

NASA Engineering Safety Center Thermal Performance Database



Michael Wright, NASA-ARC
Michael.J.Wright@nasa.gov

Richard French, NASA-JPL
Richard.T.French@jpl.nasa.gov

James Grimes, NASA-JPL
James.M.Grimes@jpl.nasa.gov

Background

Thermal performance testing and analysis costs are high and represent a significant investment. The data, even for a single test, typically reside in multiple locations. In the current situation, shown in Figure 1 below, analysts and stakeholders expend an inappropriate level of effort to collect data and validate the dataset. Much of the data is manually entered into individual spreadsheets that must be merged together to provide inputs for an analysis. Decision makers subsequently find it difficult to draw conclusions and make optimal use of the testing and analysis.

Historical data are also difficult to find and properly validate. No database currently archives the extensive results from previous NASA flight projects, technology development, and research efforts. Significant data from recent projects, in particular the Crew Exploration Vehicle (CEV) and the Mars Science Laboratory (MSL) could easily be lost as elements are misplaced and key stakeholders move on to other projects.

NESC Assessment 09-00565

The NASA Engineering and Safety Center (NESC) has chartered an assessment to address a key TPS data management problem, enable discipline enhancing analyses, and protect a critical NASA investment.

The assessment includes the development, deployment, and initial data population of a database to archive and relate thermal performance test results and analysis. The database will be deployed at the Arc Jet Complex at Ames Research Center (ARC) and the Atmospheric Reentry and Structures Evaluation Facility (ARMSEF) at Johnson Space Center (JSC) for continuing operations and maintenance. A Steering Committee will be established to steward the Database post-deployment and oversee future upgrades requests and rollout. A focused historical data collection task will also collect and digitize the results from NASA's past flight projects, technology developments, and research efforts.

Benefits

The Thermal Protection System community will benefit from the thermal performance database because it will protect critical NASA investments. Current and future projects will also benefit from the cost savings and efficiency possible with the proposed data flow illustrated in Figure 2.

The database will add value by providing functionality like outlier detection and automated validation features, enabling improved system analysis such as margins assessment.

Thermal performance test facilities will benefit from better understanding through validated environmental performance envelopes and direct facility-to-facility comparisons.

Finally, future projects will benefit from the wealth of validated data by leveraging it for less expensive and less risky development, qualification, and acceptance programs.

Figure 1 – Current Data Flow

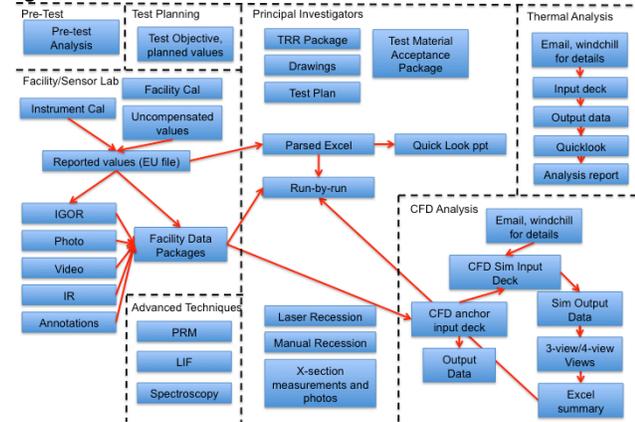
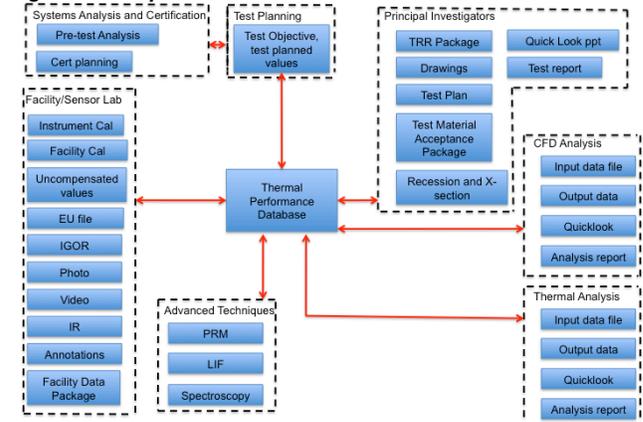


