# Summary of Lessons Learned from Previous PI-Led Missions: Studies and Assessments

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# TMC Studies and Assessments

- There are four Lessons Learned studies on the evaluation of Step 1 proposals and Step 2 CSRs that are available on the SOMA homepage. They are:
    1) **Common Management Major Weaknesses in Step One Proposals**
    2) **Summary of Lessons from Previous PI-Led Missions, August 12, 2024**
    3) **Instrument Considerations for Step 1 and Step 2 Proposals**
    4) **Instrument Considerations for Pre-Phase A Proposals**

**SOMA homepage - https://soma.larc.nasa.gov/**

# Step 2 Lessons Learned Study Update

**Study Questions**

What is the history of TMC Risk Ratings?

Are there common causes of major weaknesses?

**Results**

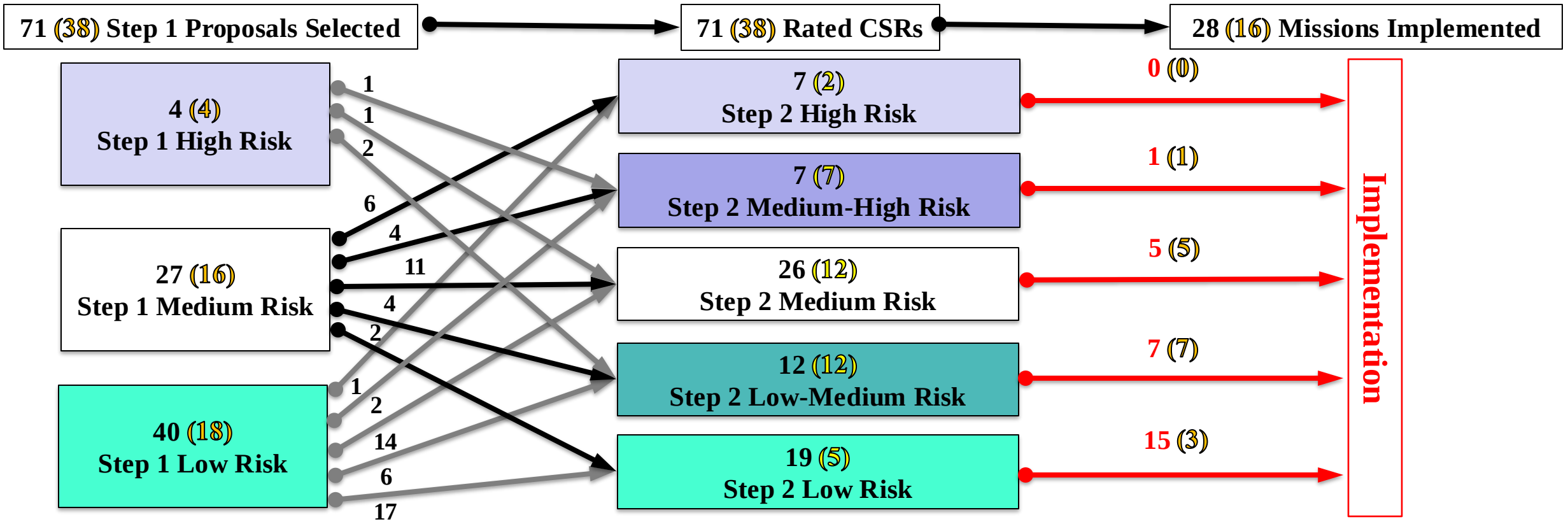
Conduct a review of formal records of approximately1300 proposals and concept study reports retained by SOMA in the on-site archive library.

- Step 2 Major Weakness Trends and Common Causes.

**Study Update**

Due to no Step 2 Down-Selections having been made since the 2023 Dynamic Neutral Atmosphere-Ionosphere Coupling (DYNAMIC) PI-Led Team Masters Forum on August 12, 2024, the data underlying this presentation remain the same.

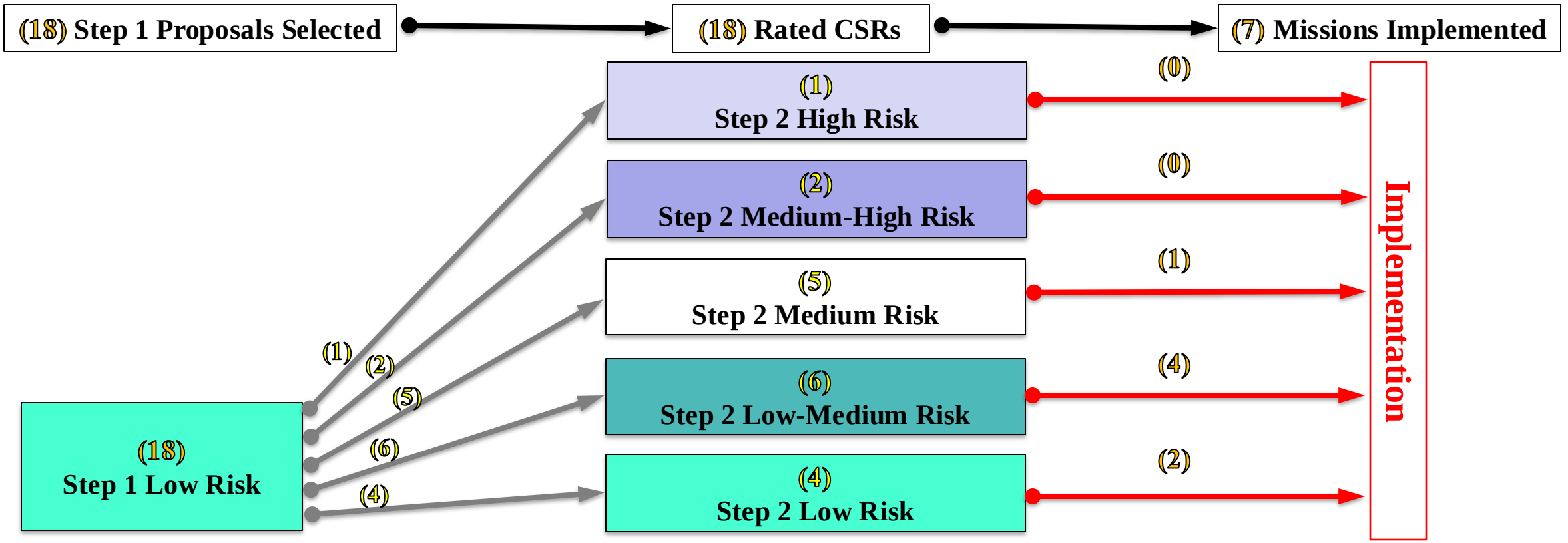
# 2009-24: Step 2 Risk Ratings of Selected Step 1 Proposals




