

TEST CONCEPTS APPLIED TO FRENCH ARMY EQUIPMENT
IN THE FIELD FROM 1990 TO 2000

APPLICATION TO ROTORCRAFTS

BU 2

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SYNOPSIS

The proposed paper presents the maintenance solutions that will be implemented by the French Army in the intermediate level for equipment of the 1990-2000 generation and its extensions to rotorcrafts.

After summarizing the experience acquired from the preceding generation, the paper describes the procedure applied to arrive at the definition of the requirement and the characteristics of the resulting test system.

1 SUBJECT

The subject concerns the maintenance facilities used at the second maintenance level, otherwise called intermediate level (I-Level).

The I-Level is part of the standard three level-maintenance concept : 0-Level, I-Level and D-Level.

1.1 0-Level maintenance

The 0-Level maintenance consists of exchanging the LRU when Built-In-Test (BIT) has indicated a unit failure. The faulty LRU is replaced in the helicopter and repaired at intermediate level maintenance facilities.

1.2 I-Level maintenance

The I-Level maintenance consists of the following :

- to verify the justification for removal of the unit from the aircraft,
- to localize the fault to the defective SRU,
- to replace the defective SRU,
- to verify after reassembly the full functional operation and the performance of the LRU.

1.3 D-Level maintenance

The D-Level maintenance consists of repairing SRU down to defective component.

2 EXPERIENCE FROM THE YEARS 1980 - 1990

The French Army developed the DIADEME program for the test of its electronic equipments of the 1970 - 80 generation.

This program, which is based on the concept of a single mobile tester, covers the following equipment :

- COTAC (AMX 10, AMX 30 battle tank fire control system),
- RiTA (Integrated Automatic Transmission Network)
- ATILA (Fire Automation and Artillery Liaison System)
- VOA (Artillery Observation Vehicle)
- HOT (Anti-tank missile)
- Helicopter-borne Inertial and Radio Navigation Systems
- Electronic Warfare systems
- Radio sets

The DIADEME station consists of a test substation containing seven electronics bays installed in an air-conditioned 20-foot shelter and an ancillary substation containing storage and drawers for the spares.

As the composition of the electronic bays differs according to the equipment to be supported, five different station configurations have been defined.

The DIADEME program was launched in 1978 and full scale development took place between 1978 to 1990.

200 test programs have been initiated and 50 operational stations have been produced.

1990 was a year of entry into service and operator training, with 30 stations and a hundred or so softwares becoming operational before the end of the year.

At the end of this period, the results were 2500 LRUs tested and a return rate of 10 % to shop level.

By the end of 1991, 40 stations and 140 softwares have been operational with a target of 3000 to 4000 LRUs tested.

The final target is a total of 195 softwares in service.

Two DIADEME stations were used in the DAGUET operation during the Gulf Conflict : they accumulated 700 operating hours with an MTBF of 300 hours.

3 DEFINITION OF REQUIREMENT

The equipment to be tested is that of the 1990-2000 generation.

Before to renew the facilities used at the I-Level for the equipments aimed, an analysis of requirement has been conducted in order to reply to the two following questions :

- is it necessary to keep a second maintenance level ?
- if so, what facilities are required ?

This analysis has been carried on the following weapons systems :

LECLERC	New generation battle tank
AC3G	Third-generation anti-tank missile
ORCHIDEE	Battlefield observation system
SAMANTHA	Anti-aircraft alert and control system
PR4G	Fourth-generation radio system

Each equipment was considered from the two basic aspects :

a) Its technology :

- digital
- hybrid digital/analog
- electromechanical
- optronic
- RF

SPREAD OF TECHNOLOGIES EQUIPMENTS BROUGHT INTO SERVICES IN 90-95	
DIGITAL	19 %
DIGITAL/ANALOG	29 %
ANALOG	26 %
ELECTROMECHANICAL	13 %
OPTO-ELECTRICAL	11 %
RF	2 %

FIGURE 1

b) Its self-test capability

This preliminary study was conducted in 1988, with 132 LRUs examined. Figure 1 shows the spread of technologies of the equipment examined.

It shows a proportion of digital or mostly-digital equipment amounting to 48 % which, although it is certainly high and increasing steadily, does not yet represent the majority.

It also shows an 11 % proportion of electro-optical LRUs, which did not appear in the preceding generation.

