Quality Assurance Surveillance Tool Designed for SLS EM-1 Certificate of Flight Readiness

SA-F2: Exploration Ground Systems S&MA Quality · Patrick Morris · Mechanical Engineering, University of Texas - San Antonio

Abstract

Exploration Mission-1 (EM-1) is an uncrewed mission that is launching on the Space Launch System (SLS) Block 1 vehicle. This is a critical flight test for the agency's human deep space exploration goals. Exploration Ground Systems (EGS) Quality (SA-F2) is responsible for providing Quality Assurance Surveillance Plans (QASPs) for NASA contracts and facilities. A QASP assures products and services are provided to EGS in accordance with the contract requirements. In order to encapsulate the multiple KSC Safety and Mission Assurance surveillance and audit activities that need to be accomplished specifically for EM-1 Certificate of Flight Reediness (CoFR), a QASP tool needed to be implemented. This tool would be able to intuitively track Work Authorization Documents (WADs) under development by Test Operations Support Contract (TOSC), reviewed and accepted WADs, Government Mandatory Inspection Points (GMIPs), Nonconformance's (NC's), Material Review Board (MRB) Status, Corrective Actions, Alterations, Deviations, and Waivers for flight hardware and Ground Support Equipment (GSE) . This would help ensure that all SLS EM-1 flight hardware and related GSE surveillances and requirements are being recognized and completed with zero constraints identified for the mission.

EGS Quality Responsibilities

Operational Quality Responsibilities: Document Review, Product Assurance, Quality System Evaluation, Quality Data Analysis, Non-conformance Reporting & Corrective Actions, & Final Acceptance.

Risk-Based Quality Surveillance Responsibilities: Sample work instructions to verify they meet all requirements, Participate in contractor internal or 3rd party audits to verify compliance with AS9100 aerospace quality standards, Process performance surveillance to evaluate work area cleanliness, Perform GMIPs to witness or verify performance of program identified high risk processes, and Sample NC reports to ensure adherence to process & corrective or preventive actions are documented and appropriate.
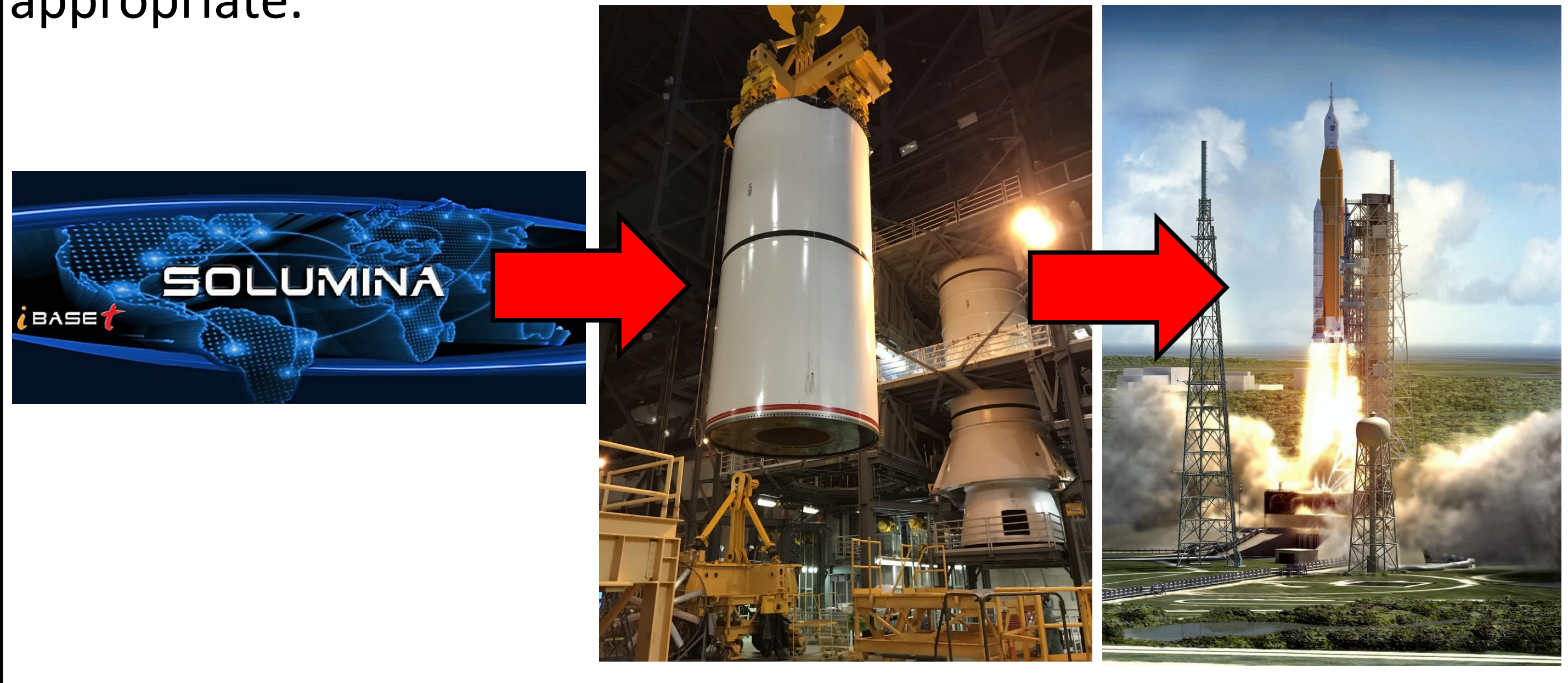
Project Scope

Limited to EM-1 Mission Insight/Oversight/Surveillance activities for SLS EM-1 flight hardware and related GSE. Tool functionality shall be flexible to include EM-2 mission and future ground processing.
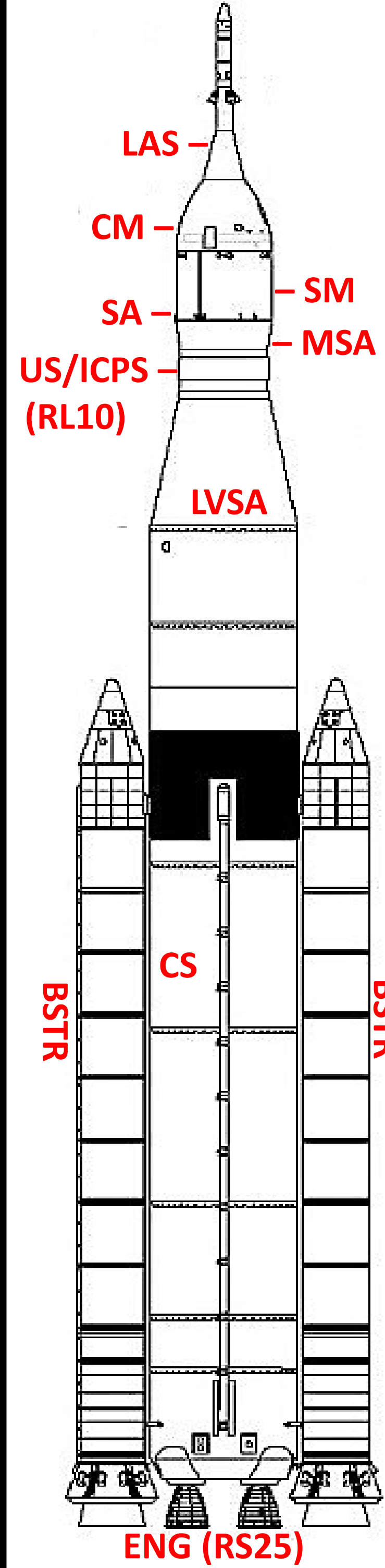