The risk rating for most of the set of missions selected for Step 2 since 2009 either remained the same or got worse. This result may be explained, in part, by more detailed reviews and less "benefit of the doubt" given in Step 2.

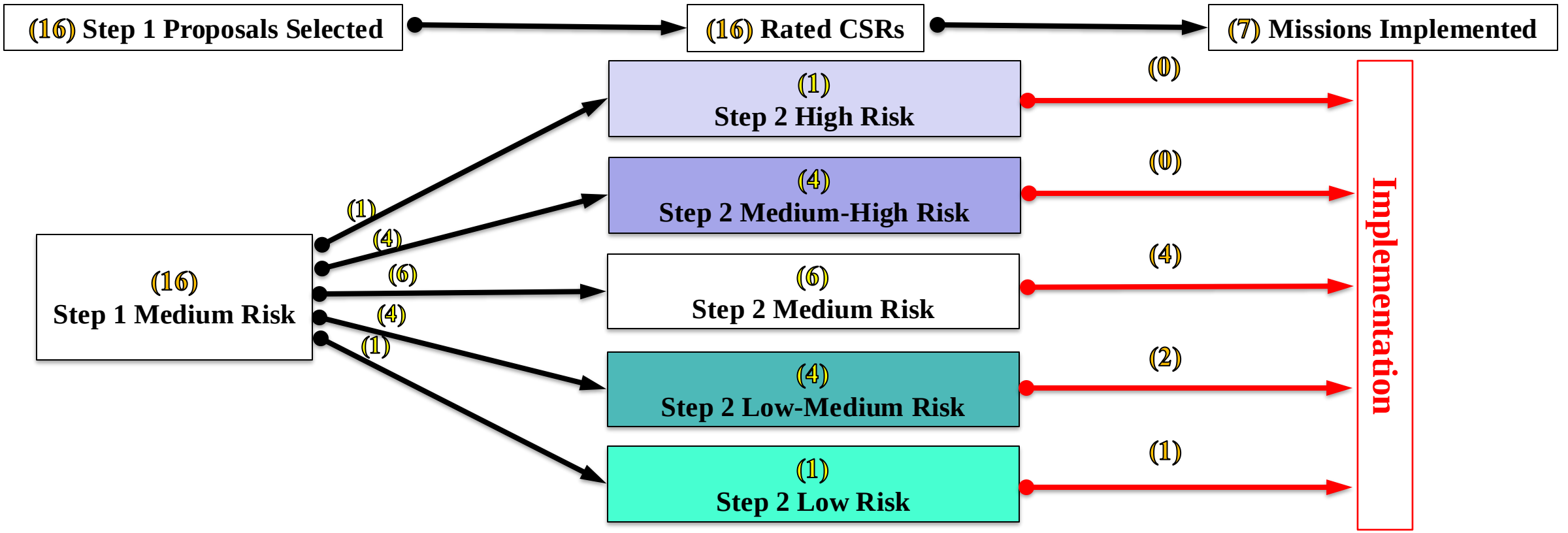
Between 2017 and 2024 (highlighted in yellow) 18 Low, 16 Medium, and 4 High Risk proposals were selected. From these proposals, 1 Medium-High, 5 Medium, 7 Low-Medium, and 3 Low Risk CSRs were down-selected for implementation.

