The role of ESA TEC-QTE in the ISS Safety Process

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ESA's Purpose

To provide for, and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems:

o by elaborating and implementing a long-term European space policy, by recommending space objectives to the Member States, and by concerting the policies of the Member States with respect to other national and international organisations and institutions;

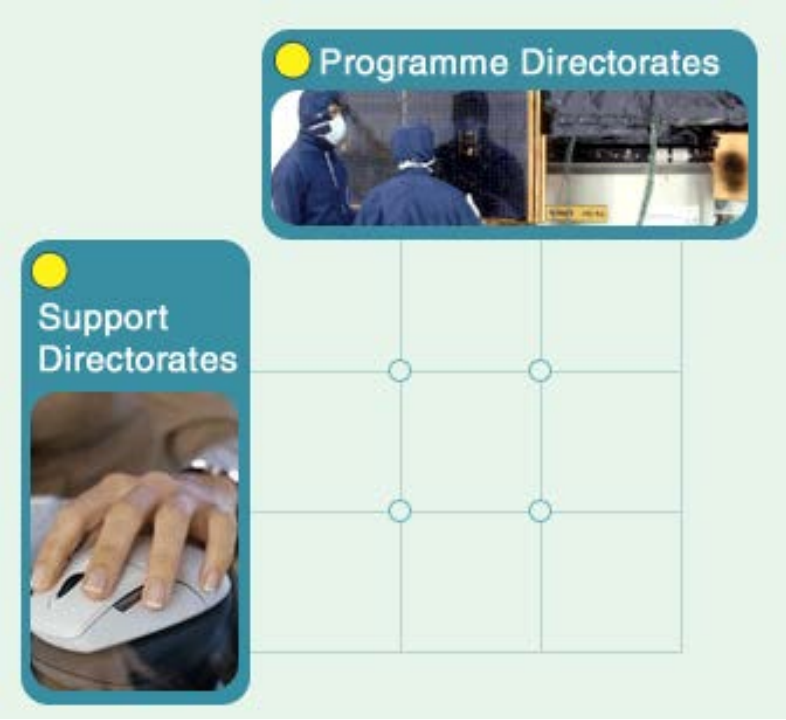
o by elaborating and implementing activities and programmes in the space field;

o by coordinating the European space programme and national programmes, and by integrating the latter progressively and as completely as possible into the European space programme, in particular as regards the development of applications satellites;

o by elaborating and implementing the industrial policy appropriate to its programme and by recommending a coherent industrial policy to the Member States.

→ see more at: **www.esa.int**

ESA Matrix Structure



Vertical directorates related to ESA programs

- D/EOP Earth Observation
- D/HSO Human Spaceflight and Operations
- D/LAU Launchers
- D/NAV Galileo Program and Navigation
- D/SRE Science and Robotic Exploration
- D/TIA Telecommunications and Integrated Applications

Horizontal directorates provide functional support to the whole organisation

- D/CR Corporate Reforms
- D/PFL Procurement, Financial Operations and Legal Affairs
- D/PPC Policies, Planning and Control
- D/TEC Technical and Quality Management
- D/HFI Human Resources, Facility Management and informatics

Majority of activities are conducted by industry.

Directorate of Technical and Quality Management, D/TEC

To provide engineering advice and assistance to ESA programmes and projects throughout their entire lifecycles.

- Bringing a project to life
- Supporting and guiding project teams
- Testing and verifying space items
- Setting engineering standards
- Pre- and post launch activities

