XMM Optical Monitor

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XMM-OM MODEL PHILOSOPHY AND TEST PLAN

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CHANGE RECORD

ISSUE	DATE	PAGES CHANGED	COMMENTS
01	28 March 1995	All new	
02	28 September 1995	All	
03	04 February 1997	All	Minor editorial changes and the addition of test references in par 8.
04	18 July 1997	2, 7, 9	Addition of EMC reference for EM plus other test reference updates.
05	21 July 1997	2, 6, 7	Clarification of OM 2 models

CONTENTS

1. INTRODUCTION

This document seeks to clarify the build standards and qualification levels for the various models of the Optical Monitor (OM). It builds on the initial concepts given in section A3-3 of the Manpower, Management and Cost Plan to the BNSC (XMM-OM/MSSL/RD/0006), revising and elaborating where necessary.

2 MODEL PHILOSOPHY

The OM programme consists of 5 models in total:-

1. Electro-optical Breadboard (EOB);
2. Structural Thermal Model (STM)
3. Qualification Model (QM);
4. Engineering Model(EM);
5. Flight Model (FM) and Flight Spares (FS).

The overall aim of the EOB model is to demonstrate the feasibility and functionality of the OM. Thus it is required that the EOB will function in such a way that allows this to be done. Clearly it is not possible (given the time scale and resources available) to design the EOB to perform all the functions of the FM; nevertheless those areas which are critical to the success of the instrument must at least be addressed, even if this is in a limited way. It is therefore not necessary that all the software should be in place, nor that the structure be fully representative, nor that redundant halves of subsystems be present. The EOB will therefore not look exactly like the FM and it is not planned to deliver the EOB to ESA.

The main part of the OM STM model(OM1) will be supplied by Dornier, with the two OM2(DEM) boxes being supplied by Sandia and the External Harness(OM3) by MSSL.

The overall aim of the QM is to qualify the OM at all levels so that at the end of the QM programme the instrument will have been fully proven at qualification levels. The QM will therefore look, operate and have the same mass as the FM in every respect, and will provide the same mechanical, thermal and electrical interfaces both internally and to the spacecraft. Software will be fully written. The only difference between the QM and the FM and FS is that non-flight quality electrical parts may be used in the QM. Where applicable, for example in the case of the optical surfaces, some subsystems may be refurbished from the EOB model. This model will not be deliverable to ESA.

An additional model, the EM, has been introduced to allow ESA to conduct full functional electronic testing of the system. No primary optical elements need to be present and of course it is deliverable to ESA.

The FM will be fully acceptance level tested and will use high-reliability electrical parts. Acceptance trials will not include tests on a telescope for field trials because of cleanliness requirements. Some FS components will be refurbished from the QM programme. The exact level of Flight Spares still needs clarification.

In this document, flight design is defined as the design envisaged for the FM. In practise there will be changes to the flight design as the programme evolves which will accommodate the lessons learned on the EOB, QM and EM programmes. The term is used to distinguish this design from one in place specifically to shortcut the full design process as in the case of the EOB model.

High-reliability components are defined as those components which will meet the relevant qualification level for flight, as defined in the OM PA plan (XMM-OM/MSSL/SP/0031).
Tests for the QM will be at qualification level which will be more stringent than the acceptance level tests for the FM and FS. The precise meaning of these terms will be defined in the appropriate test plans to be issued.

3. ELECTRO-OPTICAL BREADBOARD (EOB)

3.1 EOB Programme Aims

The detailed aims of the EOB are as follows:-

1. to demonstrate the 1 arc second imaging of the telescope/detector system;
2. to acquire data which allows confidence to be gained that the target of imaging 24th magnitude stars be reached;
3. to demonstrate that image registration can be maintained in the photon-counting/data processing system;
4. to demonstrate the correct end-to-end performance of the active beam control subsystem;
5. to verify electrical interfaces between subsystems;
6. to demonstrate the overall functionality of the instrument as controlled by the ICU;
7. to demonstrate the task scheduling and memory management software in the DPU.

3.2 EOB Build Standard Requirements

The requirements on each subsystem to achieve the above are now considered in some detail below.

3.2.1 A0000 -- Structure

The structure need only be a frame sufficient to hold the various subsystems in position for the functional verification to take place. This will not be precisely the same design as the EQM and later model structures. The materials need not be the same as those chosen for the flight design. If this is the case, however, refurbishment will not be possible.

It is not necessary that the mechanical interface be as in the flight model.

Thermal blankets will not be required. No thermal control will be required on the structure, so the ICU will not require a thermal control loop.

3.2.2 B0000 -- Optics

There will be no telescope for this model. Certain elements for the filter wheel will be present, together with the dichroic mirror.

