Closed Loop Requirements Verification Planning using Requirements Management Tools

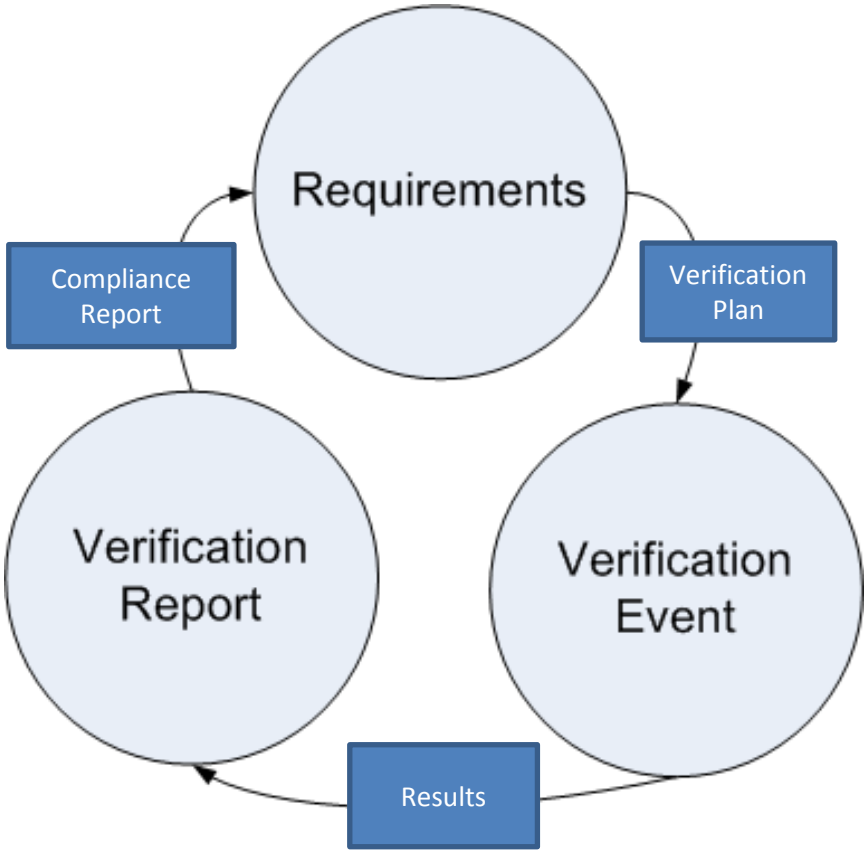
Agenda

- **Background**
- **Objective**
- **Approach**
- **Accomplishment**
- **Conclusion**

What is Closed Loop Requirements Verification?

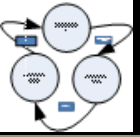
Bi-directional traceability of requirements to design features and A, D, I, T, activities that verify compliance of design with requirements.

- Mapping of specification requirements to verification activities is basis for requirements verification plan; plan is supported by:
  - Asset utilization matrix
  - Requirements verification matrix
- Results of verification activities are captured in reports that evaluate performance against A, D, I, T objectives
- Compliance reports provide phase gate assessments of design compliance and culminate in final compliance report at FCA



A = Analysis
D = Demonstration
I = Inspection
T = Test

FCA = Functional Configuration Audit



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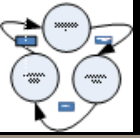
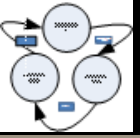


Project Objectives

Provide ability to map requirements to their verification plans and results bi-directionally

- Ensure each requirement supported by Verification Event
- Plan Verification Events to efficiently cover Verification Objectives
- Assess impact of requirements changes on Verification Plans
- Assess impact of Verification Plan changes on ability to verify requirements
- Ensure that each requirement traceable to verification results
- Evaluate risk due to product maturity
  - Risk = maturity = level to which requirements have been verified
- Communicate
  - All plan elements to all stakeholders (SE, Customer, Design, Test, and Analysis)
  - Ensure use of consistent nomenclature throughout project
    - No requirements corruptions during verification cycle
    - Reworded requirement may be interpreted as different requirement



