NDIA 11th Annual Systems Engineering Conference

"Daily Challenges of Requirements Engineering"

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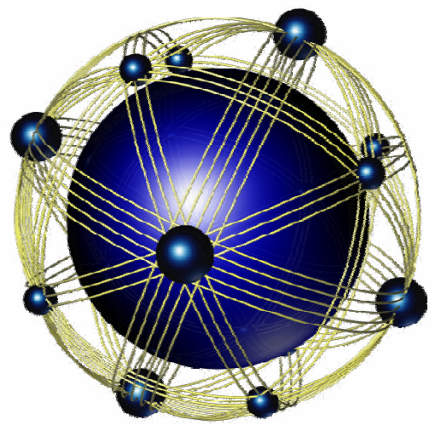
Frank Salvatore
High Performance Technologies, inc.
3159 Schrader Road
Dover NJ, 07801
(973) 442-6436 ext 249
fsalvatore@hpti.com



Outline

- Requirements Elicitation
- Requirements Capture and Management
- Requirements Traceability
- Requirements Control
- Reaching Consensus
- Eliciting Verifications
- Communicating Requirements
- Metrics

Requirements Elicitation

How do you gather the requirements?

- Interviews
- QFD Workshops
- Web Based Surveys
- Vignettes and Scenarios
- Questionnaires
- Brainstorming and Mind Mapping
- Analysis/Derivation
  - ✓ Hazard
  - ✓ Fault Tree
  - ✓ Sensitivity
  - ✓ Trade Studies
- Existing Documentation and or Policies
- Quality Assurance Provisions

It involves a lot of research and is evolutionary!

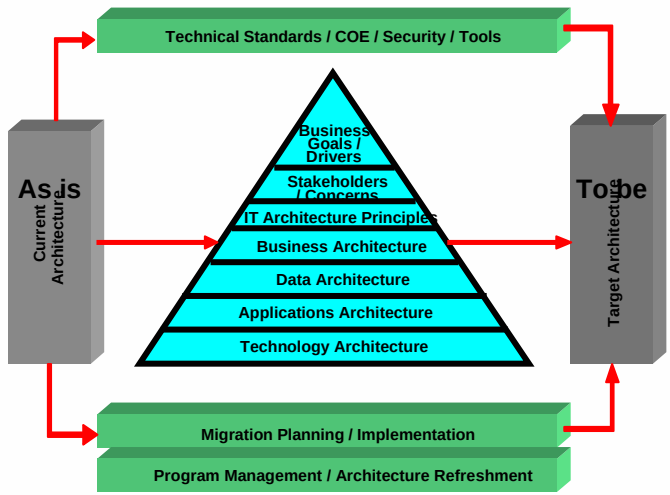
Don't forget to Document Rational. It will save you time latter when you will need to defend the requirements.

Interview Based Elicitation

Using and Enterprise Architecture approach one can first probe into Business Goals and Architecture Principles buy asking questions to understand:

- ❑ **Mission and Values of your organization**
- ❑ **Understand importance (PM Level)**
- ❑ **Understand organization structure**
- ❑ **Understand Products**
- ❑ **Understand Customers and Stakeholders**
- ❑ **Understand Daily Activities**

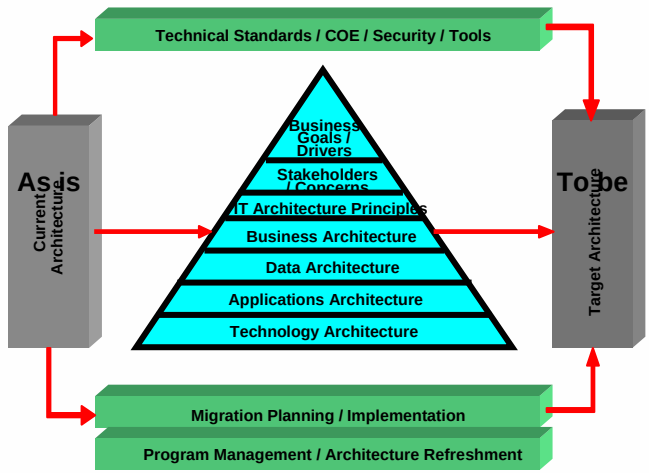
Mostly used for Business Systems



Interview Based Elicitation

Project and Product Data can be understood by asking these leading questions

- What are the Projects/Products that the organization manages?
- Who do you interact with?
- What data types do you manage?
- How do you organize your data?
- What data do you view as being most important?
- Who are the Customers for each product?
- Who are the stakeholders for each product?
- What are the day to day activities that go on for the projects you choose?



QFD Based Elicitation

			Engineering Metrics												USER RATING										
															Absolute Score					Relative Score					
			Engineering Measu 1	Engineering Measu 2	Engineering Measu 3	Engineering Measu 4	Engineering Measu 5	Engineering Measu 6	Engineering Measu 7	Engineering Measu 8	Engineering Measu 9	Engineering Measu 10	Engineering Measu 11	Customer Importance	Relative Importance	Concept A	Concept B	Concept C	Concept D	Concept E	Concept A	Concept B	Concept C	Concept D	Concept E
USER NEEDS	User Needs	Customer Need 1.0	9	9	0	0	0	9	9	9	0	0	9	5.00	26%	3	5	1	3	2	0.79	1.3	0.3	0.8	0.5
		Customer Need 2.0	0	0	9	9	9	9	9	3	0	0	9	3.00	16%	3	2	3	3	3	0.47	0.3	0.5	0.5	0.5
		Customer Need 3.0	0	0	0	0	0	3	9	1	9	0	3	5.00	26%	3	5	5	3	4	0.79	1.3	1.3	0.8	1.1
		Customer Need 4.0	0	0	0	0	0	1	3	9	0	0	1	4.00	21%	3	2	5	3	5	0.63	0.4	1.1	0.6	1.1
		Customer Need 5.0	0	0	0	0	0	1	1	1	0	5	1	2.00	11%	3	1	5	3	4	0.32	0.1	0.5	0.3	0.4
		Organizational Difficulty														57	66	69	57	67	3	3	4	3	4
		Absolute importance	45	45	27	27	27	93	131	97	45	10	93												
		Relative Importance	7%	7%	4%	4%	4%	15%	20%	15%	7%	2%	15%												
ENGINEERING RATING	Raw Score	Concept A	3	3	3	3	3	3	3	3	3	3	3												
		Concept B	4	3	2	4	3	5	3	2	1	3	3												
		Concept C	4	3	3	4	5	4	1	2	4	3	2												
		Concept D	3	3	3	3	3	3	3	3	3	3	3												
		Concept E	2	5	3	4	5	5	5	4	3	3	4												
	Weigted Score	Concept A	135	135	81	81	81	279	393	291	135	30	279												
		Concept B	180	135	54	108	81	465	393	194	45	30	279												
		Concept C	180	135	81	108	135	372	131	194	180	30	186												
		Concept D	135	135	81	81	81	279	393	291	135	30	279												
		Concept E	90	225	81	108	135	465	655	388	135	30	372												
RISK		Technical																							
		Schedule																							
		Cost																							

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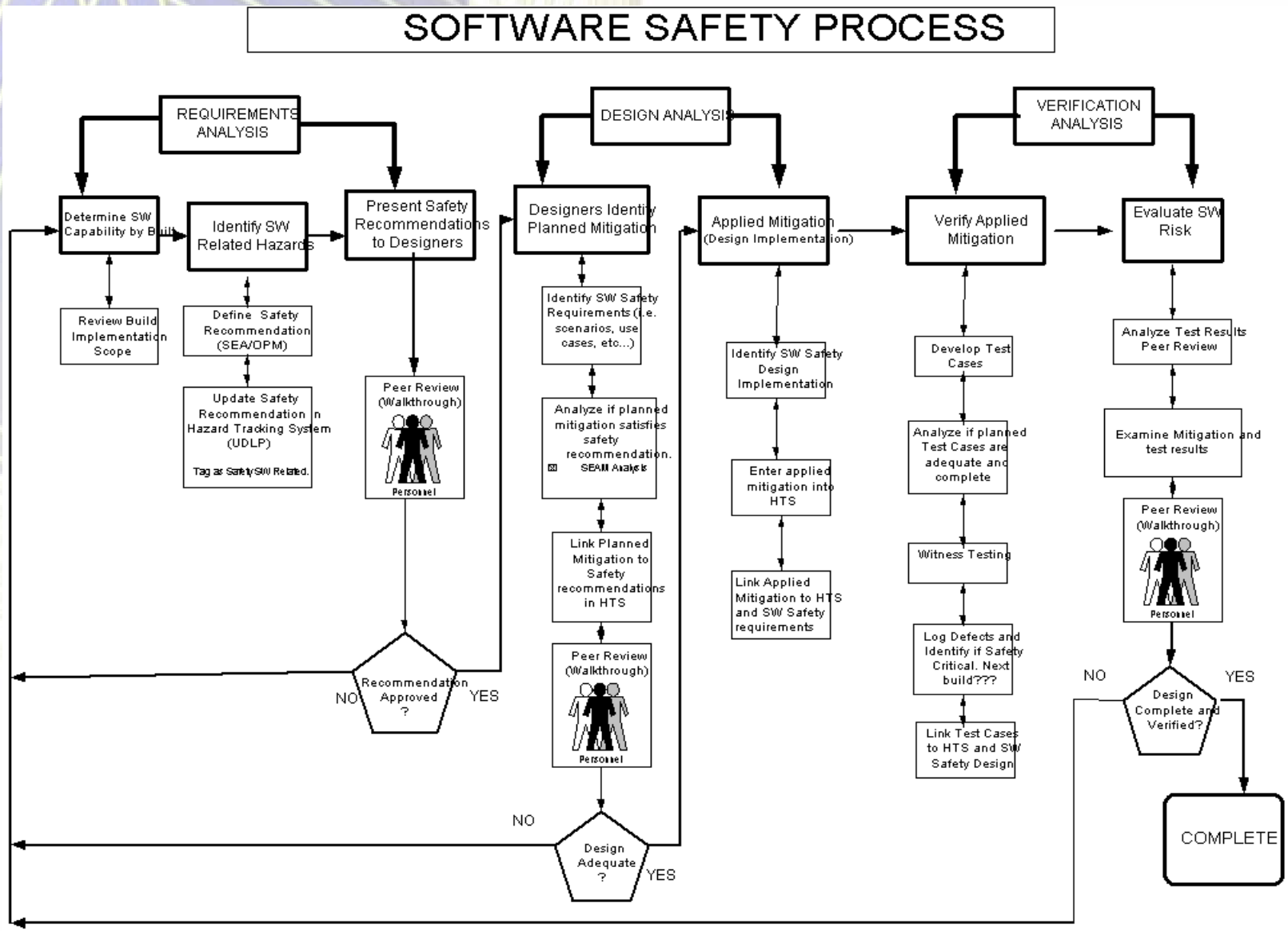
Also helps to Build Consensus and Understanding of complex relationships as well as importance.

