



# **LVM Confidence Factor**

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# LVM Confidence Factor

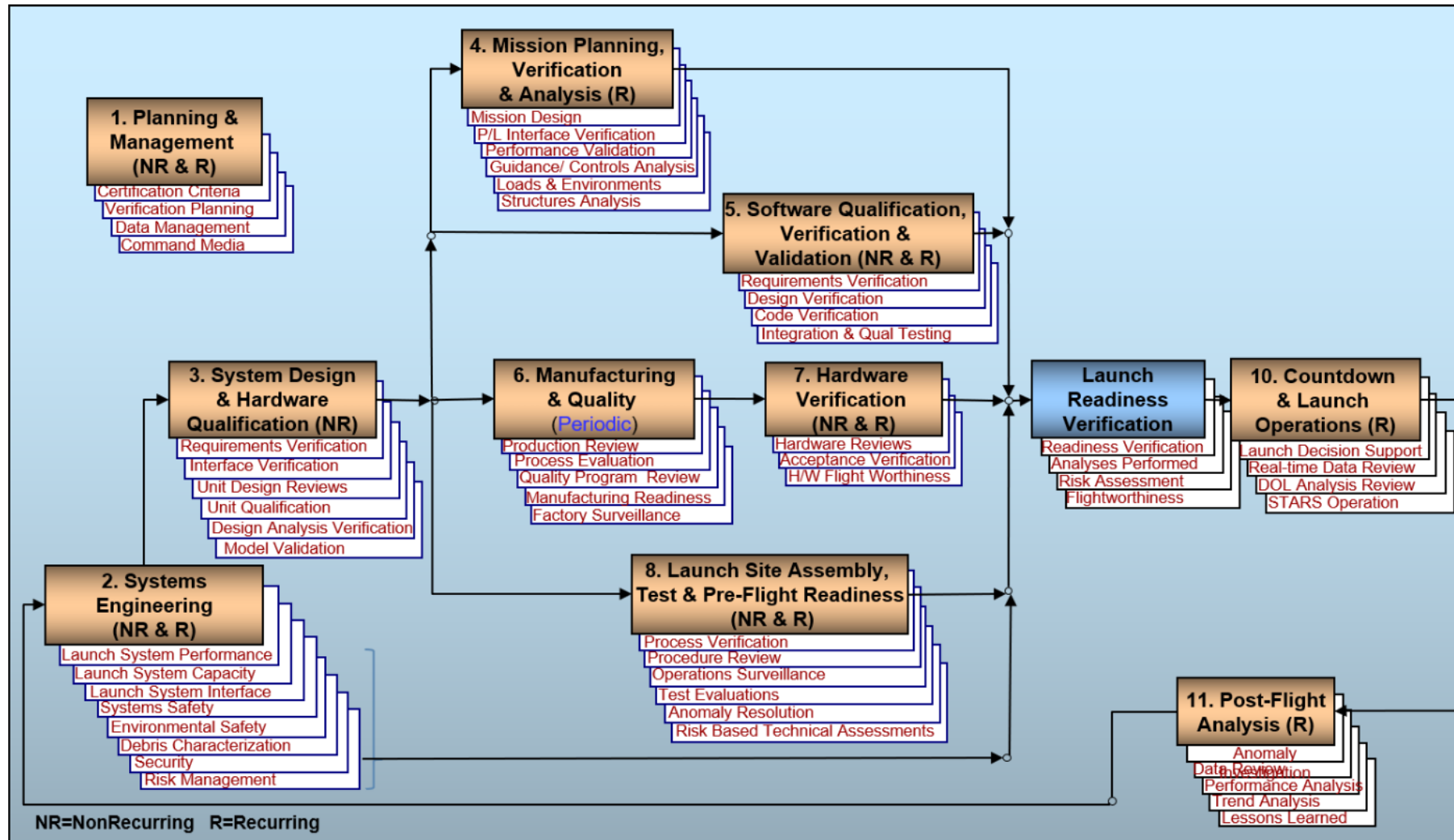
## Background & Introduction

- The Launch Verification Matrix (LVM) is the core of USSF's independent verification and validation (IV&V) process for the National Security Space Launch (NSSL) program.
  - Developed by Aerospace early in the EELV (now NSSL) program in response to 1999 BAR recommendations
  - Establishes a baseline Master Task List (MTL) for each NSSL product line (Falcon, Vulcan)
  - Defines ~500 non-recurring design validation (NRDV) tasks and ~200 recurring tasks supporting Spaceflight Worthiness certification for each launch mission
  - Each MTL task is assigned a baseline Depth-of-Effort (DoE) of 0 through 5:
    - 5: Perform complete independent modeling and analysis
    - 4: Perform partial independent modeling and analysis
    - 3: Perform limited analysis, modeling, and simulation, relying largely on contractor assumptions
    - 2: Review contractor modeling and analysis documentation
    - 1: Monitor a very limited amount of contractor analysis documentation
    - 0: Task suspended
- Historically, MTL task DoEs were relatively static – only occasional, ad-hoc changes
- To adapt to evolving USSF needs and associated resource allocation, Aerospace developed, and USSF has adopted, the LVM Confidence Factor.



# Launch Verification Matrix

A Rigorous, Structured Framework Encompassing the Full Scope of IV&V Best Practices