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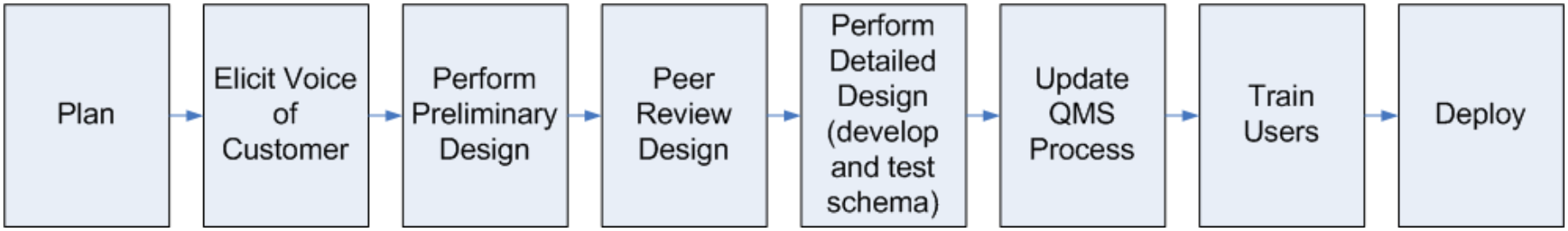
Project Approach

Build on Standard Tools and Processes

- Use existing Requirements Management Tool
- Support existing CMMI Level III, AS9100/ISO 9001 processes
- Develop automated reports to fill common needs
  - Requirements Verification Matrix
  - Requirements Verification Plan
  - Verification event Objectives
  - Functional Configuration Audit



CMMI = (Capability Maturity Model® Integration)
ISO = International Standards Organization
QMS = Quality Management System

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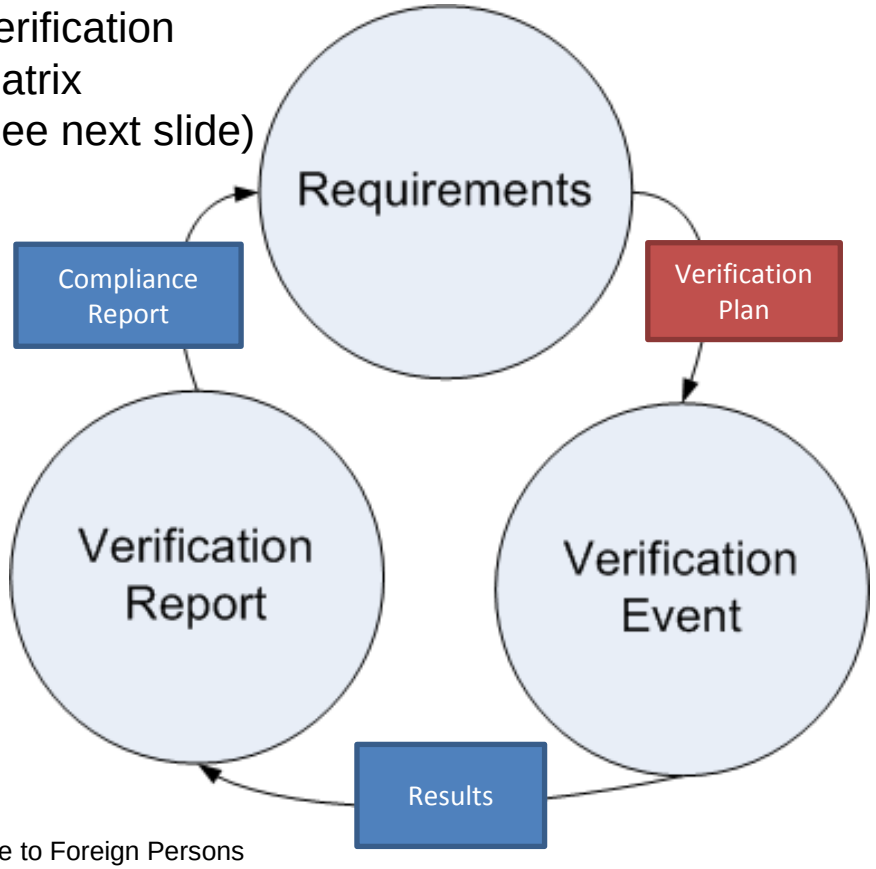
Requirements Verification Matrix Development