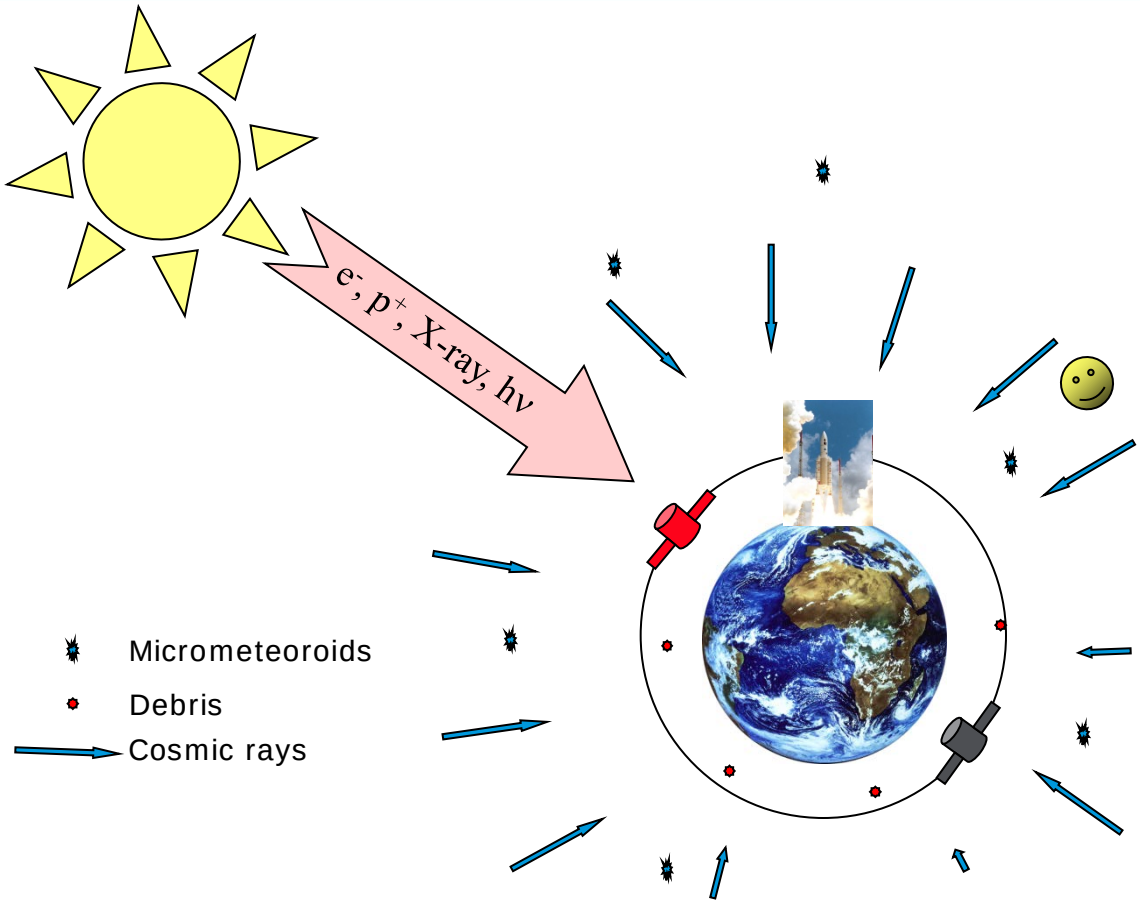
TEC-QTE in the ESA D/TEC Organigramme

Directorate of Technical & Quality Management

- Director of Technical & Quality Management D/TEC
  - Planning & Management Support Office TEC-OS
  - Institutional and Infrastructure Coordination Office TEC-IC
  - Systems, Software & Technology Department TEC-S
    - Software Systems Division TEC-SW
    - Systems & Engineering Support Division TEC-SY
    - Technology Strategy & TRP Division TEC-SB
    - Product Development & GSTP Division TEC-SG
    - Technology Transfer & Promotion Office TEC-ST
    - Support to New Member States & European Cooperating States Office TEC-SN
  - Electrical Engineering Department TEC-E
    - Electromagnetics & Space Environment Division TEC-EE
    - Power & Energy Conversion Division TEC-EP
    - Control Systems Division TEC-EC
    - Data Systems Division TEC-ED
    - RF Payload Systems Division TEC-ET
  - Mechanical Engineering Department TEC-M
    - ESTEC Test Centre Division TEC-MX
    - Mechatronics & Optics Division TEC-MM
    - Thermal Division TEC-MT
    - Structures & Mechanisms Division TEC-MS
    - Propulsion & Aerothermo-dynamics Division TEC-MP
  - Product Assurance & Safety Department TEC-Q
    - Standardisation & Engineering Knowledge Management Division TEC-QR
    - Quality, Dependability & PA Support Division TEC-QQ
    - Space Materials & Components Evaluation Div. TEC-QE