3.2.3 C0000 -- Mechanisms

One filter wheel mechanism will be required for the blue beam. This will be of flight design, but not necessarily manufactured to the high reliability standards required for the FM.

The dichroic beam-selector mechanism will not be included in the EOB.

The electrical interfaces to the ICB for the above mechanisms will be via the TMPSU. The motor drive bus will be of flight design, except for the absence of the redundant filter wheel and the dichroic beam-selector mechanism.

The filters will be selected to be adequate for optical tests. Three filters of the flight complement must be used, these being TBD, and in addition, a grism and a magnifier must be available. The rest of the filter positions will contain mass dummies.

3.2.4 D0000 -- Blue Detectors

One blue detector only will be required for the EOB. This will approach the flight design for the intensifier and processing electronics. The intensifier need not be of a design required to withstand launch loads. The overall accommodation envelope for the electronics need not be the same as that for the flight design, so that, for example, discrete components may be used instead of gate arrays if these are to be used. A flight-type EHT unit will be included, but this need not use high reliability components. The electrical interfaces to the ICB and DPU will provide flight functionality. The software and operational modes of the detector will be of flight design, so for example, it must be possible to load lookup tables, define active areas, bin, set voltages, transmit status and receive commands as for the flight design.
Diagnostic tools and engineering modes must be available.

3.2.5 E0000 -- Cooled CCD Detector

Deleted

3.2.6 F0000 -- DPU and DEM Power Supply Unit

Only one half of the DPU and DEM Power Supply Unit will be supplied for the EOB. No high-reliability components need be used. The overall dimensions of the DEM need not as for flight, so that less tightly packed circuit cards can be used. The DEM will provide an interface to the ICU on its back plane.

Interfaces to the redundant half of the DEM and detectors will be simulated appropriately.

It is not possible to produce software to a fully flight-functional standard, but critical areas must be addressed. These include the scheduling and memory management kernels and the tracking. It must be possible to process data from the detector so that end-to-end tests are possible. Windowing and binning facilities must be available.

3.2.7 G0000 -- Instrument Digital Electronics

Only one half of the ICU will be supplied for the EOB. No high-reliability components need be used. The overall dimensions of the ICU will be such that the unit fits into the EOB DEM, but less tightly packed circuit cards can be used, so that the ICU may occupy more slots than anticipated for the flight design. The ICU will interface to the DEM via its back plane, which will be of flight design. The EOB ICU will contain such spacecraft interface devices as required (for example the DBU and the RBI and timer chips).

Interfaces to the redundant half of the DEM and other subsystems will be simulated appropriately.

There will be no thermal monitoring in the EOB structure. Monitoring of temperature within subsystems (if this exists) will be passed to the ICU via the ICB as envisaged for the flight design.

It is not possible to produce software to a fully flight-functional standard, but critical areas must be addressed. These include the overall control of the instrument, the ability to communicate with and control subsystems, the ability to receive data from the DPU, and the protocols required for communication with the spacecraft. A compression algorithm must be implemented. It must be possible to process data from the detector so that end-to-end tests are possible.

The EOB instrument harness need support only those subsystems on the EOB model which are present, and need not be of flight quality.

3.2.8 70000 -- EGSE

The system-level EGSE must be sufficiently functional to simulate the spacecraft interface electrically and software produced such that data and housekeeping can be accepted from the instrument and commands passed to it at a level sufficient for end-to-end tests of the instrument. This requires that both the spacecraft simulator and Science Data Terminal be available.

Sufficient networking capabilities must be available in order to link with unit-level EGSE, and protocols to service the links must be in place.

3.3 EOB Tests

Detailed test plans are referenced in par 8. The aim of these tests is to prove the overall scientific performance of the instrument and verify the internal and external interfaces.

The test matrix for the EOB programme is given in Fig 1.

4. STRUCTURAL THERMAL MODEL (STM)

The Structural Thermal Model of the Telescope(OM1) will be supplied by Dornier. The telescope unit will be structurally and thermally representative and its dynamic properties will be representative at interfaces for frequencies up to its first resonant mode. The two digital electronics units(OM2) will be supplied by Sandia and will be thermally and structurally representative, but no attempt will be made to reproduce their dynamic properties. The External Harness(OM3) will be supplied by MSSL.

The test matrix for the STM programme is given in Fig 5.