SLS Block 1 · SLS Block 1B Crew · SLS Block 1B Cargo · SLS Block 2 Cargo
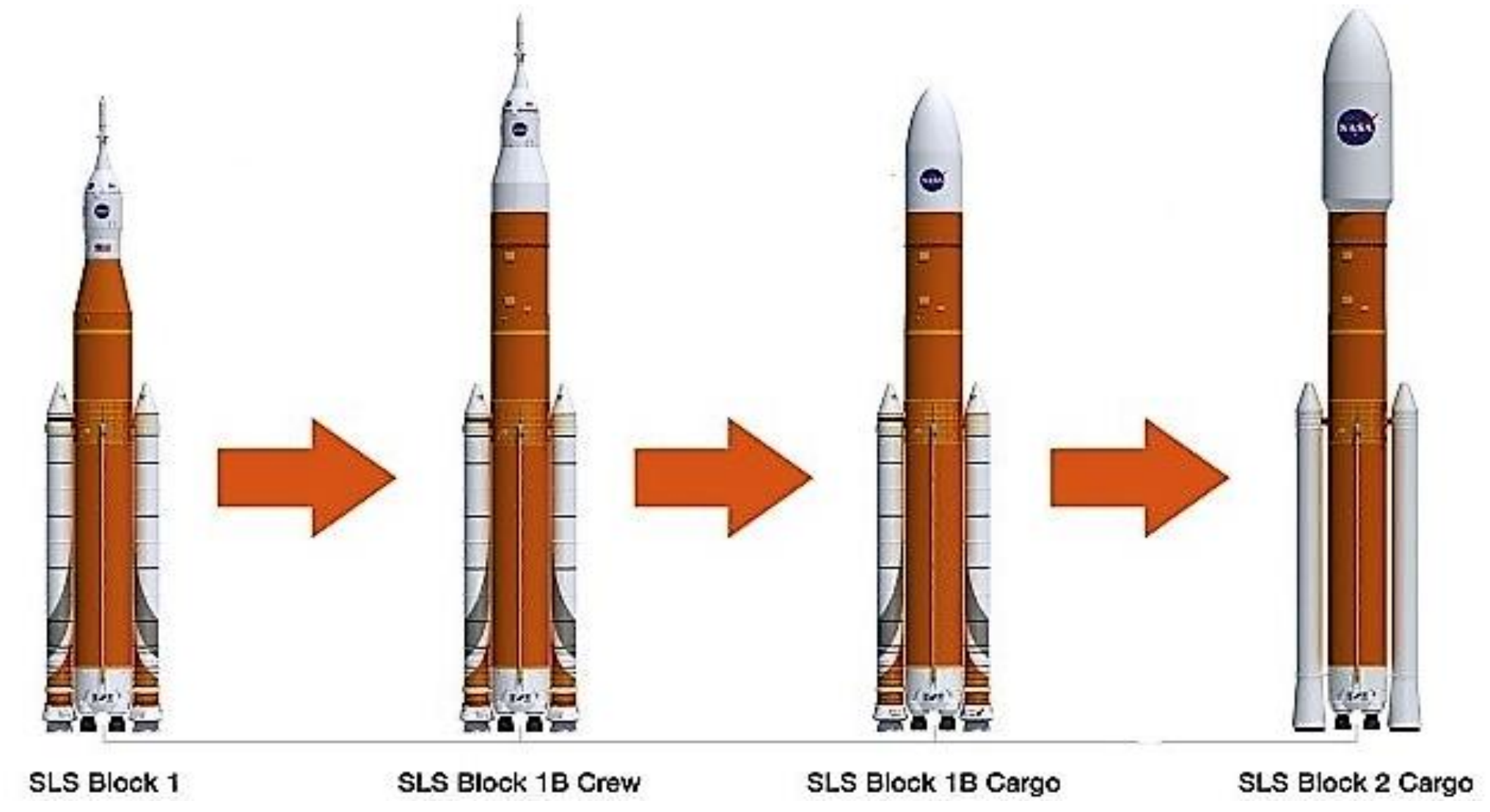
Design Approach/Methodology

The quality assurance surveillance tool should:

- Track surveillance activities related to EM-1 and encapsulate information for each individual flight hardware element and related GSE
- Identify all SLS flight hardware & GSE associated WADs and Work Orders
- Calculate the percentage of WADs reviewed by NASA EGS
- Display planned and completed GMIPs
- Track any alterations, deviations, and or waivers
- Track NC's and or any NC's that went to MRB, and out-of-position work
- Display auditing information
- Be as automated and intuitive as possible; pulling data from Solumina, SA-F2 SharePoint, and SMA Tracking Operation & Reporting Matrix (STORM) databases

VBA Code

```
Sub US_Data_Update()
'This Code updates the "US" sheet to only display the LAS related WAD item/part numbers from the "EM-1 Process Planned WADs" sheet

Dim i As Long, lastRow As Long 'Declares "i" as an integer for the code to define down to the last row of the_
                'EM-1 Process Planned WADs'.
Dim j As Long 'Declares "j" as an integer for the code to define.

Application.ScreenUpdating = False 'Turns screen updating off to help speed up the macro code
Application.Calculation = xlCalculationManual 'Stops Excel from auto calculating any cells in the workbook
                'that have relations to this code. Thus making the macro run faster too.
Application.EnableEvents = False 'Will stop any code in any Workbook, or Sheet Event code from firing while this code is running

Set rawWADs = Sheets("EM-1 Process Planned WADs") 'Sets the "EM-1 Process Planned WADs as the sheet that the raw data is being pulled from
Set finalEM1Element = Sheets("US") 'Sets the finalEM1Element sheet as the final destination for the raw data
lastRow = rawWADs.Cells(Rows.Count, "A").End(xlUp).Row 'Count the data all the way down to the last row in column A in the rawWADs sheet

For i = 4 To lastRow 'The data thats being calculated from the rawWADs sheet start in row 4

    If rawWADs.Range("A" & i).value <> "" Then 'test for any empty cells in the rawWADs sheet
        finalEM1Element.Range("A" & i + 4).value = rawWADs.Range("A" & i).value 'Puts all the data from column A row 4 down to its last row_
                'with data in it and copies it into the finalEM1Element sheet_
                'in its column A row 8 (i+4=8)

    End If 'Ends "If" procedure.
Next i 'Ends the "For i" procedure.

For j = finalEM1Element.Range("A" & Rows.Count).End(xlUp).Row To 8 Step -1 'Creates the loop for the code to loop through within_
                'the range of column A starting at row 8
    If InStr(1, Cells(j, 1), "-US-") = 0 And InStr(1, Cells(j, 1), "-ICPS") = 0 Then
        Cells(j, 1).EntireRow.Delete
    'Searches for only the EM-1 Flight Hardware or related GSE in question represented by the "-####-" section of the part/item_
    'number in the "A" column. Function is broken down as follows: InStr(Optional integer argument defaulted with "1", The string_
    'you want to search, The string that you want to search for) = 0; the 0 is a binary comparision that states that_
    'string 1 = string 2. If the cells in column A (String 1) do not equal to what is stated in "-####-" (String 2) then they are_
    'false and that entire row is deleted. This allows the sheet to only show the WADs that are related to what the sheet is_
    'looking for (i.e. LAS,CM,US,BSTR,GS,etc..)

    End If 'Ends "If" procedure.
Next j 'Ends the "For j" procedure.

    Range("B1").value = Now() 'Updates the date in which this macro was run in cell B1 of the finalEM1Element sheet in which_
                'this macro was used

Application.ScreenUpdating = True 'Turns screen updating back on
Application.Calculation = xlCalculationAutomatic 'Allows Excel to resume its auto calculations
Application.EnableEvents = True 'Allows any other code in the Workbook to run again

End Sub
```