Requirements are Discovered Thru The SW Safety Process



Eliciting Verification Methods

Similar to Requirements. Stakeholders are different. Methods are typically thru Analysis, Test, Inspection, Measurement.

- **Use Interview**
- **Use Questionnaires**
- **Include Stakeholders Early and Often.**
- **Have Stakeholders Peer Review Requirements**
- **Use a JCCB**

File Edit Insert Records Window Help

graph: Interface Definition

TRL: ☐ TRL5 ☐ TRL6 ☐ TRL7

IPT Name: Ammo Handling

Module Name AHR

ion: 3.1.2.0-1

uirements: The Ammo Handling Subsystem will interface with the Turret Structure, Gun Assembly, Fire Control, Ammo Suite and Secondary Armament.

ATD/Objective Force:

This enables and disables the required field warning:

Switch to View Mode

RL 5 Verification Method: ~~Please Select a Method~~

- Analysis
- Inspection
- Measurement
- Test
- N/A
- ~~Please Select a Method~~

Responsibility: (e.g.: IPT Name, Subcontractor, System Integrartor) Critical Test:

Location of Verif: (e.g.: Picatinny, Contractor Facility, Proving Ground) ~~Please Select a Test~~

Verification Procedure: Briefly d at this TRL level to validate or confirm the requirement.
If the requirement will not be v

Data Collected:

Clear

Reset

L 6 Verification Method: ~~Please Select a Method~~

Responsibility: (e.g.: IPT Name, Subcontractor, System Integrartor) Critical Test:

Location of Verif: (e.g.: Picatinny, Contractor Facility, Proving Ground) ~~Please Select a Test~~

Verification Procedure: Briefly describe the procedure you recommend at this TRL level to validate or confirm the requirement.
If the requirement will not be verified at this time please indicate so:

Data Collected:

Clear

Reset

L 7 Verification Method: ~~Please Select a Method~~

|< <-- --> >| Record of Exit

Requirements Capture and Management

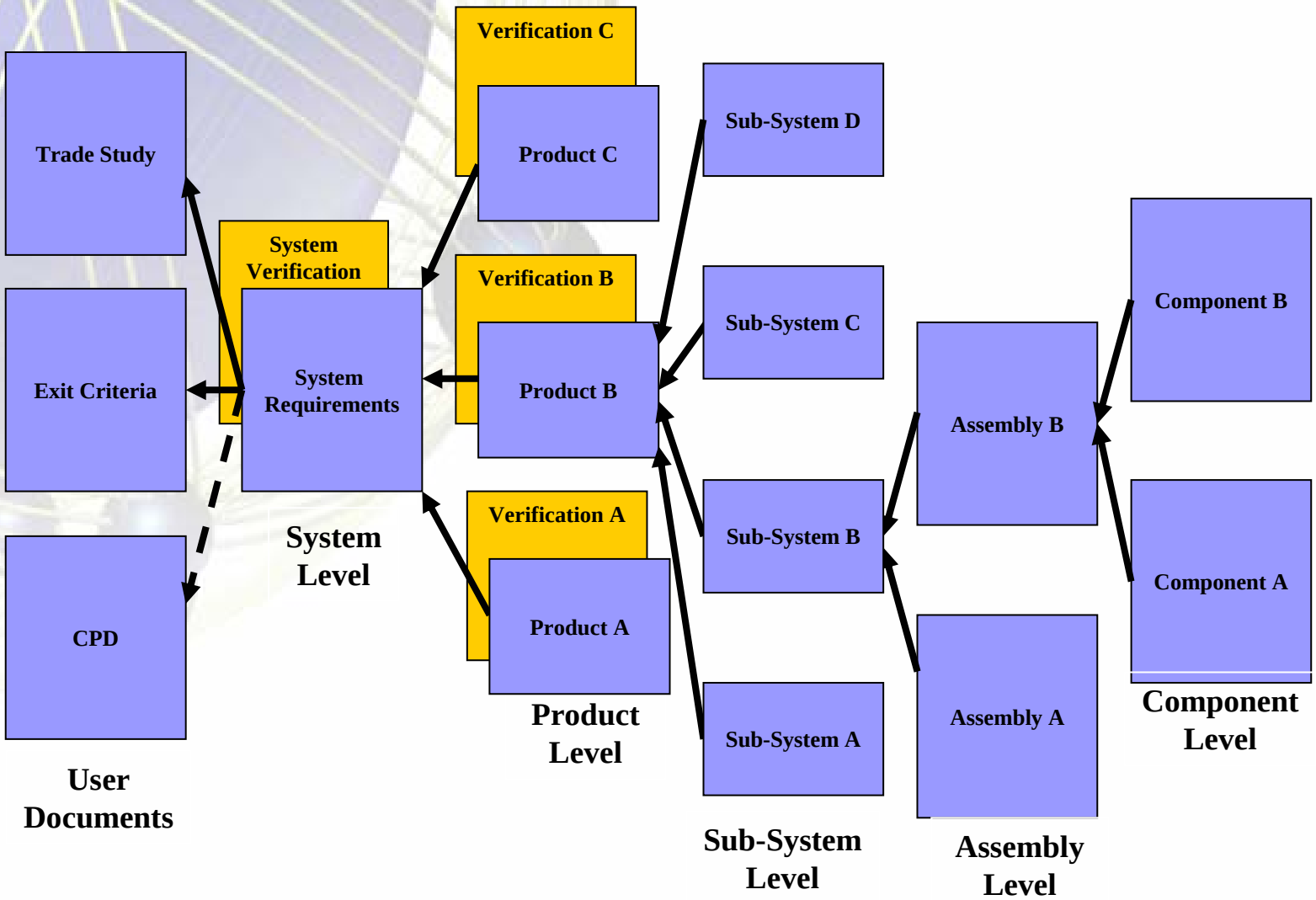
How and where do you store the requirements?

Word Documents are standard. Tools are useful and can Help. But try to get everyone to use them consistently!!!!!

- **Access**
- **Excel**
- **DOORS**
- **RTM**
- **Requisite Pro**
- **RM Calibre**
- **etc….**

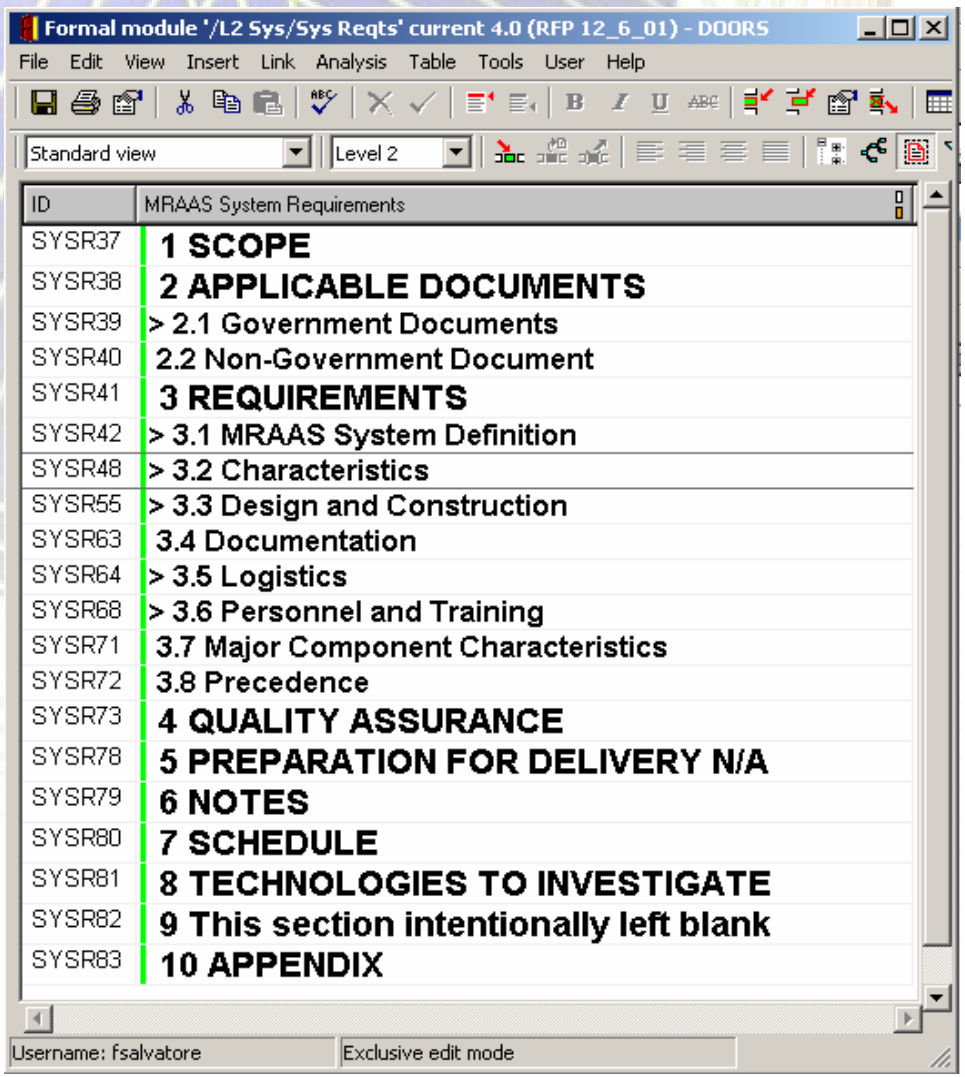
Use Document Templates Based On Standards. Also IM is Important for Efficiency.