The Master Task List specifies all IV&V tasks required for NRDV and mission-specific flightworthiness verification



# Confidence Factor Optimizes Recurring Mission Assurance Effort

Leverages industry advancements without increasing risk

Non-Recurring Design Validation (NRDV)

TRADITIONAL LVM  
RECURRING MA

CERTIFICATION

CONFIDENCE-BASED  
RECURRING MA

CONFIDENCE  
BASE CAMP 2

EXTERNAL MA

DESIGN  
MARGINS

CONTRACTOR  
MATURITY

FLIGHT HISTORY

DESIGN VALIDATION  
BASE CAMP 1

Equivalent level of launch confidence achieved by focusing on outcomes rather than activities



# LVM Confidence Factor

## Concept & Principles

- A structured, repeatable and sustained process for assessing criticality of each NSSL Launch Verification Matrix (LVM) **recurring** task based on confidence in contractor processes
- A consistent mechanism to adjust LVM Master Task List (MTL) depth-of-effort (DoE) based on current conditions
  - Determines minimum task DoE required to achieve Confidence threshold for flight certification
  - Demonstrated potential for substantial reduction in LVM execution effort on mature product lines
  - Also suitable for addressing risk of declining confidence during program fly-out or in response to adverse events/developments
- Measures confidence by six Conditions encompassing all factors relevant to recurring task DoE

1. Design Management	4. Tools & Methodology
2. Margins & Conservatism	5. Flight Experience
3. Process Management	6. Test Adequacy & Results