    - COMPONENTS TECHNOLOGY AND SPACE MATERIALS DIVISION TEC-QT Nikulainen Mikko
      - MATERIALS TECHNOLOGY SECTION TEC-QTM Ghidini Tommaso
      - MATERIALS SPACE EVALUATION & RADIATION EFFECTS SECTION - TEC-QTE Semprimoschnig Cristhoph
      - COMPONENTS TECHNOLOGY SECTION TEC-QTC Marchand Laurent
    - Quality Management System Office TEC-QP
    - Independent Safety Office TEC-QI

ESTEC
Noordwijk, The Netherlands

Challanges on M&P for a Successful Mission



Launch

Vacuum
Outgassing
Contamination

Temperature
- isothermal/thermal cycling
- entry/re-entry….

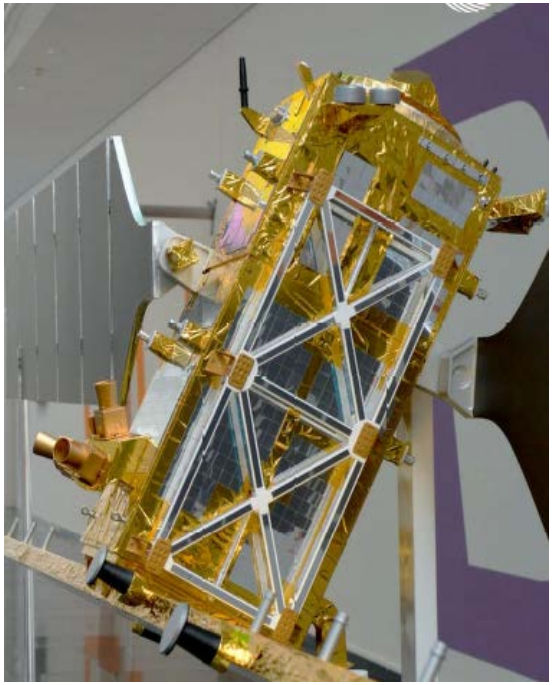
Radiation

Space Debris
Micrometeoroids
Atomic Oxygen

Manned Volumes

TEC-QTE Activities

The strategic objective of TEC-QTE is to guarantee an optimal choice of materials and processes used in assemblies for ESA missions or external projects.

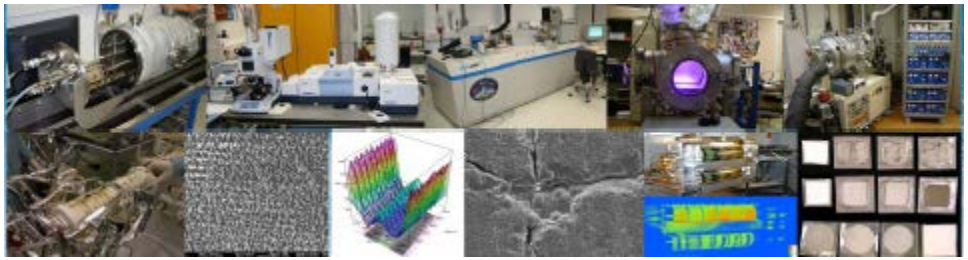


- **to enable the use of new technologies and ensure mission success**
- **to provide M&P support through hardware testing in simulated space environment**
- **to provide independent M&P support for failure analysis**
- **to develop tools and standards and act as certification authority for space M&P in Europe**
- **to support in orbit experiments and carry-out post flight investigations**
- **to exchange technical knowledge and network with external centres**
- **to assess safety aspects related to manned projects**

