NORTHROP GRUMMAN

Implementation and Verification of Mission Assurance Requirements for the James Webb Space Telescope

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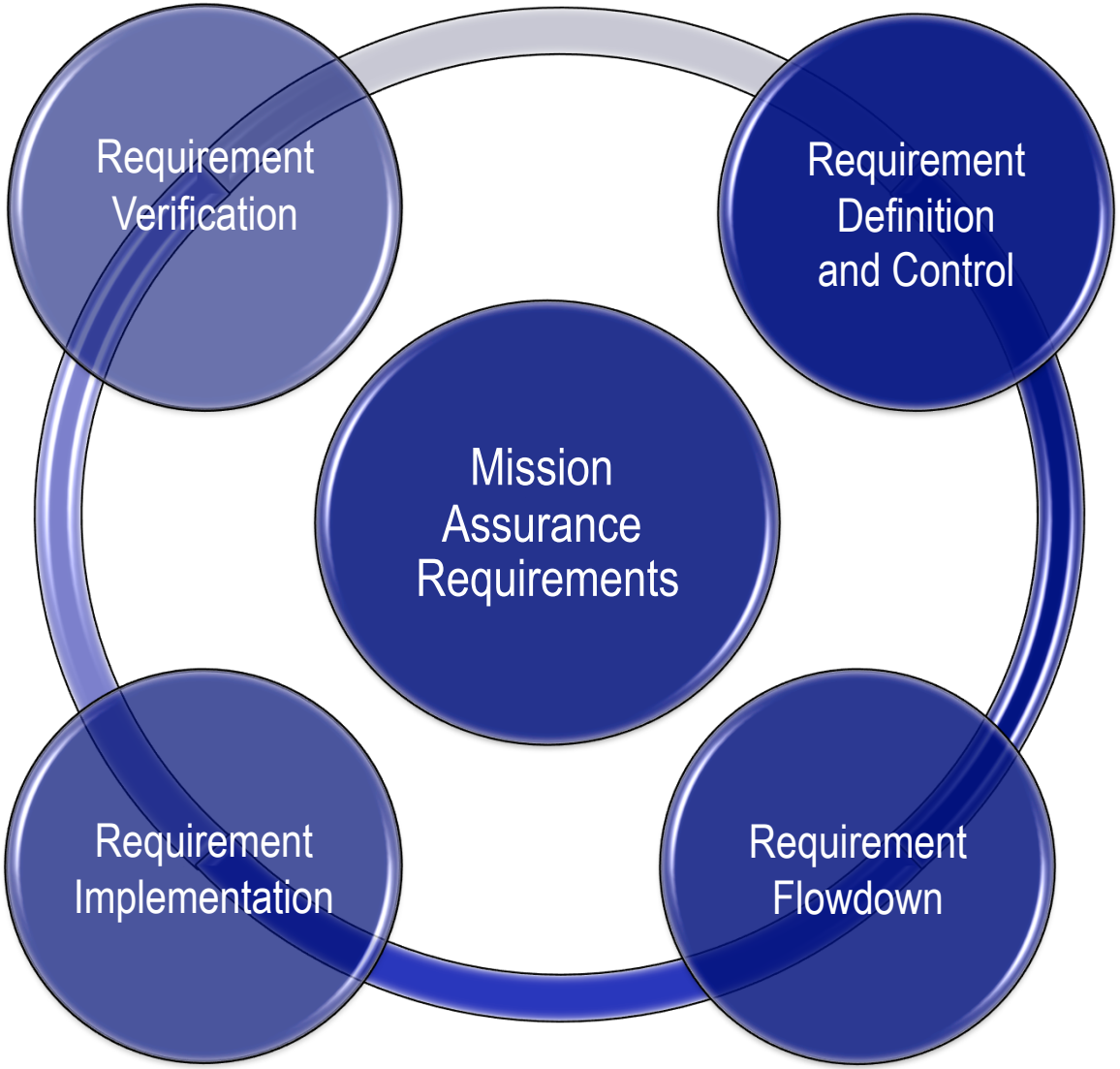
The Problem

- **NASA flows down a series of requirements in their Mission Assurance Requirements document.**
  - 383 individual “shall” statements
- **Northrop Grumman needed to establish a process to ensure compliance with these requirements.**
  - These implementations have been done countless times
  - Each time has its strengths and weaknesses
  - Major problem is verification
    - Have the requirements been properly allocated and flowed out?
    - Is there implementation ensured as part of the process?
- **James Webb Space Telescope presented significant developmental risks**
  - Aspects such as the qualification of PM&P required early action
  - Fiscal profile drove design maturity irregularities
    - Mandated consistent Mission Assurance approach

The Solution

- **JWST afforded the opportunity to test an evolutionary approach**
  - Define the requirements
  - Establish a strong voice in program management
  - Establish a strong, multi-disciplined team
  - Flow down requirements internally and to supply chain
    - Includes allocating requirements
  - Define verification approach
  - Engage early in the design and throughout the life cycle of the program