Requirements Management Specification Hierarchy



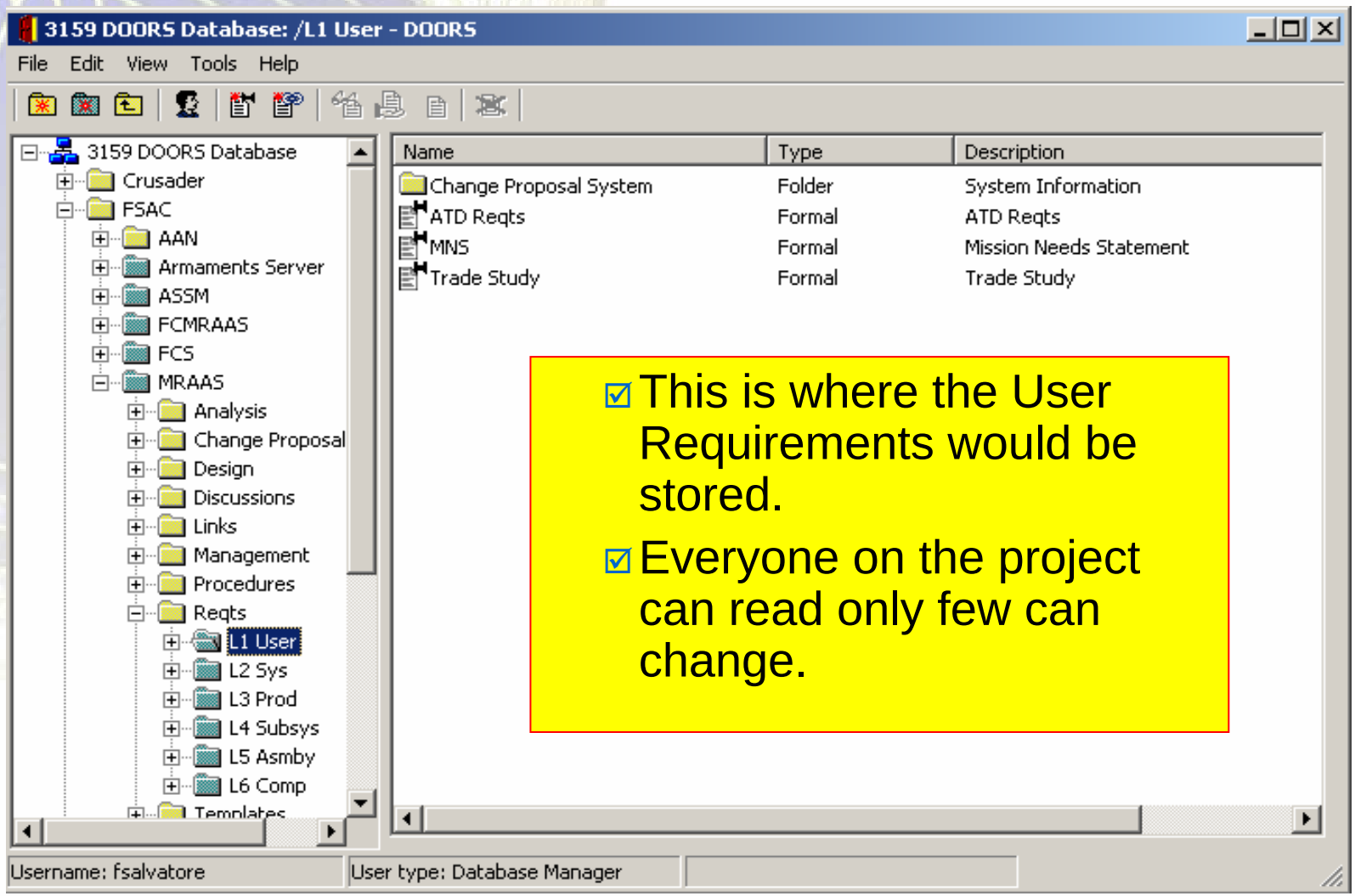
Establish Hierarchy and Naming Convention, Follow IEEE Standard

Document Outline is Standard Throughout Project.



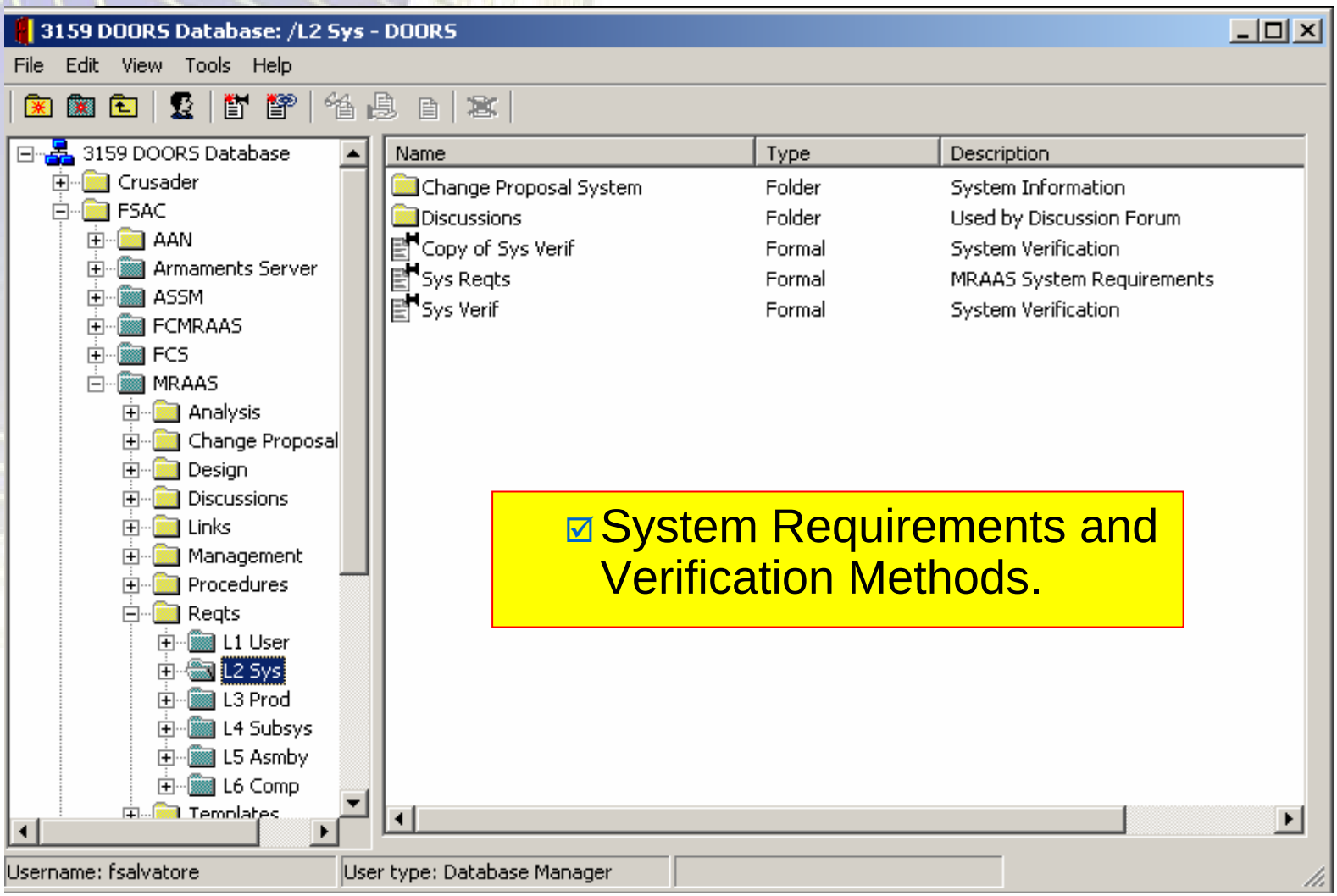
- ☑ Using Mil-STD-490/961C standard template
- ☑ Standardized Documentation format makes it easier to find what you are looking for

