



# INCORPORATING TECHNICAL MEASURES OF PERFORMANCE INTO PROJECT METRICS

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## INCORPORATING TECHNICAL MEASURES OF PERFORMANCE INTO PROJECT METRICS

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# MEASURING TECHNICAL WORK

**THE KEY QUESTION:** What Defines “Done”?

**GENERAL DEFINITION:** A shared understanding across the team what must be completed for a user story, feature, or product to be considered finished.

**SYSTEMS AND MISSION ENGINEERING DEFINITION:** Completion of delivered capabilities through the measurement of units of effectiveness and units of performance within project framing assumptions defined by program-specific key performance parameters and technical performance measures.

**CONTRACTUAL DEFINITION:** Completion of a definable measure of work, effort, or deliverable required under the terms and conditions specified in a contract.



# MEASURING TECHNICAL WORK

## Key Elements of Technical Performance Measurement – Identification & Definition

**KEY PERFORMANCE PARAMETERS:** A critical subset of programmatic framing assumptions representing those capabilities and characteristics so significant that failure to meet the threshold value of performance can be cause for the concept or system selected to be reevaluated or the project to be reassessed or terminated.

**TECHNICAL PERFORMANCE MEASURES:** Attributes that determine how well a system or systems element is satisfying or expected to satisfy a technical requirement or goal.

**MEASURES OF PERFORMANCE:** The measures that characterize physical or functional attributes relating to the system operation, measured or estimated under specified testing and/or operational conditions.

**MEASURES OF EFFECTIVENESS:** The “operational” measures of success that are closely related to the achievement of the mission or operational objective being evaluated, in the intended operational environment under a specified set of conditions; i.e., how well the solution achieves the intended purpose.



# MEASURING TECHNICAL WORK

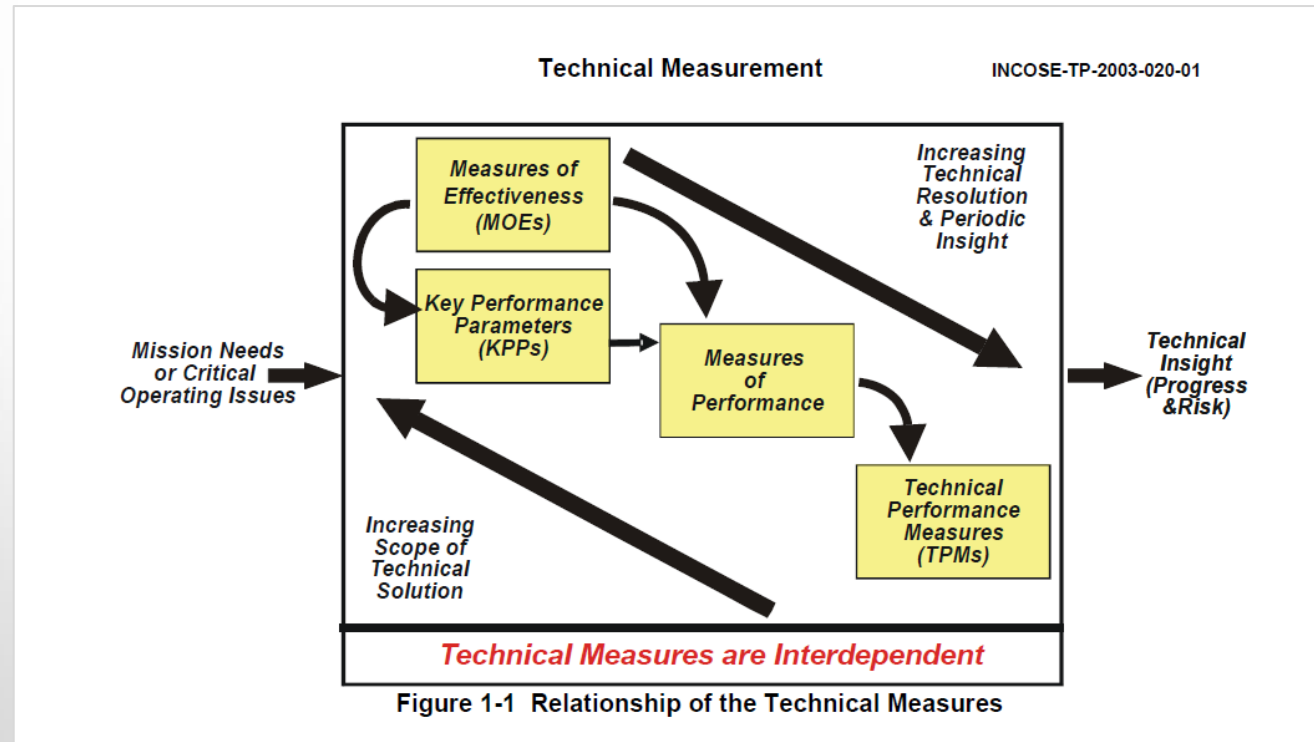
## Effectiveness vs. Performance – What is the Difference?

**PERFORMANCE:** The Quality of Doing Something. Performance within the context of an MoP indicates what something is actually capable of doing. It is evaluated against the program goals for performance, but is not necessarily an indication of fitness for service on its own merits.

**EFFECTIVENESS:** The Quality of Fitness for Service or for producing intended results. The MoE reflects the program's intention. It defines the properties a potential solution must possess in order to meet the requirements of the program in service.

# MEASURING TECHNICAL WORK

## INTERDEPENDENCE OF TECHNICAL MEASURES OF PERFORMANCE



# INCORPORATING TECHNICAL MEASURES INTO THE PROJECT

## PRACTICAL PROCESSES AND OUTPUTS

### **Define Done in Units of Measure Meaningful to Decision-makers – Create a WBS Dictionary**

**The WBS Dictionary.** Stakeholder (government and contract) WBS for program reporting purposes and includes all program elements (for example, hardware, software, services, data, or facilities), which are the contractor's responsibility. It includes the contractor's discretionary extension to lower levels, in accordance with Government direction and the contract Statement of Work (SOW).

The detailed WBS Dictionary is a document that describes each element work package in a project component of the WBS. These elements can include milestones, deliverables, activities, scope, resources, costs, quality. The main purpose of the WBS dictionary is to define and communicate the work in more detail to help those working on an element or work package understand what needs to be done.



# INCORPORATING TECHNICAL MEASURES INTO THE PROJECT

## PRACTICAL PROCESSES AND OUTPUTS

**Define Done in Units of Measure Meaningful to Decision-makers – Create an Integrated Master Plan (IMP)**

**The Integrated Master Plan (IMP).** The IMP is an event-based plan consisting of a sequence of program events, with each event being supported by specific accomplishments, and each accomplishment associated with specific criteria to be satisfied for its completion. These IMP elements are defined as:

- **Event:** a key decision point or program assessment point that occurs at the culmination of significant program activities.
- **Accomplishment:** is the desired result(s) prior to or at completion of an event that indicates a level of the program's progress.
- **Criteria:** provides definitive evidence that a specific accomplishment has been completed. Entry criteria reflect what must be done to be ready to initiate a review, demonstration, or test. Exit criteria reflect what must be done to clearly ascertain the event has been successfully completed.



## INCORPORATING TECHNICAL MEASURES INTO THE PROJECT

### PRACTICAL PROCESSES AND OUTPUTS

#### The Integrated Master Plan (IMP)

- Identify and assess actual progress vs. planned progress
- Monitor the program Critical Path and help to develop a workaround to problem areas
- Assess the status of risk management activities based on the inclusion of program Risk Mitigation activities in the IMP and IMS
- Assess the progress on selected technical measures
- Provide an objective, quantitative basis for the contractor's performance and award fee, if applicable
- Help develop and support contingency exercises and identify and assess candidate problems workarounds



**Figure 1** – The IMP and the IMS are a hierarchy of Program descriptions, each connected through a single parent and multiple children. This “well formed” tree topology is critical to the measurement of *increasing maturity* of the program.

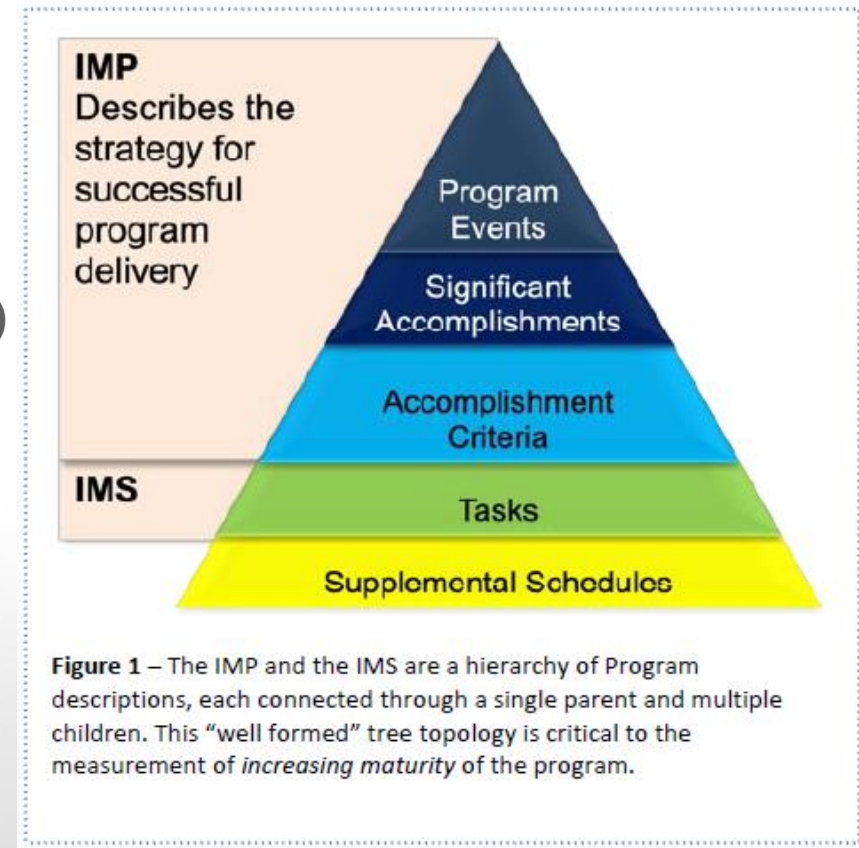
## INCORPORATING TECHNICAL MEASURES INTO THE PROJECT

### PRACTICAL PROCESSES AND OUTPUTS

#### The Integrated Master Plan (IMP).

#### The 5 Steps in Developing the Integrated Master Plan (IMP)

- **Step 1:** Determine the IMP structure and organization
- **Step 2:** Identify events, accomplishment and criteria
- **Step 3:** Prepare the introduction and narrative section
- **Step 4:** Complete the numbering system
- **Step 5:** Iterate events, accomplishments, and criteria with the Integrated Product Team (IPT) during IMS development





# INCORPORATING TECHNICAL MEASURES INTO THE PROJECT

## PRACTICAL PROCESSES AND OUTPUTS

**Develop the Plans and Schedules to Reach Done as Planned –  
Create a Systems Engineering (Management) Plan (SEMP/SEP)**

**Systems Engineering (Management) Plan.** The SEMP or SEP is to help program technical managers develop their systems engineering approach—providing a firm and well-documented technical foundation for the program. A rigorous technical planning process forces thoughtful consideration and debate, allows for integration and coordination of technical activities across all levels of management, and results in a sound systems engineering strategy commensurate with the program's technical issues, life cycle phasing, and overall objectives. Within the SEMP/SEP is the **Technical Measurement or Performance Plan**.



# INCORPORATING TECHNICAL MEASURES INTO THE PROJECT

## PRACTICAL PROCESSES AND OUTPUTS

**Develop the Plans and Schedules to Reach Done as Planned –  
Create a Technical Measurement or Performance Plan.**

**Technical Measurement or Performance Plan.** Provides the time- or event-based plan of anticipated and actual achievement of technical parameters. The elements of measurement of the plan are:

- **Achieved-to-Date.** Measured technical progress or estimate of progress plotted and compared with planned progress at designated milestone dates.
- **Current Estimate.** The value of a technical parameter that is predicted to be achieved using remaining planned resources.
- **Milestone.** Point in time when an evaluation of measure is accomplished.
- **Planned Value (Target).** Predicted value of the technical parameter for the time of measurement based on the planned profile.
- **Planned Performance Profile.** The projected time-phased demonstration of a technical parameter requirement.
- **Tolerance Band.** Alert limits placed across the planned profile to indicate the degree of variation allowed.
- **Threshold.** The limiting acceptable value of a technical parameter, usually a contractual performance requirement.
- **Variances.** The difference between planned value and achieved-to-date along the planned performance profile.

## INCORPORATING TECHNICAL MEASURES INTO THE PROJECT

DEVELOP THE PLANS AND SCHEDULES TO REACH DONE AS PLANNED – CREATE A TECHNICAL MEASUREMENT OR PERFORMANCE PLAN. – THE INCOSE MODEL

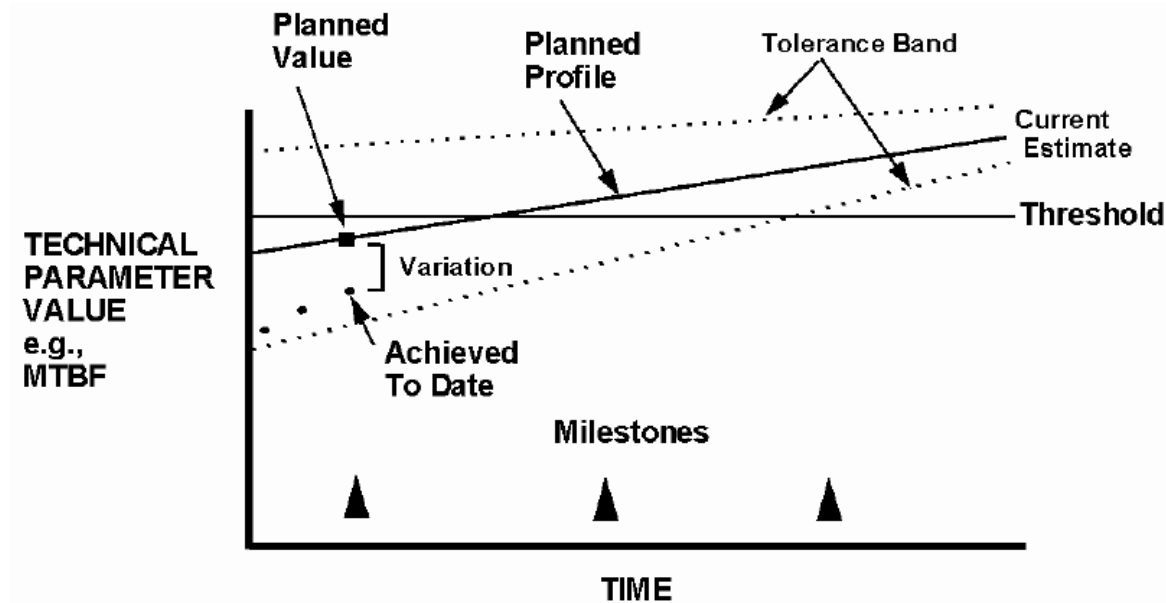
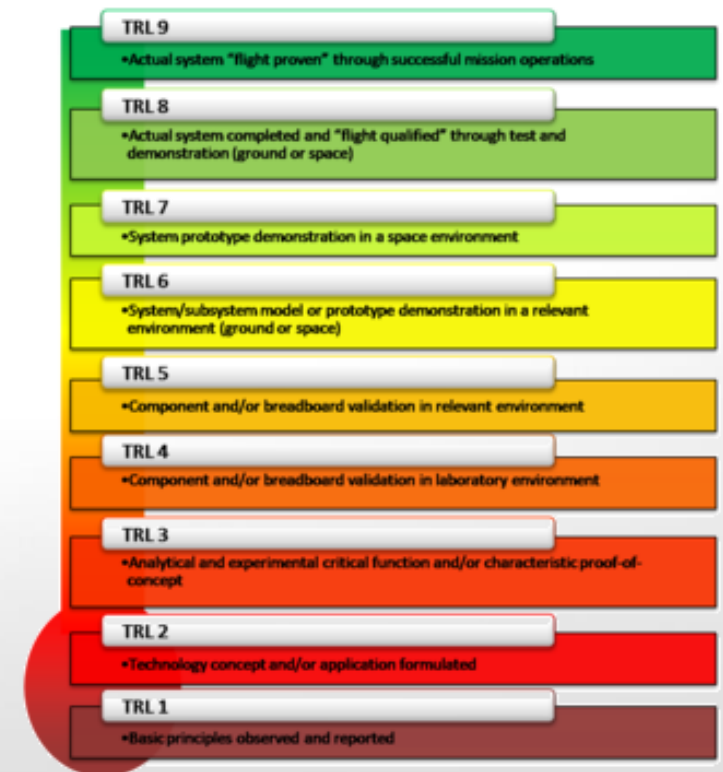


Figure 3-1 Technical Measurement Profile Illustration

## INCORPORATING TECHNICAL MEASURES INTO THE PROJECT

### DEVELOP THE PLANS AND SCHEDULES TO REACH DONE AS PLANNED — CREATE A TECHNICAL MEASUREMENT OR PERFORMANCE PLAN. — NASA TECHNOLOGY READINESS LEVELS AND RISK BANDS OF THE TPM

One of the major factors affecting the defined tolerance and risk bands on the TPM is the maturity of technology incorporated into the design of the technical solution. TRLs describe the maturity of technology being used to meet requirements for which the TPMs are indicators. Just as progress on TPMs is a precursor to project management success, TRLs are a precursor or indicator of potential difficulty in meeting technical performance. The less certain the knowledge and more risky performance, the more likely the project plan will show stress (re-plan, re-budget, re-schedule). The earlier this is known, the less likely the need for a re-baseline.



Technology Readiness Level (TRL)



## INCORPORATING TECHNICAL MEASURES INTO THE PROJECT

**DEVELOP THE PLANS AND SCHEDULES TO REACH DONE AS PLANNED – CREATE A TECHNICAL MEASUREMENT OR PERFORMANCE PLAN. – THE NAVAIR MODEL ADDS RISK AND ASSESSMENT TO NEXT PROBABLE RESULT**

Technical risk management addresses risk identification, analysis, mitigation planning, mitigation implementation, and tracking. Technical risks should be quantified and implications reflected in the program's Integrated Master Schedule and Integrated Master Plan. – DoD 5000.21

Under this model the Current Estimate is restricted to an assessment of the probability of achievement to the next technical milestone.

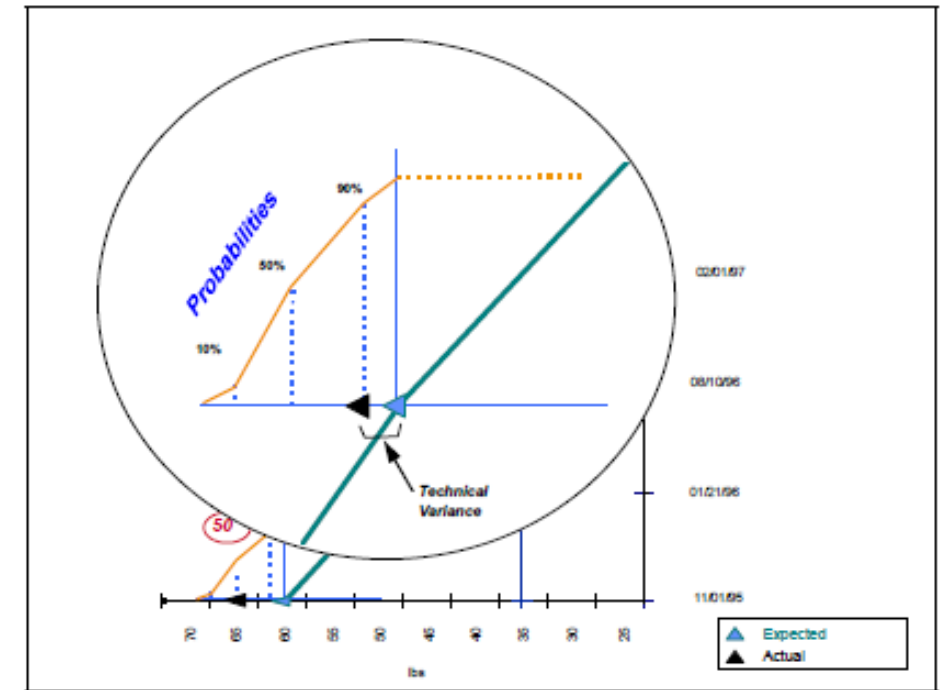


Figure 3: Progress Plan with Risk Profile

# INCORPORATING TECHNICAL MEASURES INTO THE PROJECT

## PRACTICAL PROCESSES AND OUTPUTS

### Develop the Plans and Schedules to Reach Done as Planned – Create an Integrated Master Schedule

**The Integrated Master Schedule (IMS).** The Integrated Master Schedule is derived directly from the IMP. It is not – nor should ever be – built bottom up during the first round of IMS construction. In the IMP/IMS paradigm, all the work needed to move the program forward in its maturity is defined by the Significant Accomplishments and their Accomplishment Criteria. Once these are defined in the IMP, the physical work needed to produce the Accomplishment Criteria is obvious.

Each technical performance parameter that is associated with a planned milestone. Each technical element will be associated with a WBS element at the appropriate level of work and be reflected as an IMS task.