5. QUALIFICATION MODEL (QM)

5.1 QM Programme Aims

The detailed aims of the QM programme are as follows:-
1. to carry out environmental qualification tests of all subsystems;
2. to carry out qualification level electrical and functional tests of all subsystems;
3. to carry out a full set of environmental qualification tests at instrument level;
4. to carry out qualification level optical, electrical and functional tests at instrument level;

5.2 QM Build Standard Requirements

The QM will be of flight design in all respects, except that high-reliability electrical components are not required; they must however be vacuum compatible. All redundant systems will be in place, with the exception of OM2. The OM2 unit will be one of the flight models. Some subsystems (for example the optics) may be refurbished from the EOB programme, if this is compatible with the requirements of the programme.
The QM telescope and baffles will be used for the flight model.

5.3 QM Tests

Detailed test plans are referenced in par 8. The test philosophy to be followed is that all subsystems will be qualification level tested at subsystem level, followed by instrument level qualification tests. At the end of the QM programme the QM will have been fully proven at the qualification level. The model is not deliverable to ESA.

The test matrix for the QM programme is given in Fig 2.

6. ENGINEERING MODEL(EM)

6.1 EM Programme Aims

The purpose of the EM is to provide a model that is electrically and software “as flight” to enable ESA to conduct:-

1. Electrical and software compatibility tests with the spacecraft
2. EMC tests at payload level.

6.2 EM Build Standard Requirements

The EM needs to be electrically and functionally representative of the flight model, but flight standard parts need not be used.
Only the prime channel need be present
The EM will not contain any optical element, telescope or baffle.
The OM2 unit will be the Qualification Model. This unit will be returned for refurbishment as the Flight Spare.

6.3 EM Tests

Detailed test plans are referenced in par 8.
The test matrix for the EM programme is given in Fig 3.

7. FLIGHT MODEL (FM) AND FLIGHT SPARES (FS)

Detailed test plans are referenced in par 8. The test philosophy to be followed for the Flight Model is that all subsystems will be acceptance level tested at subsystem level, followed by instrument level acceptance tests.

In principle Flight Spares will be maintained at component level only. A kit of parts will be held adequate to build a single channel of the Blue Module and a single OM3. Complete Flight Spares of a TMPSU and an OM2 will be available.

The test matrix for the FM and FS programmes is given in Fig 4.

8. TEST PLANS

The procedures for the testing of all the models are identified or referred to in this paragraph. The format uses the structure of the instrument as identified in the AIV Plan, ref XMM-OM/MSSL/0032. Each assembly and major sub-assembly has been allocated a sub-paragraph of par 8 and the following suffixes of 1,2,3 and 4 refer to the EOB-2, QM, EM and FM/FS respectively. Tests on the STM are limited and these are shown in Fig 5 and detailed in par 8.25

8.1 XMM-OM, Complete Instrument

8.1.1 EOB-2 The functional and optical calibration tests are specified in XMM-OM/OABM/SP/0110
8.1.2 QM Vibration tests specified in XMM-OM/IALS/SP/0009.
Thermal vacuum tests specified in XMM-OM/IALS/SP/0010.
Thermal balance tests specified in XMM-OM/IALS/SP/0011.
Functional and optical calibration tests specified in XMM-OM/IALS/SP/0008.
System level EMC Control Plan XMM-OM/MSSL/SP/0060. Cleanliness as XMM-OM/MSSL/SP/0027.
8.1.3 EM EMC Test Procedure XMM-OM/MSSL/SP/0137.
8.1.4 FM The tests to be performed are included in the documents identified in par 8.1.2. Cleanliness as XMM-OM/MSSL/SP/0027.

8.2 Telescope Module

8.2.1 EOB-2 Optical alignment as XMM-OM/OABM/SP/0110.
8.2.2 QM Optical alignment specified in XMM-OM/MSSL/SP/0126.
8.2.3 EM Not applicable.
8.2.4 FM Optical alignment as par 8.2.2. Cleanliness as XMM-OM/MSSL/SP/0027.

8.3 Telescope

8.3.1 EOB-2 Not applicable.
8.3.2 QM Optical alignment as par 8.2.2.
8.3.3 EM Not applicable.
8.3.4 FM Optical alignment as par 8.2.2. Cleanliness as XMM-OM/MSSL/SP/0027.

8.4 Primary Mirror Assembly

8.4.1 EOB-2 Not applicable.
8.4.2 QM Mounted as in TBA. Cleanliness as XMM-OM/MSSL/SP/0027.
8.4.3 EM Not applicable.
8.4.4 FM Mounted as in TBA. Cleanliness as XMM-OM/MSSL/SP/0027.