Level 1 User Requirements



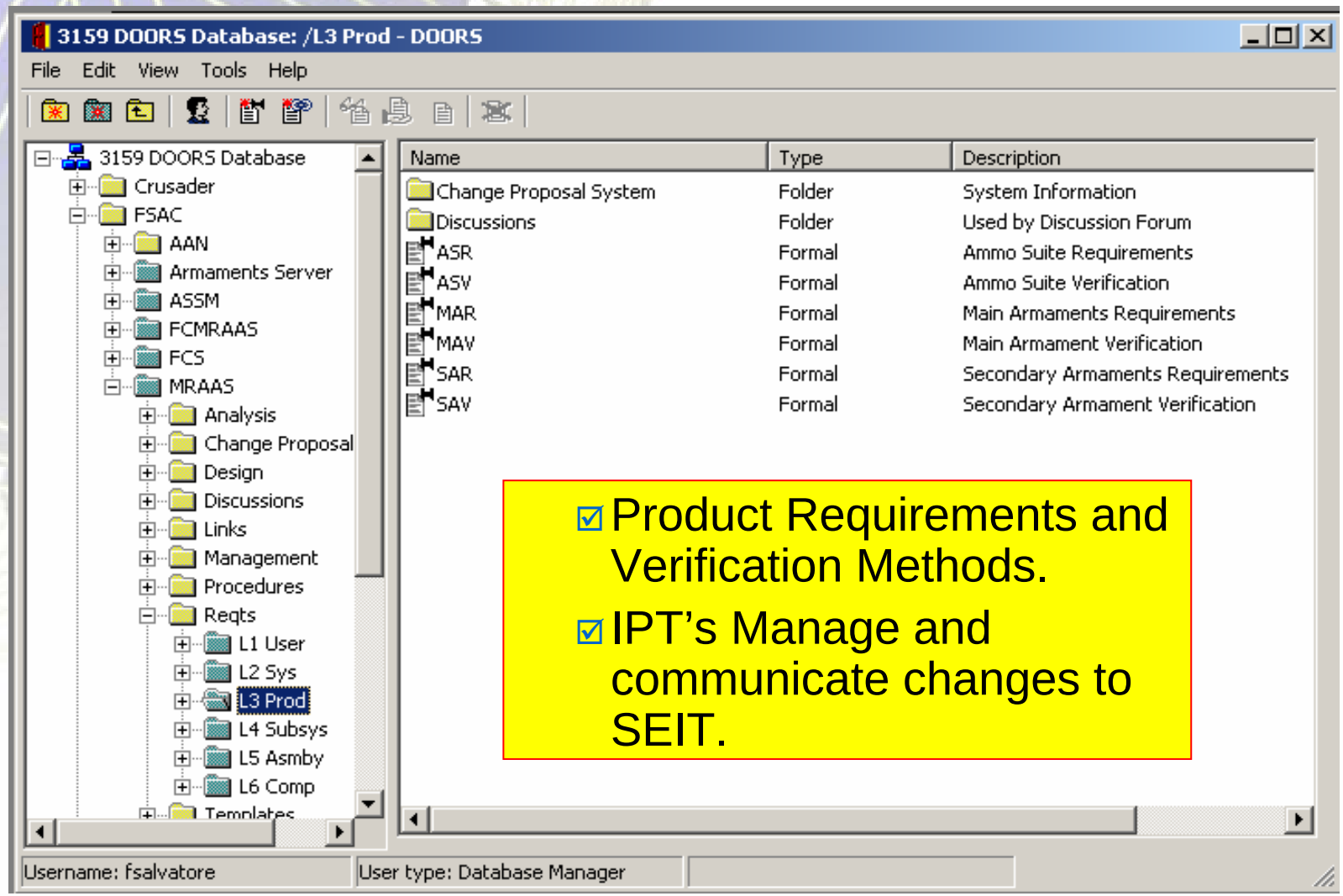
- This is where the User Requirements would be stored.
- Everyone on the project can read only few can change.

Level 2 System Requirements



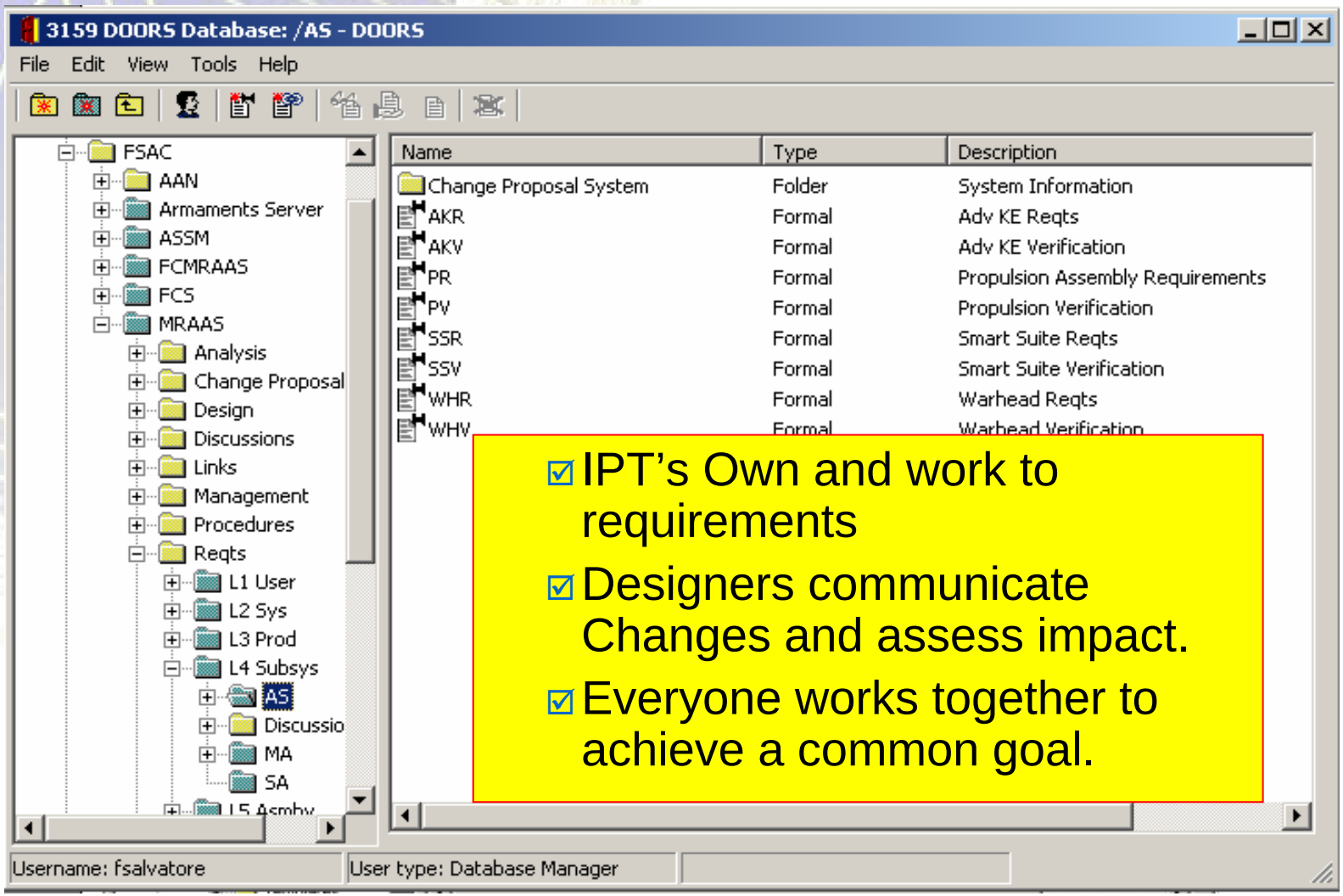
- ☑ System Requirements and Verification Methods.

Level 3 Product Requirements



- ☑ Product Requirements and Verification Methods.
- ☑ IPT's Manage and communicate changes to SEIT.

Level 4-6 Subassembly to Component Requirements



- ☑ IPT's Own and work to requirements
- ☑ Designers communicate Changes and assess impact.
- ☑ Everyone works together to achieve a common goal.

Requirements Traceability

How do you understand how the requirements are being satisfied, are complete, are accurate, etc…….

- **Trace Matrices are Typical and require constant care and feeding to maintain.**
- **Use a tool to manage your requirements and capture traceability so you can search and query when doing impact analysis.**
  - ✓ **More accurate**
  - ✓ **More efficient**
  - ✓ **More complete**

No tool will automatically generate but they will preserve it once you do it the first time.

If a requirement isn't traceable to anything it doesn't belong!!!

This is Important when performing Impact Analysis, doing FCA and PCA, etc….