The final process within IMS development is the construction of the **Basis of Estimate (BOE).**





# INTEGRATING TECHNICAL MEASURES INTO PROJECT PERFORMANCE

## ORGANIC MEASURES

- Technical Performance (variances) against the Planned Performance Profile
- Assessment of Technical Readiness Level at Each Major Milestone and Design Review
- Assessment of Technical Risk and Probability of Achieving the Current Estimate to the next milestone or, alternatively, to-complete using existing resources

## FIRST-LINE INTEGRATED MEASURES

- Schedule impact traced through WBS within IMS schedule tasks assigned to the performance parameter
- Resource impact traced through IMS schedule tasks assigned budget through BOE

## EXTENDED INTEGRATED MEASURES

- Earned Value Management assessment
- ETC/EAC assessments informed by risk analysis

# INTEGRATING TECHNICAL MEASURES INTO PROJECT PERFORMANCE

## INTEGRATION OF TECHNICAL ACHIEVEMENT AND EARNED VALUE

- Properly capture technical measures in the IMP
- Properly reflect technical measures found in the IMP in the IMS tasks
- Assign resources to each technical element found in the IMS either through resource-loading or association with the BOE cost profiles
- Associate the technical element tasks within the IMS with the Performance Management Baseline (PMB)
- Assess completion of work under the PMB using EIA-748 approved methods\*

\*Note that EVM method of % complete represents an assessment of technical achievement in terms of work completion. This method is different than either technical estimate to complete or schedule percent complete



# INTEGRATING TECHNICAL MEASURES INTO PROJECT PERFORMANCE

## INTEGRATION OF TECHNICAL ACHIEVEMENT AND EARNED VALUE — ISSUES SURROUNDING PERCENT COMPLETE

- What is the value of a failed test?
- In assessing the probability of achievement to the next measured milestone, how do we translate that into the value of work accomplished to date?
- Kinds of variances
- Expert opinion, data-driven models, risk informed models

## PUTTING IT INTO PRACTICE

### Case study of the Electrified Powertrain Flight Demonstration project of NASA

- NASA is partnering with industry to develop megawatt class electrified aviation powertrains with the goal to commercialize them by 2035
- Contract is in 2 phases: an initial firm fixed price portion and a second cost sharing portion.
- During the FFP portion, technical measures are regularly reported by the industry partners to NASA
- These technical measures form the basis of project evaluation of whether to proceed to the cost sharing phase

# PUTTING IT INTO PRACTICE

## TECHNOLOGY WORKSPACE

- Key Performance Parameters

Proteus U.S. Government Edition

File View Tools Window Money Twins Help

Configuration Management & Contracts Systems Engineering Technology

Filters

TRLs (11 of 11) Vision Vehicles (4 of 4) Test Vehicles (0 of 0) MOEs (5 of 5) KPPs (13 of 13) MOPs (6 of 6) TPMs (6 of 6) TPM Measurements (12 of 12) KPP Measurement (14 of 14) Demonstrator Vehicles (2 of 2)

| TRL_ID | Category | Technology | Source | At_Formulation | At_Proposal | At_SRR | Component_Sy... | At_PDR | At_CDR | Integrated_Gro... | Pre_Flight | At_PPAR |
|--------|----------|------------|--------|----------------|-------------|--------|-----------------|--------|--------|-------------------|------------|---------|
| N%LC   | N%LC     | N%LC       | N%LC   | =              | =           | =      | =               | =      | =      | =                 | =          | =       |

Dashboard

Vision Vehicles Demonstration Vehicles TRLs MOEs MOPs

Vision Vehicles KPPs KPP Measurements

KPPs

Aircraft

| ID                            | Description                          | Full Success Value | Full Success UoM | Minimum Success Value | Minimum Success UoM |
|-------------------------------|--------------------------------------|--------------------|------------------|-----------------------|---------------------|
| <b>Aircraft: 19 PAX</b>       |                                      |                    |                  |                       |                     |
| KPP-1                         | Total Power level of the Integr...   |                    |                  | 500                   | Kilo Watt           |
| KPP-2                         | Power Level of individual electri... |                    |                  | 250                   | Kilo Watt           |
| KPP-3                         | Operating Voltage of the Integ...    |                    |                  | 500                   | Volts               |
| KPP-4                         | Altitude Capability of the Integ...  |                    |                  | 20000                 | Feet                |
| KPP-5                         | Specific Power of the Integrate...   |                    |                  | 1                     | KkW/kg              |
| KPP-7                         | Mission Fuel Burn/Energy Redu...     |                    |                  | 10                    | Percent             |
| <b>Aircraft: Single Aisle</b> |                                      |                    |                  |                       |                     |
| KPP-1                         | Total Power level of the Integr...   | 2                  | Mega Watt        |                       |                     |
| KPP-2                         | Power Level of individual electri... | 1                  | Mega Watt        |                       |                     |
| KPP-3                         | Operating Voltage of the Integ...    | 1000               | Volts            |                       |                     |
| KPP-4                         | Altitude Capability of the Integ...  | 40000              | Feet             |                       |                     |
| KPP-5                         | Specific Power of the Integrate...   | 1                  | kW/kg            |                       |                     |
| KPP-6                         | End to End loss of the Integrat...   | 20                 | Percent          |                       |                     |
| KPP-7                         | Mission Fuel Burn/Energy Redu...     | 4                  | Percent          |                       |                     |

Save

Repository: D:\Proteus EPFD Repository, Workspace: Technology

## PUTTING IT INTO PRACTICE

### TECHNOLOGY WORKSPACE

- Technical Performance Measures

Proteus U.S. Government Edition

File View Tools Window Money Twins Help

Configuration Management & Contracts Systems Engineering Technology

Filters

TRLs (11 of 11) Vision Vehicles (4 of 4) Test Vehicles (0 of 0) MOEs (5 of 5) KPPs (13 of 13) MOPs (6 of 6) TPMs (6 of 6) TPM Measurements (12 of 12) KPP Measurement (14 of 14) Demonstrator Vehicles (2 of 2)

| TRL_ID | Category | Technology | Source | At_Formulation | At_Proposal | At_SRR | Component_Sy... | At_PDR | At_CDR | Integrated_Gro... | Pre_Flight | At_PPAR |
|--------|----------|------------|--------|----------------|-------------|--------|-----------------|--------|--------|-------------------|------------|---------|
| 1%     | 1%       | 1%         | 1%     | =              | =           | =      | =               | =      | =      | =                 | =          | =       |