Figure 2 – Proposed Data Flow



Level 1 Requirements

- Deliver an operational database by the end of FY11.
- Deploy an operational database accessible to all participating NASA Centers and Industry partners with proper security and permissions.
- Deploy an operational database operated and maintained at the ARC Arc Jet Complex and the JSC ARMSEF.
- Collect, reformat, and input NASA's thermal performance test results, including all historical data.
- Collect and store data related to thermal performance testing (arc jet, radiant, solar tower, laser, etc.), including test results, calibration records, test article configurations, facility operating parameters, and analysis results.
- Accept data from test facilities, test engineers, test principal PIs, thermal analysts, and computational fluid dynamics (CFD) analysts.
- Search for, and report on, holdings based on user-specified criteria.
- Extract specified data for general analysis purposes such as thermal analysis, CFD, data traceability, and margins assessment.
- Extract specified data for use in verification and validation (V&V) roll-up and design documentation.

Development Plan

- Database systems engineering (underway, FY10)**
 - Full-system definition and scope for production database, System Requirements, Concept of Operations, Data Model
- Implement and test the database (prototype by end of FY10)**
 - Database framework selection and procurement
 - Detailed logical and physical design, screen designs, report/layout designs, data model, and processing rules
 - Test with V&V dataset, including CEV ablative, seals and backshell arcjet test results, RCC and tile arcjet test results, and Orbiter radiant test results
- Operate, maintain, and manage the database (2011–2012)**
 - Deploy database, initial feedback and re-work
 - Manage initial user and project account development
 - Transition operations to Arc Jet Facilities
- Historical data collection (2010–2012)**
 - Collect, reformat, and input historical data
 - Collect MSL data and develop task plan for other datasets, including data prioritization (2010)
 - Collect balance of V&V dataset (2011)
 - Collect the balance of NASA thermal performance test results (2011- 2012)

Operations Concept

- NASA Arc Jet Facilities**
 - Deployed, operated, and maintained at both Ames Research Center (ARC) Arc Jet Complex and Johnson Space Center (JSC) Atmospheric Reentry and Structures Evaluation Facility ARMSEF
 - Direct upload of facility data and test results to customers
- Steering Committee**
 - Chartered to take responsibility for the stewardship of the Thermal Performance Database
 - Oversee future upgrades requests and rollout
 - Provides a stabilizing influence so that the vision of the database is maintained
 - Made up of representatives of the TPS community
- Data Access**
 - Global data access for non-ITAR, non-proprietary data
 - Project creation will allow for tailoring of project policy and intended use/functionality
 - Individualized access controls for project-specific data
 - ITAR-sensitive restrictions
 - Proprietary and commercial use

Collaboration

- CEV TPS test principal investigators, CFD, thermal analysis, test planning systems analysis, certification
- Mars Science Laboratory TPS
- Ames Research Center Arc Jet Complex
- Johnson Space Center Atmospheric Reentry and Structures Evaluation Facility
- Arnold Engineering Development Center HEAT

Conclusions

- No data central archive exists for thermal performance data, resulting in excessive effort required to access and validate the data, and decision makers subsequently find it difficult to draw conclusions and make optimal use of the testing and analysis
- Data-loss is continuing even for recent projects as test principal investigators and analysts move to other projects
- The NESC will develop an economical, low-risk solution for archiving related thermal performance results with automated functionality for users in a web-based relational database
- The database will protect a critical NASA investment, save money through increased efficiency, and enable discipline enhancing analysis such as less risky margins assessment
- Seeking stakeholder support to insure funding post-PDR to implement the operational database
- Seeking stakeholder support and involvement for review of the database development, aid in the data collection and population, and encouraging participation in the user community.

Future Work

- Develop system scope and definition by PDR (Sept. 2010)
- Prototype database fielded with facility data input functionality by PDR
- Work with community to identify additional data for V&V dataset
- Work with community to collect all thermal performance results
- Propose for FY11 Implementation with NESC and back-up funding sources