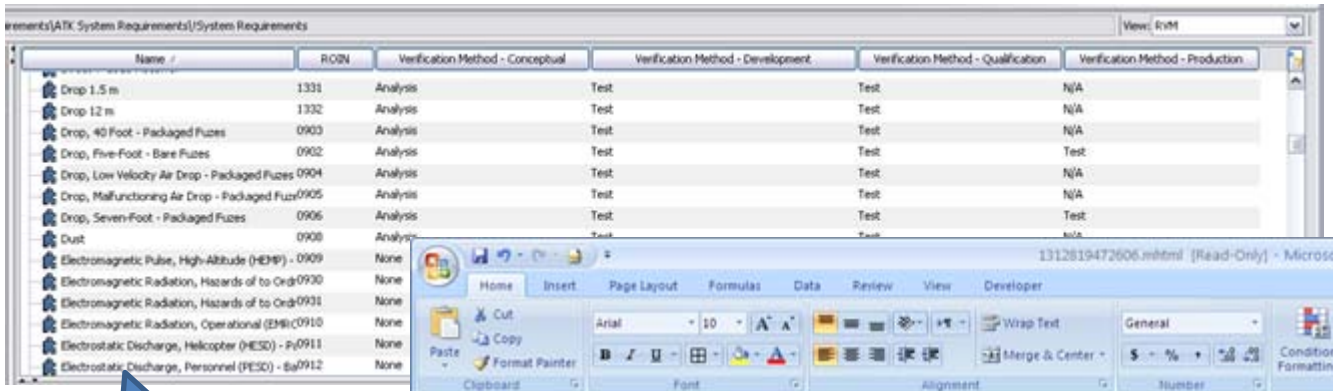
- Initial Program Plan
- Customer Technical Requirements
- Standard Capabilities

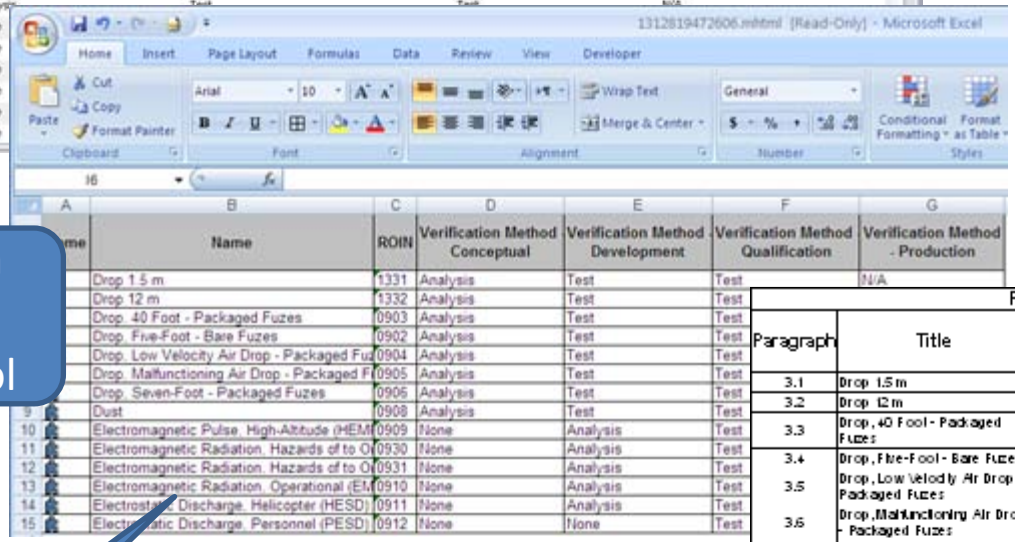
- Analyze Program Plan for verification timing (phase) needs
- Analyze Customer Technical Requirements for verification technical needs
- Analyze Program Plan and Standard Capabilities for availability of verification resources

Requirements Verification Matrix (see next slide)



