

Appendix K

Overview of ECSS Activities for Space Thermal Analysis

James Etchells
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Abstract

This presentation will provide an overview of the two ongoing ECSS activities in the field of space thermal analysis, in particular:

- ECSS-E-HB-31-03: Thermal analysis handbook
- ECSS-E-ST-3104: Exchange of Thermal Model Data for Space Applications

The thermal analysis handbook will soon be sent out for public review and this workshop therefore provides an opportunity to make the community aware of it.

Concerning the standard on thermal model exchange, this is the formalisation under ECSS of the STEP-TAS protocol. The aims and objectives of the working group will be presented along with some discussion about the expected form of the final standard.



Overview of ECSS Activities for Space Thermal Analysis

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What is ECSS



- ECSS = **E**uropean **C**ooperation for **S**pace **S**tandardization
 - Organization started in 1993
 - task is to develop a common set of **consistent** standards for hardware, software, information and activities to be applied in space projects




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ECSS in the Thermal Control Area

ECSS-E-ST-31




Space e
Thermal control requirements

ECSS-E-HB-31-01




Space er
Two-phase heating equipment

ECSS-E-HB-31-01



Space e!
Testing

ECSS-E-HB-31-01 Part 1A
2 October 2011




Space engineering
Thermal design handbook - Part 1: View factors

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Documents in the pipeline

ECSS-E-HB-31-01A DRAFT
10 September 2015



Space engineering
Thermal analysis handbook

This draft is circulated to the TAAR, DIFP and ES for parallel assessment


Start Parallel Assessment: 11 Sept 2015

End of Parallel Assessment: 25 Sept 2015

DISCLAIMER (for drafts)

This document is an ECSS Draft Standard. It is subject to change without any notice and may not be referred to as an ECSS document until published as such.

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Space engineering
Exchange of Thermal Model Data for Space Applications

This document is ...


END-OF-...-IS

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ECSS-E-HB-31-03 THERMAL ANALYSIS HANDBOOK

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History of the handbook

Proposal at NESTA:


- Handbook on Thermal Model *Validation*

Conclusions:

- General agreement with idea
- Checklist would be useful
- Not a standard (not applicable doc)
- Don't be too prescriptive
- Old ECSS standard content
- Observation that is a big undertaking
- Action on ESA to make 1st draft



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DOCUMENT

Guidelines for Space Thermal Modelling and Analysis

In the context of computational analysis:

- Verification "did we solve the equations correctly?"
- Validation "did we solve the correct equations?"





Space engineering

Thermal analysis handbook

S. De Paio (IAS-I)
G. Jahn (Airbus DS)
P. Lardet (SODERN) *
P. Oger (Airbus DS)
J. Vallega (CRISA)
* Left WG due to new roles

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Thermal Analysis Handbook: Table of Contents



4	Modelling guidelines	7	Ancillary analysis tasks
4.1	Model management	7.1	Model transfer
4.2	Model configuration and version control	7.2	Model conversion
4.3	Modularity and decomposition approach	7.3	Model reduction
4.4	Discretisation		
4.5	Transient analysis cases		
4.6	Modelling thermal radiation		
4.7	Considerations for non-vacuum environments		
5	Model verification		
5.1	Introduction to model verification		
5.2	Topology checks		
5.3	Steady state analysis		
5.4	Finite element models		
5.5	Verification of radiative computations		
6	Uncertainty analysis		
6.1	Uncertainty philosophy		
6.2	Sources of uncertainties		
6.3	Classical uncertainty analysis		
6.4	Stochastic uncertainty analysis		
6.5	Typical parameter inaccuracies		

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Current Status



- Draft reviewed by Working Group (Internal Assessment)
- Draft reviewed by TAAR (Parallel Assessment)
 - Comments/suggestions have been included
- Next step is **Public Review**, options :
 1. Limit review to NESTA members
 2. Full public review

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ECSS-E-ST-31-04 EXCHANGE OF THERMAL MODEL DATA

aka STEP-TAS

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Why STEP-TAS?



SET-ATS (1991)

- CNES Initiative "Standard d'Exchange et Transfert – Application Thermique Spatiale"
- Based on French SET Z68-300 European aircraft industry

ICE-TAS (1994)

- ESA study to find common data models for exchanging thermal data between tools
- Identified "STEP" standard as most promising technology of the day

STEP-TAS (1998-2008)

- 1st prototype in Europe and US in 1998
- Simplification and rigourisation of STEP-TAS internally at ESTEC
- Development of TASverter to *facilitate* exchange + *validate* protocol

IITAS (2009)

- Industrial Implementation of STEP-TAS (Conformance Class 1 or 3)
- Interfaces in ESATAN-TMS, eTherm, Thermica, TMG, Thermal Desktop

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What is STEP-TAS?