Rocket labels: LAS, CM, SA, SM, MSA, US/ICPS (RL10), LVSA, CS, BSTR, ENG (RS25)

ToC · MACRO: US Data Update

US - Upper Stage (ICPS - Interim Cryogenic Propulsion Stage)

WAD Status		GMIP Status						Alteration / Deviation Status		Waiver Status		Nonconformance Status		MRB Status	
WAD item/Part No.	WADs Reviewed By SA-F2	Work Orders Generated	GMIPs Planned	Additional GMIPs Added After WAD Alterations	Work Order Executions	Total GMIPs	All GMIPs Completed	Y/N	No. Per WAD	Y/N	No. Per WAD	Y/N	No. Per WAD	Y/N	No. Per WAD
TOTAL: 88	Percentage 1%	TOTAL: 13	TOTAL: 2	TOTAL: 2	TOTAL: 86	TOTAL: 172	TOTAL: 172	TOTAL: 5	TOTAL:	TOTAL: 0	TOTAL: 0	TOTAL: 7	TOTAL:	TOTAL: 0	TOTAL: 0
COM-US-0009	NO	None	None	None	0	0	0	0		N		N		N	None
COM-US-0010	NO	None	None	None	0	0	0	0		N		N		N	None
COM-US-0011	NO	None	None	None	0	0	0	0		N		N		N	None
COM-US-0012	NO	None	None	None	0	0	0	0		N		N		N	None
COM-US-0013	NO	None	None	None	0	0	0	0		N		N		N	None
ENG-US-0001	NO	None	None	None	0	0	0	0		N		N		N	None
ENG-US-0002	NO	3	2	0	79	158	158	Y	5	N		Y	1	N	None
ENG-US-0003	YES	2	None	2	7	14	14	Y	1	N		N		N	None
ENG-US-0004	NO	None	None	None	0	0	0	0		N		N		N	None
ENG-US-0005	NO	None	None	None	0	0	0	0		N		N		N	None
ENG-US-0006	NO	None	None	None	0	0	0	0		N		N		N	None
ENG-US-0007	NO	None	None	None	0	0	0	0		N		N		N	None
ENG-US-0008	NO	None	None	None	0	0	0	0		N		N		N	None
EPS-US-0002	NO	None	None	None	0	0	0	0		N		N		N	None
EPS-US-0003	NO	None	None	None	0	0	0	0		N		N		N	None

... LAS CM SA MSA US SP LVSA BSTR CS RS25 RL10 CSM FS LV ILV SPIE GS | Total WAD Status | Total

Future Work

- Minimize manual updating features
- Implement automated solutions to replace manual inputs (alterations, deviations, waivers)
- Reduce probability of human error inputs (STORM)

Other Tasks and Projects

- Inert Booster Stacking Operations

- MSA Offloading, Transfer, & Lifting Operations

- ICPS GMIPs

- MPPF Facilities V&V
- Launch Pad 39B Wet Flow Test

What Was Learned

QE & SMA roles, disciplines, and requirements. Quality assurance programs. Purpose & implementation of a QASP. Performing surveillances. AS9100. VBA code.