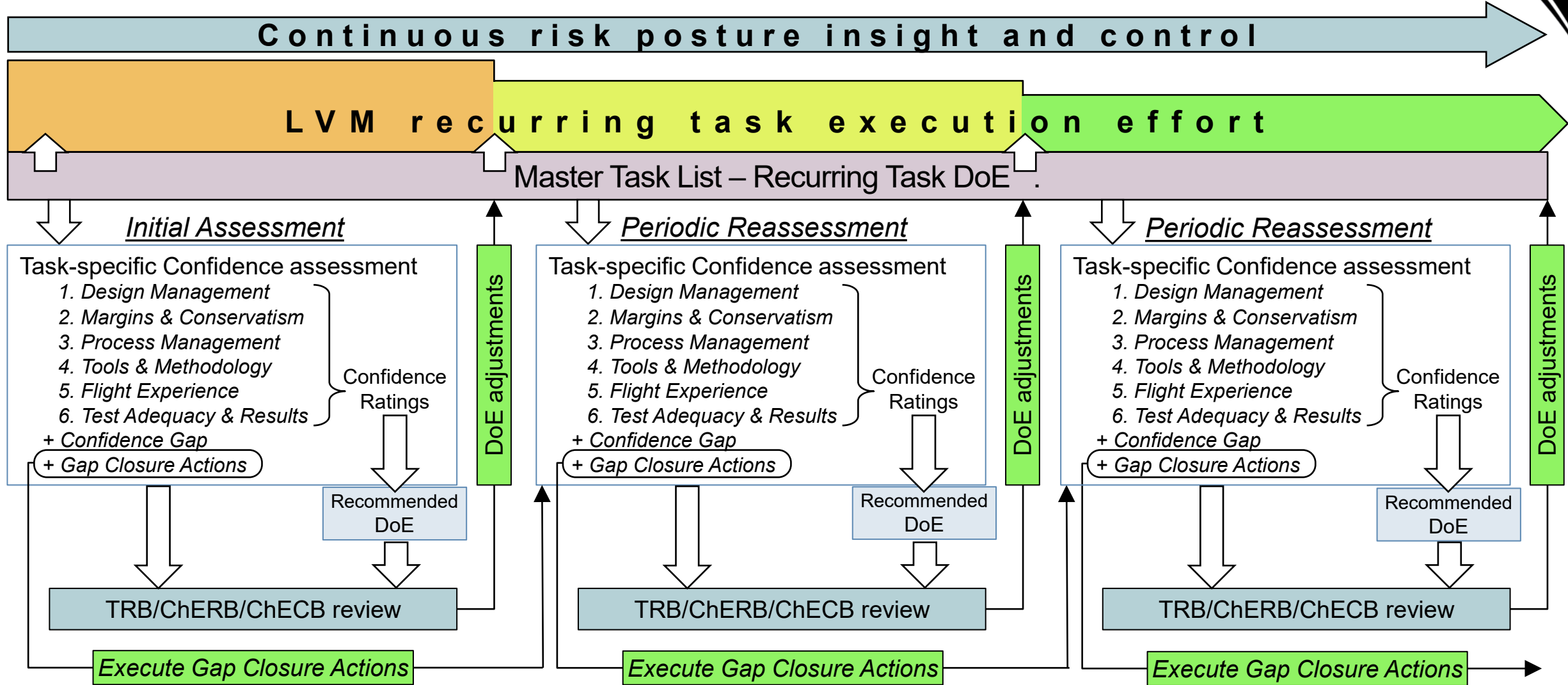
- Substantiates & documents DoE rationale via **Confidence Gap**: areas requiring attention before further DoE reduction
- Defines **Gap Closure Actions** to increase confidence & allow further DoE reduction
- Ensures continuous insight into, and control of, overall mission risk posture
- Establishes a common baseline process for optimizing IV&V resource allocation across product lines
- Does not address mission-specific IV&V requirements: mission DoE adjustment remains a function of LVM Technical Review Board and Chief Engineer Review Board (TRB/ChERB)

**The LVM Confidence Factor ensures structured, repeatable and sustained “credit” for contractor MA gains**



# LVM Confidence Factor

Structured, Repeatable and Sustained Assessment of Confidence in Contractor Processes