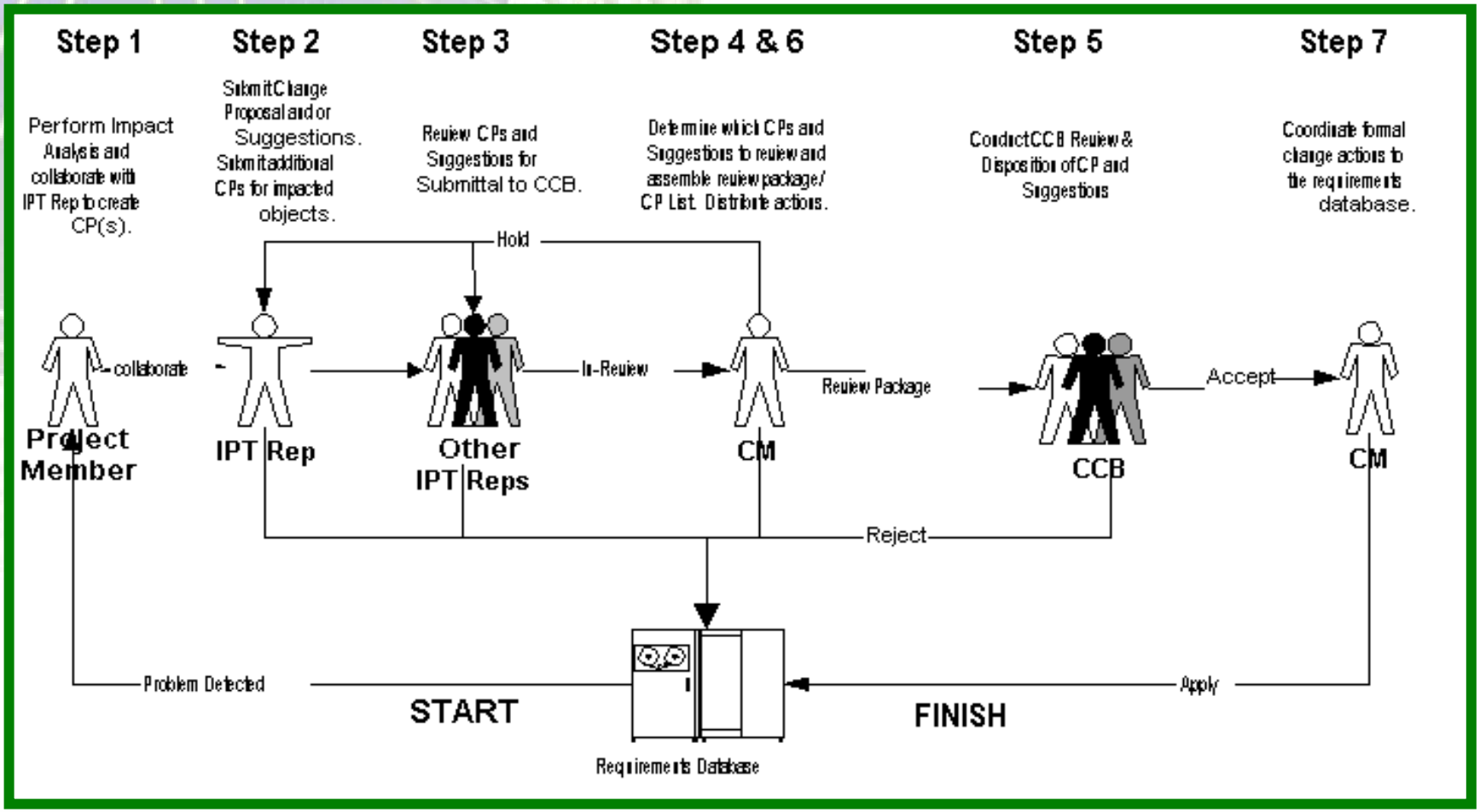
Requirements Change Control

If a Requirement is changed, how do we determine effects on other Requirements, Verifications or Schedule Events?

- **Use Inter-IPT Coordination**
- **Use Impact Analysis & Visualization Tools**
- **Use Formal Change Control Procedures**
- **Attributes**

With a tool you have better and more efficient ways of controlling the requirements.

Follow a Change Proposal Process



Starting the Change Process

IPT Member brings an issue to attention of IPT Lead

IPT Lead makes an initial determination:

PURSUE – Proposed change has merit and is worth further investigation

DISCARD – Proposed change does not have merit or is not worth further investigation at this time

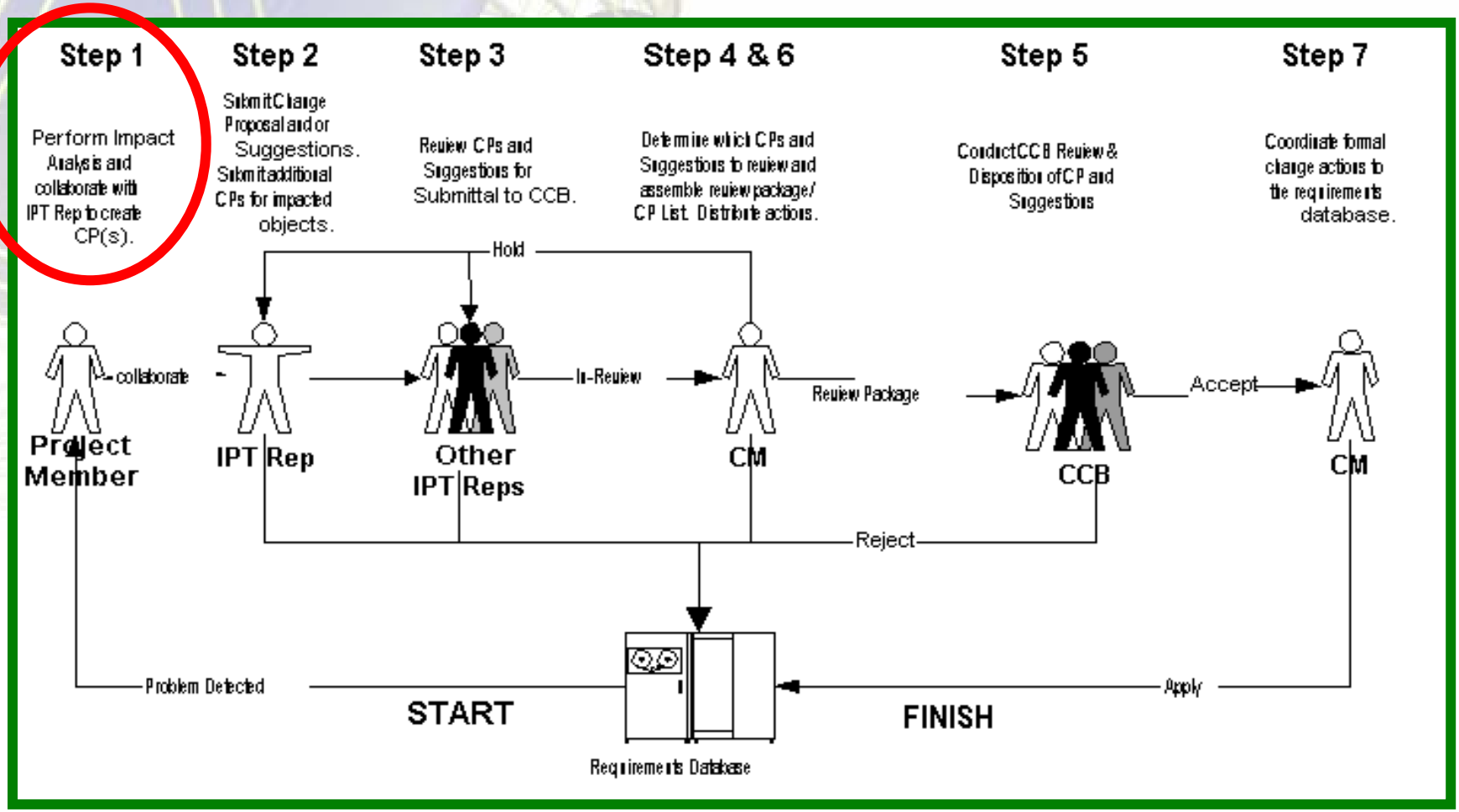
If you choose to PURSUE the potential change:

1. **Coordinate with other IPT's to discuss**
2. **Initiate working group(s) as needed**

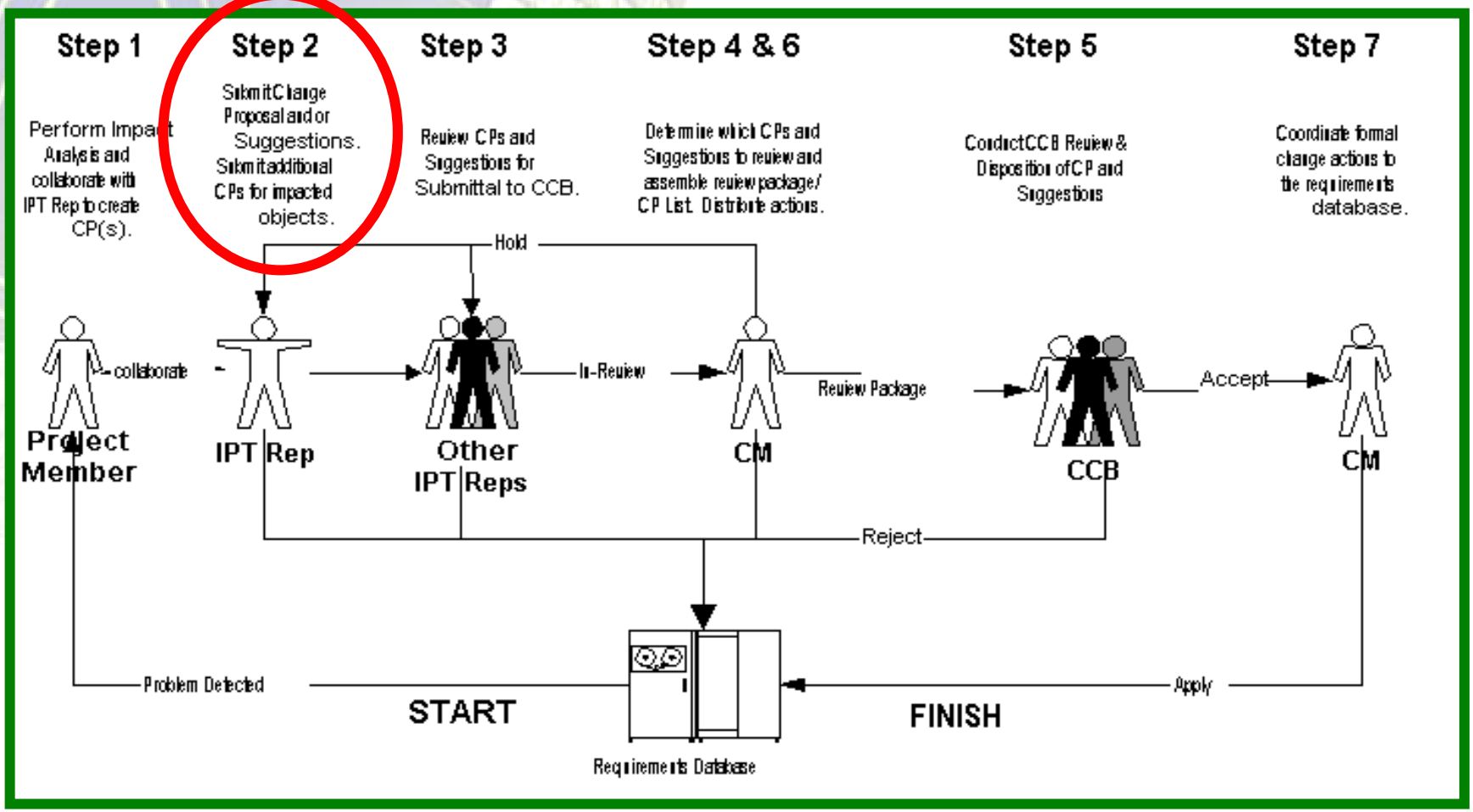
COMMUNICATE !!!