# 2017-24: Step 2 Risk Ratings of Selected Step 1 Proposals



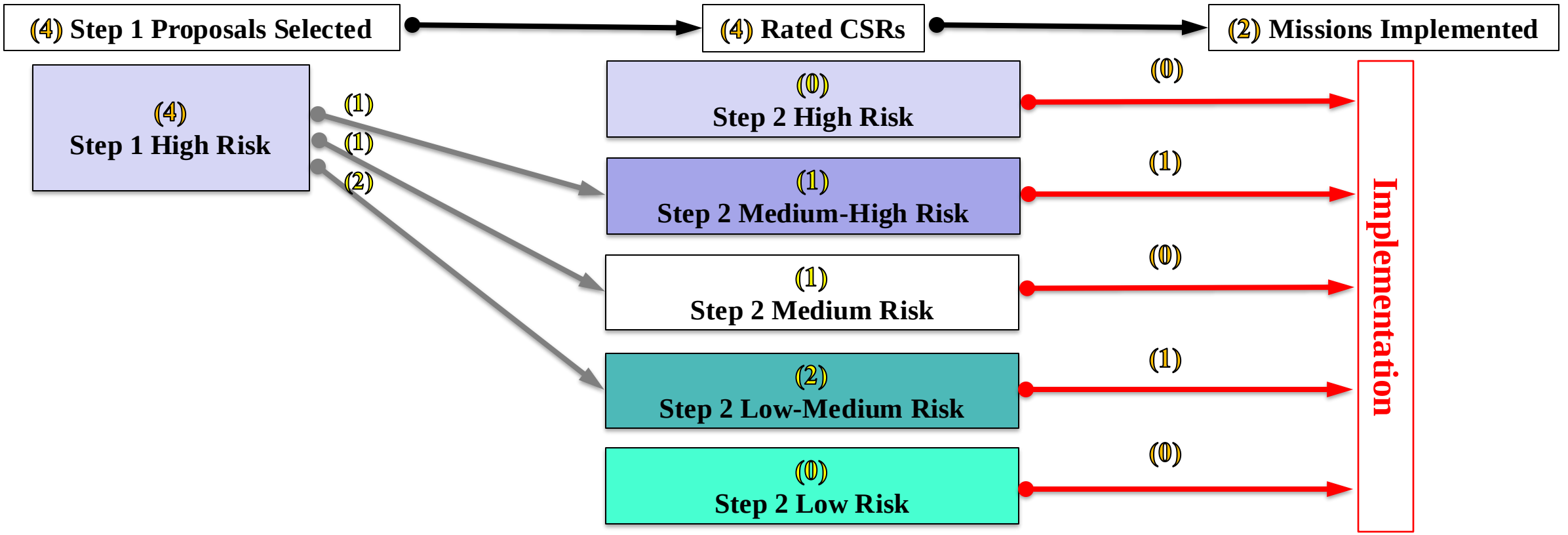

Between 2017 and 2024 (highlighted in yellow), 18 Low Risk proposals were selected. From these proposals, 1 Medium 4 Low-Medium, and 2 Low Risk CSRs were down-selected for implementation.

# 2017-24: Step 2 Risk Ratings of Selected Step 1 Proposals



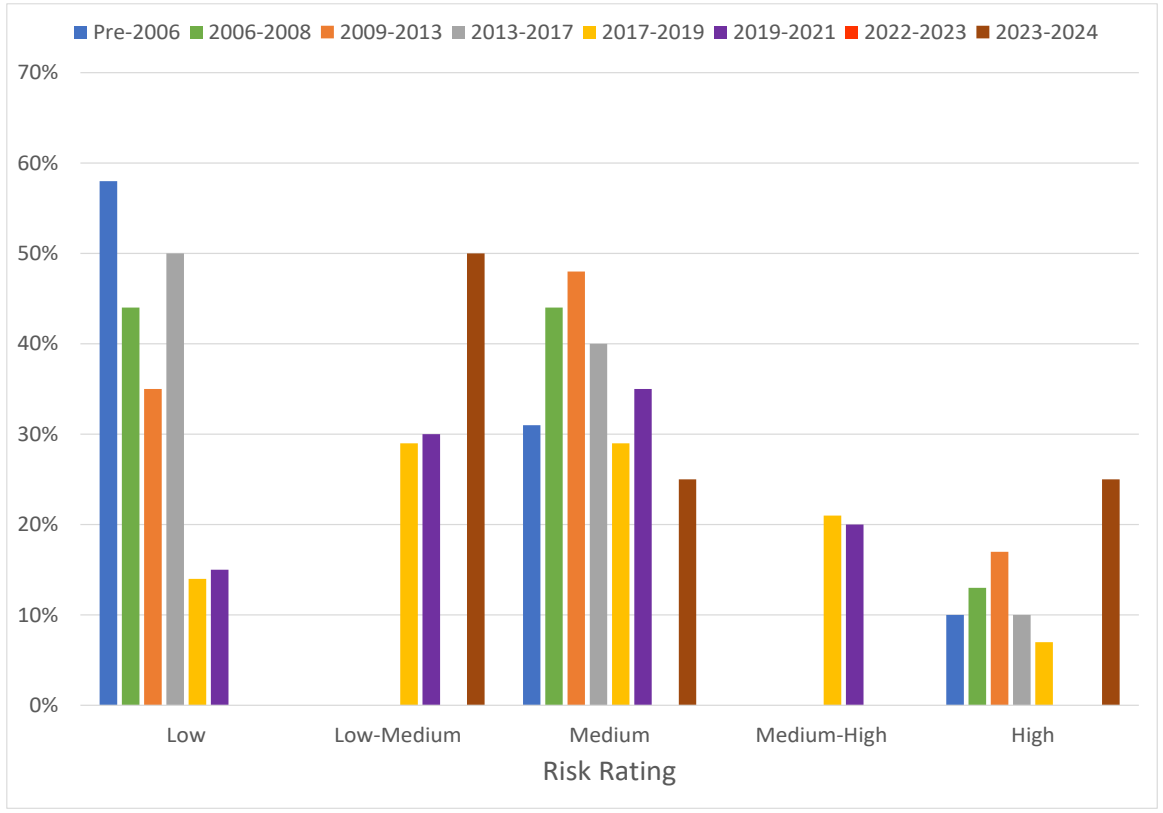

Between 2017 and 2024 (highlighted in yellow), 16 Medium Risk proposals were selected. From these proposals, 4 Medium 2 Low-Medium, and 1 Low Risk CSRs were down-selected for implementation.

# 2017-24: Step 2 Risk Ratings of Selected Step 1 Proposals




Between 2017 and 2024 (highlighted in yellow), 4 High Risk proposals were selected. From these proposals, 1 Medium-High and 1 Low-Medium Risk CSRs were down-selected for implementation.