Edit Filter

Dashboard

Vision Vehicles Demonstration Vehicles TRLs MOEs MOPs

Demonstration Vehicles TPMs TPM Measurements

TPMs

Drag a column header here to group by that column

| ID    | Description                           | Full Success Value | Full Success UoM | Minimum Success Value | Minimum Success UoM |
|-------|---------------------------------------|--------------------|------------------|-----------------------|---------------------|
| TPM-1 | Total Power level of the Integr...    | 2                  | Mega Watt        | 500                   | Mega Watt           |
| TPM-2 | Power level of individual electric... | 1                  | Mega Watt        | 250                   | Mega Watt           |
| TPM-3 | Operating Voltage of the Integ...     | 1000               | Volts            | 500                   | Volts               |
| TPM-4 | Altitude Capability of the Integ...   | 30000              | Feet             | 15000                 | Feet                |
| TPM-5 | Specific Power of the Integrate...    | 1                  | kW/kg            | 1                     | kW/kg               |
| TPM-6 | End to End loss of the Integrat...    | 20                 | Percent          | 25                    | Percent             |

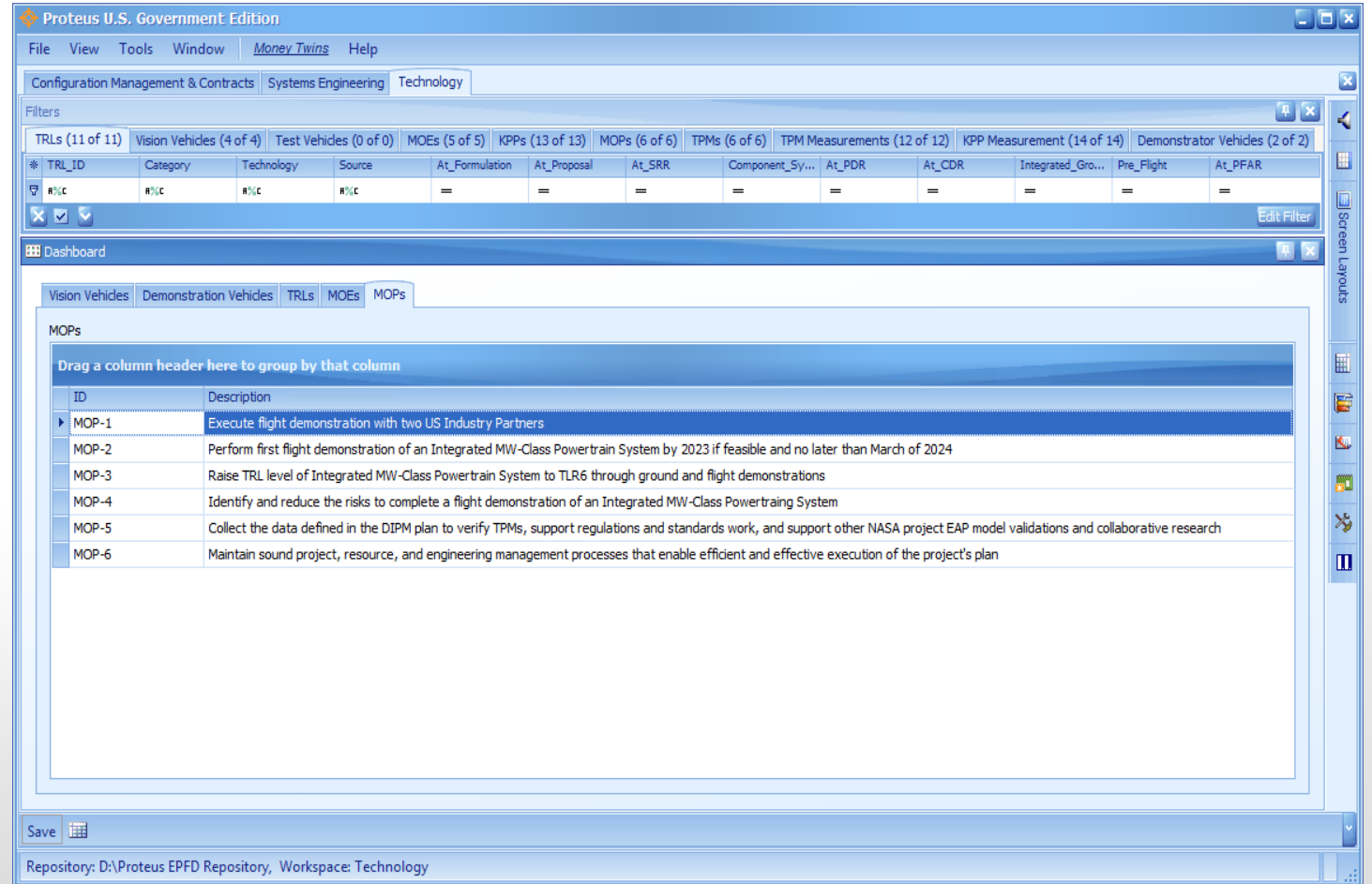
Save

Repository: D:\Proteus EPFD Repository, Workspace: Technology

# PUTTING IT INTO PRACTICE

## TECHNOLOGY WORKSPACE

- Measures of Performance



The screenshot shows the Proteus U.S. Government Edition interface. The top menu bar includes File, View, Tools, Window, Money Twins, and Help. The main workspace is titled "Technology" and displays a table of Measures of Performance (MOPs). The table has columns for ID, Description, and various performance metrics. The MOPs are listed as follows:

| ID    | Description   |
|-------|---|
| MOP-1 | Execute flight demonstration with two US Industry Partners  |
| MOP-2 | Perform first flight demonstration of an Integrated MW-Class Powertrain System by 2023 if feasible and no later than March of 2024  |
| MOP-3 | Raise TRL level of Integrated MW-Class Powertrain System to TLR6 through ground and flight demonstrations   |
| MOP-4 | Identify and reduce the risks to complete a flight demonstration of an Integrated MW-Class Powertrain System  |
| MOP-5 | Collect the data defined in the DIPM plan to verify TPMs, support regulations and standards work, and support other NASA project EAP model validations and collaborative research |
| MOP-6 | Maintain sound project, resource, and engineering management processes that enable efficient and effective execution of the project's plan  |

The bottom status bar indicates the Repository: D:\Proteus EPFD Repository, Workspace: Technology.

# PUTTING IT INTO PRACTICE

## TECHNOLOGY WORKSPACE

- Measures of Effectiveness

Proteus U.S. Government Edition

File View Tools Window Money Twins Help

Configuration Management & Contracts Systems Engineering Technology

Filters

TRLs (11 of 11) Vision Vehicles (4 of 4) Test Vehicles (0 of 0) MOEs (5 of 5) KPPs (13 of 13) MOPs (6 of 6) TPMs (6 of 6) TPM Measurements (12 of 12) KPP Measurement (14 of 14) Demonstrator Vehicles (2 of 2)

| TRL_ID | Category | Technology | Source | At_Formulation | At_Proposal | At_SRR | Component_Sy... | At_PDR | At_CDR | Integrated_Gro... | Pre_Flight | At_PEAR |
|--------|----------|------------|--------|----------------|-------------|--------|-----------------|--------|--------|-------------------|------------|---------|
| 1%     | 1%       | 1%         | 1%     | =              | =           | =      | =               | =      | =      | =                 | =          | =       |

Dashboard

Vision Vehicles Demonstration Vehicles TRLs MOEs MOPs

MOEs

Drag a column header here to group by that column

| ID    | Description  |
|-------|--|
| MOE-1 | Establish at least two Vision Vehicles that address the single-aisle, regional or thin haul markets  |
| MOE-2 | Define a viable path that accelerates U.S. Industry product introduction of the Vision Vehicle and execute the part of the path that requires government participation |
| MOE-3 | Identify and reduce Barrier Technical Risks to the introduction of Vision Vehicle through the ground and flight tests  |
| MOE-4 | Reduce regulations and standards barriers to the introduction of Vision Vehicles with Integrated MW-Class Powertrain Systems into the air fleet                        |
| MOE-5 | Collect the data defined in the Data and Intellectual Property Management (DIPM) plan to verify Key Performance Parameters and support regulations and standards work  |

Save

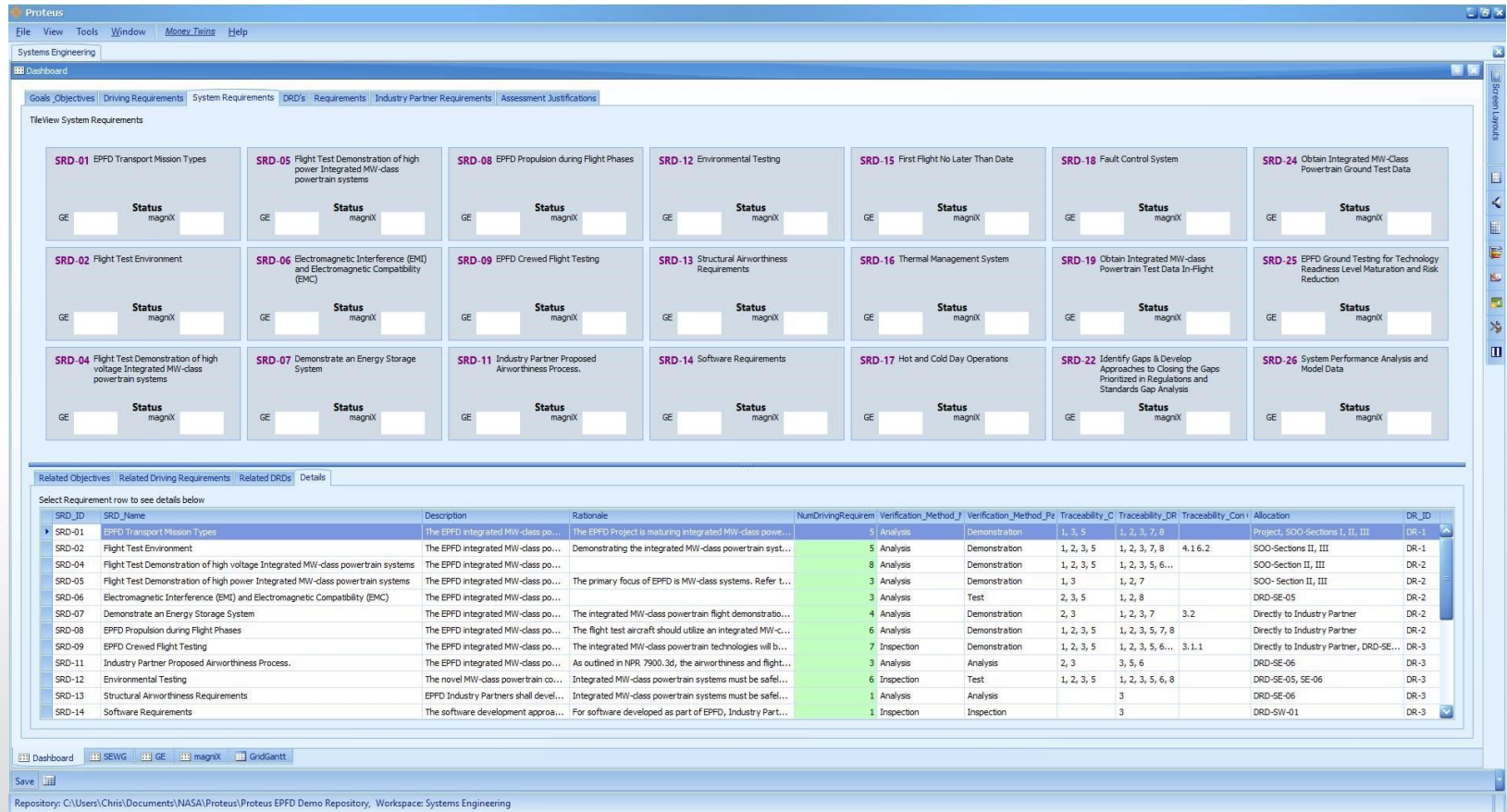
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# PUTTING IT INTO PRACTICE