Starting the Change Process

Still think a change is needed? Perform an "Impact Analysis"

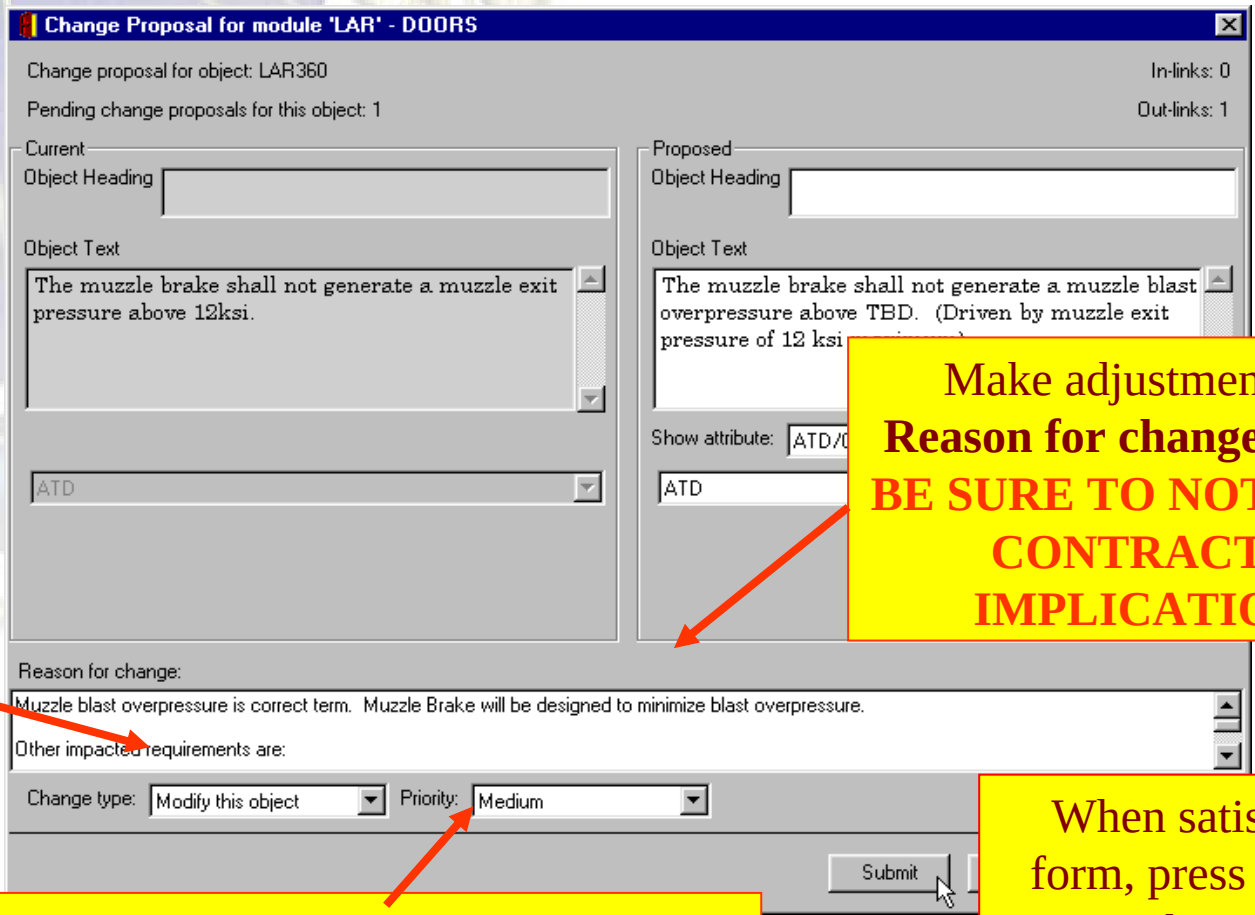


Impact Analysis Complete… Submit a Change Proposal



Submit Change Proposal

Fill out appropriate fields in the 'Proposed' half of the Change proposal Form. Remember to address any affected attributes.



Select Change Type

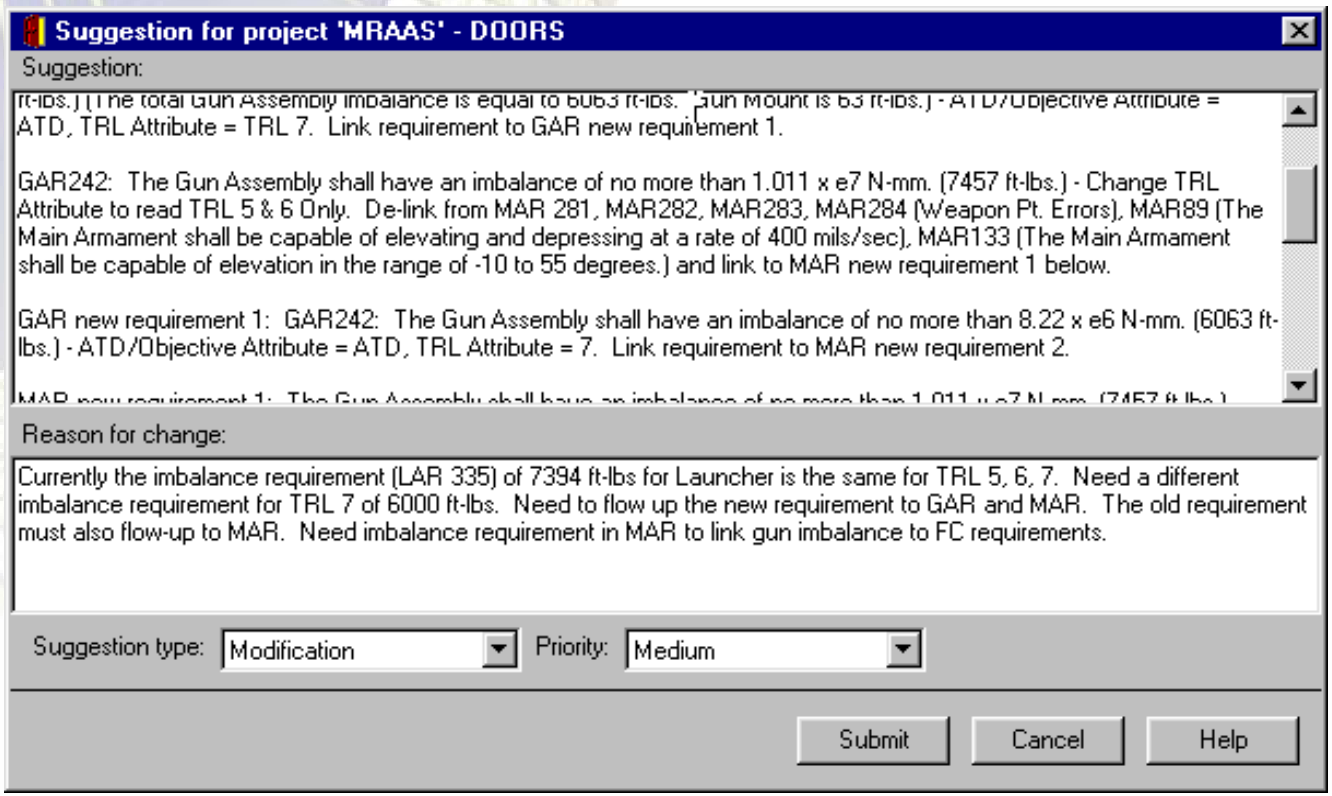
Make adjustments to the **Reason for change** as needed. **BE SURE TO NOTATE ANY CONTRACTUAL IMPLICATIONS!!!**

Select Very High, High, Medium or Low (refer to CPP Document for details)