# Step 2 TMC Risk Rating Distribution (1996-2024)

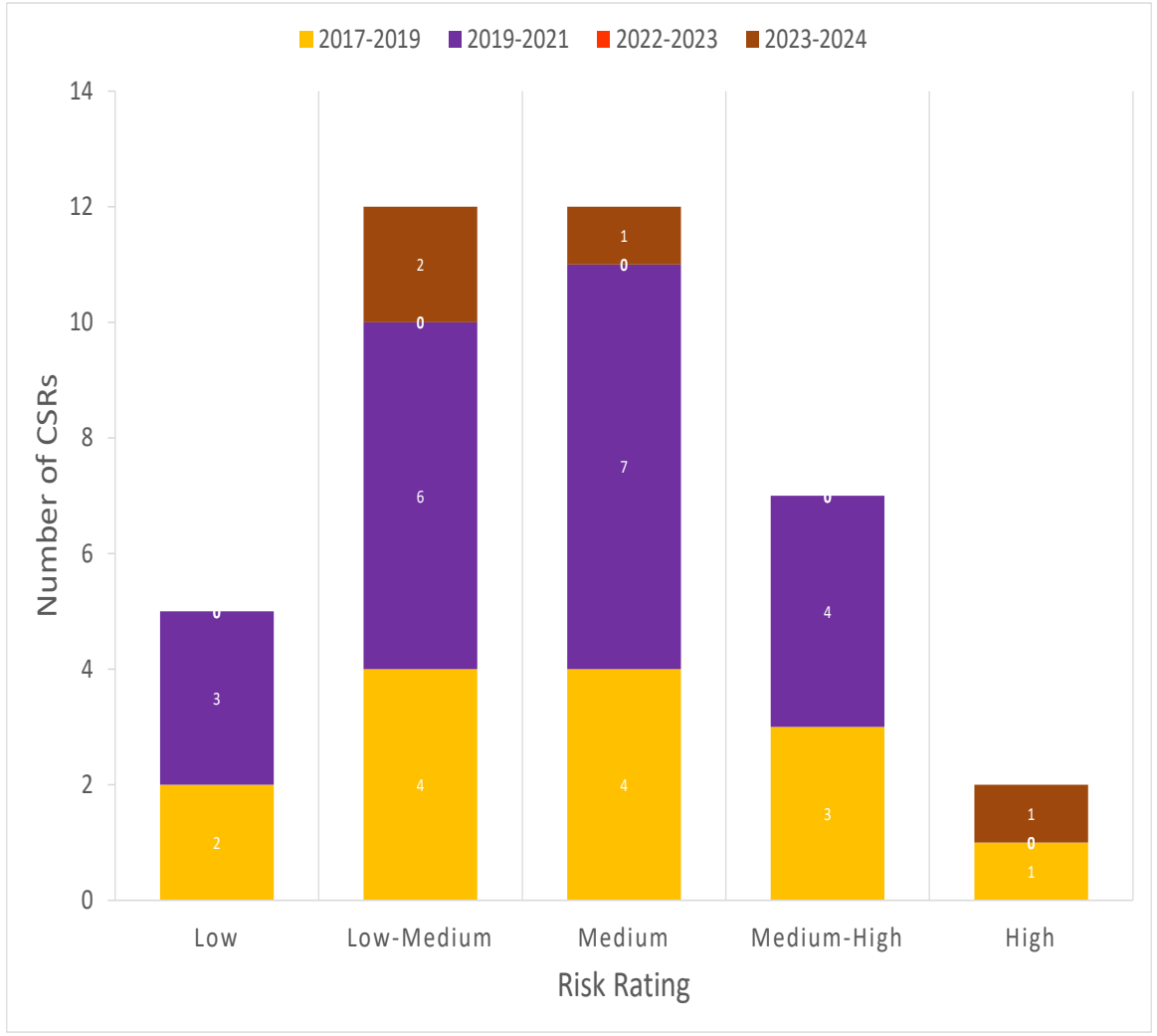



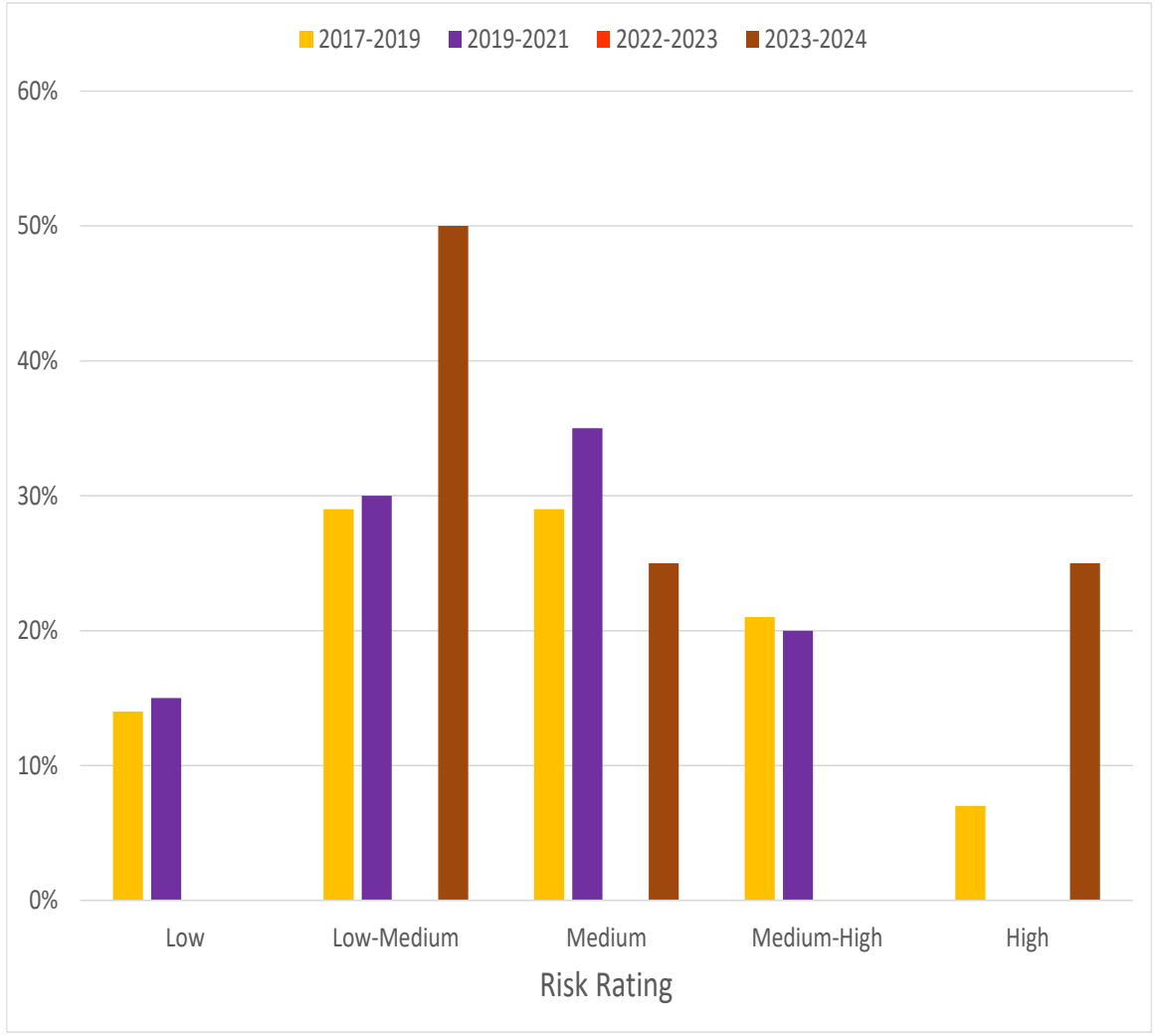

42% of all 1996-2024 Step 2 CSRs were rated Low Risk, 8% Low-Medium Risk, 36% Medium Risk, 5% Medium-High Risk, and 10% High Risk. Two additional risk ratings (Low-Medium, and Medium-High) were added beginning with the 2017 evaluations.

51% of all pre-2017 Step 2 CSRs were rated Low Risk, 37% Medium Risk, and 12% High Risk.

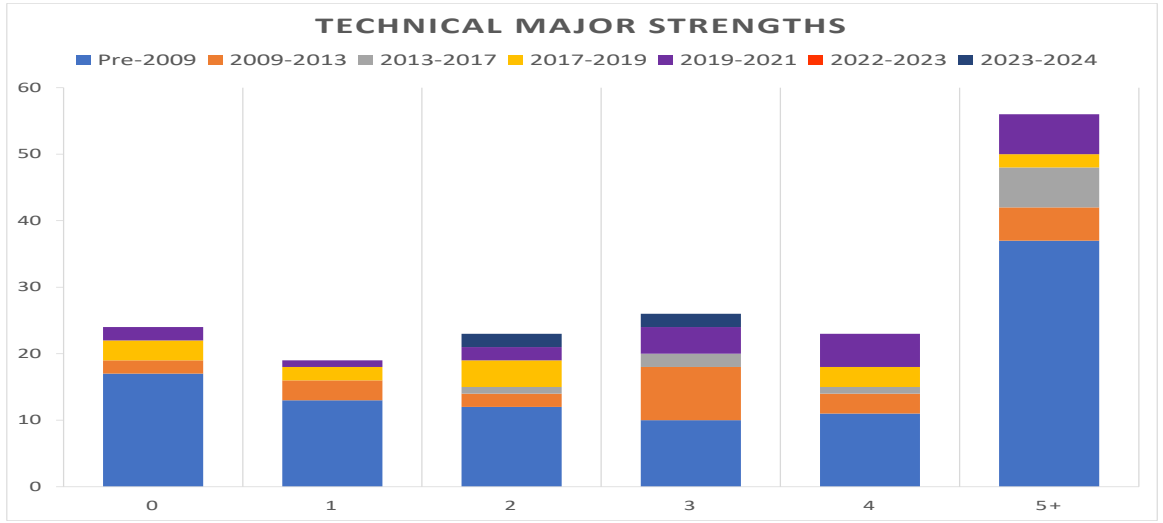
13% of all 2017-2024 Step 2 CSRs were rated Low Risk, 32% Low-Medium Risk, 32% Medium Risk, 18% Medium-High Risk, and 5% High Risk.

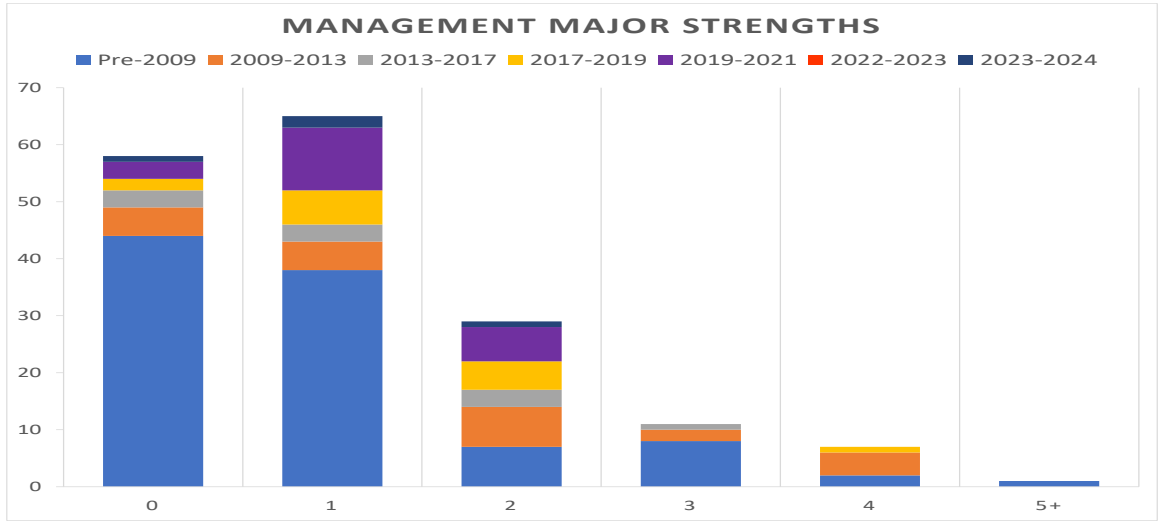
# Step 2 TMC Risk Rating Distribution (2017-2024)

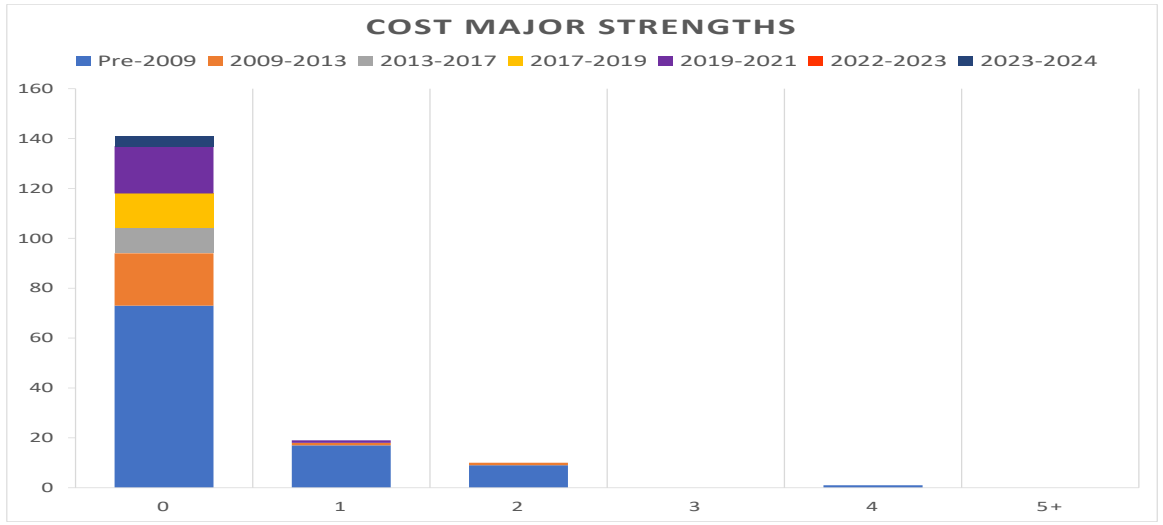


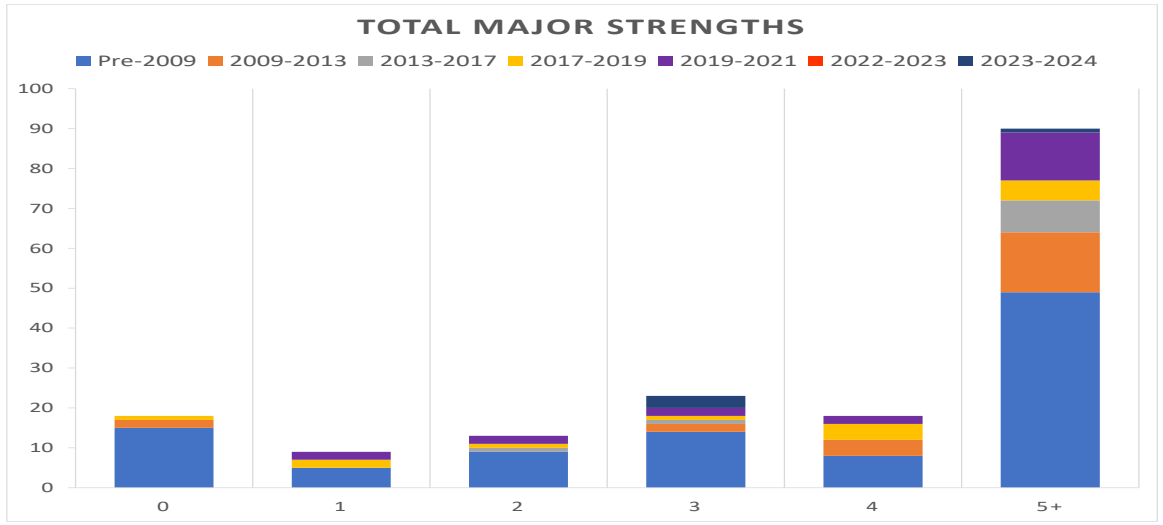



# Step 2 TMC Major Strengths (1996-2024)

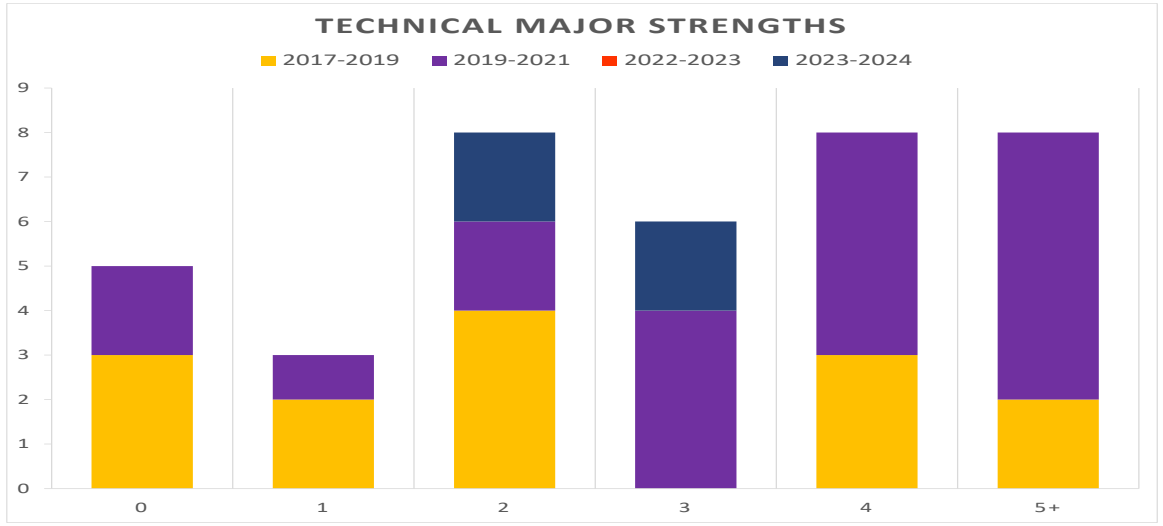


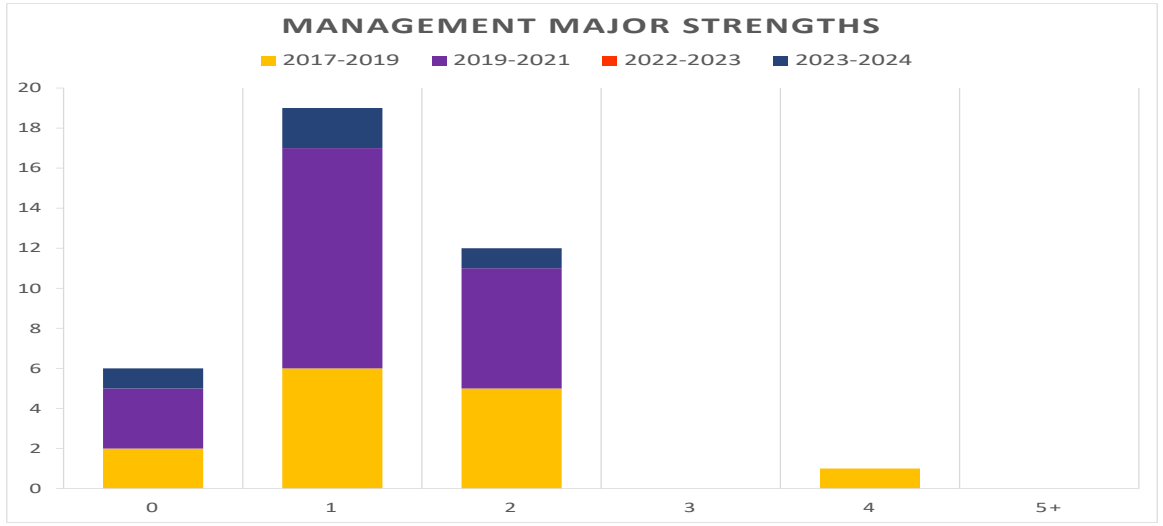



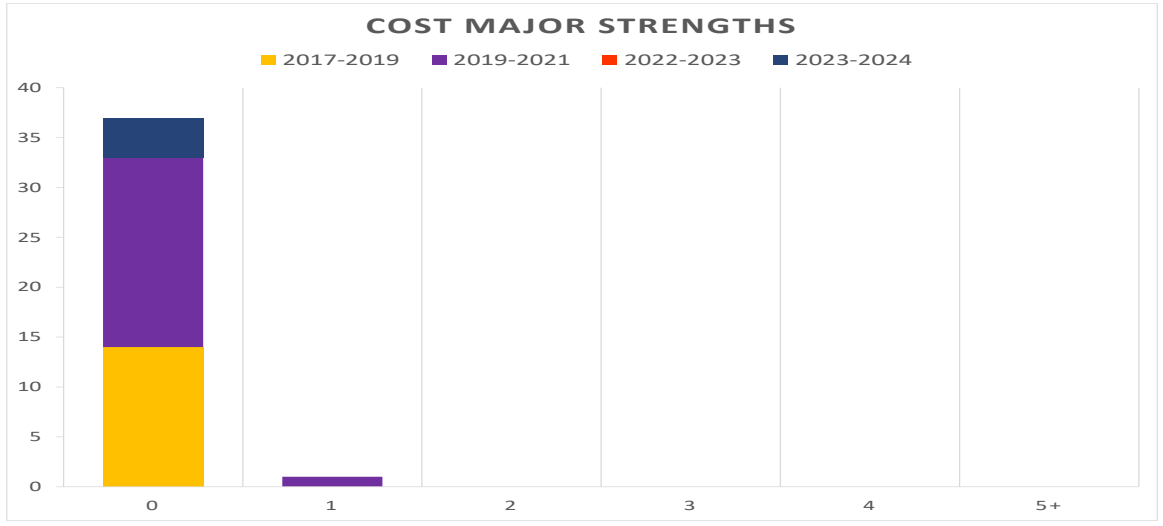



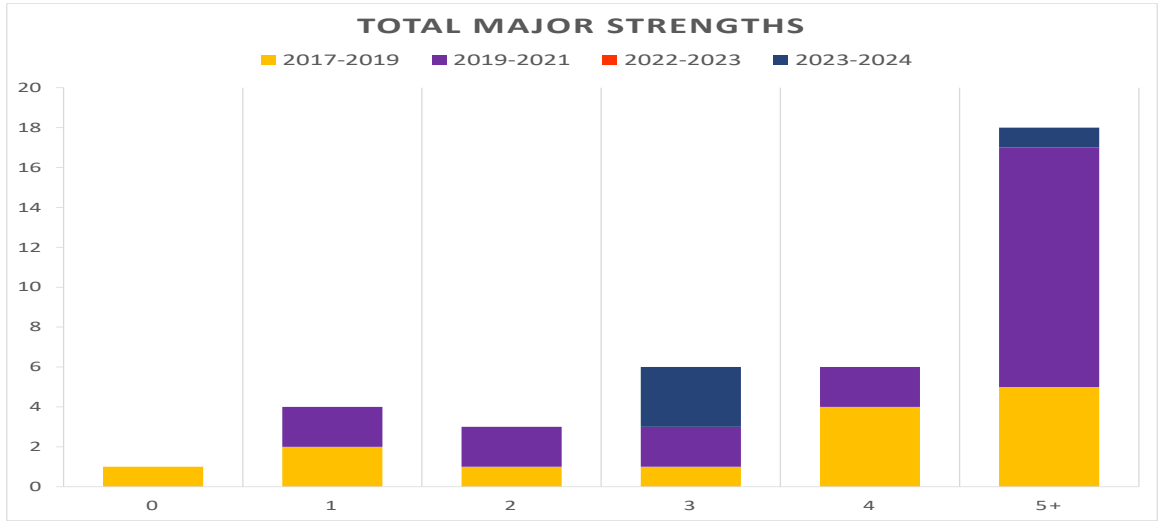



# Step 2 TMC Major Strengths (2017-2024)



# Step 2 Common Causes of Major Weaknesses (1/4)

Common causes of Major Weaknesses (MWs) from 154 CSRs are summarized.

**Step 2 Technical Major Weaknesses**

Issues with requirements definition and flow-down, overstated heritage, and inadequate plans for instrument and flight system verification dominate the technical category.

- **Requirements** – These major weaknesses are due to problems with requirements definition, traceability and flow-down.
- **Verification** – These weaknesses are due to issues with inadequate plans for verification of the instrument and flight system.
  - These findings cover testing and verification during the period after the instrument and flight system each reach TRL 6, but before they are flight qualified.
  - CSRs with this weakness also often had a major weakness related to requirements, system complexity, or design maturity.
- **Heritage** – These weaknesses are due to issues with the implementation of heritage elements or the support of heritage claims.
  - Overstatement of the benefits of the heritage.
  - Modifications of the heritage element is required but not adequately accounted for in the proposal.

# Step 2 Common Causes of Major Weaknesses (2/4)

**Step 2 Technical Major Weaknesses (continued)**

- **TRLs** – These weaknesses are related to overstated TRLs or inadequate technology development plans.
  - These findings are primarily instrument related.
  - See *Assessment of TRL in AO-Based Evaluations and Common Causes of Major TRL Weaknesses* in Program Library