8.5 Secondary Mirror Assembly

8.5.1 EOB-2 Not applicable
8.5.2 QM Mounted as in TBA. Cleanliness as XMM-OM/MSSL/SP/0027
8.5.3 EM Not applicable
8.5.4 FM Mounted as in TBA. Cleanliness as XMM-OM/MSSL/SP/0027

8.6 Blue Module

8.6.1 EOB-2 Electronic tests are defined in Blue Detector Acceptance Test XMM-OM/MSSL/SP/0046
8.6.2 QM Electronic tests as par 8.6.1. Optical alignment as XMM-OM/MSSL/SP/0126. Cleanliness as XMM-OM/MSSL/SP/0027
8.6.3 EM As par 8.6.1
8.6.4 FM As par 8.6.2. Cleanliness as XMM-OM/MSSL/SP/0027

8.7 Blue Camera Head

8.7.1 EOB-2 See par 8.6.1
8.7.2 QM See par 8.6.2
8.7.3 EM See par 8.6.1
8.7.4 FM See par 8.6.2. Cleanliness as XMM-OM/MSSL/ SP/0027

8.8 Filter Wheel

8.8.1 EOB-2 Life test conducted (XMM-OM/MSSL/TC/0037), Test procedure TBA
8.8.2 QM Acceptance test TBA
8.8.3 EM Not applicable
8.8.4 FM Acceptance test TBA. Cleanliness as XMM-OM/MSSL/SP/0027

8.9 Dichroic

8.9.1 EOB-2 Life test conducted (XMM-OM/MSSL/TC/00??)
8.9.2 QM TBA
8.9.3 EM Not applicable
8.9.4 FM. Cleanliness as XMM-OM/MSSL/SP/0027

8.10 Blue Processing Electronics

8.10.1 EOB-2 See par 8.6.1
8.10.2 QM See par 8.6.1
8.10.3 EM See par 8.6.1
8.10.4 FM See par 8.6.1. Cleanliness as XMM-OM/MSSL/SP/0027

8.11 Blue Internal Harness

8.11.1 EOB-2 See par 8.6.1
8.11.2 QM See par 8.6.1
8.11.3 EM See par 8.6.1
8.11.4 FM See par 8.6.1. Cleanliness as XMM-OM/MSSL/SP/0027

8.12 Red Module

Deleted

8.13 Detector and Cryostat

Deleted

8.14 Filter Wheel

Deleted

8.15 Focal Reducer

Deleted

8.16 TMPSU

8.16.1 EOB-2 Not applicable

8.16.2 QM Electrical test as XMM-OM/IALS/SP/0002. Cleanliness and environmental checks as XMM-OM/IALS/SP/0003.

8.16.3 EM Electrical test as XMM-OM/IALS/SP/0002.

8.16.4 FM See par 8.16.2

8.17 Red Detector Electronics

Deleted

8.18 Red Internal Harness

Deleted

8.19 DEM

8.19.1 EOB-2

8.19.2 EQM Vibration Test plan XMM-OM/PENN/SP/0013. EMC Test Plan XMM-OM/PENN/SP/0014

8.19.3 EM Not applicable

8.19.4 FM Thermal Test Plan XMM-OM/PENN/SP/0012. Vibration and EMC as in par 8.19.2. Cleanliness as XMM-OM/MSSL/SP/0027

8.20 Data Processing Unit

8.20.1 EOB-2 Software Validation Plan, XMM-OM/PENN/SP/0006. Acceptance Test Plan, XMM-OM/PENN/SP/0007

8.20.2 EQM TBA

8.20.3 EM Not applicable

8.20.4 FM As par 8.20.1. Cleanliness as XMM-OM/MSSL/SP/0027

8.21 Instrument Control Unit

8.21.1 EOB-2 Acceptance Test Plan XMM-OM/MSSL/SP/0041

8.21.2 QM As par 8.21.1

8.21.3 EM Not applicable

8.21.4 FM As par 8.21.1. Cleanliness as XMM-OM/MSSL/SP/0027

8.22 DEM PSU

8.22.1 EOB-2 TBA

8.22.2 EQM TBA

8.22.3 EM Not applicable

8.22.4 FM TBA. Cleanliness as XMM-OM/MSSL/SP/0027

8.23 Enclosure

8.23.1 EOB-2 Not applicable

8.23.2 EQM Inspect to drawings

8.23.3 EM Not applicable

8.23.4 FM Inspect to drawings. Cleanliness as XMM-OM/MSSL/SP/0027

8.24 External Harness

8.24.1 EOB-2 Not applicable

8.24.2 QM Harness Electrical Test Procedure XMM-OM/MSSL/SP/0116

8.24.3 EM As 8.24.2

8.24.4 FM As 8.24.2. Cleanliness as XMM-OM/MSSL/SP/0027

8.25 STM

Tests on the two OM2 units will be conducted by Sandia and these will include vibration, thermal vacuum and balance, static load together with a simple function check. Details of these tests are contained in XMM-OM/PENN/SP/0016.01.

The External Harness(OM3) will be checked for continuity and workmanship.