Materials and Electrical Components Laboratory

Within the Materials and Processes Division the laboratory provides:

- Support to all ESA projects during all phases in the field of M&P to guarantee successful missions
- Provision of non economically viable but strategically important facilities and expertise to investigate the effects of the environment PMP
- Impartial and independent M&P support for failure investigations (on-ground and in-orbit anomalies)
- Qualification of materials (toxicity, flammability, corrosion, thermo mechanics, etc.) and assessment/validation of processes including electronic materials



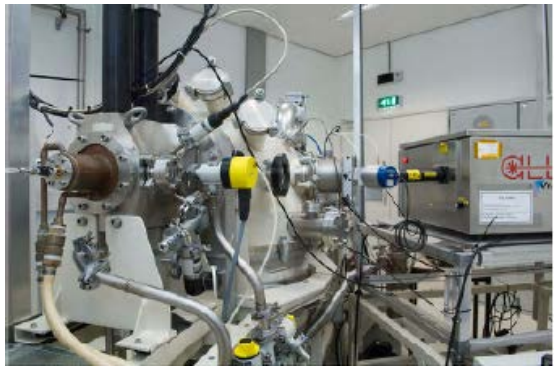
- Cleanliness and contamination control with chemical and physical analysis

→ see more at: **http://esmat.esa.int**

TEC-QTE Laboratory Infrastructure: Space Simulation and Materials Analysis

All topics supported by laboratory facilities:

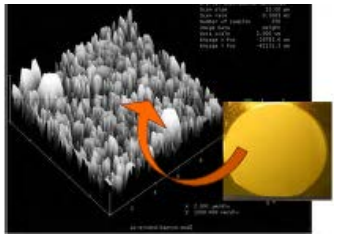
- High vacuum (outgassing, dynamic outgassing, modelling …):VBQC, DOK, uVCM
- Temperature (low (cryogenic)/ thermal cycling/elevated): BOF2, XTES, HITES
- Simulation of atomic oxygen : ATOX
- Simulation of charging/ESD behaviour : SORASI
- Flammability
- Simulation of electro-magnetic (UV, VUV, X-ray): CROSS, BOF
  - and particle radiation (e-, p+) : STAR

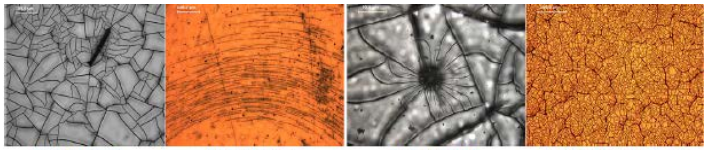


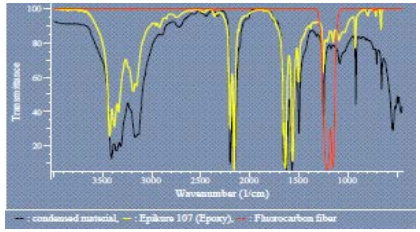
TEQ QTE Laboratory Infrastructure: Space Simulation and Materials Analysis

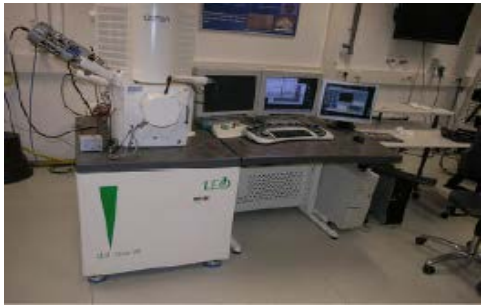
Materials analysis such as:

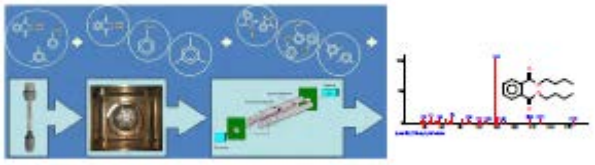
- Spectrometry: UV-VIS-IR, FTIR, Raman, XPS, AFM, ESR
- Microscopy: SEM's, AFM, optical, confocal (QTM)
- Mechanical: tensile, lapshear, hardness, nanoindenter (QTM)
- Chemical: GC/MS, contact angle
- Thermal Analysis: DSC, TGA, TMA, DMA, LFA, Dilatometer, Hot Disc, coupled tech.