From these figures and the self-test capabilities that were examined and that are directly linked to the proportion of digital technology, the following conclusions were reached :

1. For the electronics :

- The conditions for eliminating the second maintenance level have not been met :
 - . the built-in tests are not powerful enough
 - . the electronic boards are not suited to replacement in the field.

- When the conditions have been met :

- . it is not the case for all the equipment of a weapons system
- . various generations of weapons systems are obliged to exist side by side.

2. For the electro-optical devices :

- it is possible to conceive a universal tester,
- it is possible to perform the repair in the field.

3. A multipurpose tester for each support point remains preferable to several dedicated testers.

In fact, multipurpose testers have greater operating flexibility as they adapt more easily to the organization of the regiments supported and they are of course fewer in number.

4. Board screening is an interim solution before the elimination of second level maintenance.

In two-level maintenance, SRU are directly exchanged at the 0-Level and as a consequence the need for LRU stock is eliminated.

Board screening consist of performing individual GO-NOGO testing on SRU's detected as failing at the 0-Level. The associated facilities therefore offer the capacity to :

- confirm LRU failure by testing all SRU exchanged,
- reduce weapons system immobilization by replacing batches of SRU's without the need to increase SRU stock or to have recourse to SRU sorting,
- test SRU spares.

Board screening is a process that does not significantly increase test resource requirements and can be used to perform maintenance at two levels on equipment which is designed for this purpose but whose self diagnostic performance is not yet satisfactory.

4 SPECIFIC CONSTRAINTS LINKED WITH HELICOPTERS

Helicopter fleets are characterized by their diversity and their high mobility. Moreover, a combat helicopter is a weapons system and must be treated as a whole, including all its possible variants for different missions.

The related support facilities must therefore be mobile and as universal as possible.

Here again, the aim is to be able to do without such facilities; but if they do exist, they must contribute to the following:

- a reduction in the technical documentation carried in the field (for support facilities and equipment),
- less training for operators, who are subject to frequent transfers,
- shorter intervention times,
- better repair quality and hence greater fleet readiness.

5 THE PLANNED TEST SYSTEM

5.1 MAIN FEATURES

The major orientations are as follows :

- equipment and board capability
- test capacities :
 - . analog up to 18 GHz
 - . digital up to 40 MHz
 - . electro-optical testing
- use of the following standards :
 - . ATLAS 716-89
 - . VXI
 - . UNIX
- on-line documentation processing capability
- self-maintenance capability with repair of the tester's boards
- management of repair data.

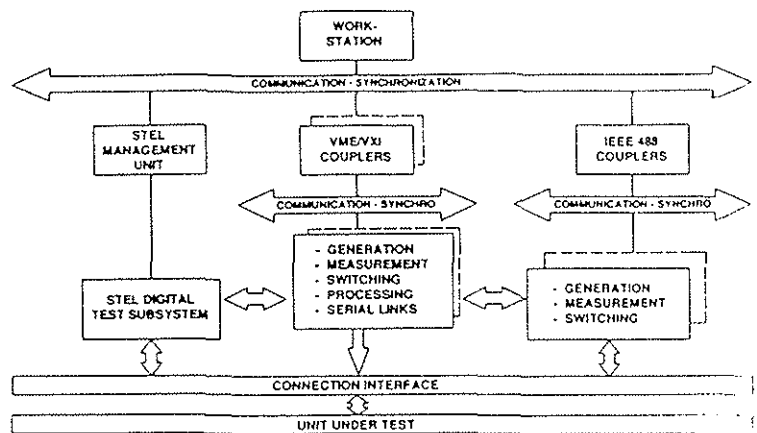
5.2 SOLUTIONS CHOSEN

5.2.1 Tester architecture

The general architecture of the tester is shown on figure 2.

It is broken down into three subsystems :

- the data processing subsystem consisting of a workstation and its peripherals,
- the digital test subsystem,
- the analog test subsystem consisting of racks with their own local bus which can be either a VXI or IEEE bus.



ARCHITECTURE

FIGURE 2

The exchanges between these various parts are performed through a high-speed digital bus which can be used for communication between the central computer and the other subsystems or racks and for communication and synchronization between the racks themselves or, between the Digital Test System and an analog rack.

The DTS management unit is responsible for sequencing the DTS commands, monitoring its resources and exchanging data with the central computer.

The couplers of the analog racks do not play an active role. They are simply transparent bus translators. Local intelligence, when it is necessary, is either set out on the instrumentation modules or is provided by dedicated modules that can work on behalf of local instrumentation modules or those located in other racks.