Requirements Verification Matrix Outputs





Analyst View in Systems Engineering Tool

Export to EXCEL for other groups

Standard RVM for Specification Documents

Requirement		Verification Methods and Phases															
		Conceptual				Development				Qualification				Production			
Paragraph	Title	A	D	T	N/A	A	D	T	N/A	A	D	T	N/A	A	D	T	N/A
3.1	Drop 1.5 m	X						X				X					X
3.2	Drop 12 m	X						X				X					X
3.3	Drop, 40 Foot - Packaged Fuzes	X						X				X					X
3.4	Drop, Five-Foot - Bare Fuzes	X						X				X				X	
3.5	Drop, Low Velocity Air Drop - Packaged Fuzes	X						X				X					X
3.6	Drop, Malfunctioning Air Drop - Packaged Fuzes	X						X				X					X
3.7	Drop, Seven-Foot - Packaged Fuzes	X						X				X				X	
3.8	Dust	X						X				X					X
3.9	Electromagnetic Pulse, High-Altitude (HEMP) - Packaged Fuzes					X						X					X
3.10	Electromagnetic Radiation, Hazards of to Ordnance (HERO) - Bare Fuzes					X						X					X
3.11	Electromagnetic Radiation, Hazards of to Ordnance (HERO) - Packaged Fuzes					X						X					X
3.12	Electromagnetic Radiation, Operational (EMRO) - Bare Fuzes					X						X					X
3.13	Electrostatic Discharge, Helicopter (HESD) - Packaged Fuzes					X						X					X
3.14	Electrostatic Discharge, Personnel (PESD) - Bare Fuzes											X					X

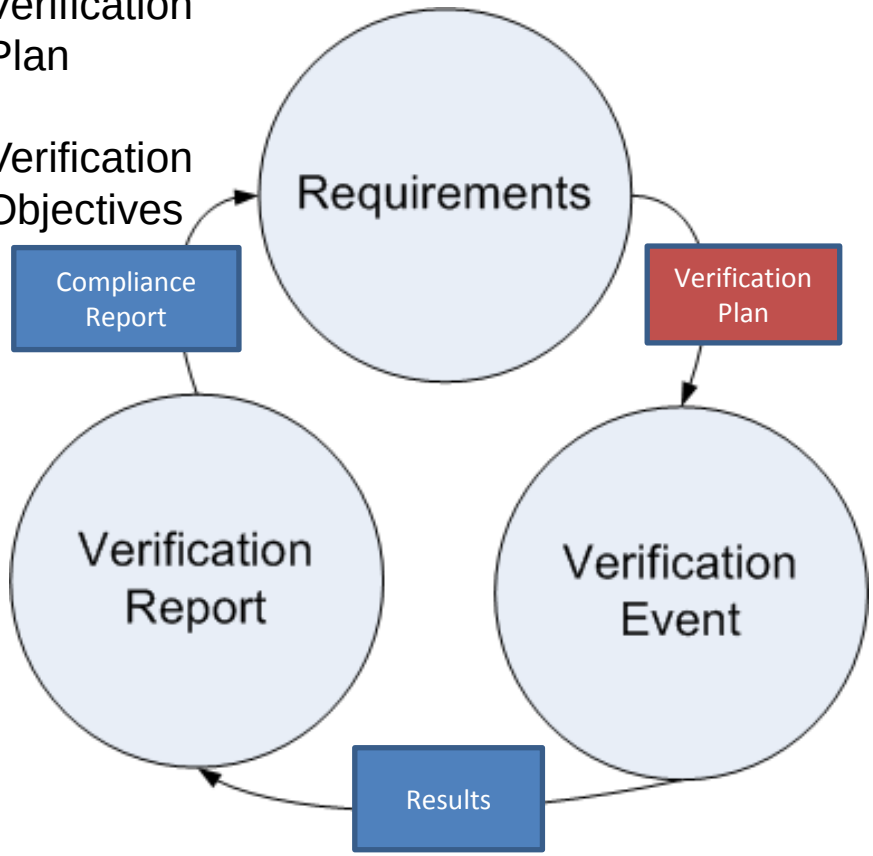
Requirements Verification Plan Development