When satisfied with form, press **Submit** to create the new Change proposal

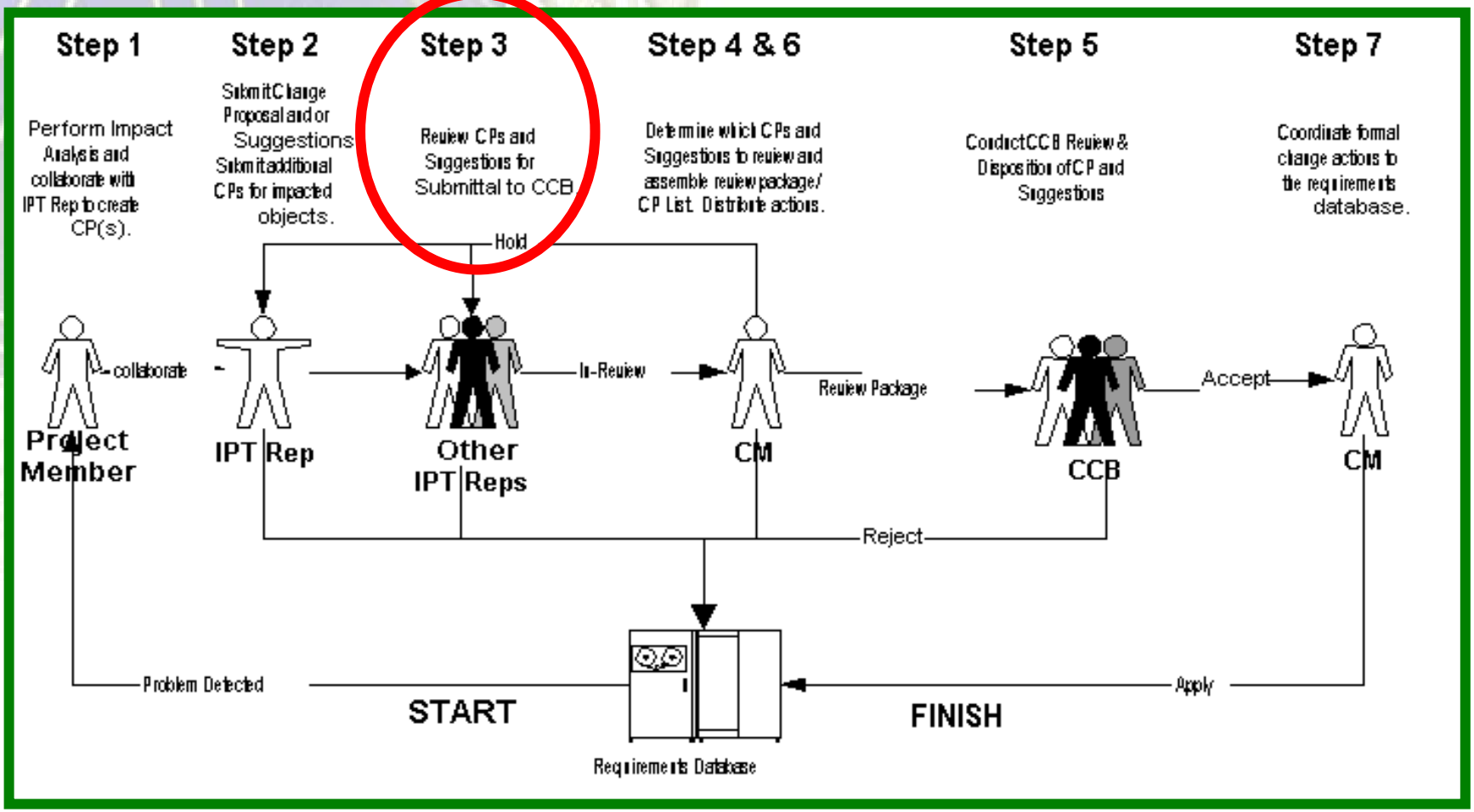
Submit Change Suggestion

When 5 or more actions need to occur (I.e., Change proposals) in order to fully satisfy a Change Proposal, a Change Suggestion should be created instead of a change proposal.

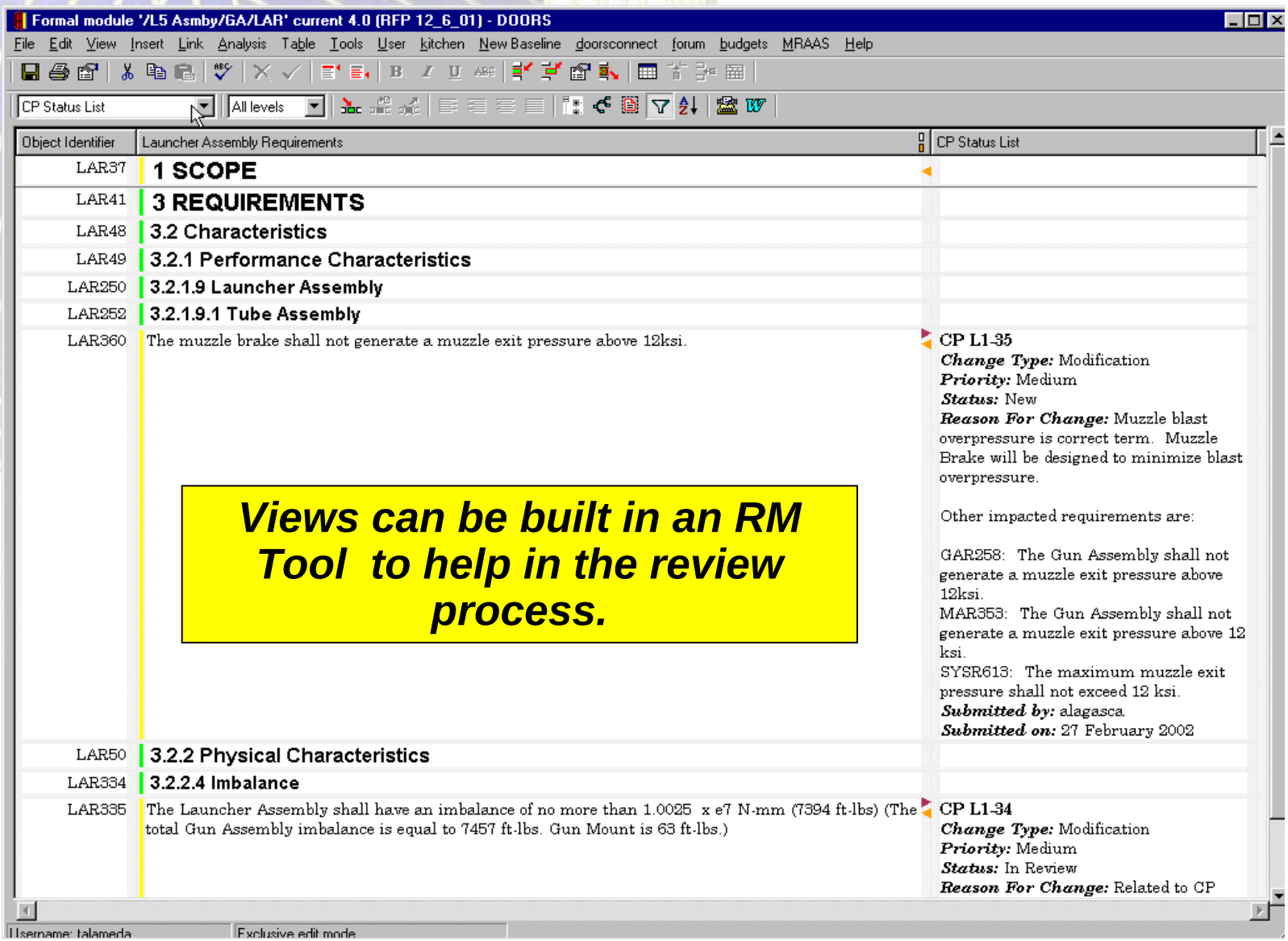


Fill out fields as needed and press **Submit** to create a new suggestion. The JCCB will approve and apply suggestions via the Change Proposal System.