Requirements Lifecycle

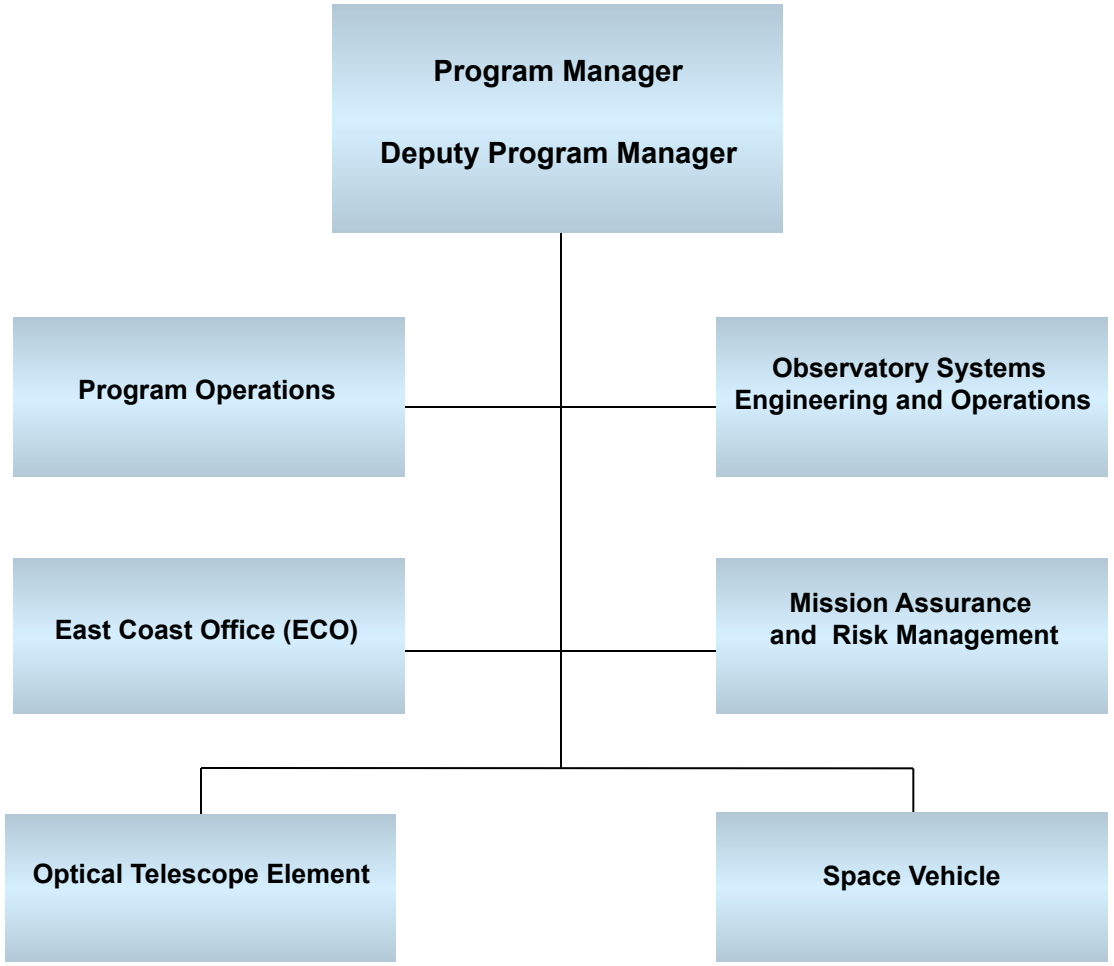


NASA Mission Assurance Requirements

- **MAR flows down requirements for:**
  - Quality Assurance
  - Parts Management
  - Materials and Processes
  - Reliability Engineering
  - System Safety
  - Contamination Control
  - Risk Management
  - Configuration Management
- **During proposal, NGAS defined methodology for implementation and flowdown**
- **Submitted document describing implementation with proposal**
  - Outlined requirements and organization to implement them
  - Did not establish methodology for ensuring implementation
- **JWST contract approved NGAS implementation plan by including it as attachment**