Inputs → Process → Output

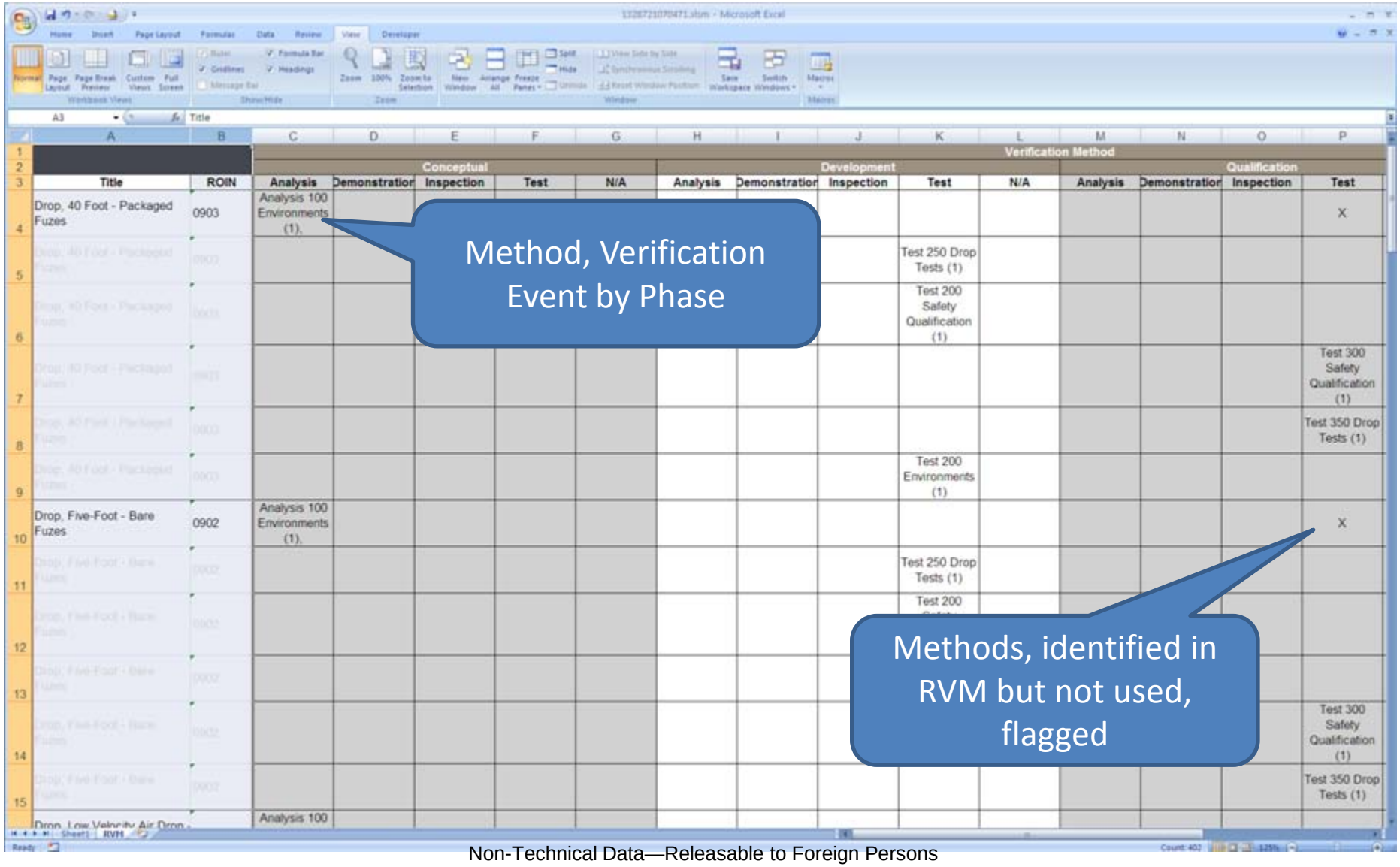
- Detailed Program Schedules
- Requirements Verification Matrix
- Preliminary Design Information

- Update verification timing needs analysis
- Update verification technical needs analysis
- Create Verification Objectives for requirements
- Assign Verification Objectives to Verification Events

- Requirements Verification Plan
- Verification Objectives



Requirements Verification Plan Report



		Verification Method													
		Conceptual					Development					Qualification			
Title	ROIN	Analysis	Demonstration	Inspection	Test	N/A	Analysis	Demonstration	Inspection	Test	N/A	Analysis	Demonstration	Inspection	Test
Drop, 40 Foot - Packaged Fuzes	0903	Analysis 100 Environments (1),													X
										Test 250 Drop Tests (1)					
										Test 200 Safety Qualification (1)					
															Test 300 Safety Qualification (1)
															Test 350 Drop Tests (1)
										Test 200 Environments (1)					
Drop, Five-Foot - Bare Fuzes	0902	Analysis 100 Environments (1),													X
										Test 250 Drop Tests (1)					
										Test 200					
															Test 300 Safety Qualification (1)
															Test 350 Drop Tests (1)
Drop, Low Velocity Air Drop -		Analysis 100													

Method, Verification Event by Phase

Methods, identified in RVM but not used, flagged

Objectives Matrix Report

Test 300 Safety Qualification			
Objective Number	**Objective Title**	**Success Criteria**	**Data Requirements**
1	Verify that widget is safe following drops	The widget S&A remains in the safe state after the required drops.	Data in accordance with MIL-STD-ZYZ.
2	Verify that widget is safe following EMI exposure	The widget explosive components do not detonate in the presence of the required fields.	Data in accordance with MIL-STD-EMI.

