George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Materials and Processes Laboratory, EM01

Metals Engineering Branch, EM30

EM30-WI-003
02/11/2005

ORGANIZATIONAL WORK INSTRUCTION

EM30

MATERIALS AND FAILURE ANALYSIS

Baseline

RELEASE AUTHORITY	NAME	TITLE	ORG	DATE
Management Representative	Timothy P. Vaughn	Branch Chief	EM30	2/11/2005

CHECK THE MASTER LIST--ONLY THE LATEST REVISION IS VALID

THE MASTER VERSION OF THIS DOCUMENT IS LOCATED AT
http://maptis.nasa.gov/em30/em30masterlist.html/
ALL OTHER ELECTRONIC AND PRINTED VERSIONS ARE
FOR REFERENCE ONLY

DOCUMENT HISTORY LOG

Revision	Date	Originator	Description
Baseline	02-11-2005	T. Vaughn	Document rebaselined due to reorganization of Departments and Laboratories at the Center

THE MASTER VERSION OF THIS DOCUMENT IS LOCATED AT
http://maptis.nasa.gov/em30/em30masterlist.html/
ALL OTHER ELECTRONIC AND PRINTED VERSIONS ARE
FOR REFERENCE ONLY

1 SCOPE

1.1 ***SCOPE:*** This document provides materials and failure analysis procedures and requirements for the Materials and Processes Laboratory, Metals Engineering Branch's, Materials Diagnostics Team within the scope defined by MPD 1280.1.

1.2 ***PURPOSE:*** To establish the procedures for materials and failure analysis within the Materials Diagnostics Team.

1.3 ***APPLICABILITY:*** This organizational work instruction applies to the Materials, and Processes Laboratory, Metals Engineering Branch, Materials Diagnostics Team.

2 APPLICABLE DOCUMENTS

2.1	MPD 1280.1	Marshall Management Manual
2.2	MPR 8730.5	Control of Inspection, Measuring, and Test Equipment
2.3	MWI 8715.15	MSFC Grounds Operations Safety Assessment and Risk Mitigation Program
2.4	EM30-WI-002	EM30 Work Tracking, Product Traceability and Control, and Data Control

2.3 Operating and maintenance instruction manuals provided by the instrument manufacturers.

3 DEFINITIONS

3.1	SEI	Secondary Electron Imaging
3.2	BEI	Backscattered Electron Imaging
3.3	TEI	Transmitted Electron Imaging
3.4	TED	Transmitted Electron Diffraction
3.5	CBED	Convergent Beam Electron Diffraction
3.6	ESD	Environmental Scanning Detector
3.7	EDS	Energy Dispersive X-ray Spectroscopy
3.8	WDS	Wavelength Dispersive X-ray Spectroscopy
3.9	OEM	Original Equipment Manufacturer

3.10 ULO User Line Organization

3.11 OCV Outside Calibration Vendor

4 INSTRUCTIONS

4.1 ***GENERAL:*** Work performed and data generated in the process of materials and failure analysis shall be documented and controlled.

4.2 ***REQUESTS FOR WORK:*** The EM30 Electronic Work Request System (EWRS), found on the Organizational World Wide Web site, (http://ed33mmtfa/PublicMMTF/WorkRequest.aspx/), must be completed prior to the start of work.

4.2.1 The work request form shall be filled out by the requester and/or by Organizational personnel.

4.2.2 The request for work shall be approved by Branch/Team level management or their designee and assigned to appropriate personnel.

4.3 ***WORK ACCOMPLISHMENT:*** The materials and/or failure analysis work shall be accomplished by various personnel based on the customer requirements for diagnostic procedures.

4.3.1 A fault tree describing failure modes shall be prepared if required.

4.3.2 Detailed background and relevant historical information about the submitted materials or failure shall be compiled from the Customer, published data, and EM30's Failure Analysis Database when applicable.

4.3.3 One or more of the following analyses shall be performed as required. The order of analysis work performed may vary.

4.3.3.1 Overall optical photography.

4.3.3.2 Optical Microscopy.

4.3.3.3 Non-destructive sample preparation as required.

4.3.3.3.1 Sample dusting.

4.3.3.3.2 Sample solvent cleaning.

4.3.3.4 Destructive sample preparation using one or more of the following
techniques as needed.

4.3.3.4.1 Sample cutting.

4.3.3.4.2 Sample cleaning.

4.3.3.4.3 Sample mounting.

4.3.3.4.4 Sample polishing.

4.3.3.4.5 Sample etching.

4.3.3.4.6 Sample coating.

4.3.3.5 Surface morphology and chemistry analysis using one or more of the following techniques as required.

4.3.3.5.1 Scanning Electron Microscopy (SEM), using SEI, BEI, and/or EDS.

4.3.3.5.2 Field Emission Scanning Electron Microscopy (FESEM), using SEI, BEI, and/or EDS.

4.3.3.5.3 Environmental Scanning Electron Microscopy (ESEM), using ESD and/or EDS.

4.3.3.5.4 Electron Probe Micro-Analysis (EPMA), using SEI, BEI, EDS, and/or WDS.

4.3.3.5.5 Scanning Transmission Electron Microscopy (STEM), using SEI, BEI, TEI, TED, CBED, and/or EDS.

4.3.3.5.6 Auger Electron Spectroscopy (AES).

4.3.3.5.7 Electron Spectroscopy for Chemical Analysis (ESCA).

4.3.3.5.8 Secondary Ion Mass Spectroscopy (SIMS).

4.3.3.6 Metallographic examination using one or more of the following techniques as required.

4.3.3.6.1 Microstructural analysis.

4.3.3.6.2 Macro-hardness testing.

4.3.3.6.3 Micro-hardness testing.

4.3.3.6.4 X-ray photography.

4.3.3.6.5 Hot stage metallography.

4.4 ***GENERATION OF RESULTS:*** A report or compilation of relevant data shall be organized from all available information.

4.4.1 All data pertinent to the analysis including Customer supplied information and diagnostic test data shall be reviewed by the Team personnel responsible for work completion.

4.4.2 Team personnel shall fulfill the customer documentation requirements:

4.4.2.1 Write comprehensive materials analysis report.

4.4.2.2 Write comprehensive failure analysis report.

4.4.2.2.1 Formulate conclusions about the most likely reasons for failure.

4.4.2.2.2 Formulate recommendations for prevention of similar failures in the future.

4.4.2.3 Directly report raw data to the Customer.

4.4.2.4 Write Branch memorandum explaining raw data.

4.4.2.5 Write weekly note.

4.4.3 Print out images, spectra, and reports as requested.

4.5 ***DATA REVIEW, APPROVAL, AND REPORTING:*** Reports, memos, and data shall be reviewed, approved, and reported to the customer in accordance with standard Organizational practices described in EM30-WI-002.

4.6 ***QUALITY RECORD ARCHIVING:*** All quality records produced in fulfillment of customer requirements described in the work request shall be stored in accordance with standard Organizational practices found in EM30-WI-002.

4.7 ***SAMPLE DISPOSITION:*** All samples and/or non-consumable Customer supplied materials shall be returned to the Customer or stored in accordance with standard Organizational practices described in EM30-WI-002.

4.8 ***WORK REQUEST CLOSE OUT:*** Once all applicable work has been completed, data distributed, and quality records archived, the work request shall be closed out in accordance with standard Organizational practices described in EM30-WI-002.

5 NOTES

5.1 The type of analyses to be performed and the order of execution are determined from consultations with the Customer and the desired materials analyses and/or failure analyses results.

6 SAFETY PRECAUTIONS AND WARNING NOTES

6.1 Various sample preparation equipment utilizes rotating polishing wheels and abrasive cut off saws. All loose clothing, jewelry, and hair must be secured before operation.

6.2 Etching of metal samples requires acidic and basic solutions that may cause burns or produce toxic vapors. Consult the listing of standard handling procedures or qualified personnel before mixing or utilizing etching solutions.

6.3 Electron microscopes produce high voltages. Do not move, pickup, or step on wires or cables located near or on the equipment.

7 APPENDICES, DATA, REPORTS, AND FORMS

7.1 Not Applicable.

8 QUALITY RECORDS

8.1 The following listing includes EM30 Quality Records that are collected and saved by the Metallurgical and Failure Analysis Team.

8.1.1 EM30 Metallurgical & Failure Analysis Calibration Logbook

8.1.2 Photographs

8.1.3 Digital images

8.1.4 Chemical analysis spectra

8.1.5 Failure analysis reports

8.1.6 Metallurgical analysis reports

8.1.7 Branch Memoranda

8.1.8 Equipment specific job hazard analysis forms

8.2 All schedules pertaining to EM30 Quality Record retention and disposition are compiled in the EM30 Quality Records Listing located on the master list of the EM30 Branch website (http:/maptis.nasa.gov/em30/em30masterlist.html/) .

9 TOOLS, EQUIPMENT, AND MATERIALS

9.1 ***CALIBRATION:*** Equipment that requires calibration, shall be calibrated in accordance with MPR 8730.5

9.1.1 Using Line Organization (ULO) initiated calibration of diagnostic and/or metallographic equipment shall follow the equipment manufacturer's calibration procedures as defined in the Original Equipment Manufacturer (OEM) supplied operations or service manuals.

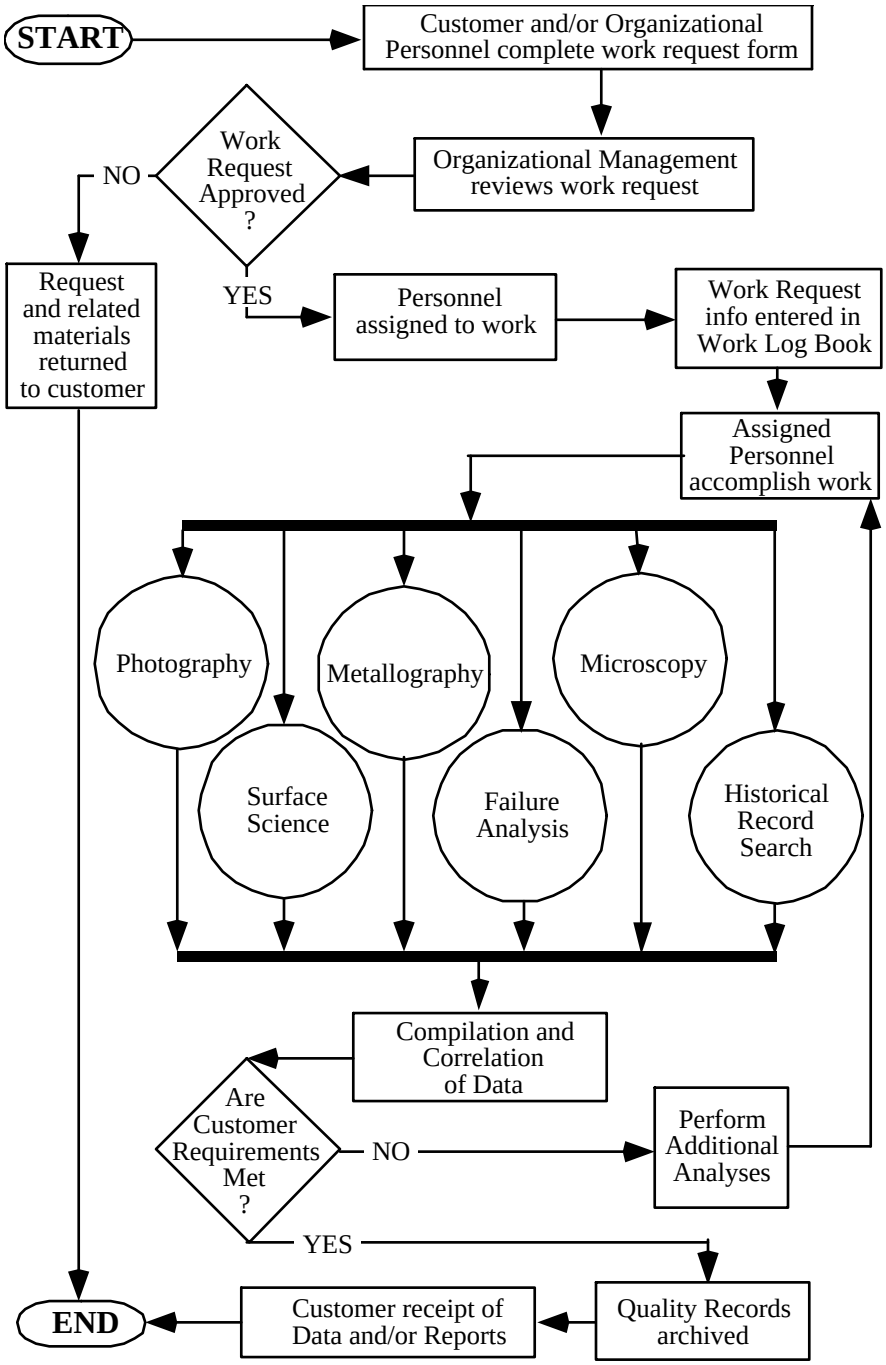
9.1.2 An Outside Calibration Vendor (OCV) that may include an OEM service representative shall calibrate equipment, not calibrated by the ULO.

10 PERSONNEL TRAINING AND CERTIFICATION

10.1 The primary operator of each metallographic or diagnostic instrument utilized by EM30 shall receive operations training from one or both of the following sources.

10.1.1 Previous primary instrument operator.

10.1.2 Instrument manufacturers training representative.

10.2 Instrument operations will not be allowed until basic safety, maintenance, and operational readiness is achieved by the operator.

11 FLOW DIAGRAM