- **Mass Margin** – These weaknesses are issues with mass margin or contingency.
  - Mass margin major weaknesses still occur, but less frequently than in Step 1.
- **Thermal** – These weaknesses are due to inadequate thermal design or performance claims that are not supported.
  - These findings are primarily instrument related.
- **ADCS** – These weaknesses are issues with attitude determination and control.
  - Inadequate description of the pointing budget.
  - Mismatch between hardware capability and required performance.
- **Optics or Focal Plane** – These findings are related to the design and development of the instrument optics and focal plane.
  - Overstatement of performance is often cited.

# Step 2 Common Causes of Major Weaknesses (3/4)

**Step 2 Management Major Weaknesses**

- **Key Individuals:**
  - Lack of relevant experience among core team.
    - Some PM candidates proposed had good management credentials but limited or no history of flight project accountability.
  - Low time commitments for key members of the core team: Project Manager, Systems Engineer, Flight System Manager, Key Instrument Engineer, etc.
- **Systems Engineering (SE):**
  - The flow-down, traceability, completeness, consistency, or stability of the top-level mission or flight hardware requirements is flawed.
  - The SE plans or approach, including clearly identifying the roles and responsibilities of the PSE, are flawed.
  - Often reflects lack of consistency among project elements.
  - Most management weaknesses since 2009 are in systems engineering.
- **Schedule:**
  - Inadequate or inappropriately placed schedule reserve.
  - Missing key elements.
  - Inadequate definition or missing critical path.