The advantage of this architecture is that, from a functional point of view, it represents an association of facilities that are interconnected at the same level.

This architecture offers the maximum capability for exchanges of data between the various components of the system, whatever their role, and therefore provides the best distribution of tasks between the various processors of the system for a given function.

5.2.2 Software architecture

Figure 3 shows the general organization of the software tools, with the tools designed for test program development and the tools used in operational service.

5.2.2.1 Development tools

All the development tasks are managed by a set of software facilities which are used to :

- control the sequencing and planning of the execution tasks for the various test programs (PROJECT MANAGEMENT),

- assure the coherence between the various elements created during the development (SOFTWARE WORKSHOP). These elements are for example : the source and object programs, the simulation results, the documentation (functional, organic, implementation) the connecting tools, their files, etc.

The general development management facilities also include quality measurement tools which are used according to a methodology suited to the project.

To execute the initial development phases of a test software, specification-aid tools are included that allows to formalized the test program design phase. The use of such a tool gives a better view of the suitability and completeness of the solutions chosen and better development traceability.

Editing and documentation tools for production of the ATLAS source program are also available during these phases.

The program created at this stage may follow the classic path of the ATLAS production line (compilation, link editing, execution simulation, etc.) possibly incorporating the self-test data output by the LRU development lines. The result is an object code that can be executed on the tester. This is the path normally used for the LRU test softwares.

For boards, whether GO-NOGO programs alone or GO-NOGO programs with fault isolation are concerned, a board test program specific production line is included which uses a logic simulator and allows a digital test program to be debugged without the need of the configured tester. If the board under test has been developed using CAD facilities, it is possible to retrieve its description and any stimuli according to a process that is described below.

To finish with the development phase, it should be noted that creation facilities in the form of a documentary base image are provided. This image will contain :

- the documentation for the LRUs
- the operating documentation for the test stations.

An ATLAS program may refer to the drawings or figures of the LRU documentation (or the drawings made using editing tools), for example to illustrate an operating procedure during the test.

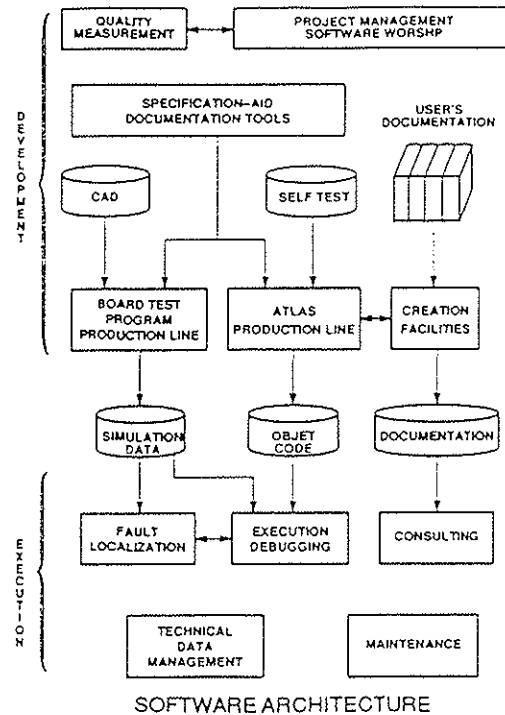


FIGURE 3

5.2.2.2 Execution tools

The tools used at this level primarily include the executives responsible for running the tester according to the commands of the operator and of the object program resulting from the previous phase. They are supplemented by the debugging tools designed to allow an efficient check of the machine and to provide good visibility of the tester and program statuses.

The execution of the test programs with fault isolation is performed under the supervision of automatic fault isolation tools which enable the faulty node or component on a board to be located.

The facilities available in operation are supplemented by a technical data management software (station logbook, stock management, etc) and maintenance tools (self-test and calibration programs, etc.).

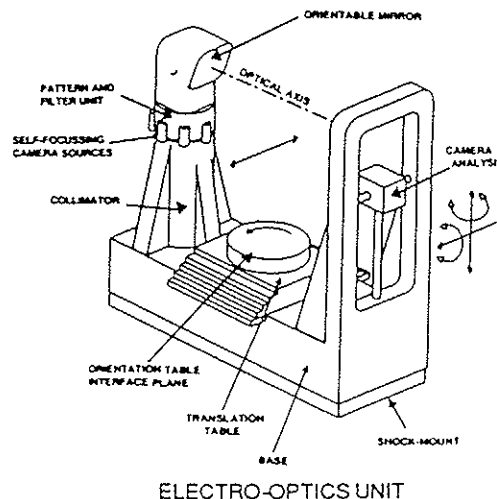


FIGURE 4

5.2.3 Electro-Optics subsystem

For tests and intervention on electro-optics LRUs, a multipurpose optics test bench is installed in the clean zone (see figure 4).