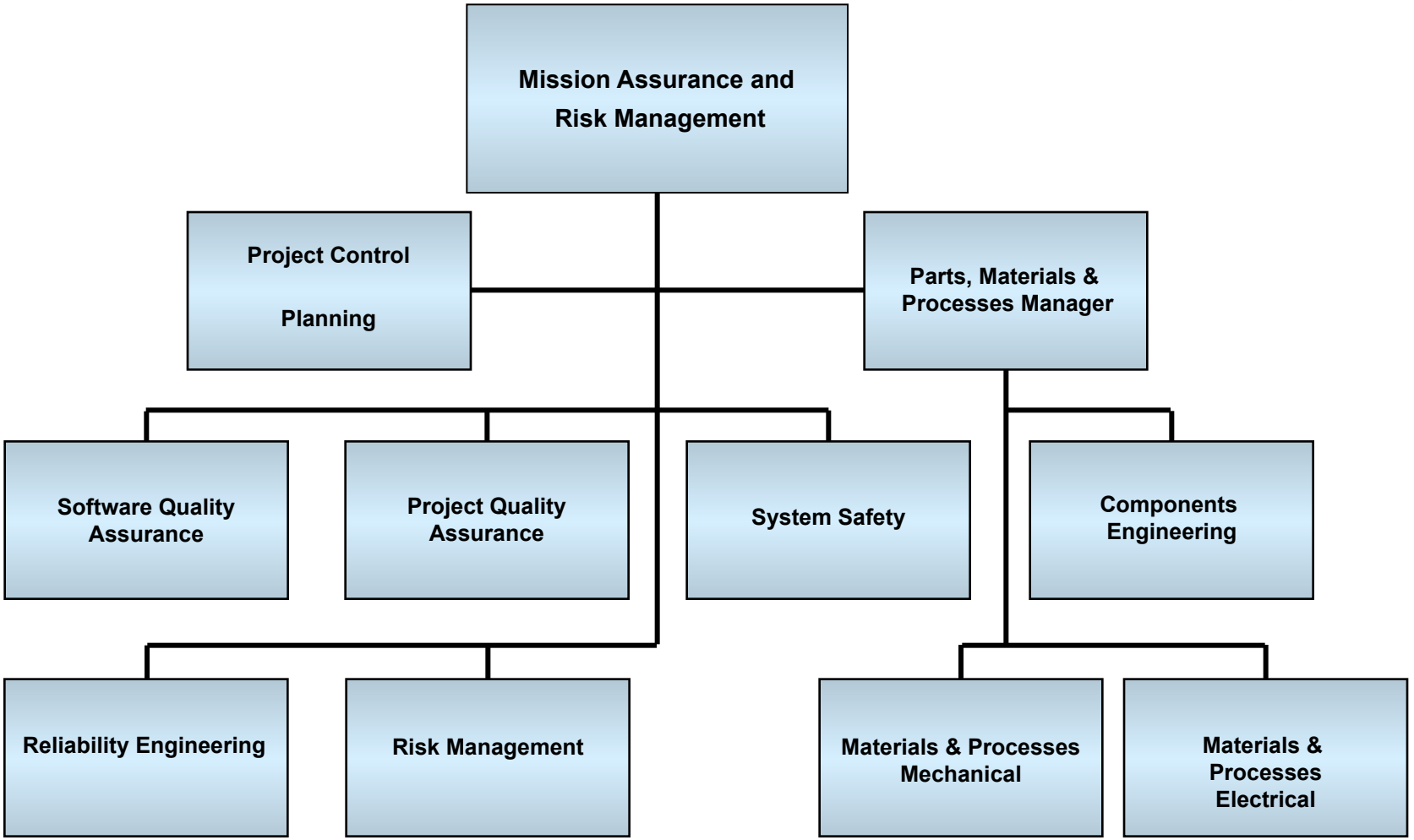
Define the requirements

NGAS JWST Program Organization



JWST organization ensures Mission Assurance has strong voice

NGAS MA/RM Organization



Multi-disciplined team ensures implementation of MAR

Establish Requirements Flowdown

- **Flowdown of requirements is accomplished through specification system**
  - Observatory specification flows down:
    - Design and Construction requirements
    - Reliability requirements including design life and numerical allocations
    - Safety
    - Contamination requirements
  - QPRs establish additional requirements beyond standard QMS
    - Written for Receiving Inspection, Engineering Model Production, Integration and Test
  - Subcontract SOWs flow Subcontractor PAR and identify SDRLs
- **Requires definition of approver roles**
  - Mission Assurance established as approver of most specifications, drawings, and SOWs
  - Complexity and scope of specifications requires defining expectations for approval
  - Drawing Review Checklist
    - Verifies that drawings capture PM&P, critical item control & safety requirements
  - Quality Assurance verifies that drawing notes are captured in planning activities
  - Normal oversight and verification ensure product meets requirements.

Mission Assurance Requirements Flow

JWST Observatory Contract

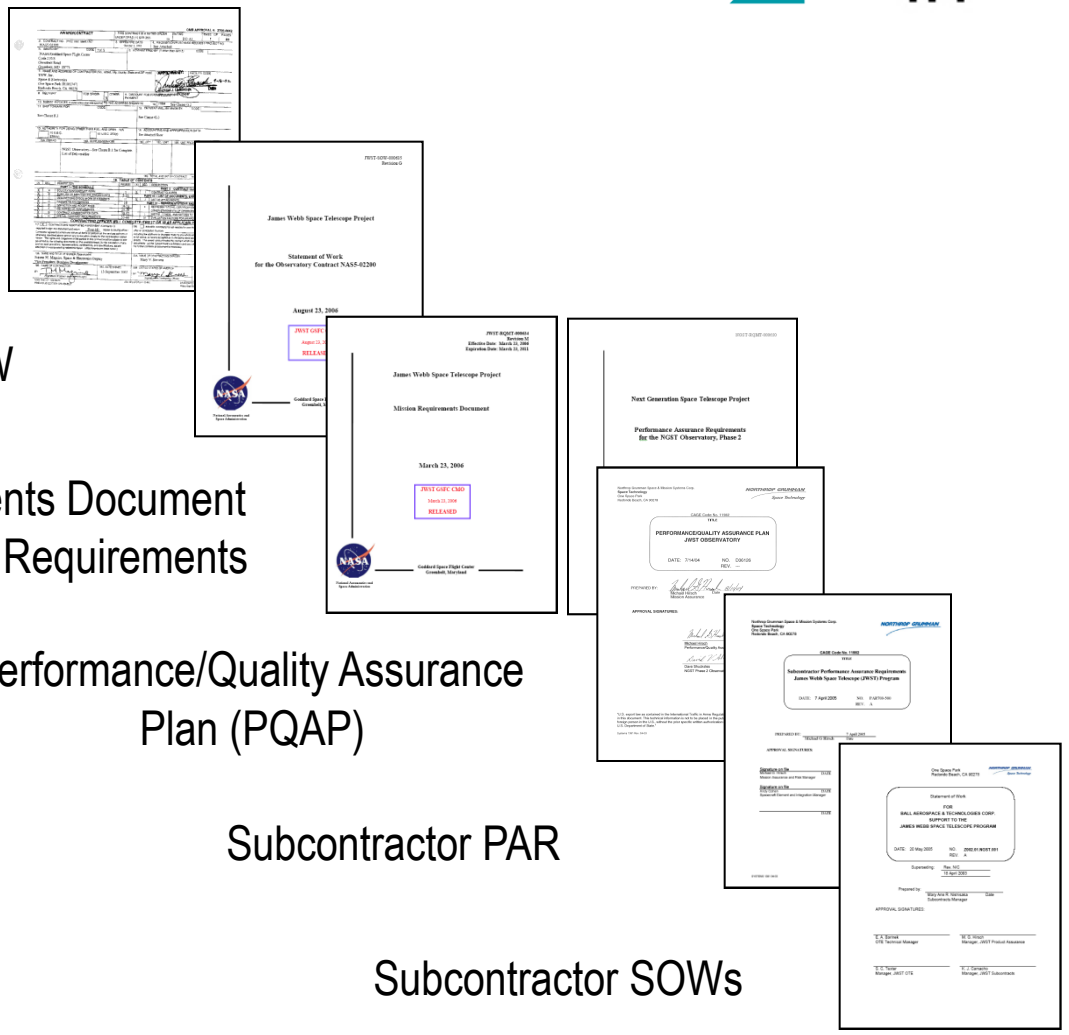
JWST Observatory SOW

Mission Requirements Document
Mission Assurance Requirements

Performance/Quality Assurance
Plan (PQAP)