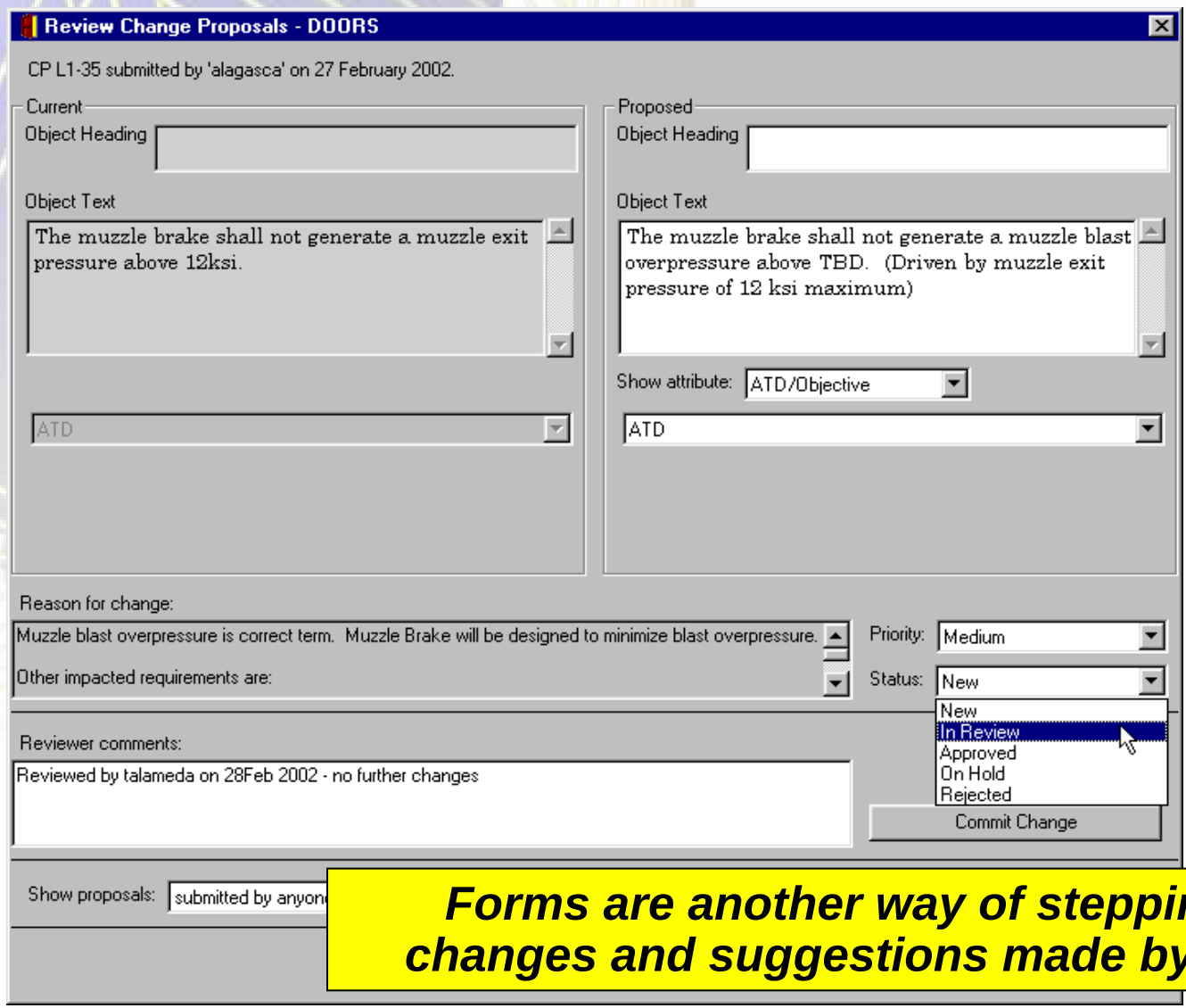
Review CP's and Suggestion



Predefined Views Can Help

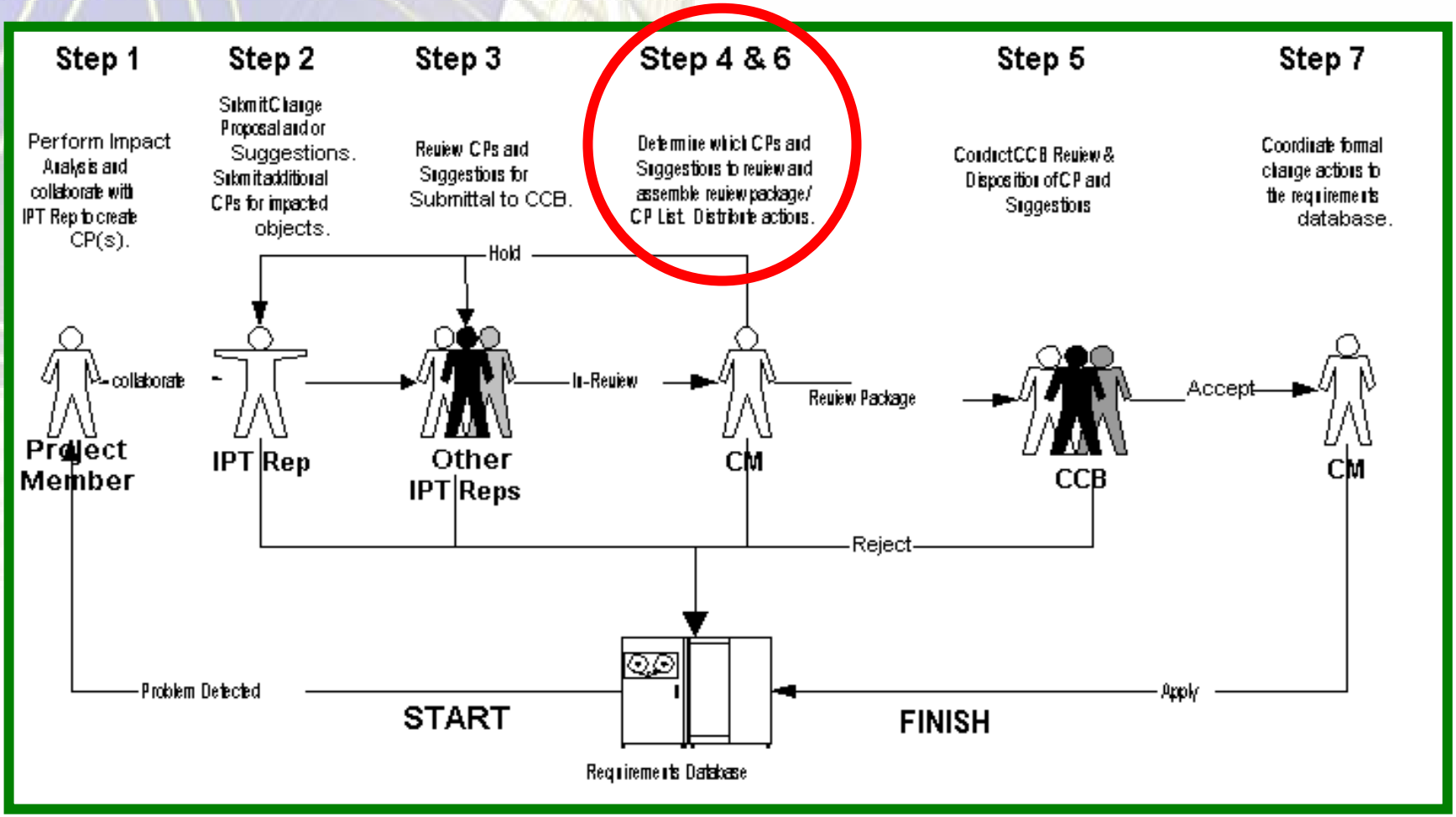


Forms Can Also Help

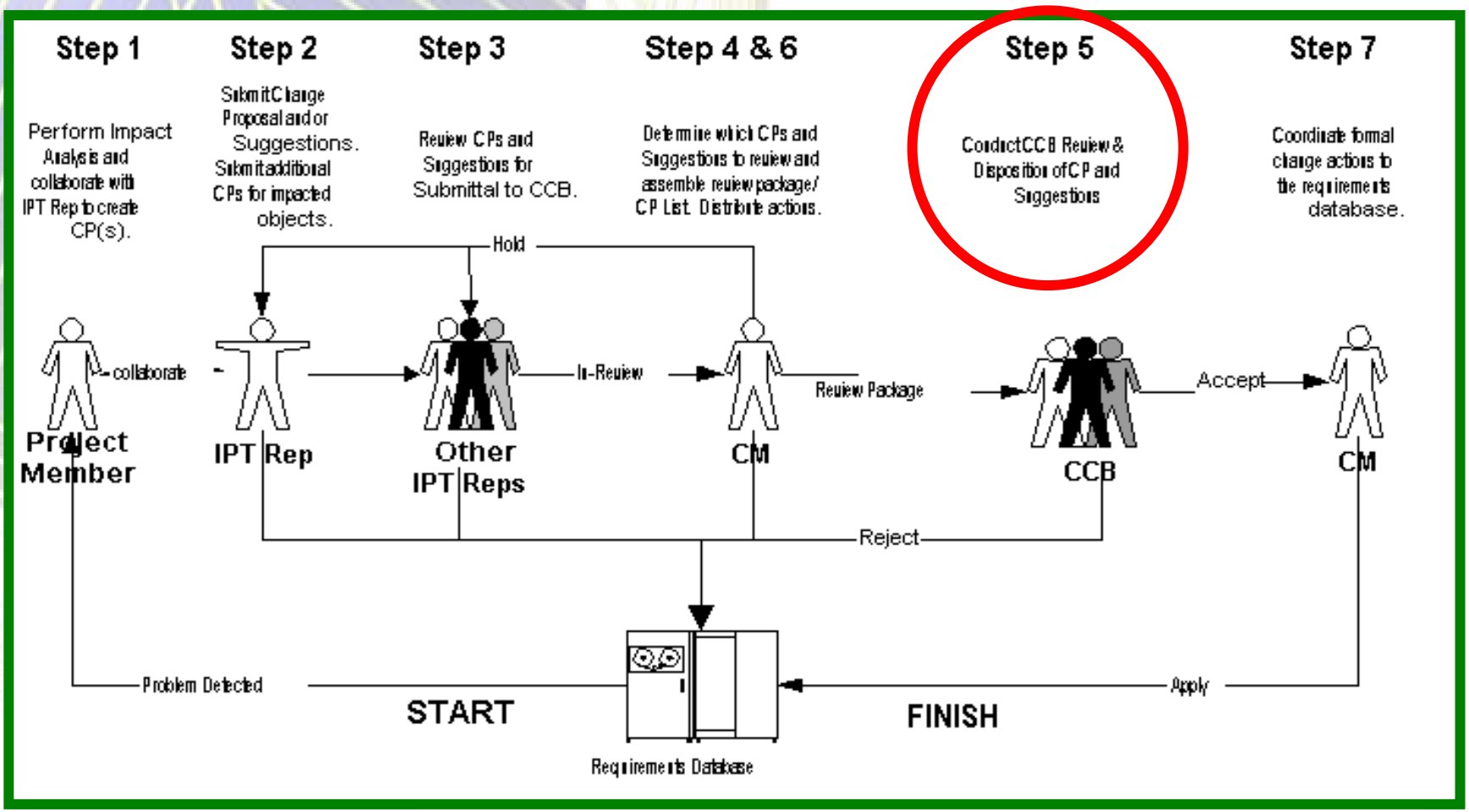


Forms are another way of stepping thru changes and suggestions made by the IPT.

ID CP's and Suggestions and Schedule JCCB



Perform JCCB and Update dB with Results.



Approved (ready for implementation)

On-Hold (further investigation needed)

Rejected (requested change discarded)

Reaching Consensus

Use IPT forum to Elicit Requirements.

- **Include Stakeholders Early and Often.**
- **Have Stakeholders Peer Review Requirements**
- **Document Rational. It will save you time latter when you will need to defend the requirements.**
- **Use a JCCB**
- **Try using QFD Method to Build Consensus**

Communicating Requirements

Use of DOORS has helped BUT!!

- **Culture shock is hard to overcome.**
- **Revert back to WORD and EXCEL documents.**
  - **Not so efficient and may introduce errors.**
- **May need to hold hands**
- **Provide Training and Tailor it to the project.**
- **Need to pay close attention to Permission and database administration details.**
- **JCCB has forced communication to happen and has made it mandatory.**
- **Will need good IT support to reach remote locations when using a tool.**

Requirements Metrics

Select metrics you will use.

Don’t try to many or they won’t be managed.

You can build them into an RM tool.

Some Examples Include:

- **Volatility**
- **# Requirements**
- **# TBD**
- **# Verified**

Using a tool will produce metrics naturally.

Requirements Attributes

Attributes are additional defined characteristics of a requirement and they provide essential information in addition to requirement text

Source	**Who specified this requirement?**
Priority	**What is the priority of this requirement?**
Verifiability	**Is the requirement verifiable?**
Accepted	**Has this requirement been accepted by the developers?**
Review	**Review status of this requirement**
Safety	**Is this a safety-critical requirement?**
Comments	**Any comments on the requirement to clarify its meaning**
Questions	**Any questions that must be clarified with the source**

You can define attributes that will support your process and make your database more productive for you

Summary

The use of an RM tool is an enabling technology to achieve greater accuracy and efficiency when engineering requirements.

There are definite skills and disciplines required to do requirements engineering

Not only will One need to understand how to:

- **Elicit Requirements**
- **Capture and Control Them**
- **Establish and maintain Traceability**
- **Reach Consensus**
- **Elicit Verification Methods**
- **Communicate Requirements**
- **Defined some Metrics and Attributes**

They will also need to be proficient in using and tailoring an RM Tool

Questions?