Insert Objectives at beginning of plan and report:

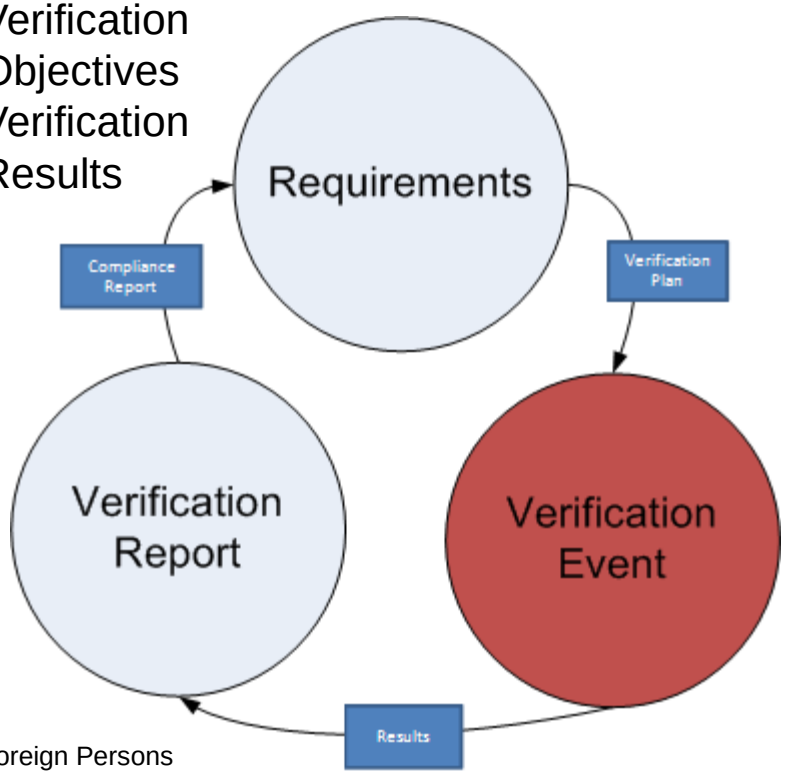
- Analysis
- Demonstration
- Inspection or
- Test

Requirements Verification Execution

- Requirements Verification Plan
- Verification Objectives

- Prepare Verification Event Plan
  - Verification Objectives
  - Special equipment needs
  - Staffing
  - Facilities required
  - Security considerations
  - Safety considerations
- Perform the verification
  - Analysis
  - Demonstration
  - Inspection or
  - Test

- Requirements Verification Report
- Verification Objectives
- Verification Results