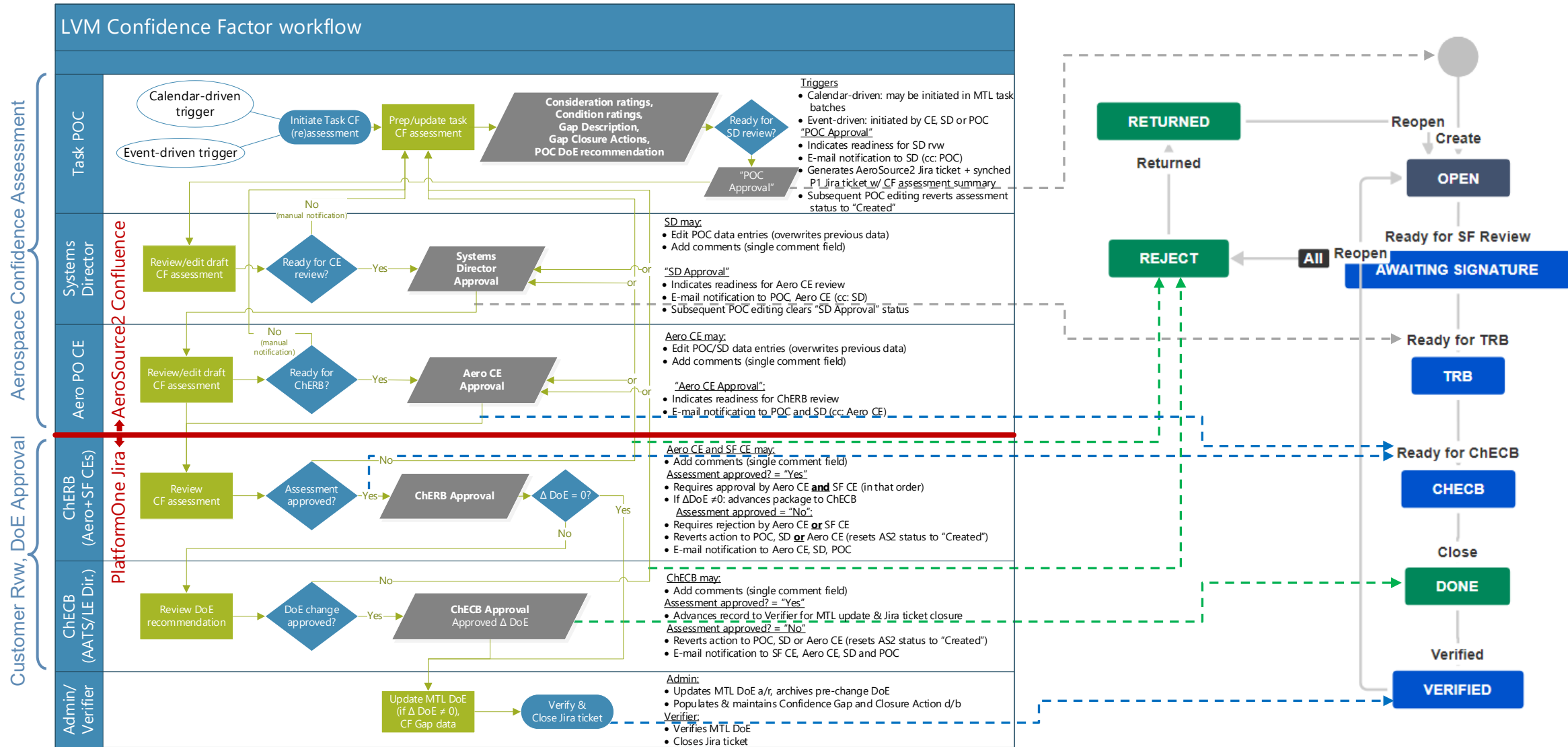


**LVM Confidence Factor optimizes recurring task effort and proactively increases process confidence**



# LVM Confidence Factor

## Operational Workflow: MTL Task Confidence Assessment & DoE Review/Revision



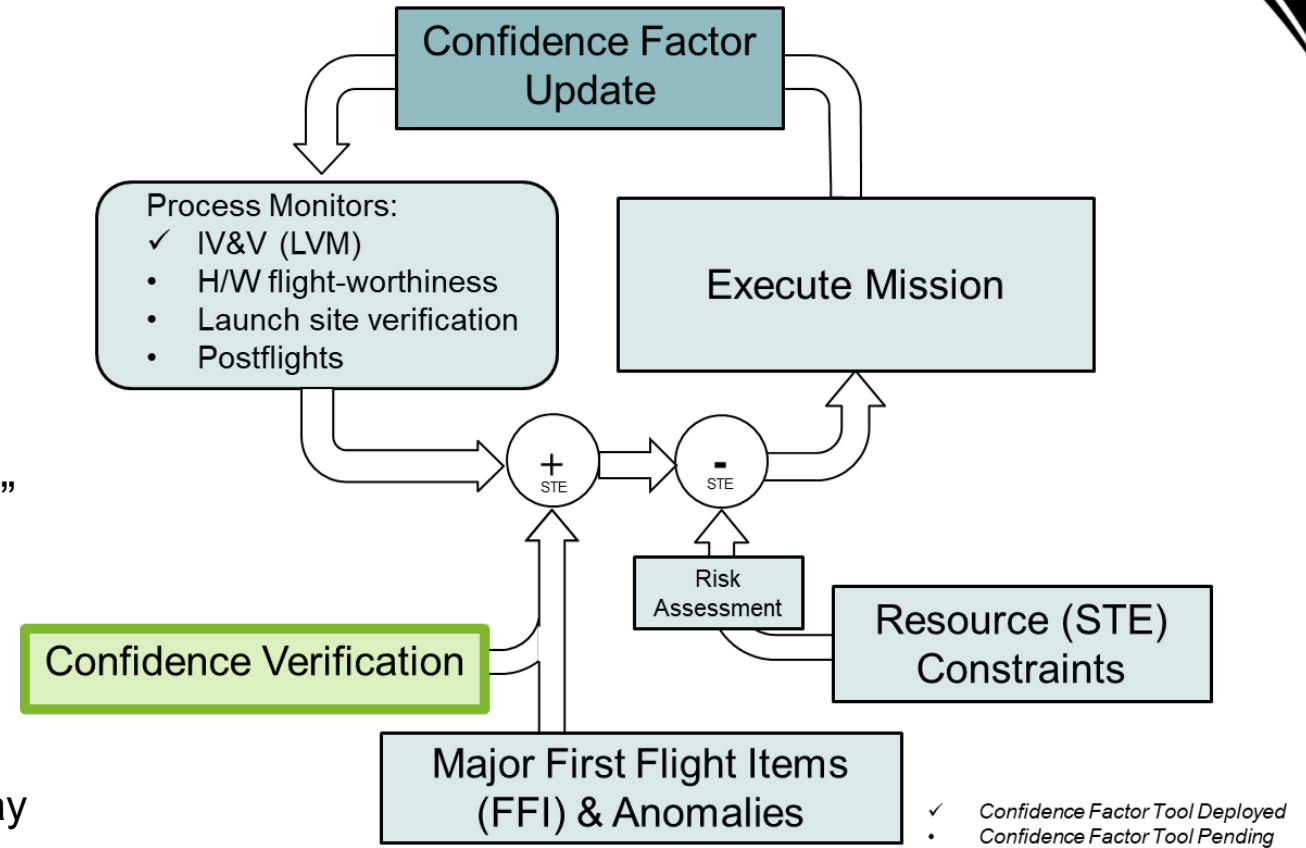
Process workflow is implemented in automated Confluence + Jira toolset



# LVM Confidence Factor Toolset

## Confidence Verification

- Confidence Factor success in reducing LVM task DoE introduces certain concerns:
  - Continued ability to detect emergent systemic issues without in-depth IV&V
  - Retention of skills and maintenance of capability needed to solve the hardest problems
- To address these concerns, Aerospace has implemented a process of “Confidence Verification”
  - Methodically revisits reduced-DoE tasks to:
    - Reconfirm contractor process health
    - Maintain Aerospace capabilities & tools
- Specific CV elements:
  - DoE Triggers: Mission-specific considerations that may warrant an increase in DoE for a given LVM task
  - Minimum frequency to perform tasks at increased DoE to maintain Aerospace capabilities
  - Task Interdependencies: coupling of DoE increases



**Confidence Factor + Confidence Verification provides closed-loop, systematic and sustainable IV&V reductions based on growth of confidence in contractor processes**





# LVM Confidence Factor Implementation Status

## Operational Roll-Out

- The NSSL Falcon program completed Confidence Factor assessment of 177 MTL recurring tasks
  - Resulted in DoE reduction for 115 tasks, suspension of 4.
  - Substantial contribution to program's ability to support a rapidly growing manifest with constrained resources.
  - Program is now focused on:
    - Confidence Verification planning and implementation
    - Gap Closure Action review, prioritization and joint review with the launch service provider
  - Gap Closure Action completion will allow further DoE reduction via future Confidence Factor reassessments
- The NSSL Vulcan program will apply LVM Confidence Factor as the program matures.
  - Execute several missions at baseline DoE
  - Specific criteria for first Confidence Factor application are TBD

**The LVM Confidence Factor process and toolset are fully operational and supporting LV MA optimization**



**Questions?**



***Thank you***



# **Backup: LVM Confidence Factor Implementation**



# LVM Confidence Factor Toolset

## MTL Task Confidence Assessment

- The heart of the Confidence Assessment process
- Intuitive, logically structured format for Aero RE to initiate and complete the MTL task-specific Confidence Assessment
  - Step-by-step rating of Confidence in each of the six Confidence rating Conditions
  - Each Condition broken down into 3-5 subordinate Considerations
  - Statement of **Confidence Gap** for each Consideration rated at less than full Confidence (1)
  - Statement of notional **Gap Closure Action** corresponding to each Confidence Gap
  - Pop-up for each input field: detailed guidance and instructions
- Aero RE submission forwards assessment to Aero Systems Dir. for review/approval

RE = Responsible Engineer

MTL = Master Task List

**Structured, intuitive interface for in-depth Confidence Assessment**

MTL Task Confidence Assessment

Required Field

MTL Task No. & Title:

Systems Director:

Chief Engineer:

Current Depth of Effort:  1  2  3  4  5

Important! The assessment below must be limited to considerations ONLY as they apply to the subject MTL task.

AWI: 3501 xxx\_LVM\_CF\_LVPL\_application\_draft.docx

Design Management Condition	
<b>Design Stability:</b> How stable has the launch system design (portions relevant to this LVM task) been through recent missions? <input checked="" type="radio"/> N/A <input type="radio"/> Very Stable (1) <input type="radio"/> Few & minor recent changes (3) <input type="radio"/> Major recent changes (5) <a href="#">Click here for rating definitions...</a>	<b>Change Intent:</b> To what extent are recent design changes intended to improve system reliability? <input checked="" type="radio"/> N/A <input type="radio"/> Entirely reliability motivated (1) <input type="radio"/> Roughly even mix (3) <input type="radio"/> Not reliability motivated (5) <a href="#">Click here for rating definitions...</a>
<b>Change Increment:</b> To what extent have recent changes been implemented and validated incrementally? <input checked="" type="radio"/> N/A <input type="radio"/> Small, controlled increments (1) <input type="radio"/> Moderate batches (3) <input type="radio"/> Many simultaneous changes (5) <a href="#">Click here for rating definitions...</a>	<b>Effect On Prediction:</b> To what extent do recent design changes invalidate or call into question the accuracy of analytical predictions? <input checked="" type="radio"/> N/A <input type="radio"/> Negligible effect (1) <input type="radio"/> Manageable effect (3) <input type="radio"/> Predictions invalidated (5) <a href="#">Click here for rating definitions...</a>
Average Consideration Rating: <input type="radio"/> 0 <input checked="" type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5 <input checked="" type="radio"/> N/A <a href="#">Click here for guidance...</a>	Condition Confidence Rating: <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5 <input checked="" type="radio"/> N/A <a href="#">Click here for guidance...</a>
Gap Description: Gap Description required for consideration ratings > 1. <input type="text"/> <a href="#">Click here for guidance...</a>	Gap Closure Action(s): Gap Closure required for consideration ratings > 1. <input type="text"/> <a href="#">Click here for guidance...</a>
Comments: See Guidance for minimum comment requirements. <input type="text"/> <a href="#">Click here for guidance...</a>	

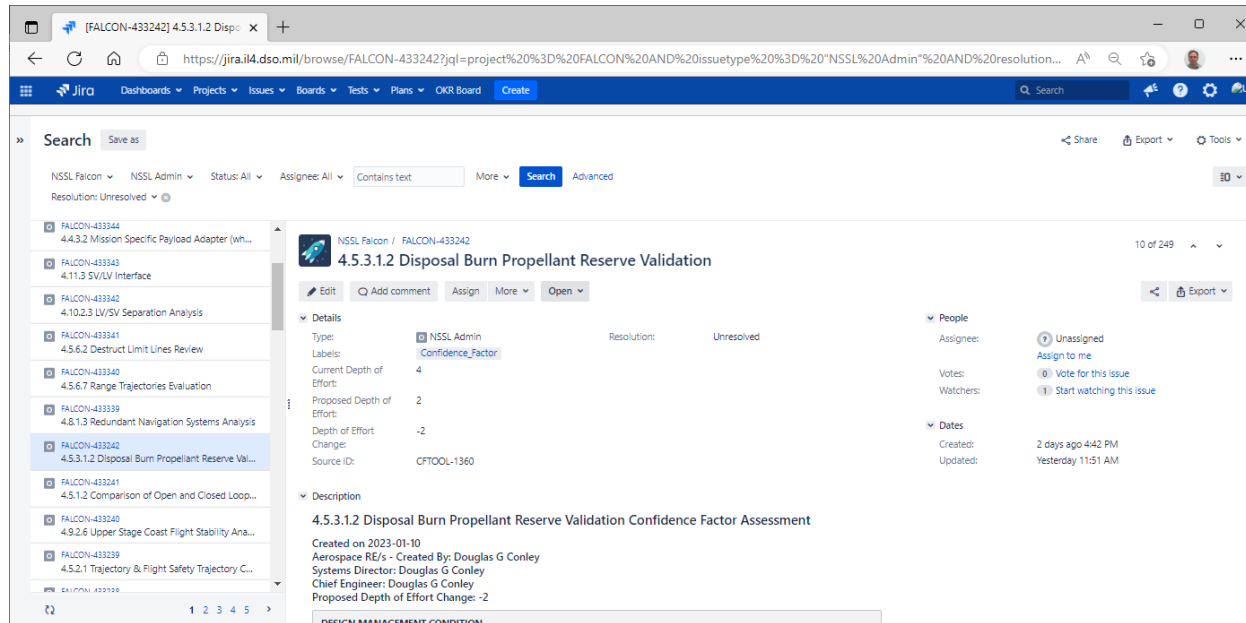
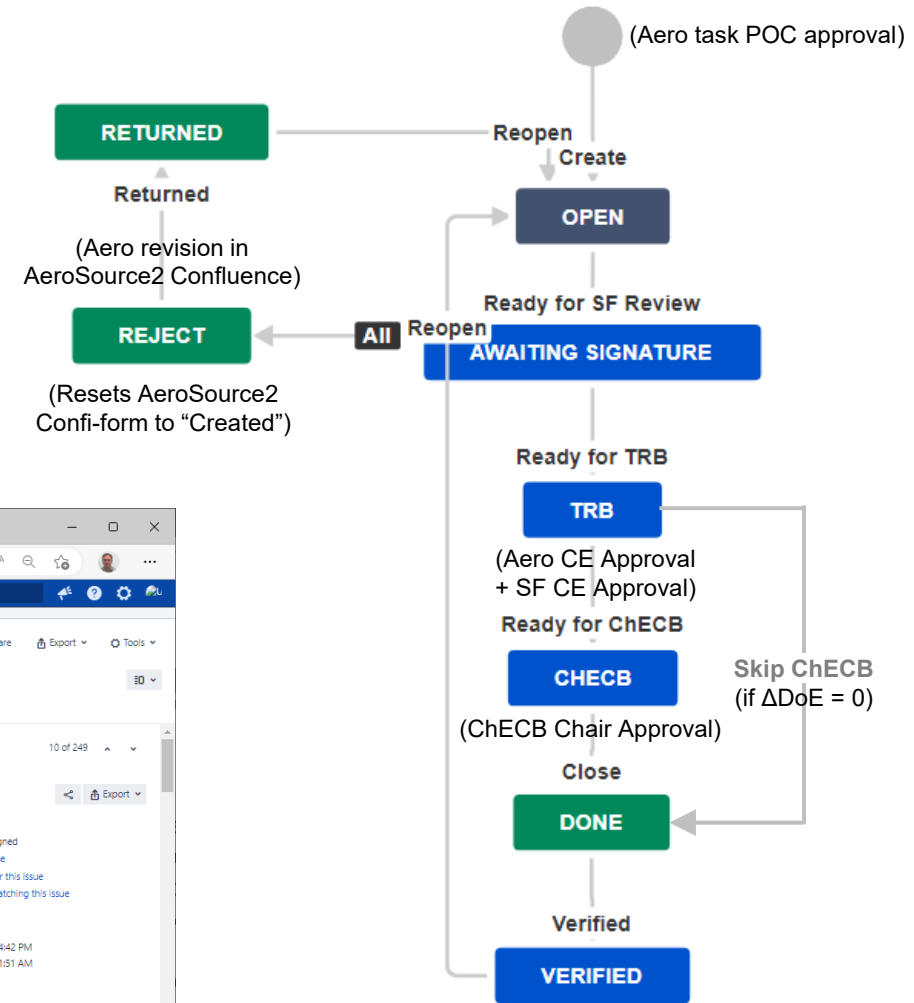
Margins & Conservatism Condition	
<b>Margin Application:</b> To what extent have required/appropriate margins or factors of safety been applied in launch system and process design? <input checked="" type="radio"/> N/A <input type="radio"/> Appropriate & consistent (1) <input type="radio"/> Small but acceptable (3) <input type="radio"/> Inadequate (5) <a href="#">Click here for rating definitions...</a>	<b>Worst Case Envelope:</b> To what extent do margins or factors of safety account for and envelope worst case conditions? <input checked="" type="radio"/> N/A <input type="radio"/> Fully enveloped (1) <input type="radio"/> Mostly enveloped (3) <input type="radio"/> Envelope far exceeded (5) <a href="#">Click here for rating definitions...</a>
<b>Conservatism:</b> To what extent is conservatism consistently applied?	<b>Fault Tolerance:</b> To what degree is the system or process failure tolerant?



# LVM Confidence Factor Toolset

## Task Depth of Effort Review and Approval

- Platform One Jira ticket workflow
  - ChERB approval of each MTL task assessment
    - Option to return to Aerospace for review (“Reject”)
      - If  $\Delta DoE = 0$ , ChECB is bypassed
  - ChECB approval (DoE changes only)
    - Option to return to Aerospace for review (“Reject”)
  - Verified & closed following MTL update



ChERB = Chief Engineer Review Board  
ChECB = Chief Engineer Control Board

DoE = Depth of Effort  
MTL = Master Task List

Structured, repeatable workflow for customer review and approval



# LVM Confidence Factor Toolset

## Platform One Jira Ticket Summarizes Aerospace Task Confidence Assessment

**4.5.3.1.2 Disposal Burn Propellant Reserve Validation Confidence Factor Assessment**

Created on 2023-01-10  
 Aerospace RE/s - Created By: Douglas G Conley  
 Systems Director: Douglas G Conley  
 Chief Engineer: Douglas G Conley  
 Proposed Depth of Effort Change: -2

DESIGN MANAGEMENT CONDITION	
Condition	Assessment
Design Stability	Very Stable (1)
Change Intent	Roughly even mix (3)
Change Increment	Small, controlled increments (1)
Effect on Prediction	Negligible effect (1)
Average Consideration Rating	1.5
Condition Confidence Rating	2
Gap Description	1. Change Intent: Change XYZ (approved 12/24/22) was motivated by cost reduction.
Gap Closure Action(s)	1. As part of approval process for changes driven by cost reduction, include analysis of potential mission assurance impacts. (SpaceX)
Comments	-

... (repeat for 6 Conditions)...

Sample Only

**Task Assessment Summary**

Condition	Assessment
Average Condition Confidence Rating	1.4
Task Confidence Rating	2
Proposed Depth of Effort	2
Comments	Per ChERB request,

Attachments

Drop files to attach, or browse.

Activity

All Comments Work Log History Activity Newest first ↓

Brandon Wong added a comment - 2 days ago

2023-02-23T18:47:17.000-0800 // Comments from Aerospace MTL Task

Complete, compact summary of each MTL task Confidence Assessment, Confidence Gaps and Gap Closure Actions