## SYSTEMS ENGINEERING WORKSPACE

- System Requirements
- Requirements color coded for health



The screenshot displays the Proteus Systems Engineering workspace. The top section shows a dashboard with 24 system requirements (SRD-01 to SRD-26) arranged in a grid. Each requirement card includes a title, a status indicator (magnX), and a color-coded health status. Below the dashboard, a table provides detailed information for the selected requirement (SRD-01).

| SRD_ID | SRD_Name   | Description                           | Rationale   | NumDrivingRequire | Verification_Method_I | Verification_Method_Pe | Traceability_C | Traceability_DR  | Traceability_Con | Allocation                              | DR_ID |
|--------|--|---------------------------------------|---|-------------------|-----------------------|------------------------|----------------|------------------|------------------|---|-------|
| SRD-01 | EPFD Transport Mission Types   | The EPFD integrated MW-class po...    | The EPFD Project is maturing integrated MW-class powe...      | 5                 | Analysis              | Demonstration          | 1, 3, 5        | 1, 2, 3, 7, 8    | 4.1.6.2          | SOO-Sections II, III                    | DR-1  |
| SRD-02 | Flight Test Environment  | The EPFD integrated MW-class po...    | Demonstrating the integrated MW-class powertrain syst...      | 5                 | Analysis              | Demonstration          | 1, 2, 3, 5     | 1, 2, 3, 5, 6... |                  | SOO-Section II, III                     | DR-2  |
| SRD-04 | Flight Test Demonstration of high voltage Integrated MW-class powertrain systems | The EPFD integrated MW-class po...    | The primary focus of EPFD is MW-class systems. Refer t...     | 3                 | Analysis              | Demonstration          | 1, 3           | 1, 2, 7          |                  | SOO-Section II, III                     | DR-2  |
| SRD-05 | Flight Test Demonstration of high power Integrated MW-class powertrain systems   | The EPFD integrated MW-class po...    |   | 3                 | Analysis              | Test                   | 2, 3, 5        | 1, 2, 8          |                  | DRD-SE-05                               | DR-2  |
| SRD-06 | Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC)       | The EPFD integrated MW-class po...    |   | 4                 | Analysis              | Demonstration          | 2, 3           | 1, 2, 3, 7       | 3.2              | Directly to Industry Partner            | DR-2  |
| SRD-07 | Demonstrate an Energy Storage System   | The EPFD integrated MW-class po...    | The integrated MW-class powertrain flight demonstratio...     | 6                 | Analysis              | Demonstration          | 1, 2, 3, 5     | 1, 2, 3, 5, 7, 8 |                  | Directly to Industry Partner            | DR-2  |
| SRD-08 | EPFD Propulsion during Flight Phases   | The EPFD integrated MW-class po...    | The flight test aircraft should utilize an integrated MW-c... | 7                 | Inspection            | Demonstration          | 1, 2, 3, 5     | 1, 2, 3, 5, 6... | 3.1.1            | Directly to Industry Partner, DRD-SE... | DR-3  |
| SRD-09 | EPFD Crewed Flight Testing   | The EPFD integrated MW-class po...    |   | 3                 | Analysis              | Analysis               | 2, 3           | 3, 5, 6          |                  | DRD-SE-06                               | DR-3  |
| SRD-11 | Industry Partner Proposed Airworthiness Process.                                 | The EPFD integrated MW-class po...    | As outlined in NPR 7900.3d, the airworthiness and flight...   | 6                 | Inspection            | Test                   | 1, 2, 3, 5     | 1, 2, 3, 5, 6, 8 |                  | DRD-SE-05, SE-06                        | DR-3  |
| SRD-12 | Environmental Testing  | EPFD Industry Partners shall devel... | Integrated MW-class powertrain systems must be safel...       | 1                 | Analysis              | Analysis               |                | 3                |                  | DRD-SE-06                               | DR-3  |
| SRD-13 | Structural Airworthiness Requirements  | EPFD Industry Partners shall devel... |   | 1                 | Inspection            | Inspection             |                | 3                |                  | DRD-SIW-01                              | DR-3  |
| SRD-14 | Software Requirements  | The software development approa...    | For software developed as part of EPFD, Industry Part...      |                   |                       |                        |                |                  |                  |   |       |

# RESOURCES

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# THANK YOU!!!



Please visit our booth for more information or questions

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