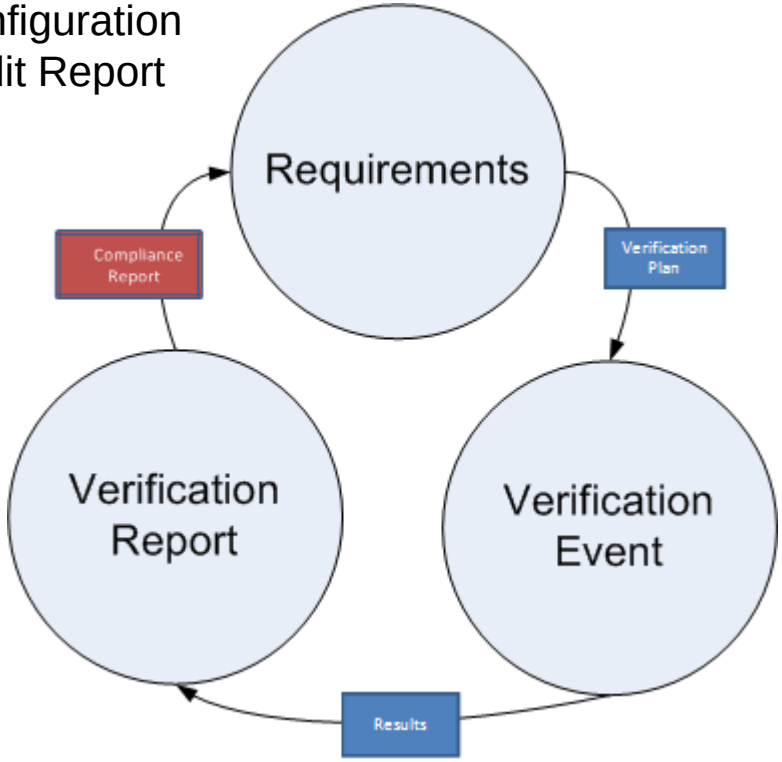


Functional Configuration Audit

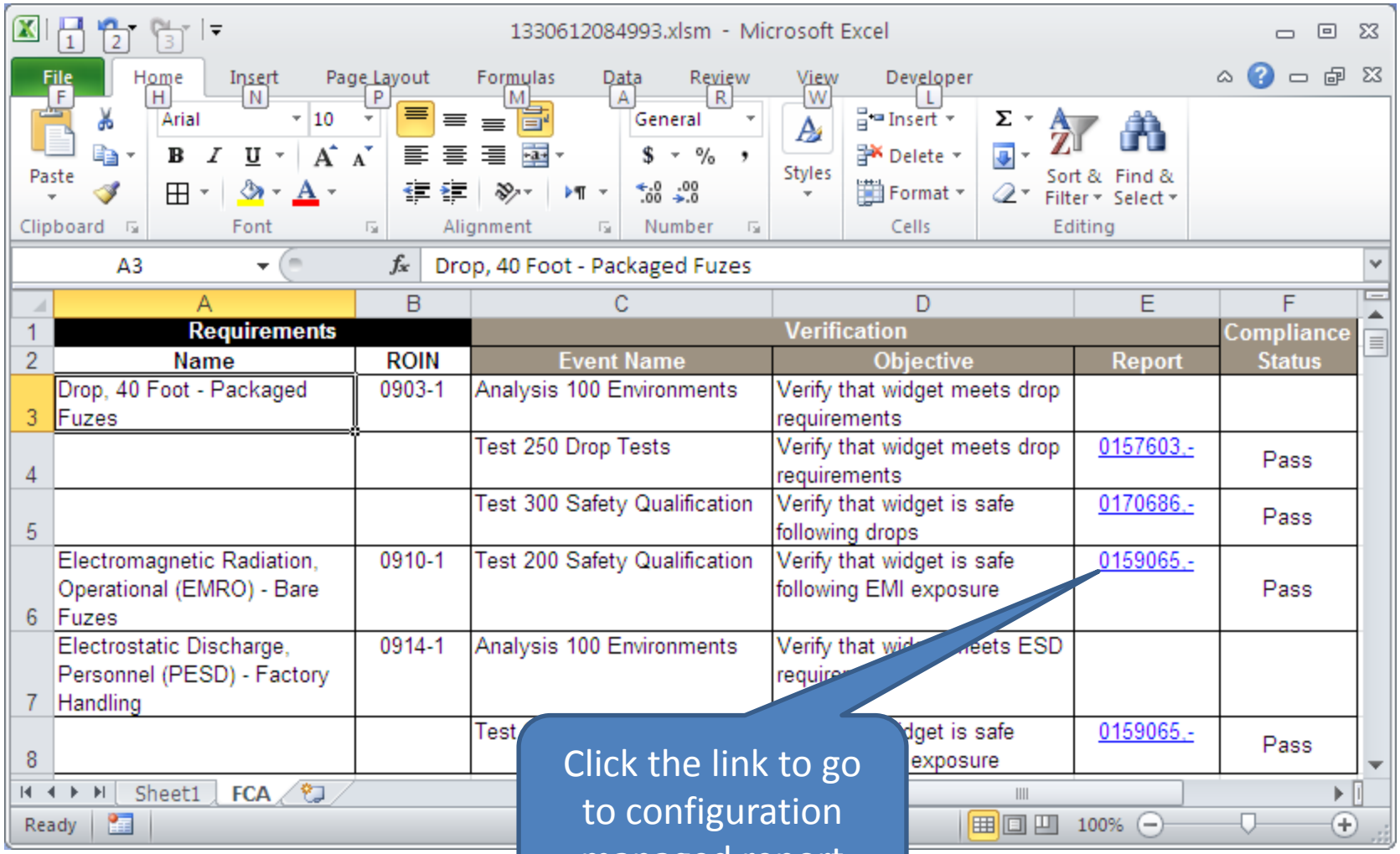
- Requirements in Database
- Verification Events & Objectives in Database
- Verification Reports in Configuration Management