Subcontractor PAR

Subcontractor SOWs

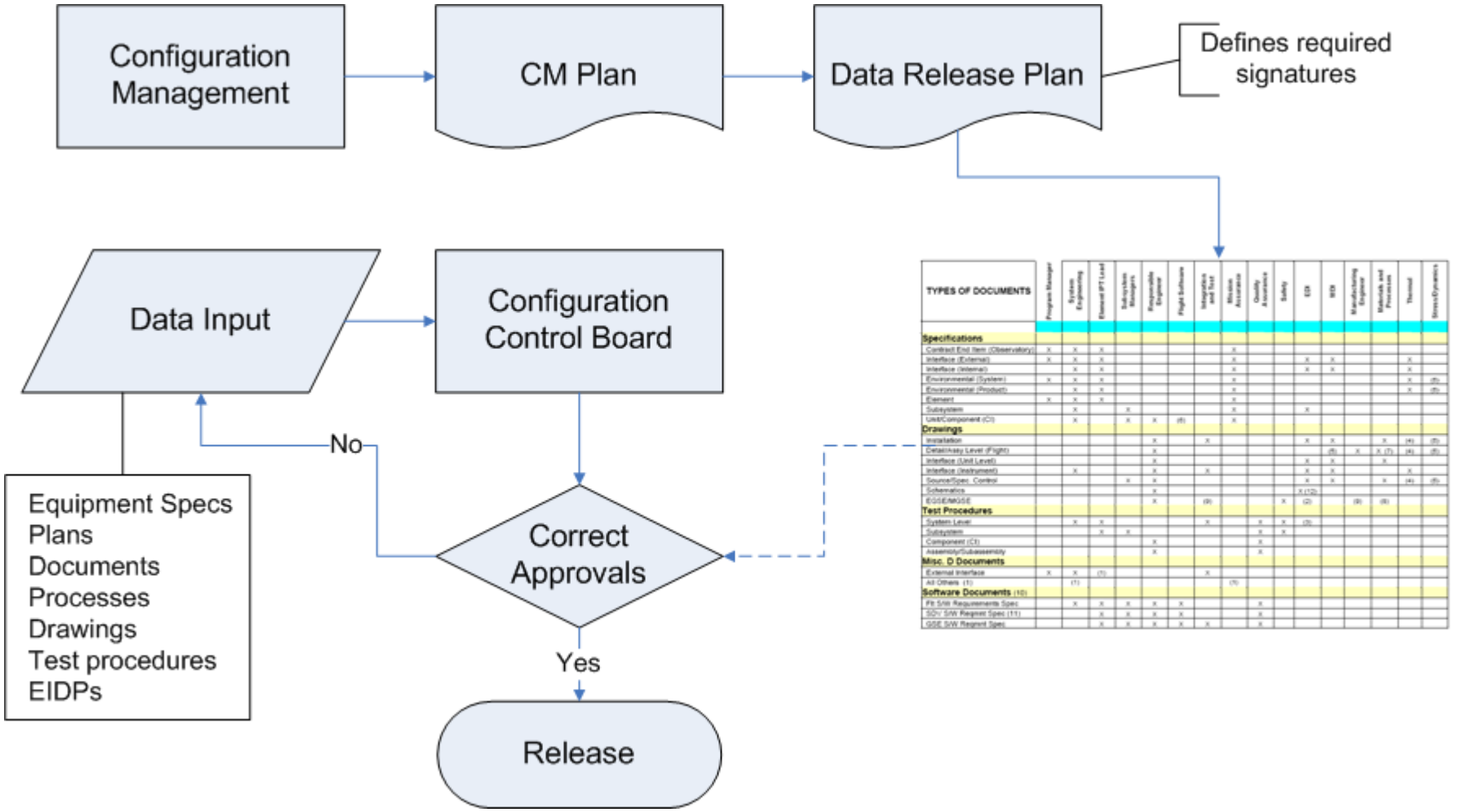


NGAS audits the requirements flowdown to verify compliance

Define Verification Plan

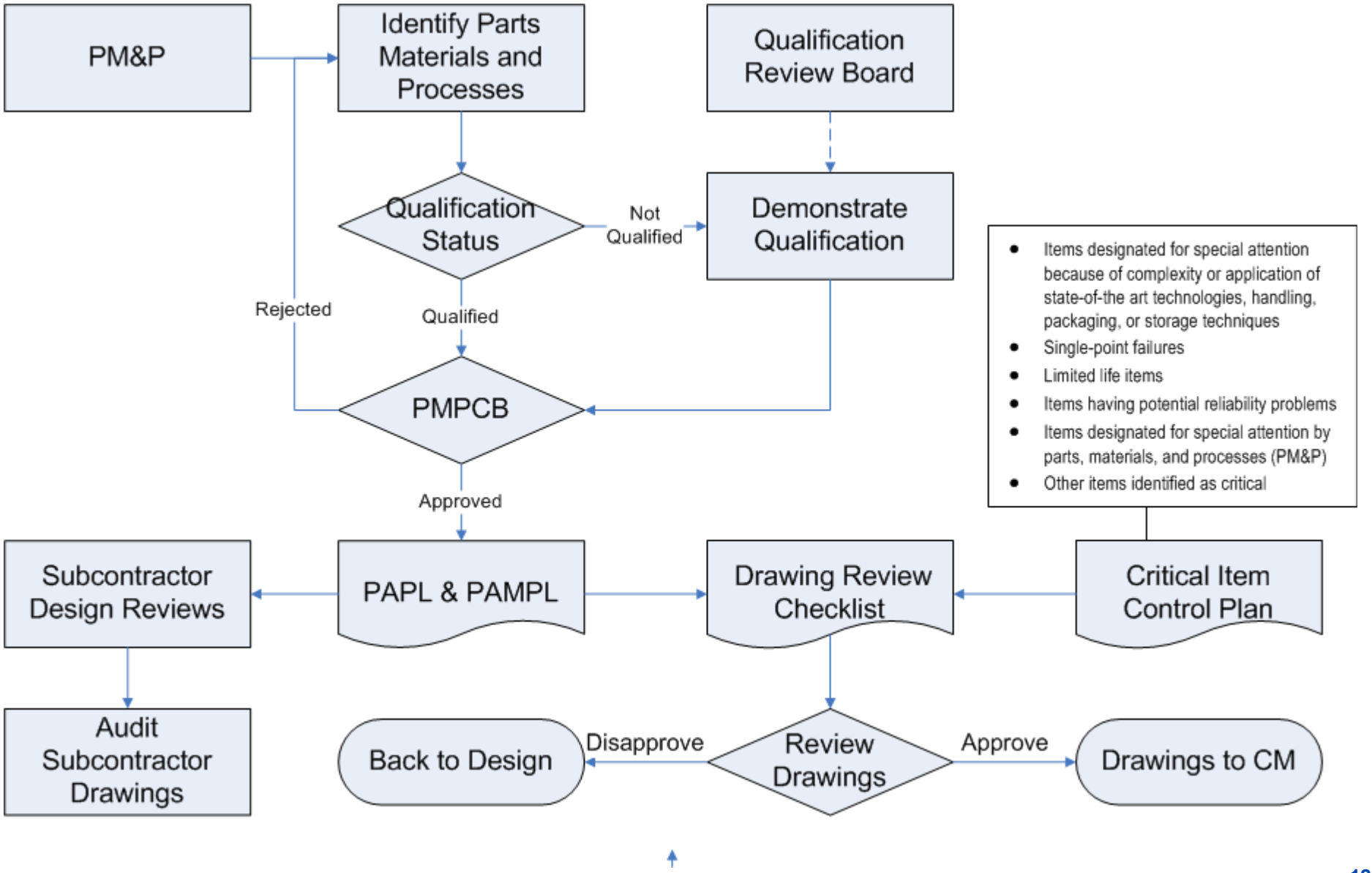
- **Document methodology used to flowdown requirements**
- **Establish where in the mission lifecycle each will be verified.**
- **Document describes planned process but does not institute requirements**
- **Clarifies assumptions of in-place process controls**
  - MRB processes track and reconcile discrepancies in accordance with requirements
  - FRB processes in place to adjudicate concerns
  - Workmanship requirements in drawings verified by Quality Assurance
  - Periodic audit ensures implementation of standards:
    - Configuration and Data Management,
    - Quality Assurance
    - Parts, Materials, and Processes
    - System Engineering
    - Reliability Analyses