# Step 2 Common Causes of Major Weaknesses (4/4)

**Step 2 Management Major Weaknesses (continued)**

- **Management Plans:**
  - Key elements such as risk management are inadequate.
- *Common Management Major Weaknesses in Step One Proposals* - Located at SOMA website: https://soma.larc.nasa.gov/tmcll/ManagementFindingsStudy-to-post-R3.pdf

**Step 2 Cost Major Weaknesses**

- Significant and unreconciled differences between the proposed cost and the independent cost estimate.
- Inadequate Basis of Estimate (BOE).
- Inadequate cost reserve.
- Credibility or relevance of the supporting cost data.

# Step 2 TMC Summary

SOMA has directed the evaluation of 154 Step 2 CSRs submitted by PI-led teams since the office was formed in 1996.

Are there common causes of major weaknesses in Step 2 TMC reviews? Yes! Certain types of weaknesses persist, specifically:

- Proposed costs with their supporting BOEs could not be validated by TMC using independent cost models.
- The flow-down, traceability, completeness, consistency or stability of the top-level mission or flight hardware requirements is flawed.
- Development schedules that lack sufficient detail to verify their feasibility, have missing elements, allocate too little time for typical activities without sufficient rationale (e.g., AI&T), or have too little funded schedule reserve for the identified development risks.
- Inadequate verification plans for the instrument and flight system.
- Overstated instrument or Flight System TRLs (usually based on overstated heritage) or inadequate plans to demonstrate existing component technologies in newly integrated systems or operating in new environments.
- Inadequate margins for technical resources. Mass is the most common issue.
- Thermal design is not demonstrated to be viable.
- ADCS performance claims are not supported.
- Lack of time commitment from key management team.