to determine the ‘H’ dimension that is to be achieved to complete the procedure. Nitrogen is removed from the 2nd stage cylinder by following the same procedure for removing nitrogen from the 1st stage. In this case nitrogen is removed from the 2nd stage cylinder until the shock absorber just starts to move. When this occurs, stop removing nitrogen and re-measure the 1st stage nitrogen pressure. Use this pressure to determine the correct ‘H’ dimension from DIAGRAM 1. Re-commence removing nitrogen from the 2nd stage cylinder until the desired ‘H’ dimension is achieved. For condition (b) the procedure is now complete.

**CONCLUSION**

The two-stage shock absorber is necessary to give the desired passenger comfort levels when landing the aircraft and it is equally necessary that the charging sequence described in the AMM be adhered to. It is important to remember during the nitrogen replenishment sequence, that an over-pressurised, or under-pressurised shock absorber has the potential for causing internal damage to shock absorber components and of course discomfort to the aircraft’s occupants! The information provided in this article will help to ensure that main landing gears and passengers will always have happy landings.
The current QSR is a paper document issued for each aircraft type and containing:
- each aircraft’s life history,
- the main monthly operational reliability characteristics for each operator (such as aircraft in service, daily utilisation, average flight duration and operational reliability*)
- engine removal and reliability data
- ETOPS operations, whenever applicable.

It is widely used by the industry for reliability monitoring and benchmark purposes.

In 1998, over 20,000 paper copies of the QSR, including all aircraft types, were produced and distributed to hundreds of addressees within the operators, suppliers, aviation authorities and 3rd party maintenance organisations.

The required amount of paper for this year so far has reached 6.5 tons, and piling up those 20,000 copies would have led to a 200 meter-high column, about two thirds of the height of the Eiffel tower.

In the last seven years the quantity of copies required has doubled and the increasing number of delivered aircraft, operators, and aircraft types of the Airbus family would probably require a further doubling of the paper volume in the next five years.

There was therefore the need to develop a simple and practical tool. By using a relatively recent but wide spread Web technology, the QSR-Web application allows consultation of operational reliability information at a glance. By providing accessible Microsoft® Excel source files, personal applications requiring Airbus reliability data may now be updated without need for retyping.

After almost 20 years of existence, the Quarterly Service Report (QSR) is now being re-shaped to provide more operational reliability information about the Airbus family aircraft more quickly.

**QSR-Web**

A new format for the Quarterly Service Report

The QSR is now available on CD-ROM and will soon be integrated within the Airbus On-Line Services (AOLS) environment.

This article introduces the QSR-Web, a new electronic format of the QSR, featuring Web technology, with simple ergonomy and improved features.

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*Operational Reliability = 100% minus the rate of revenue flights involving a ground or flight interruption (Delay/Cancellation or Diversion/In-Flight Turn Back), per 100 revenue take-offs.
The aviation industry has only recently started to fully recognize the value of digital technical data but Airbus Industrie has been working on the necessary foundations for today’s digital data products and services since the beginning of the 1990s.

Airbus Industrie delivered the first Aircraft Maintenance Manual and Illustrated Parts Catalog in SGML (Standard Generalized Markup Language) to airlines in July 1993. In July 1994 it launched digital data consultation tools using the CD-ROM technology with ADRES (Aircraft Documentation Retrieval System) containing the Maintenance Manual and Illustrated Parts Catalog. One year later CAATS (Computer Assisted Aircraft Trouble Shooting) a specific trouble shooting tool became available. Since then, Airbus Industrie has developed a wide range of digital technical data products to support the consultation and processing of technical data by the airlines. Until now, all these products were delivered off-line on computer tapes, floppy disks or CD-ROMs.

With the availability and growing influence of Internet and Web technology, Airbus Industrie has decided to put in place the necessary means to support on-line access to its Technical Data in a secure and reliable system environment.
AIRBUS ON-LINE SERVICES

All future on-line access to Airbus services will be provided as far as possible through one single interface called Airbus On-Line Services (AOLS). The general AOLS architecture is characterised by:
- utilisation of standard hardware (PC, Pentium)
- use of standard software tools (Web browser, Acrobat Reader and other plug-ins)
- on-line access via TCP/IP network
- information access through a common user interface
- specific access rights for each customer
- user authentication through the use of certificates (standard X.509 V3)
- data integrity during transfer through the use of the Secure Socket Layer (SSL) protocol
- upload and download functions for Technical Data
- availability 24 hours per day, 365 days per year.

Customers who want to connect to AOLS are not required to use a particular network connection but Airbus recommends the use of SITA AeroNet. AeroNet represents a worldwide available private network, dedicated to the aerospace industry that is based on Internet standards. It is secure and reliable and it guarantees the capacity of the network connection.

This article focuses on AIDA. It is fully “AOLS compliant” in terms of hardware and software architecture, network connection, security and user interface. It is undergoing its pilot phase with ten airline customers.

AIDA represents a new way of distributing drawings, which will replace drawings supplied on microfilm aperture cards and film cartridges for associated data. Up to now each new operator received with its first aircraft a package of between 80,000 and 120,000 drawing aperture cards with a set of associated data on film. These aperture cards and films were subject to updates to cover possible configuration changes of additional aircraft.

Depending on the size of the operator and its fleet, some airlines have to face the management of several collections reaching to some 1.8 million drawing aperture cards. Sometimes Airbus Industrie was asked to supply several sets of engineering drawings, required by the airline for maintenance, overhaul or repair at different locations.

With engineering drawings on-line, the airline will be relieved of the heavy task of keeping up-to-date the huge collections of drawing aperture cards. The current possibility of the misplacing an aperture card is removed. Also the time spent in searching for drawings and information will be drastically reduced.

AIDA provides the airlines with on-line access to mechanical drawings for all major aircraft assemblies, sub-assemblies and installations, for the whole fleet of Airbus aircraft. Access to drawings of detail parts is the subject of contract negotiation.

The drawings available in the AIDA service reflect the latest production drawing evolution (last issue). As with the aperture cards, drawings of non-Airbus proprietary parts are not included in the service. AIDA gives on-line access to the technical drawing set of firstclass structure, payload and mechanical systems.

A drawing consists of three separate documents:
- the Drawing Picture (graphical part)
- the Parts List (also called Bill of Materials or Schedule)
- the Parts Usage, which provides the next higher assembly (NHA) with corresponding aircraft effectivities.

All three documents bear the same number. This is the number that the user will enter in the Reference box on the query screen, before selecting which one of the three documents, Drawing Pictures (Picture Sheet), Parts List, or Parts Usage to be displayed.

With AIDA it is possible for the user to view and print either the information on the screen or the complete drawing set in a few seconds. It is also possible to zoom and rotate within a specific area of the drawing and to obtain an enlarged section of the drawing.

The Parts List and the Parts Usage enable the navigation within the drawing hierarchy from the aircraft general assembly down to detail parts, and the inverse.

The Parts List calls up all parts, sub-assemblies and items that are shown on the Drawing Picture sheet (detail parts, components and standard parts). On the picture, detail parts are indicated with a balloon, which provides a cross-reference between the Parts List and the Drawing Picture.

All drawn parts bear a part number derived from its drawing number by adding three additional digits. The inquiry by the part number will display the Parts List information related to this part.

To obtain the next higher assembly of a part, the user will select the Parts Usage. The Parts Usage displays the part variants (3-digit suffix) with their associated next higher assemblies and effectivities expressed in customer version/rank.
PUTTING AIDA TO TEST WITH AIRBUS ENGINEERS

Currently the Airbus Technical Library manages more than one million aperture cards. In order to reduce that management two AIDA consultation stations with a dedicated high-resolution printer capable of printing pages in A3 format have been installed. The system is used on a self-service basis and perceived as very user-friendly by the Customer Support engineers dealing with drawings. Assuming that the user already works in a Windows environment, minimum guidance is required.

The main functions of AIDA

DIRECT ACCESS TO A DRAWING

There are several ways to access a drawing:

- Direct access to the drawing by entering nine digits (ex: D53110011) in the Reference box
- A search facility using seven characters and a *, as shown in example 1, will display a drawing list from which the user can select the desired drawing.

Two additional criteria may be used:

- Title - key words (ex: splicing) describing the detail or assembly
- Geo Ref - Geographical reference of the main aircraft sections.

Example 1

✓ Enter the search criteria: Reference - D531100*, Title - splicing, Geo Ref. - B0
✓ Double click on the required Drawing Picture sheet highlighted in blue.

The picture is displayed by using the TIFF viewer plug-in of the browser. The splicing frames are indicated by the balloons (example item 35).
TOP-DOWN NAVIGATION IN THE DRAWING HIERARCHY USING THE PARTS LIST

This can be accomplished, for example by selecting the Parts List option in the contextual area (command bar) above the Drawing Picture, and the Parts List will be displayed. Clicking on one of the blue-highlighted part numbers allows navigation to the next-lower assembly.

Example 2

Looking for the drawing of item 35 (see example 1):

1. Click on the blue-highlighted part number reference within the Parts List:

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>D53110201000</td>
<td>SPLICING-FRAME 23</td>
</tr>
<tr>
<td>D53110930000</td>
<td>SPLICING-FRAME 21 RH</td>
</tr>
<tr>
<td>D53111099000</td>
<td>SPLICING FR21RH</td>
</tr>
<tr>
<td>D53110920000</td>
<td>SPLICING-FRAME 21 LH</td>
</tr>
<tr>
<td>D53110196000</td>
<td>SCISSAGE C21G</td>
</tr>
</tbody>
</table>

Then AIDA both updates

- the hierarchical navigation tree,
- and displays the Parts List of this drawing.

✓ Clicking on the Sheet link displays the Picture Sheet of the part.

Starting with a given drawing, it is possible to navigate downwards or upwards through the drawing hierarchy.
**BOTTOM-UP NAVIGATION USING THE PARTS USAGE**

This can be accomplished e.g. by selecting the Parts Usage option in the contextual area above the Picture Sheet and the Parts Usage will be displayed. Clicking on one of the blue-highlighted next-higher assemblies allows then navigating upwards.

**Example 3**

✓ From a Drawing Picture sheet (drawing D53210059) select the Parts Usage option:

✓ Then click on one of its blue-highlighted next-higher assemblies:
AIDA then both updates:

- the hierarchical navigation tree
- and displays the associated Parts Usage.

Then click on the Drawing Pictures option. The next-higher assembly picture is displayed.

As shown above, AIDA offers a very efficient way to manage the drawing set, view drawings (and print if needed).
HARDWARE AND SOFTWARE REQUIREMENTS

The following prerequisites are required in terms of network connection, hardware and software in order to be able to connect to AIDA:

- TCP/IP network connection - Airbus recommends a minimum bandwidth of 256 kbit/s and will support: AeroNet, Internet, ISDN, PSTN, direct lines
- Pentium 166 MHz with 64 MB RAM
- 17" screen (1024 x 768), but 20" screen is recommended
- 1 GByte hard drive
- Windows 95, 98, NT4
- 300 dpi A3/A4 Laser Printer, Adobe compliant. (A3 is necessary to be able to read the majority of drawings).
- Netscape Navigator 4.51 or (from year 2000 onwards) Internet Explorer 5.0 for security reasons
- Browser plug-ins:
  - TIFF plug-in recommendations (ViewDirector Prizm 2.3 or CSView 150)
  - PDF plug-in: Acrobat Reader 3.01 or higher

Access to AOLS and AIDA will be the subject of a commercial agreement between Airbus Industrie and the user.

Airbus Industrie is investigating the possibility of including additional drawing families in the service such as tool drawings and electrical drawings.

Should you need more information on AOLS and AIDA, please contact:

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LIST OF ABBREVIATIONS

AD Airworthiness Directive
ADRES Aircraft Documentation REtrieval System
AIDA Airbus Industrie Drawing Access
AOLS Airbus On-Line Services
AOT All Operators Telex
BFEMS Buyer Furnished Equipment Management System
CAATS Computer Assisted Aircraft Trouble Shooting
CD-ROM Compact Disk - Read Only Memory
CN Consigne de Navigabilité
FCOM Flight Crew Operating Manual
FOT Flight Operations Telex
ISDN Integrated Services Data Network
MID Modification Information Document
OIT Operators Information Telex
PDF Portable Document Format
PSTN Public Switch Telephone Network
SB Service Bulletin
SGML Standard Generalized Mark-up Language
SIL Service Information Letter
TCP/IP Transmission Control Protocol/Internet Protocol
TFU Technical Follow-Up
TIFF Tagged Information File Format
The QSR-Web application can be run with either MSIE5 on a Macintosh computer, or Netscape 4.51 browser versions on a PC. The minimum pre-requisites are delivered with the QSR-Web CD-ROM, which also includes a detailed userguide to provide you with necessary information to install (if required) the Web browsers, start the application, use the button bar and even some troubleshooting advice.

After launching the application, the legal terms of use precede the main presentation screen “Airbus Quarterly Service Report”, the layout of which is similar to the AOLS environment. This is followed by access to a navigation tree allowing selection of the required aircraft type. For each aircraft type, an image appears with a colored shade similar to the cover of the corresponding paper version of the QSR.

The sections available for access are similar to those available in the paper booklets. When selecting the “airline data” section, it is easy to switch from the data table for a given operator to the associated graphs by clicking on the link: “Show Graph”.

The new CD-ROM version of the QSR presents a range of improvements such as:
- improved ergonomy, with a 50g CD-ROM instead of two kilogrammes of paper copies for the existing eight aircraft types
- earlier availability (2 to 3 weeks reduction in the QSR production process)
- simultaneous information on all Airbus aircraft types
- access to the Excel source files to avoid the retyping of reliability data
- sharing possibilities by installing the application on a network
- a user friendly but also “environmentally friendly” product with its recyclable cardboard cover; which saves trees as well as time.

Very soon, access to QSR-WEB will be possible via AOLS.

A simplified paper version of the QSR will be maintained until the end of the year so that all the QSR readers get their EDP equipment upgraded to process CD-ROMs or access AOLS. However all the benefits of the QSR-Web mentioned above justify the discontinuation of a paper service by 2000.

The QSR-WEB on a CD-ROM benefits the user by providing more information, more quickly, in a user-friendly Microsoft ® Excel format, allowing updating of the user’s personal files without need for typing. Also the weight of a set of information on the whole Airbus fleet is reduced by 97.5% with the associated reduction in storage volume. New technology for the benefit of all.
A view of the future seen by some German scientists in 1917 (“Hamburger Anzeiger”).

“Rocket aircraft during take-off” by Max Balier, an engineer from Munich, who calculated that this aircraft would fly from Berlin to New York in one and a half hours at an altitude of 50,000 meters.

“Ocean aircraft of the future”: Passengers are embarked in a Trans-ocean Monster Aircraft operating between Hamburg and America. It would be furnished with the highest cabin comfort and the journey would last one and a half days.

“A floating ocean tank”: A giant monster of the Atlantic Ocean which could cross from Germany to America in two days, shown meeting a Zeppelin and a transport aircraft. It is interesting to note the shape of today’s low radar signature naval ships are approaching that of the “1917 monster”.

“Technology in the year 2000”
As an airline operator, your number one priority is to optimise the performance and profitability of your fleet. At Airbus, we constantly track our aircraft, monitoring everything from flight cycles and hours to efficiency and reliability. By sharing this experience with all our operators, we ensure that your aircraft are fully utilised and help you avoid any potential problems by keeping you one step ahead. Airbus Customer Services. Dedicated to meet your requirements.

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