ORIGINAL

SILOMS as maintenance data source for MSG-3 methodology applied to C-105 Amazonas airship maintenance plan

SILOMS como la fuente de datos de mantenimiento para la metodología MSG-3 aplicada al plan de mantenimiento de la aeronave C-105 Amazonas

SILOMS como a fonte de dados de manutenção para a metodologia MSG-3 aplicada ao plano de manutenção da aeronave C-105 Amazonas

Lt Col Fabrício José Saito, Master
Aeronautical Material Park of São Paulo - PAMASP
São Paulo/SP - Brazil
fabriciojsaito@gmail.com

ABSTRACT

This paper to intended to present how a set of logistic information, made available by the Materials and Services Integrated Logistics System (SILOMS), complies with MSG-3 (Maintenance Steering Group-3) methodology, applied to Brazilian Air Force (FAB) C-105 Amazonas airship maintenance plan. The research, based on technical documents on MSG-3 and COMAER handbooks and instructions, has identified the information required to an eventual review of the maintenance plan. A comparison between the needs and the content made available by SILOMS has shown a partial compliance that hinders the plain use of MSG-3 methodology. In this paper it is concluded that this lack of information available makes unfeasible any initiative related to C-105 Amazonas airship maintenance plan review, if the correct support of MSG-3 methodology is a requirement.

Keywords: MSG-3. SILOMS. Maintenance plan. C-105 Amazonas.

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RESUMEN

Este articulo tiene como fin presentar de qué forma el grupo de informaciones logísticas, ofrecidas por el Sistema Integrado de Logística de Material y de Servicios (SILOMS), cumple con la metodología MSG-3 (Maintenance Steering Group-3) que fue aplicada al plan de mantenimiento de la aeronave C-105 Amazonas de la Fuerza Aérea Brasileña. La investigación, basada en documentos técnicos sobre MSG-3 y en manuales e instrucciones del COMAER, identificó las informaciones necesarias para una eventual revisión del plan de mantenimiento. Al comprar las necesidades con aquello que es ofrecido por el SILOMS, se verificó un cumplimiento parcial que impide la utilización de la metodología MSG-3 en su plenitud. En este artículo se concluye que esa indisponibilidad de informaciones torna inviable cualquier iniciativa referente a la revisión del plan de mantenimiento de la aeronave C-105 Amazonas, si el debido soporte de la metodología MSG-3 fuera un requisito.

Palabras-clave: *MSG-3. SILOMS. Plan de mantenimiento. C-105 Amazonas.*

RESUMO

Este artigo visa apresentar de que forma o conjunto de informações logísticas, disponibilizadas pelo Sistema Integrado de Logística de Material e de Serviços (SILOMS), atende à metodologia MSG-3 (Maintenance Steering Group-3) que foi aplicada ao plano de manutenção da aeronave C-105 Amazonas da Força Aérea Brasileira. A pesquisa, com base em documentos técnicos sobre MSG-3 e em manuais e instruções do COMAER, identificou as informações necessárias para uma eventual revisão do plano de manutenção. Ao serem comparadas as necessidades com aquilo que é disponibilizado pelo SILOMS, verificou-se um atendimento parcial que impede a utilização da metodologia MSG-3 em sua plenitude. Neste artigo conclui-se que essa indisponibilidade de informações torna inviável qualquer iniciativa referente à revisão do plano de manutenção da aeronave C-105 Amazonas, se o devido suporte da metodologia MSG-3 for um requisito.

Palavras-chave: *MSG-3. SILOMS. Plano de manutenção. C-105 Amazonas.*

1 INTRODUCTION

Like most different military forces worldwide, the Aeronautic Command (COMAER) is also challenged to find solutions that make feasible the increase of efficiency in its several operations. Most of the challenges identified by this Command are listed in two documents basically: National Defense Strategy (END) and Aeronautic Military Strategic Plan 2010-2031 (PEMAER).

END establishes that, in times of peace

> military organizations will be articulated to combine compliance with Job Hypotheses and the need to optimize maintenance costs and provide execution of instruction in specific operational environments. (BRASIL, 2008).

PEMAER composes END unfolding within COMAER ambit and clearly points to

> the need that logistic activities are well tuned in technological evolution of tools that support maintenance and procurement logistic functions. (BRASIL, 2010).

In this context, it is perfectly aligned to the search for alternatives that lead to increases in airships availability with the proper maintenance costs reduction. Generally, efficiency measures are translated by means of the quotient between production (available airships) and inputs (budget resources). The effort should be, therefore, to do more with less, attacking simultaneously the numerator and the denominator of this ratio. When focus is kept on airships availability and budget resources binomial, it is clear that the logistic support to a weapon system should be subject to permanent analysis and follow-up. Part of this analysis will mandatorily approach the frequency of maintenances (corrective and preventive) and the respective maintenance tasks, required to ensure a safe operation. However, every time these tasks occur, expenses are made and unavailableness occurs.

The aeronautical systems technological evolution has shown to the market airships with larger operational capacity, and structures increasingly more complex. Modern airships are composed of several systems, with specific functions integrated. In this scenario, would it be correct to imagine that the safe operation of an airplane requires a solid knowledge of its systems functioning and interaction? Partially.

For a safe flight, it is required, no doubt, to understand the airship functioning, but this is not sufficient, since it is not enough to know how the system works, but to understand how it fails. In this sense, safety will also be ensured if the mechanic of all possible failures is perfectly identified and described.

Though not as clear as a design alteration, airships maintenance has evolved in failure mechanisms understanding. Airships from the 50s presented rigorous preventive maintenance plans, contemplating, many time, the complete review of an equipment, system or airship. For a layman, to know that the plane was disassembled, reviewed and assembled again indicated safety warranty. For several years, this was common sense for airships like Douglas DC-3, DHC-5 Bufalo and Boeing 707, using only FAB patrimony airships as examples.

Today, analyzing these old maintenance plans, one observes that the lack of knowledge of failure process has taken to conservative decisions of requiring, periodically, the overhaul (disassembly, inspection, review and assembly task) of equipment, systems and airships. This paradigm lasted until the moment when larger and more complex airships maintenance plan started to require high levels of labor and costs. The counterpart was the low operational availability due to extended terms to fulfill maintenance tasks, which would make economically infeasible the use of future airships.

So, in face of the need to improve the maintenance plan and ensure acceptable safety levels, the RCM – Reliability Centered Maintenance – concept was introduced, where, essentially, failure modes are identified that affect the system functioning and, then, the consequences of each failure are assessed to finally be established, in maintenance plan, tasks applicable and effective to prevent functional failures. Nowlan and Heap (1978), presenting a new focus, have revolutionized the maintenance plan development process and have provided the logical basis for MSG-3 methodology.

When an airship goes into service, it is common that all operation data tried are not exactly those that were considered during the development. Thus, updated information should be collected to re-feed the MSG-3 process, and, then, eventually, review tasks and intervals of the original maintenance plan.

In COMAER ambit, the airship Central Park, is the body responsible for conducting the maintenance plan review process, while the Material and Services Logistic Integrated System (SILOMS) is the source of operational data. Such system would have, then, the role of providing the same set of information from equipment/systems used in the initial MSG-3 process.

The C-105 Amazonas is operating at COMAER since 2006 and its preventive maintenance plan was developed according to MSG-3, so, it is plausible to foresee a future need for the Central Park, São Paulo Aeronautical Material Park (PAMASP) to review C-105 Amazonas maintenance plan. This review, due to operational and economic impacts, should be object of study in order to ensure that C-105 Amazonas will have an efficient maintenance plan, coherent with the airship operational reality.

Given the challenges posed by END and PEMAER, this study, seeking maintenance efficiency, intends to check SILOMS capacity to make available to PAMASP the maintenance data required by MSG-3 methodology.

2 LITERATURE REVIEW

This chapter presents the main concepts of a maintenance plan developed according to MSG-3, based on the work of Nowlan and Heap and document ATA MSG-3: Operator/Manufacturer Scheduled Maintenance Development Document. In the literature accessed, maintenance data required to methodology application are identified. Finally, to place this work in FAB logistic scenario, a SILOMS description is provided.

2.1 MSG-3 – History and concept

The development of a preventive maintenance plan always gives rise to economical and technical discussions. For equipment with complex systems like an airplane, whose failure may result in large losses, it is natural that a conservative behavior is adopted. Such thought has dominated the initial operation scenario of airships and maintenance paradigms, based on inspections and frequent changes of components. Maintenance plans were prevailing and a way to avoid occurrence of catastrophic failures. When the item presented unacceptable failure rates, the solution would be the increase of inspections, overhauls and replacements frequency.

In terms of project and fabrication, the 60s has seen large technological advances that affected positively the reliability inherent to aeronautical components, however maintenance plans of new airships did not present the same evolution rhythm. The consequence of keeping these old paradigms in more complex systems maintenance was the increase in support costs. On the second half of that decade, the development of the Boeing 747, first wide body airship, has brought the required motivation that led air companies analyze operational data, and it was observed that aeronautic systems reliability did not keep a direct relation with the frequency of inspections and interval of overhauls.

In July 1968, the Maintenance Steering Group (MSG), formed by Federal Aviation Administration (FAA) representatives, manufacturers and air companies, develop the Handbook MSG-1 (Maintenance Evaluation and Program Development), which would be used to elaborate the Boeing 747 (AIR TRANSPORT ASSOCIATION, 2003) maintenance plan. That was the first attempt to apply the Reliability Centered Maintenance – RCM – concepts (NOWLAN; HEAP, 1978).

Then, improvements were incorporated to the decision process initially presented in MSG-1 and a second MSG-2 document (Airline/Manufacturer Maintenance

Program Planning Document) was developed and applied to Lockheed 1011 and Douglas DC-10 (NOWLAN; HEAP, 1978) airships maintenance plan. Both documents aimed to develop a preventive maintenance program, able to ensure maximum safety and operational reliability as close as possible of the inherent at a minimum cost. The initiative success was immediately noticed when maintenance plans of airships similar in size (DC-8 and DC-10) were compared. In order to keep the DC-8 a periodical review of 339 items would be required, while in DC-10, based on MSG-2, only 7 items presented the same demand (NOWLAN; HEAP, 1978).

In 1979, MSG group composition has gained diversity by counting on the participation of ATA (Air Transport Association), FAA, UK Civil Aviation Authority (CAA/UK), North-American Navy, foreign airlines and several components and motor manufacturers' representatives. Though keeping fundamental concepts, the new MSG-3 document was elaborated to make its application more friendly. (SPITLER, 1990).

Baptized as "Operator/Manufacturer Scheduled Maintenance Development Document", the MSG-3, as a decision process, has brought improvements, as compared to MSG-2 (AIR TRANSPORT ASSOCIATION, 2003). Among them, we may include:

a) functional failure consequence analysis, categorizing it as safety and economic;

b) incorporation of considerations on structural damages;

c) orientation to maintenance task instead of process as was established in MSG-2;

d) inclusion of service/lubrication task as part of the logic; and

e) clear separation of economically desirable and required tasks for a safe operation.

The MSG-3 process, as a whole, clearly defined the following objectives for a scheduled maintenance (AIR TRANSPORT ASSOCIATION, 2003):

a) ensure that the airship inherent reliability and safety levels will be reached;

b) recover the airship inherent reliability and safety levels when deterioration occurs;

c) obtain required data for improvements of items project, whose inherent reliability is inadequate; and

d) reach objectives at a minimum cost.

2.2 MSG-3 – The logic

The decision logic shall be applied to each MSI (Maintenance Significant Item). MCA 400-15 defines MSI as

> Significant maintenance item, whose functional failure presents operational, economic or safety impact on the system. Usually chosen based on a specific logic, seeking an excellent level of details of the system studied. (BRASIL, 2006).

For each MSI, it should be defined:

a) function: what the item does in the system;

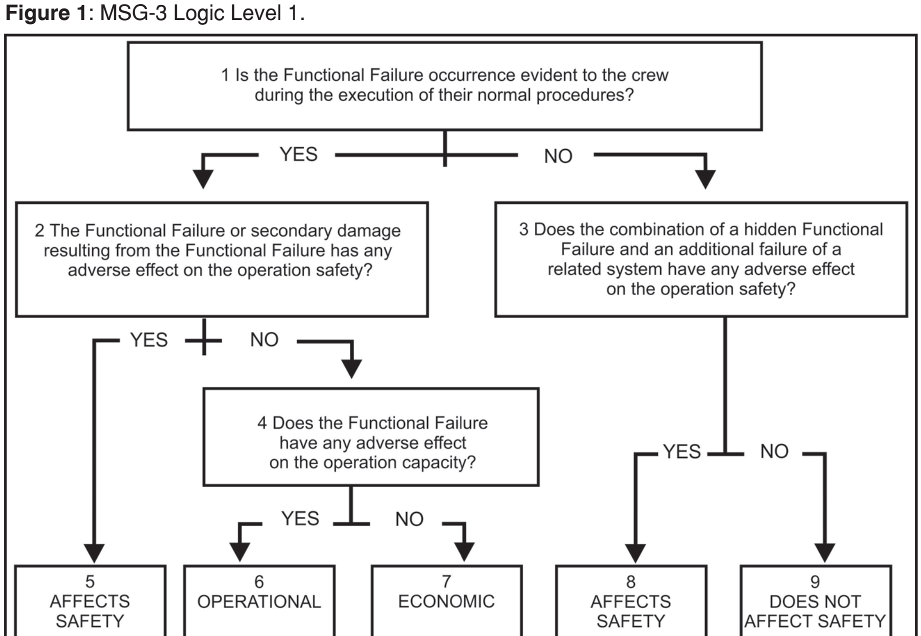
b) functional failure: when the item does not fulfill its function;

c) failure effect: result of the functional failure; and

d) failure cause: reason why the failure occurred.

Figure 1 represents the logic to be applied in the first level of analysis (questions 1, 2, 3 and 4) and the search to identify each functional failure consequences in order to determine the failure effect category (categories 5, 6, 7, 8 or 9).

Figure 1: MSG-3 Logic Level 1.



Source: Brasil (2006).

2.3 MSG-3 – Criterion to chose maintenance task

At the second level, each MSI failure causes are searched, and immediately, the feasibility of a preventive maintenance task able to ensure the airship inherent reliability is assessed. For such, the following questions must be analyzed for failure categories from 5 to 9:

a) is a lubrication task or service applicable and effective?

b) is an operational or visual check applicable and effective? (hidden functional failure categories, 8 and 9)

c) is a functional inspection or check to detect the function degradation applicable and effective?

d) is a restoration task to reduce failure rate applicable and effective?

e) is a discard task to avoid failures or reduce failure rate applicable and effective?

f) is there any other task or task combination applicable and effective? (safety categories, 5 and 8)

Chart 1 below, adapted from MCA 400-15, contains the column "Example", in which some typical tasks of scheduled maintenance are listed.

Chart 1: Tasks selection criterion.

TASK	APPLICATION CRITERION	EXAMPLE	SAFETY EFFECTIVITY	OPERATIONAL EFFECTIVITY	ECONOMIC EFFECTIVITY
LUBRICATION OR SERVICE	Replacement of consumption items should reduce functional degradation rate.	Lubricate hinges and check tires pressure.	The task should reduce failure risk.	The task should reduce failure risk to an acceptable level.	The task should be cost-effective (task cost lower than failure cost).
OPERATIONAL OR VISUAL CHECK	Failure identification should be possible.	Check oil level.	The task should ensure adequate availability of hidden function in order to reduce multiple failures risk.	Not applicable.	The task should ensure adequate availability of hidden function in order to avoid multiple failures economic effects and be cost-effective (task cost lower than failure cost).
FUNCTIONAL INSPECTION OF CHECK	Reduction of resistance to failure should be detectable. There must be a reasonable interval between the degradation condition and the functional failure.	Visual inspection of engine, x-ray, ultrasound.	The task should reduce failure risk to ensure a safe operation.	The task should reduce failure risk to an acceptable level.	The task should be cost-effective (task cost lower than failure cost).
RECOVERY	MSI should present characteristics of functional degradation in an identifiable operational age and most units should survive until this specified age. It should be possible to restore the MSI until an acceptable standard of failure resistance.	Cleaning of filter, engine overhaul.	The task should reduce failure risk to ensure a safe operation.	The task should reduce failure risk to an acceptable level.	The task should be cost-effective (task cost lower than failure cost).
DISCARD	MSI should present characteristics of functional degradation in an identifiable operational age and most units should survive until this specified age.	Change of filters, items with useful life limit.	Discard at limit age should reduce failure risk and ensure safe operation.	The task should reduce failure risk to an acceptable level.	Discard task at limit age of MSI should be cost-effective (task cost lower than failure cost).

Source: Adapted from Brasil (2006).

As the logic is applied, in case no adequate maintenance action is reached, the system re-project is mandatory, because safety is essential.

2.4 MSG-3 – Tasks interval

Having defined the maintenance tasks able to avoid the undesired failure, we get to another dimension of any maintenance plan: definition of each task periodicity. The most adequate maintenance frequency should be selected, based on information available on the system operation. Maintenance intervals may be defined, for example, in terms of time units, days, flight hours and landings.

ATA MSG-3 and NAVAIR 00-25-403 identify aspects to be considered in the following maintenance tasks:

a) lubrication or service – focus on failure prevention:

- interval based on the item use and its deterioration characteristics; and
- weather conditions and operational environment should be considered to define deterioration characteristics.

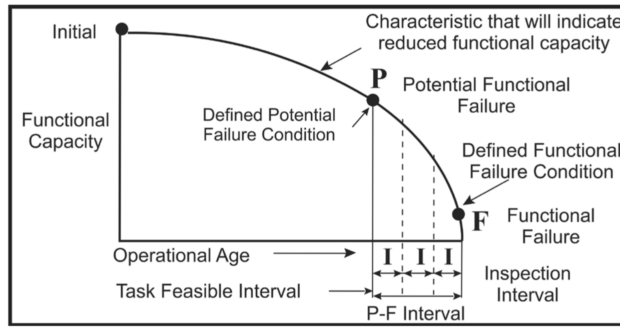
b) operational or visual check – focus on failure identification:

- time of exposure to a hidden failure and potential consequences in case the hidden function is not available;
- intervals should reduce the probability of occurrence of multiple failures to a tolerable level; and
- probability that the task itself leads hidden function to failure.

c) functional inspection or check – focus on potential failure identification:

- there must be a clear condition for potential failure;
- such condition should be detectable and indicate that a failure process is in progress. When the inspection reveals such conditions ("on condition" task), corrective action shall be conducted. On condition task occurs only when required, letting the equipment operate until a new potential failure is detected, maximizing its useful life and minimizing repair costs; and
- Figure 2 of P-F Curve, shows that, at the moment when functional degradation ratio is identified, one interval I is established so that there is wide opportunity for this condition to be detected before the equipment functional failure. For such, there must be a defined condition of potential failure (P point) and the time estimate, until the functional failure (F point) is reached.

Figure 2: P-F Curve.

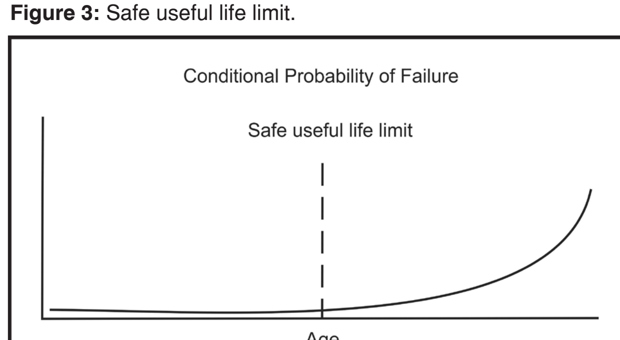


Source: Adapted from United States of America (2003, p. III-14, our translation).

d) recovery or discard – focus on avoiding failure:

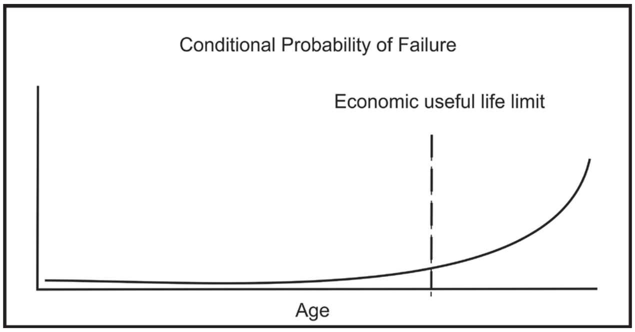
- intervals should be based on the concept of existing a useful life limit to the component, requiring overhaul or replacement so that the reliability inherent to the system is recovered;
- two terms are used to distinguish the item whose useful life limit affects safety from the item that causes only economic impact: safe useful life limit and economic useful life limit, respectively;
- safe useful life limit should ensure that failure occurrence will not occur (Figure 3), because failure consequences affect safety; and
- economic useful life limit causes just economic impacts, and can include risk of eventual failure (Figure 4).

Figure 3: Safe useful life limit.



Source: United States of America (2003, p. III-18, our translation).

Figure 4: Economic useful life limit.



Source: United States of America (2003, p. III-18, our translation).

The challenge of establishing the appropriate interval will remain throughout the whole operational life of the airship, and may evolve along this period. Hence the indispensable need for a precise and complete record of the different equipment functional history, since such information, when duly analyzed, will support future reviews of the maintenance plan.

2.5 SILOMS

On January 21, 1993, the Materials and Services Integrated Logistics System (SILOMS) was created in order to unify COMAER logistic processes by means of an integrated data base. For that, one single tool would be made available to manage activities, to standardize methods and processes.

SILOMS is an online system, ERP (Enterprise Resources Planning) type, which comprises MRP II (Management Resources Planning) functionalities with a centralized data bank, destined to support COMAER logistic activities management, integrating the supply chain, as well as the whole Material Catalog by OTAN System. Besides, it is integrated to the Catalog Military System – SISMICAT (SILOMS, 2013).

To reach its objective, SILOMS is divided in modules and sub modules, among which the most important are Administration, Acquisition, Procurement, Fuels and Lubricants, Cataloguing, Maintenance, Transport, Human Resources, Support to Decision and Military Equipment (BRASIL, 2007). Specifically, in Maintenance module the following activities are carried out: planning of resources required to maintenance; services planning and programming; defects control and analysis; and obtention of logistic indicators.

For that, it is divided in the following sub modules: Production, Control, Planning, Engineering and Publishing.

Currently, SILOMS is effectively used by around 333 (three hundred and thirty three) units in all states of the country, with a total of over 15,000 (fifteen thousand) users registered (SILOMS, 2013).

3 METHODOLOGY

This work consisted of documental research based on official and technical document analysis. The methodology adopted is based on the following aspects:

a) survey the set of data required to elaborate a maintenance plan according to MSG-3 methodology. For that, a literature review was required to obtain a list of maintenance and operation data which should be made available to the analyses defined in MSG-3 methodology;

b) based on C-105 Amazonas airship maintenance plan, take as sample the maintenance task related to the hydraulic pump for illustrative purposes of MSG-3 methodology final product, and to assist in the research on maintenance data currently made available by SILOMS. Alternative sources (or non official) which could meet MSG-3 analysis are not considered;

c) with a brief presentation of the item, check SILOMS capacity to provide required information so that PAMASP could carry out a maintenance task review under e MSG-3;

d) the work with SILOMS included interviews with programmers and access to the system itself in its current version; and

e) during these opportunities, it was positively checked whether SILOMS provided the information by asking for the report and/or module/sub module that would make available the required datum.

4 DATA PRESENTATION AND ANALYSIS

Nowlan and Heap (1978) stated that a scheduled maintenance program should be dynamic and the airship user should count on a system for equipment operational data collection and analysis. This information is required to determine necessary improvements and changes, both in manufacturer original plan and in the product per se. The authors have also presented information required to Reliability Centered Maintenance (RCM), as shown in Chart 2.

Chart 2: Data required for analysis.

1. Item identification	a. Type of airship b. System designation c. Name d. Manufacturer PN e. Amount per airship (QPA)
2. Item information	a. Description (function and main components) b. Redundancies and protection characteristics (including instrumentation) c. Self-test equipment (BIT – Built-in Test)
3. Reliability data	a. Premature removal rate b. Failure rate
4. Operational restrictions	a. Airship can be shipped with item in failure? b. If Yes, are there limiting conditions?
5. Data for RCM / MSG-3	a. Item function b. Functional failures for each function c. Failure modes d. Failure effect for each failure mode e. Functional failure evidences f. Effects of function loss on operational capacity g. Effects of failure beyond function loss (secondary damages) h. Evidence of reduction in failure resistance that can be used to define conditions of potential failure i. Experience with other equipment where the same item or similar is used.

Source: Nowlan and Heap (1978).

Though his work is not dedicated to MSG-3 and RCM, Blanchard (1992) presents a list of data that should be treated by a maintenance management system. Such system should have forms for complete data collection and should be easily understood. Chart 3 below, adapted from Blanchard (1992), presents information that should be common to this type of information systems.

Chart 3: System maintenance data.

1. System factors	a. Equipment and manufacturer PN b. Serial number c. System operation time when event has not occurred d. Mission segment when event occurred e. Event description (symptom of failure for not programmed actions)
2. Maintenance factors	a. Maintenance requirements (repair, calibration, services, etc.) b. Description of maintenance task c. Downtime for maintenance d. Time of effective maintenance e. Delays in maintenance (wait for part, delay for testing equipment, downtime, wait of labor, etc.)
3. Logistic factors	a. Start and end times for each technician work b. Handbooks used c. Testing equipment used d. Description of facilities used e. Identification of replaced material

Source: Adapted from Blanchard (1992, p. 329, our translation).

To complement all that, MCA 400-15 establishes, for each Reliability Centered Maintenance methodology, the need to fulfill collection and organization phase while analyzing maintenance data. For that, a standardized spreadsheet is presented, according to Figure 5, for record of information.

Figure 5: Standardized spreadsheet.

Part I: Information on MSI	
MSI	
PN	
Manufacturer	
TBO	
TO	

Part II: Failure data								
SN	TSN	TSO	TSNA	TSOA	Removal	Failure cause	OBS	HH Repair

Source: Brasil (2006).

Where:

a) MSI: item name;

b) PN (Part Number): MSI code, assigned by manufacturer;

c) manufacturer: manufacturer name/code (MFG);

d) TBO (Time Between Overhauls): interval between general reviews;

e) TO (Technical Order): MSI review and operation technical order;

f) SN (Serial Number): item serial number;

g) TSN (Time Since New): accumulated operation hours, since new, in hours: minutes format, according to record in MSI history card;

h) TSO (Time Since Overhaul): accumulated operation hours since the last overhaul, in hours: minutes format, according to record in MSI history card;

i) TSNA (Adjusted TSN): accumulated operation hours, since new, in decimal format;

j) TSOA (Adjusted TSO): accumulated operation hours since the last overhaul, in decimal format;

k) removal: cause of removal. In this item, one of the following categories shall be used: Failure, TBO or Functional Test;

l) failure cause: description of failure cause, determined when MSI maintenance intervention occurs;

m) category of service executed. To complete the executed service category, one of the following options should be used: Inspection and Test or Overhaul; and

n) HH Repair: Number of men-hour used in maintenance action.

As indicated in 3.b, the maintenance task that was used as example in this work is related to Hydraulic Pump models MPEV3-011-8UK2B and MPEV3-011-8UK2C, manufactured by Eatom Aerospace to CASA-295 (C-105 Amazonas) airship. It is a pump with electric engine to supply 3,000 psi pressure to the airship hydraulic system.

As exercise of the logic presented in 2.2, one can, in a simplified way, and for just one failure mode, define for this selected MSI the following:

a) function: provide continuous hydraulic flow to the 3,000 psi pressure for appropriate operation of the airship system which are hydraulically driven;

b) functional failure: do not provide continuous hydraulic flow to the 3,000 psi pressure;

c) failure effect: pump overheat; and

d) failure cause: defective bearings.

From this point on, for one of the possible causes, the description in 2.3 applies to check the need of maintenance task for this item. Developing the analysis described in 2.4, this task interval is defined. In consultation to the airship maintenance plan, maintenance card 29.11.00.04 (Figure 6) is observed, the result of the methodology application. The task is the pump removal, at each 2,000 hours of flight, for detailed visual inspection of cooler, bearings and brushes with regards to cleaning, wear and condition.

Figure 6: Maintenance card 29.11.00.04.

CASA C295M — MAINTENANCE REVIEW BOARD DOCUMENT

Systems & Powerplant Program

Task Number	TASK Type	Cat	Interval	Effect	AMM Ref.	MSI / TASK DESCRIPTION
						ATA 29: HYDRAULIC POWER
						MSI 29.11.00.: MAIN HYDRAULIC POWER
29.11.00.01	SV	9	S	ALL	12-12-29 29-11-00	Check hydraulic fluid level on Hydraulic Reservoir.
29.11.00.02	IN	6	S	ALL	29-11-00	General visual inspection of Differential Pressure Indicators of Return, Pressure and Case Drain Filters on Modular Unit for correct indication.
29.11.00.03	OP	9	C	ALL	29-11-00	Operational check of Manual Control Mode.
29.11.00.04	IN	6	2000FH	ALL	29-11-51	Remove Hydraulic Electrical Motor Driven Pump for detailed visual inspection of cooler, bearings and brushes for cleanliness, wear and condition.

Source: EADS CASA (2010, **our emphasis**).

Charts 2 and 3 and Figure 5 were sent to SILOMS with a questioning on the publication by this information system listed in each chart.

In an immediate analysis, with only each chart portion complied with by SILOMS calculated, the quotient between amount of information provided and the total requested, we obtain the results below, according to Table 1.

Table 1: Percent of SILOMS compliance.

Source	Amount of information	Amount of data provided by SILOMS	Amount of data not provided by SILOMS	Compliance %
Chart 2 Nowlan and Heap	21	8	13	38,1
Chart 3 Blanchard	15	11	4	73,3
Figure 5 MCA 400-15	14	9	5	64,3
TOTAL	50	28	22	56,0

Source: The author.

We can observe a lower level of compliance in Nowlan and Heap Chart (Chart 2), which was built specifically to MSG-3 methodology. Blanchard Chart (Chart 3), for being in a more generic context of maintenance data, presents the higher level. In intermediary position, the level corresponding to MCA 400-15 figure (Figure 5). This quantitative analysis, however, provides an incomplete assessment of SILOMS level of compliance with MSG-3 methodology.

The three relations were developed in distinct contexts and for distinct applications, but it is possible to identify two segments in each one of the three lists: cadastral and dynamic. The first is about data with item identification characteristics (PN, Name, QPA), while the second corresponds to characteristics whose values evolve or change along the life cycle (failure rate, repairs, failure modes).

Specifically, the dynamic segment is the one that requires more capacity and integrity for the information system, for in it are contained data that must be continuously recorded, according to the airship use. These are records that change at each change of the equipment state, from 'available' to 'breakdown' or 'under maintenance'. All results from diagnoses and corrective actions shall also be recorded, since they are indispensable to failure modes follow-up. It is worth emphasizing that this process will occur along the whole life cycle of the airship.

Chart 4 summarizes only information that, for not being included currently in SILOMS reports structure, have not been processed in a structured way.

Chart 4: Data not available on SILOMS.

Source		Data not available on SILOMS
Chart 2 Nowlan and Heap	2.b.	Redundancies and protection characteristics (including instrumentation).
	2.c.	Self-test equipment (BIT – Built-in Test).
	4.a.	Can airship be shipped with failure in item?
	4.b.	If Yes, are there limiting conditions?
	5.a.	Item function.
	5.b.	Functional failures for each function
	5.c.	Failure modes.
	5.d.	Failure effect for each failure mode.
	5.e.	Functional failure evidences.
	5.f.	Effects of function loss on operational capacity.
	5.g.	Effects of failure beyond function loss (secondary damages).
	5.h.	Evidence of reduction in failure resistance that can be used to define conditions of potential failure.
	5.i.	Experience with other equipment where the same item or similar is used.
Chart 3 Blanchard	2.e.	Delays in maintenance (wait for part, delay by test equipment, downtime, wait for labor, etc.).
	3.b.	Handbooks used
	3.c.	Testing equipment used.
	3.d.	Description of facilities used.
Figure 5 MCA 400-15	i.	TSNA (Adjusted TSN): accumulated operation hours, since new, in decimal format.
	j.	TSOA (Adjusted TSO): accumulated operation hours since the last overhaul, in decimal format.
	k.	Removal: cause of removal. In this item, one of the following categories shall be used: Failure, TBO or Functional.
	l.	Failure cause: description of failure cause, determined when MSI maintenance intervention occurs.
	m.	Category of service executed. To complete the executed service category, one of the following options should be used: Inspection and Test, Repair and Test or Overhaul.

Source: The author.

The analysis of Chart 4 complements the aspects observed in Table 1 to the extent that information concentration not provided by SILOMS is from the dynamic segment. Unavailable data are those that should be used to an effective follow up of each MSI operation and those that allow the access to operational reliability, becoming, thus, required to MSG-3 methodology logic. With regard to SILOMS parallel controls, in this scenario, the most recurring question about the preventive maintenance appropriate interval cannot be appropriately answered.

5 CONCLUSION

In the present paper, we have attempted to assess how the set of logistic information, made available by SILOMS, meets MSG-3 methodology, which was applied to C-105 Amazonas airship maintenance plan. It was shown that, eventually, operational evidences may make COMAER review this maintenance plan, and such review should follow the same steps as the initial process, complemented by actual operation data that are influenced by the operational environment and profile of missions executed. The review action, as it seeks maintenance costs reduction, is totally supported by objectives established by END and PEMAER.

The literature review presented MSG-3 concepts and logic, the reason why the methodology is widely used in the development of new airships. Then, as SILOMS history is described and its role in COMAER logistic support structure, it was observed that this system is the source of maintenance and operation data for all and any logistic analysis.

The methodology adopted has favored the survey of data required by MSG-3, consolidating such data in a list of required information. With this list, interactions with SILOMS administration were carried out to identify, positively, the level of compliance by the system.

In data analysis, it was observed that, today, SILOMS meets, partially, the need for data to be used by MSG-3 and that the portion not met corresponds to data that effectively describe each MSI operational behavior, impeding MSG-3 the full application of the MSG-3. One immediate consequence is the impossibility of a technically responsible review of periodic maintenance intervals according to MSG-3. Therefore, even with airships operational data flying on the unique Amazon environment since 2006, C-105 fleet follows and will keep on following the original maintenance plan developed by the European manufacturer.

Finally, it is suggested a study that makes information required in MCA 400-15 “Reliability Centered Maintenance” compatible with those indicated in Nowlan and Heap with SILOMS. While such information is not duly made available, any initiative corresponding to C-105 Amazonas airship maintenance plan review will not be duly supported by MSG-3 methodology.

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