Configuration Management

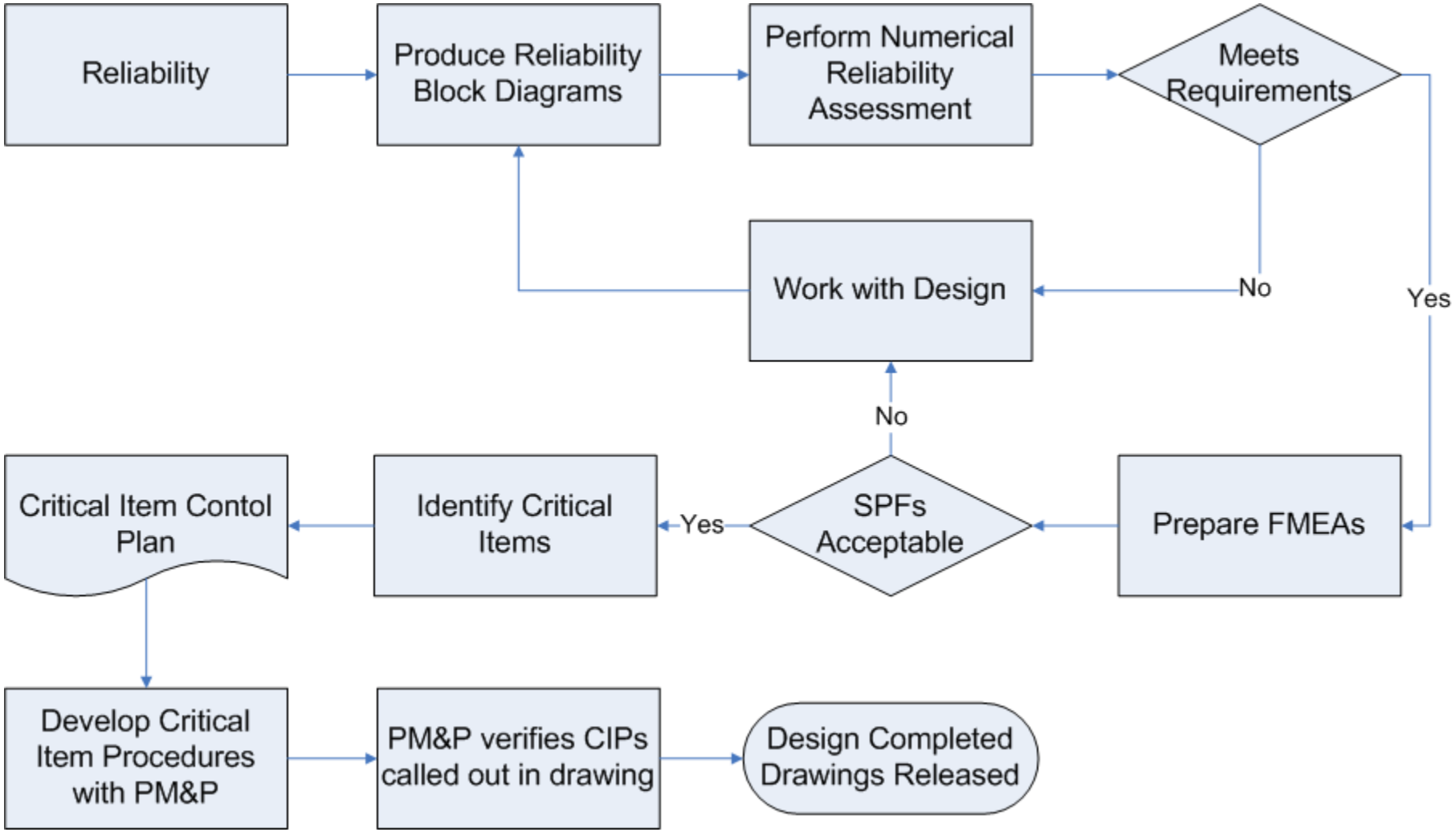


CM is the gatekeeper for specification and document approval

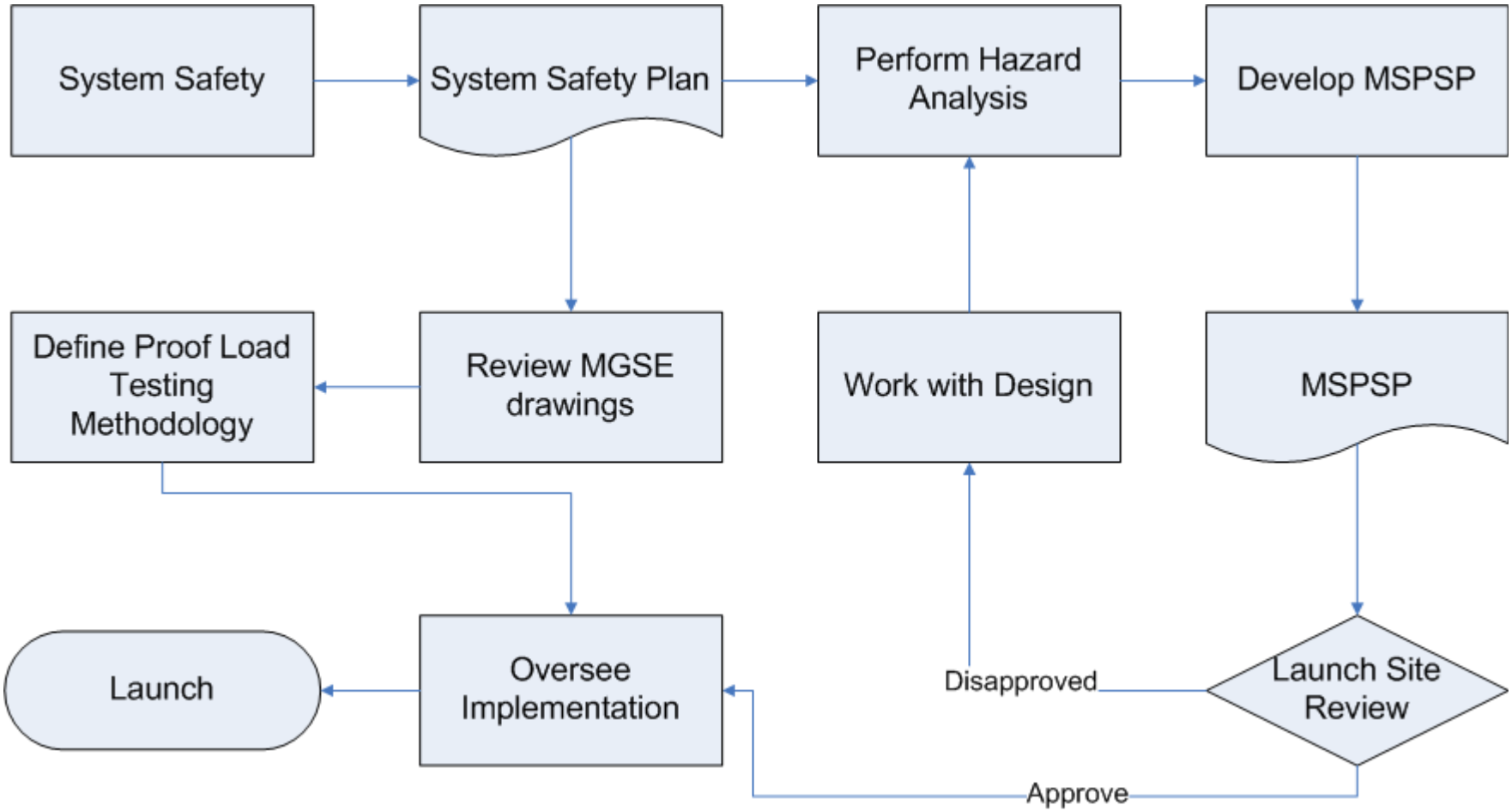
Parts, Materials, and Processes



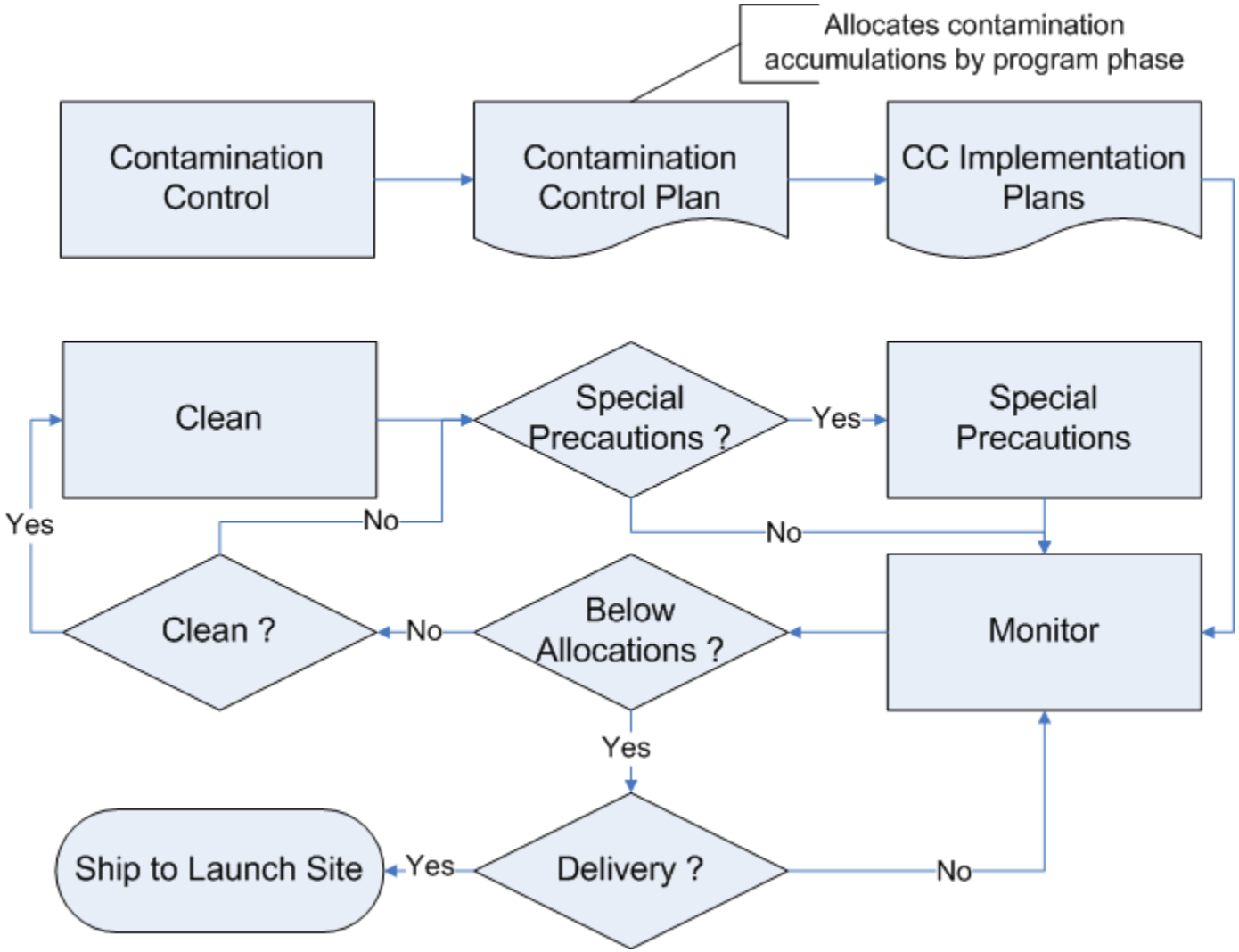
Reliability



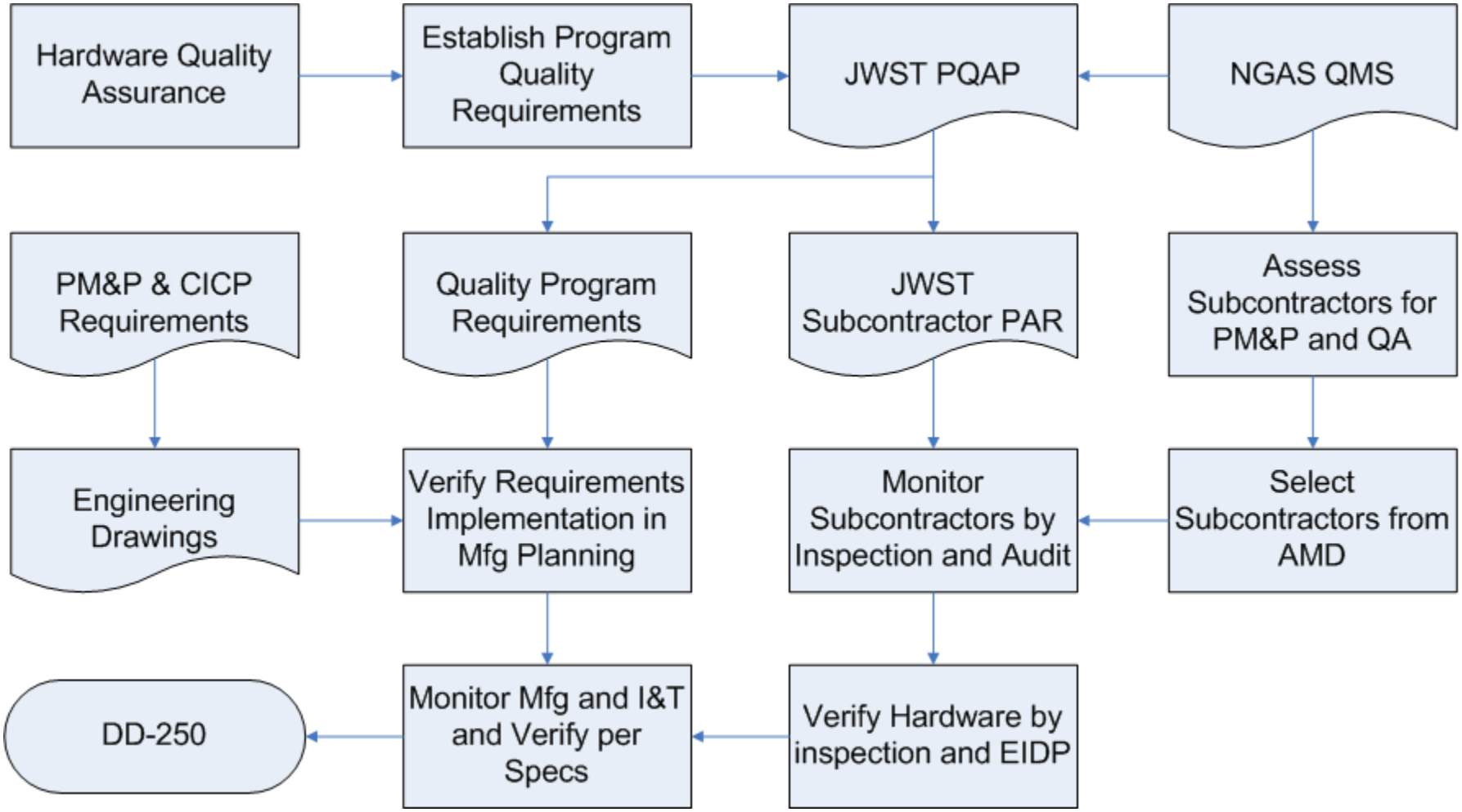
System Safety



Contamination Control



Hardware Quality Assurance



Summary

- **Closed loop Mission Assurance approach requires**
  - Early definition of requirements
  - Strong Multi-disciplined team to allocate and flow down requirements
  - Strong voice in design and subcontracting activities
  - Clear process to flow multiple requirements into design
  - Clear methodology to verify requirements implementation during design
  - Interleaved team to ensure requirements are bought off at the earliest opportunity

- **Difficulties include:**
  - Staffing team with skilled and open-minded members
  - Avoiding pitfall of myopia
  - Infighting for budget due to forgetting the common goal of program success
  - Providing a supportive environment where individual empowerment is key

Success or Failure is a result of how well the team works together.