This bench consists basically of the following :

- a source focussed at infinity (multispectral collimator),
- a fixture for positioning the LRUs in front of the collimator,
- a system for detecting and measuring the collimated source seen through the LRU under test.

This type of test bench is used to handle LRUs of considerable size and weight, it has a compact design so that it can be integrated in the shelter.

Even in its basic version, it is coupled to an equipment for processing images and interpreting the results.

The concept of the electro-optics station is based on and is justified by the generalized use of image processing methods.

This is in order to :

- make the working methodology as universal as possible,
- limit the quantity and diversity of the equipment and accessories required,
- reduce the intervention time on the LRUs,
- increase the reliability of maintenance operations by eliminating the subjectivity (inherent in optics tests) of the personnel,
- allow the station to be run by non-specialized personnel.

The test bench has five main functions :

5.2.3.1 Source function

This is used to generate an object at infinity in each of the spectral bands. It consists basically of the following :

- the collimator,
- the sources
- the filters
- the test patterns.

a) Main features of the collimator

- collimator characteristics : diameter 200mm and focal length 1200mm, determined to handle all the LRUs of the reference weapons systems
- collimator mounted vertically to reduce the surface area occupied and guarantee good benchidity
- mirror set out on the base.

b) Characteristics of the sources, filters and test patterns

Considering the high number of sources, filters and test patterns, use will be made of manually-adjustable cylinders to avoid complicated handling operations :

- one cylinder containing all the test patterns,
- one cylinder containing all the filters,
- one cylinder containing the sources required for this setup.

c) Characteristics of the steering mirror

The optical axis of the collimator is deflected to the horizontal plane by a 45-degree steering mirror measuring 200x400mm.

About its nominal position, this mirror is :

- orientable in elevation and azimuth by two angular movements
- adjustable in height by a vertical translation movement.

These three movements allow the optical axis of the test bench to be set to :

- the geometrical datum lines of the LRU under test
- the optical axis of the channel under test.

5.2.3.2 The support function

The support part accommodates the LRU assembly mounted on its specific attachment tooling and, owing to the tooling design, sets it roughly with respect to the optical axis of the test bench.

It comprises the following :

- one translation table which assures the horizontal optical setting perpendicular to the optical axis of the test bench (see above),
- one interface plane compatible with all the LRU attachment tooling,
- one manual-control turntable that can be set with good repeatability, the only function of which is to facilitate the operator's access during work on the LRU.

5.2.3.3 The detection function

Depending on the tests, the detection function is performed by the following :

- one analysis camera : image reading camera (with its lenses) capable of aligning itself with the optical axis of the test bench at the optical channel output of the LRU under test.

The alignment is performed by a camera support with :

- two degrees of translation freedom in the horizontal plane to the optical axes,
- two degrees of rotation freedom : elevation and azimuth.
- one autocollimating camera : image reading camera (with its lenses) set out on the exit lens of the collimator
- direct video link when the LRU already has image reading.

5.2.3.4 The measurement function

The measurement function is performed via the means of dialog with the tester, including :

- a screen for :
 - . editing the results and illustrating the test instructions and procedures
 - . directly displaying the video image of the test in progress,
- a command keyboard and mouse,
- a control unit for the electro-optics test bench including the control and safety devices.

The arrangement of the test bench allows the following :

- access to the item under test on the maximum number of sides (4 or 5 thanks to the "turntable") in order to facilitate manual operations,
- access to the console (display and commands) whatever the working area of the operator around the test bench.

5.2.3.5 The control and computation function

The control and computation function performs the control of the optics test bench by the test system :

- automatic sequencing of the tests,
- analysis of the measurements by the processing modules,
- selection of the instructions,
- check that the instructions are executed correctly.

6 CONCLUSIONS

The Full Scale Development of DIADEME 2 program will take place from September 1991 to september 1994.

The first scheduled application is the LECLERC battle tank and the test program development will take place between 1996 to 1998.

If the need is confirmed for an external support equipment, DAIDEME 2 will be the candidate to support TIGER helicopter and the TTH version of NH90.