FAST

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TYRE SERVICING WITH NITROGEN

F. Sarmentero A300 Engineering Manager Iberia

The FAA has recently issued an Airworthiness Directive (AD 87.08.09) which requires that the concentration of oxygen in a fully inflated tyre be kept below 5%. If this level is exceeded, the oxygen content must be reduced to the required level within a further fifteen hours in service.

The main problem in complying with the AD arises when nitrogen is not available and air is used instead to service the tyre. Some questions need answers before the proper maintenance task can be established :

How much air was added ?
How much pressure should be purged to reduce the oxygen level to within AD requirement ?
Was the 5% oxygen level exceeded ?
Is the tyre purged or left in operation if the maximum percentage has not been exceeded ?
How many times can the tyre be deflated and reinflated ?
What amount of pressure must be purged each time ?

The procedure described in this article keeps the percentage of oxygen by volume below the maximum 5% and establishes a maintenance task which is independant of the amount of air added to a tyre. The procedure gives the **minimum pressure to be purged in all cases** when air is used to service a tyre, if the tyre is initially inflated with nitrogen from ambient air pressure.

SCHEMATIC CYCLE FOR AIR SERVICING, PURGING AND INERT GAS RESTORATION

First of all let us have a look to one's component percentage variation in gas mixture during a complete cycle for air servicing and restoration:

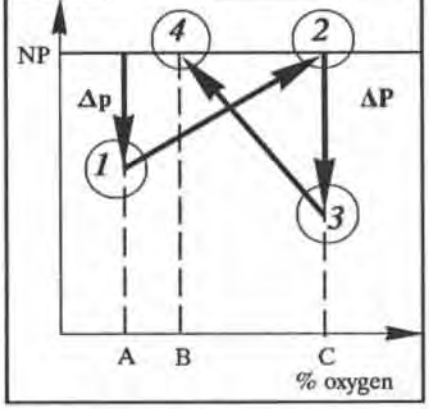
1 The tyre pressure is found to be **Δp** *below the Nominal Pressure (NP), nitrogen is not available.*

2 The pressure is restored by using air therefore increasing the oxygen content.

3 The tyre is purged a certain amount of pressure **ΔP**.

4 The tyre is refilled with nitrogen.

Figure 1



The final **B**% in oxygen may be higher or lower than the initial **A**%, depending on the values given to **Δp** and **ΔP**.

Keeping constant **Δp** and **ΔP**, the percentage of oxygen in volume contained in a tyre will be increased or decreased depending on the amount of **Δp** and **ΔP**, but *the variation tends to balance and stabilize after a certain number of repetitive cycles.*

STABLE CONDITIONS

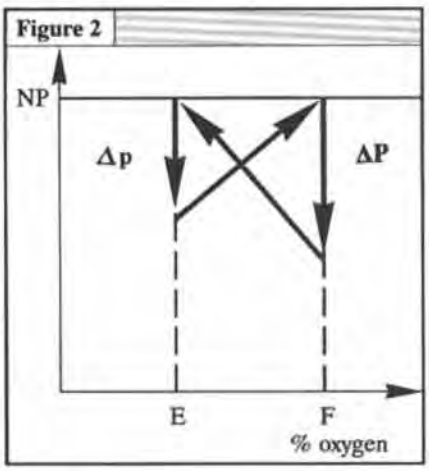
When the stable condition is reached following a number of deflation/re-inflation cycles, the amount of oxygen charged during servicing is the same as the one drained during purging.

After repetitive cycles the initial and final conditions will remain the same, this is the **E**% stable condition.

The maximum **F**% of oxygen in the tyre is reached after refilling with air from the **E**% stable condition.

The greater the **ΔP** is, the lower **E**% comes and vice-versa.

Figure 2

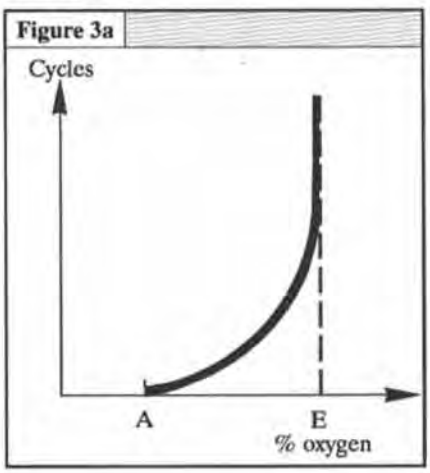


PERCENTAGE OF OXYGEN VARIATION WITH REPETITIVE CYCLES FROM INITIAL CONDITION

The initial condition is defined by the percentage of oxygen when the wheel is installed on the aircraft.

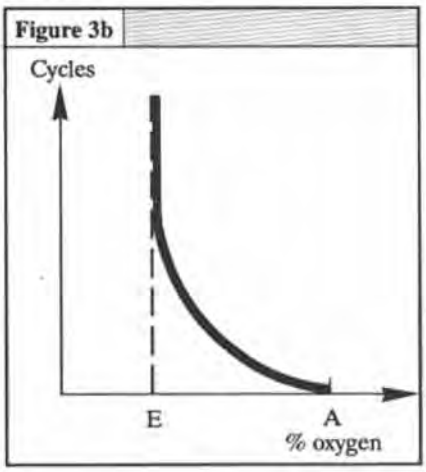
● If the initial %**A** of oxygen in volume is lower than the stable %**E** condition, the percentage oxygen variation versus the number of repetitive cycles is shown in the figure 3a below :

Figure 3a



● If the initial %**A** of oxygen in volume is higher than the stable %**E** condition, the percentage of oxygen variation versus the number of repetitve cycles is shown in the figure 3b below :

Figure 3b

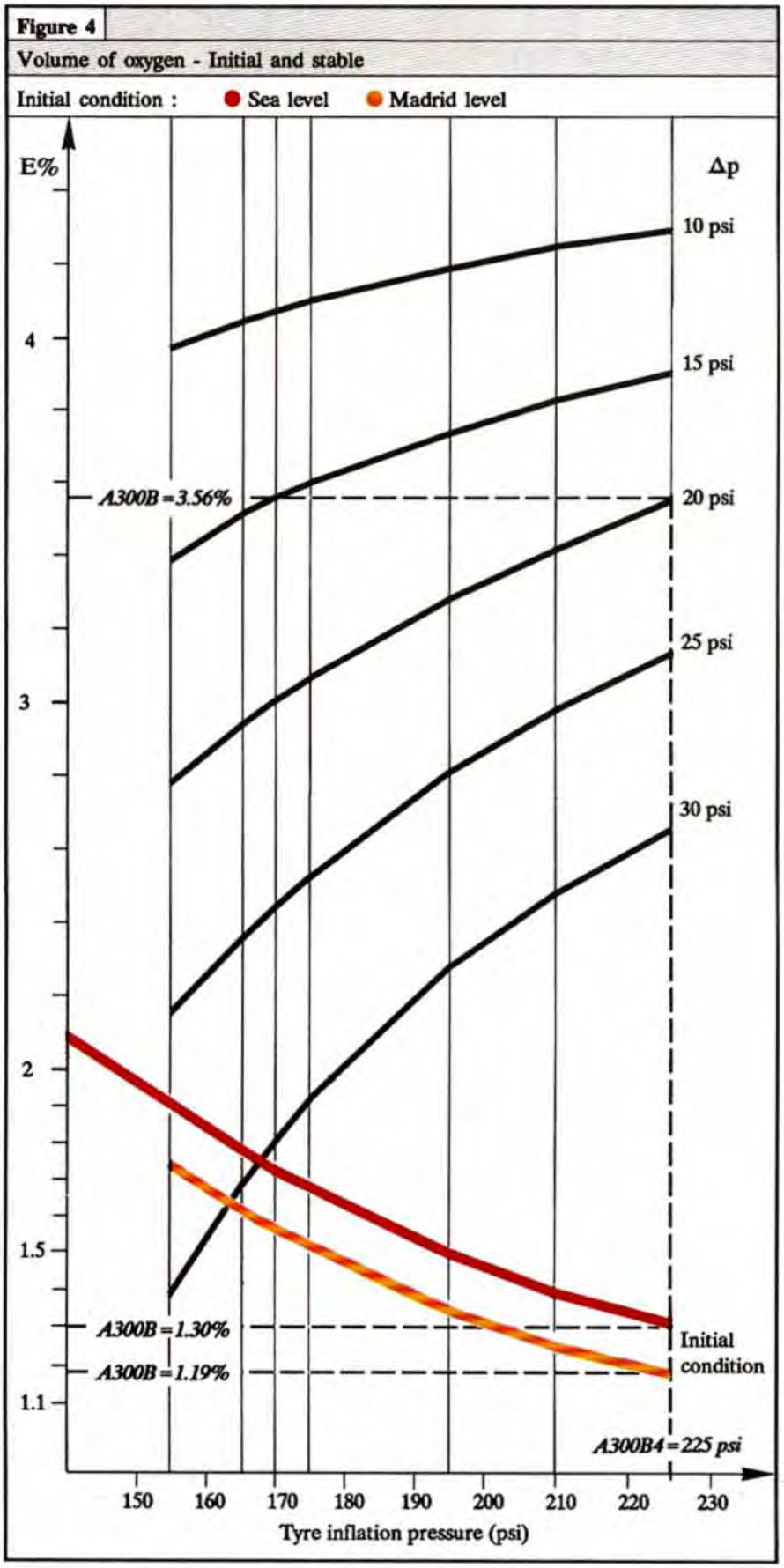


In Figure 4 the initial condition curves show the initial percentage of oxygen in a tyre when it is installed on the aircraft for the first time at the nominal inflation pressure. It has been assumed that the tyre was assembled at sea level and the ambient air in it was not purged prior to the inflation; therefore one tyre volume of air remained in the tyre.

Δp in Figure 4 is defined by the aircraft manufacturer as the maximum allowable pressure drop without requiring wheel removal. Therefore the reinflation pressure during servicing will never exceed the allowable deflation.

Figure 4

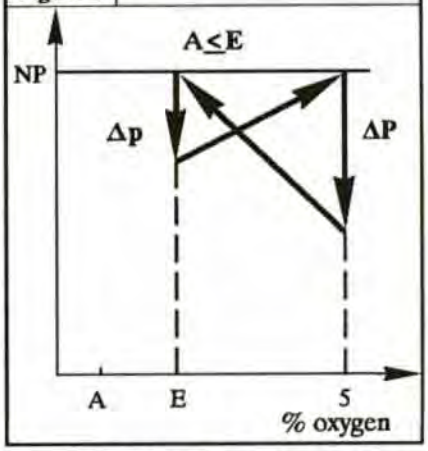
Volume of oxygen - Initial and stable



ESTABLISHING THE PROCEDURE

The maximum percentage of oxygen following repetitive deflation/reinflation cycles (**F** in figure 2) must not exceed 5%. For a given nominal pressure (NP) and **Δp,** the stable oxygen level **E** can be obtained (figure 4). The initial concentration of oxygen **A** must be lower than the obtained stable level **E.** (If not, the following example would not be applicable). With the NP and the **Δp** pressure to be purged (**ΔP**) can be obtained from figure 6 *(which is followed by a practical example)..*

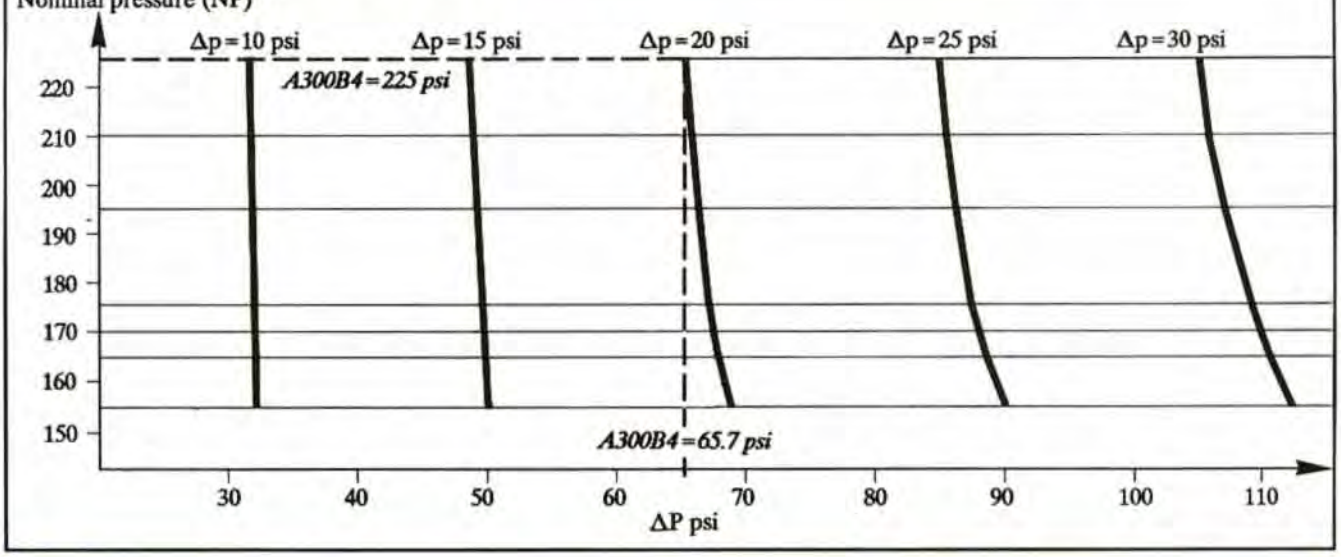
Figure 5



Once the **ΔP** has been defined, operators will always comply with the AD following this simple rule : **Each time a tyre is serviced with air, the required amount of pressure to be purged, in order to keep the concentration of oxygen below 5 %, is ΔP. This process of purging must be done before any additional refilling with air. A second air servicing to the same tyre without the necessary previous purging would require, within 15 hours time in service, a complete purging in order to warrant full compliance with the AD in all possible cases.** Once the gas mixture gets the stable level of oxygen, it will always remain in this condition each time a complete cycle is repeated.

Figure 6

Deflation - Establish pressure to be purged **ΔP**



A practical example for the Airbus A300B4 for an NP of 225 psi and Δp of 20 psi:

Figure 4 gives:
1.30% for the initial percentage of oxgen at sea level
3.56% for the stable percentage of oxygen
The initial percentage is lower than the stable percentage.

Figure 6 gives:
ΔP of 65.7 psi to be purged when a tyre has been serviced with air.

Therefore in four steps:
a) 20 psi pressure leak
b) 20 psi reinflation with air
c) 65.7 psi deinflation
d) 65.7 psi reinflation with nitrogen
an oxygen content will be achieved which even with repetitive deflation/reinflation cycles will not exceed the stable oxygen percentage E of 3.56%.

CONCLUSION

It must be clearly understood that during a normal tyre life this situation of repetitive air servicing and purging is unrealistic, but even if this rare case happens with the procedure described, the maximum 5 % concentration of oxygen by volume will never be exceeded.

To simplify the mechanics' job and avoid possible mistakes, it is recommended that **ΔP** is calculated for each of the aircraft types in the operator's fleet and then the highest **ΔP** is used on all aircraft.

The avionics workshop

What's new?

The impact of the first generation digital aircraft on avionics shops had been underestimated by the whole aviation industry due to the lack of a pertinent test concept. This two part article shows the evolution of new concepts for avionics shop maintenance by the airlines. The first part deals with the Arinc/Aerospatiale concept, the second part highlights the Airbus Industrie concept and its links to the Arinc concept.

THE SMART STORY

by Gérard Darteyre, Avionics & Systems Division, Aerospatiale

In the early 1980's, with the introduction of the A310 and the 767 and their digital technology, two solutions were offered to the airlines for testing and repair of avionics. While Boeing proposed to the airlines to use as many different pieces of automatic test equipment (ATE) as there were major equipment manufacturers on the aircraft (Collins, Boeing Electronics Co., Sundstrand, Sperry, General Electric...), Airbus Industrie offered its customers a free choice between such a solution (so called dedicated testers) and the solution based on a single modular ATE, capable of testing a wide range of avionics of different aircraft types. With the exception of one customer, all A310 and A300-600 customers have selected the modular solution. The majority of the airlines selected the dedicated testers, not for economic reasons, but because a modular solution was not available at the time of introduction of the 767 (three years were necessary to develop a complete library of test programs).

By the end of 1985, to avoid such a situation in the future (which resulted in sky rocketing costs for avionics' shop maintenance), these airlines (in particular Delta and American Airlines) and Arinc asked the Test Equipment Guidance (TEG) 103 group to define a solution. The TEG 103 group was formed by the Aircraft Radio Inc. (Arinc) and the Airline Electronic Engineering Committee (AEEC).

TEG 103 took into account a previous experiment in 1982 when it issued the Arinc 602 recommendation for the modular ATE which never became a reality because it addressed only the hardware part of the problem and not the software one (system software to operate the ATE, create and debug the test programs). This time, TEG 103 came rapidly to the following concept: *the equipment manufacturers (for their avionics production), the aircraft manufacturers (for their quality control and their assembly line) and the airlines (for the maintenance of these avionics) should be free to select any hardware of their choice, but use the same test programs.* In other words, the development of the test program should be done once, and the test program should be transportable from one ATE to another.

This goal being defined, TEG 103 checked whether that dream could become a reality and by which means. The answer was yes it is

possible, under the following conditions:

- Use a standard language for the test program development. The standard retained is Atlas 626 (Abbreviated Test Language for All Systems).
- Use common guidelines when writing an Atlas 626 program. An Atlas programmer guide, defined as Arinc 627 standard is being created.
- Standardize the interface between the Line Replaceable Unit (LRU) under test and the ATE used. This standard is defined by the Arinc 608 document.
- Use a single software system for creating, updating and compiling Atlas sources, then running and debugging the test programs. So as to allow a freedom of hardware choice, this system shall be easily portable from one computer type to another.

This is how the SMART (Standard Modular Avionics Repair and Test system) concept was born. A SMART ATE can be any combination of resource and measurement devices with a SMART switch (as defined in the Arinc 608 document) interconnected via a standard IEEE (Institution of Electrical and Electronic Engineers) 488 bus to any type of computer capable of running Atlas 626 test programs under the control of this SMART software.

The question then was, how to distribute the SMART software? Larry D. Carpenter of Arinc gave the answer : the SMART software with the updates and evolutions will be purchased by Arinc itself from the industry and they will distribute it to all the SMART ATE's users. By mid 1986, Arinc launched a Request for Proposal to the industry so as to get such a SMART software users club to finance this project, and proposed a SMART Service contract, where the user has to pay a monthly fee over a period of five years starting from the delivery of the SMART software. Having reached the critical mass in terms of number of SMART service contracts signed by April 1987, Arinc selected the winner to develop the SMART software and demonstrate it on a SMART hardware. Competitors were Sperry, Westinghouse/British Aerospace, AAI, GEC Avionics, and Aerospatiale/Lexico. Aerospatiale associated with Lexico* won this competition and the contract was signed with Arinc on 15 June, 1987. By this contract Aerospatiale will deliver to Arinc the following :

- One SMART ATE made up of Atec 5000 resources and measurement devices, a SMART switch, and a Mo-