- **STEP** = Standard for the Exchange of Product Model Data, ISO 10303
 - There are a number of STEP standards - Application Protocols (APs)
 - Best known is AP203/214 for CAD
 - Uses a formal data model definition language called EXPRESS (ISO10303-11)
 - STEP protocol provides structure, but also algorithmic rules to ensure integrity of datasets
- **TAS** = Thermal Analysis for Space
 - Specific AP for space thermal analysis with 4 modules:
 - NRF : Network Results Format [TMM / Test data]
 - MGM : Meshed Geometric Module [GMM - static]
 - SKM : Space Kinematic Module [GMM - moving]
 - SMA : Space Mission Analysis [GMM - trajectory]
 - Protocol very generic, can be applied to other disciplines e.g. space environment (STEP-SPE)
 - Thermal specific information introduced via run-time dictionary specifying, e.g. what thermal nodes is, what a thermo-optical property is, etc.

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Formalisation under ECSS



- Original plan was to formalise STEP-TAS standard under ISO
 - STEP-TAS is a fully conforming ISO 10303 application protocol
- Eventually ECSS was preferred over ISO
 - Lighter process, quicker to update if needed, more relevant to space domain
- Working Group starting in 2015:

H. Brouquet (ITP Engines)	P. Hugonnot (TAS-F)
K. Duffy (MAYA HTT)	R. Muenstermann (Airbus DS (D))
J. Etchells (ESA)	T. Soriano (Airbus DS (F))
A. Fagot (DOREA)	T van Eekelen (Samtech / Siemens)
D. Gibson (ESA)	

- *But*, no precedent in ECSS for this kind of standard ... how to deal with it?

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Formalisation under ECSS



```

ENTITY mgm_rectangle
  SUBTYPE OF(mgm_primitive_bounded_surface);
  p1 : mgm_3d_cartesian_point;
  p2 : mgm_3d_cartesian_point;
  p3 : mgm_3d_cartesian_point;
WHERE
  wr1: mgm_verify_points_use_context_length_quantity_type(
    [p1, p2, p3], geometric_item.containing_model);
  wr2: mgm_verify_points_span_orthogonal_system(p1, p2, p3,
    mgm_get_context_uncertainty_value(
      geometric_item.containing_model, 'point_coincidence_length'));
END_ENTITY;

```

Data structure

Rules

Difficult to reconcile these two styles

- Inspection of the spacecraft (including structure and cable harnesses) shall be performed to verify that there are no ungrounded metal components.
- Resistance testing shall be carried out on grounded metal components to ensure that their grounding meet the requirements in 9.2.2.

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Expected Outputs



- Short set of ECSS style requirements targeted at tool developers
 - Focus on: validation, conformance, diagnostics
- STEP-TAS Protocol captured as a *normative* annex
 - Normative Annex must be a DRD description
- Change request to thermal standard

Formal
ECSS

Where do you come in (as an end-user)?

- Use the STEP-TAS Interfaces
 - They work pretty well (last slide)
- Report any problems to tool developers and ESA
 - step-tas@thermal.esa.int

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Future perspectives



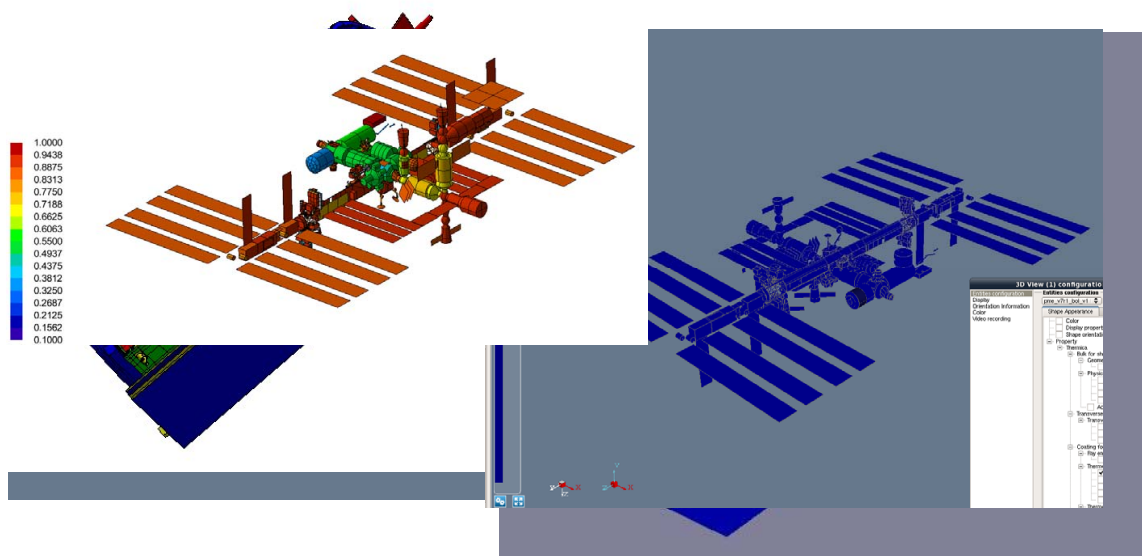
- Make TASverter for TMM available soon
 - First issue supports SINDA <-> ESATAN
- Updates to STEP-TAS SDK
 - full validation
 - Improve diagnostics emitted by STEP-TAS SDK
- Web portal for STEP-TAS with forum, FAQ, recipes, downloads etc
- STEP-TAS viewer and validation
 - To replace BagheraView

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Current Status



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END

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