TEC-QTE: ECSS Standards

- ECSS-Q-ST-70-29C (equivalent to NASA STD 6001 test 7): Offgassing
- ECSS-Q-70-21A (equivalent to NASA STD 6001 tests 1, 4, 5, 10) : Flammability (ESA facility in Astrium Bremen)
- ECSS-Q-ST-70-02C (equivalent to ASTM E-595) : Outgassing
- ECSS-Q-ST-70-06C: UV/particle
- ECSS-Q-ST-70-05C: IR spectroscopy

→ see more at: **www.ecss.nl**

NASA/ESA MoA in Materials and Processes

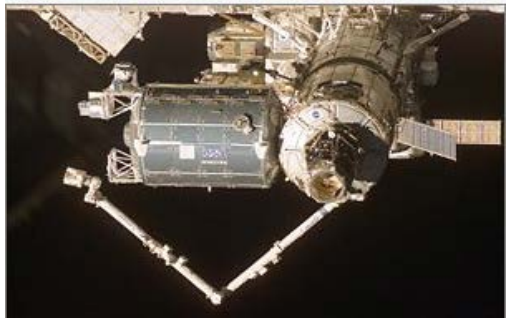
On the 17th of July 2000, the **Materials and Processes Reciprocal Agreement** was signed between NASA and ESA to define the process for selection and certification of materials used in the Space Shuttle and the International Space Station.

→ On the 20th of June 2003 this agreement was extended to the Automated Transport Vehicle (ATV).

ESA TEC-QTE, the Materials Space Evaluation and Radiation Effects section, is responsible for the evaluation of materials and processes employed in ISS payloads.

PSRP Activities

- Support to FSR as PSRP member
- Review and approval of offgassing and flammability evaluations
- Review and approval of PMP lists
- Review and approval of RFA's (MUA's)



- Risk assessments (dust formation, leakage of toxic gases, explosion, contamination, compatibility,...)
- Release of Materials Certification (BIOLAB, MSL, FASES,...)

MMOP

TEC-QTE is responsible for air toxicity aspects as part of the MMOP

- **Environmental Health Monitoring of Columbus and ATV on ISS**: Revision of IDRD Annex 4
    - Revision of flight rules
    - Revision of applicable standards (*e.g.* MORD)

- **NASA MMOP**: Representation in the AQS, a sub-group of the MMOP participated by all international partners.
    - Biweekly interaction by telecon and annual TIM
    - Revision of flight rules
    - Air toxicity assessment for cargo vehicles
    - Revision of applicable standards (*e.g.* MORD)

Air Quality Measurements

- off-gassing testing for materials or experiments to be flown
- ATV: Offgassing tests prior to launch at CSG, in Kourou (French Guyana)

Two phases:

1. at Nominal dry cargo → model prediction for the evolution of offgassing products (mg/m3) and toxicity levels (T values)
2. at Late dry cargo → estimation of offgassing products and toxicity levels at the docking of ATV with ISS.

Offgassing tests are performed jointly with Russian counterpart from the Institute of BioMedical Problems (IBMP) in Moscow.

Conclusion

TEC-QTE plays a primary role within the ISS payload safety process.

- Evaluation of all materials, parts and processes and CAM equipment
- Verification of all materials related hazards
- Operation of materials tests facilities according to international standards
- Provision of air quality measurements by performing offgassing tests