- Run the tool

- Functional Configuration Audit Report

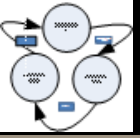


Functional Configuration Audit Report



Requirements		Verification			Compliance Status
Name	ROIN	Event Name	Objective	Report	
Drop, 40 Foot - Packaged Fuzes	0903-1	Analysis 100 Environments	Verify that widget meets drop requirements		
		Test 250 Drop Tests	Verify that widget meets drop requirements	0157603.-	Pass
		Test 300 Safety Qualification	Verify that widget is safe following drops	0170686.-	Pass
Electromagnetic Radiation, Operational (EMRO) - Bare Fuzes	0910-1	Test 200 Safety Qualification	Verify that widget is safe following EMI exposure	0159065.-	Pass
Electrostatic Discharge, Personnel (PESD) - Factory Handling	0914-1	Analysis 100 Environments	Verify that wid…eets ESD requir…		
		Test…	…dget is safe …exposure	0159065.-	Pass

Click the link to go to configuration managed report



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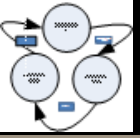

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Acknowledgements

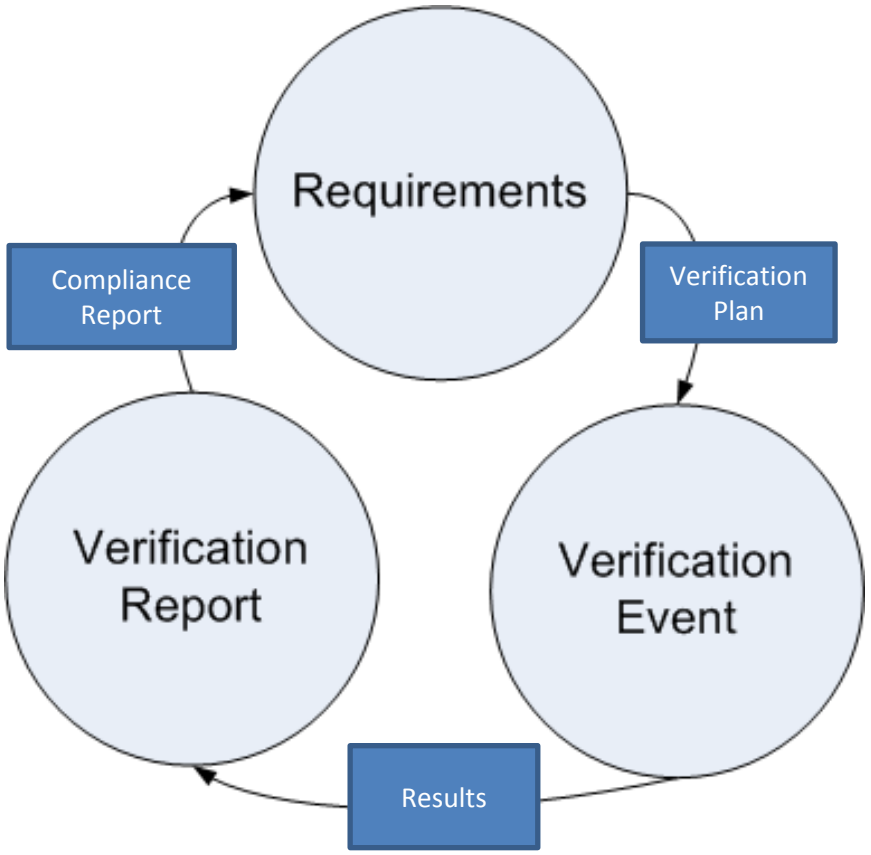
- **Project Sponsor:**

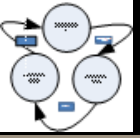
  Mr James Kalberer

- **Teamcenter Systems Engineering Technical Wizardry:**

  Ms Krista Vilandre

Closed Loop Requirements Verification Planning





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Abstract ID Number: