

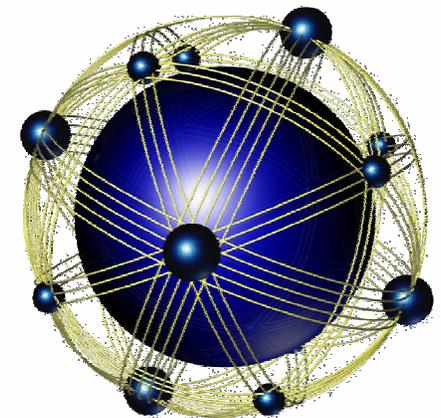
***NDIA 8<sup>th</sup> Annual Systems Engineering  
Conference***

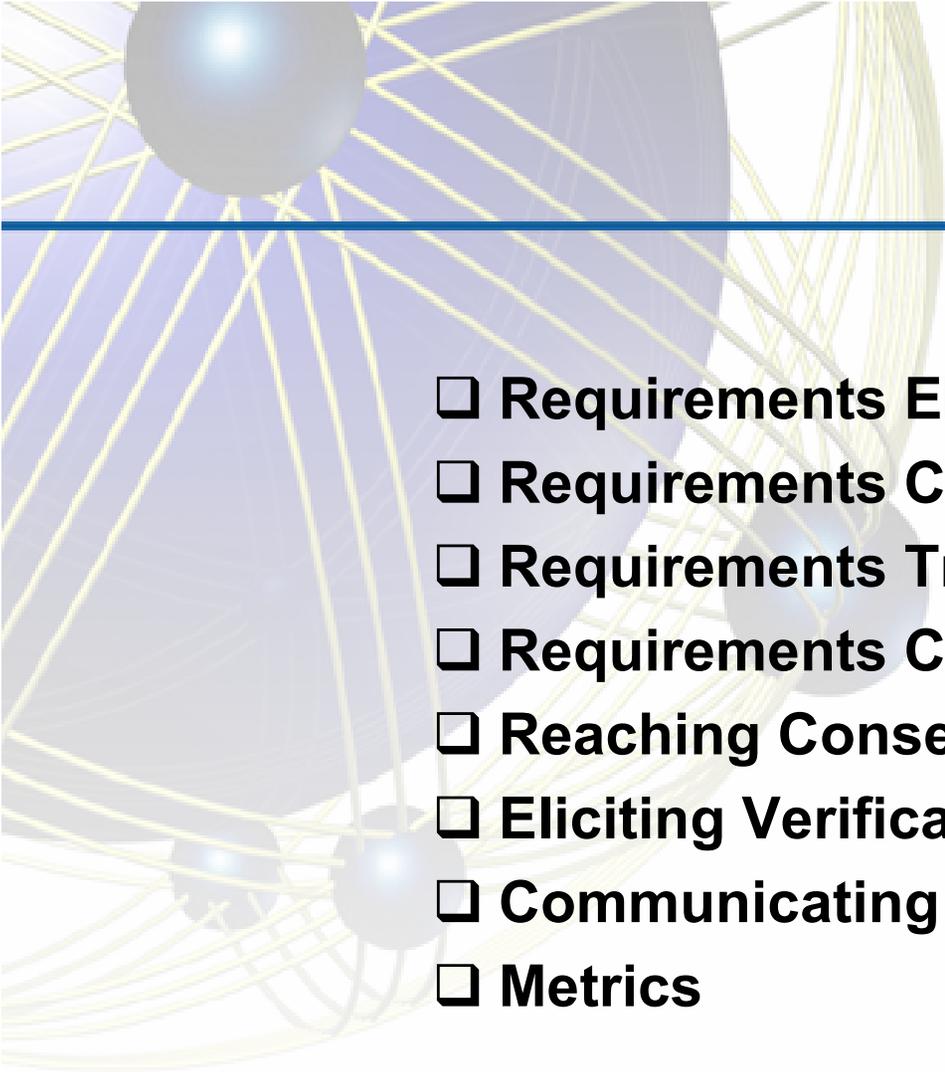
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***“Requirements Management Tips  
and Tricks”***

***October 27, 2005***

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





# ***Outline***

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- 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!*

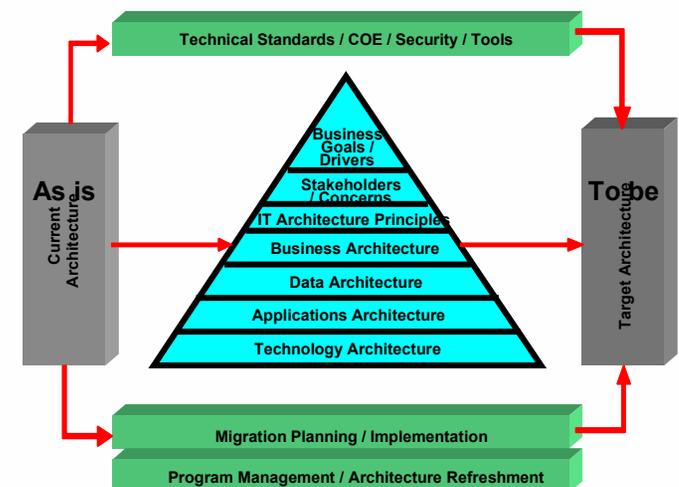
*Don't forget to Document Rational. It will save you time latter when you will need to defend the requirements.*

# Interview Based Elicitation

Using an Enterprise Architecture approach one can first probe into Business Goals and Architecture Principles by 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

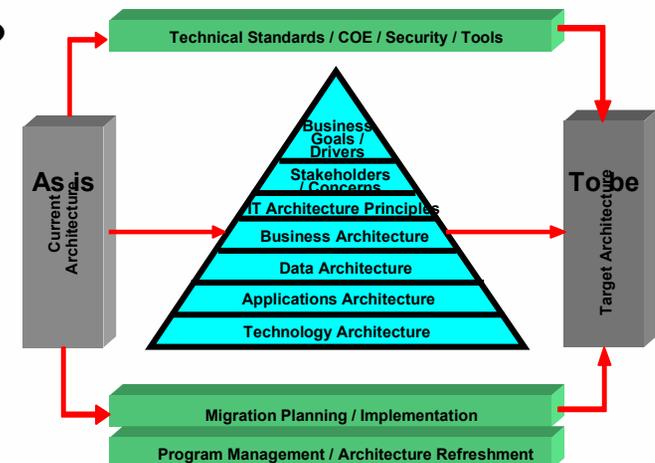
**Mostly used for Business Systems**



# Interview Based Elicitation

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

- What are the Projects/Products that PM Mortars 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?

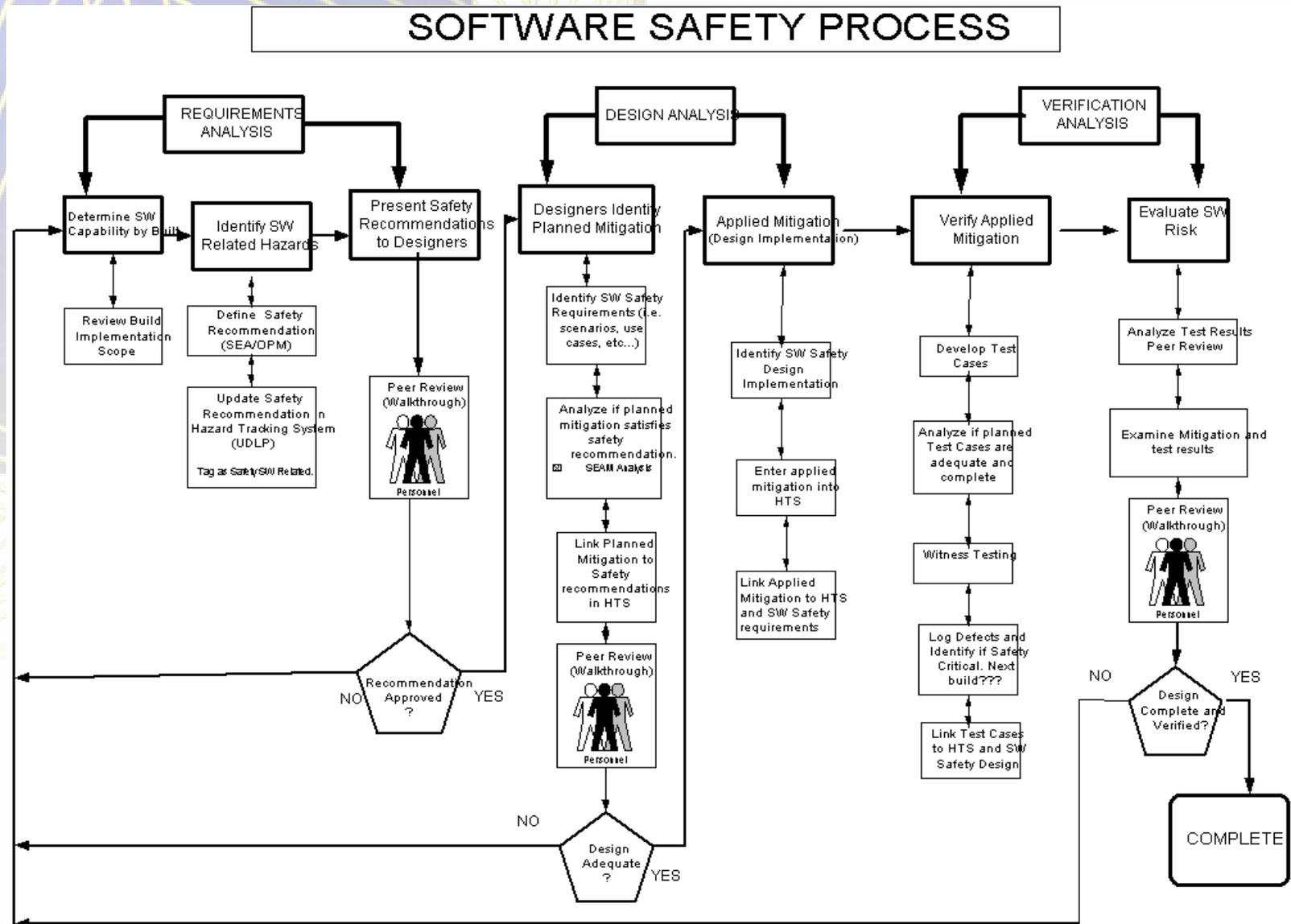


# QFD Based Elicitation

		Engineering Metrics													USER RATING												
		Engineering Measur 1	Engineering Measur 2	Engineering Measur 3	Engineering Measur 4	Engineering Measur 5	Engineering Measur 6	Engineering Measur 7	Engineering Measur 8	Engineering Measur 9	Engineering Measur 10	Engineering Measur 11	Customer Importance	Relative Importance	Absolute Score					Relative Score							
USER NEEDS	User Needs	Customer Need 1.0	9	9	0	0	0	9	9	9	0	0	9	5.00	26%	Concept A	3	5	1	3	2	Concept A	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%	Concept B	3	2	3	3	3	Concept B	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%	Concept C	3	5	5	3	4	Concept C	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%	Concept D	3	2	5	3	5	Concept D	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%	Concept E	3	1	5	3	4	Concept E	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														
	Weighted Score	Concept A	135	135	81	81	81	279	393	291	135	30	279	1920													
		Concept B	180	135	54	108	81	465	393	194	45	30	279	1964													
		Concept C	180	135	81	108	135	372	131	194	180	30	186	1732													
		Concept D	135	135	81	81	81	279	393	291	135	30	279	1920													
		Concept E	90	225	81	108	135	465	655	388	135	30	372	2684													
RISK	Technical																										
Schedule																											
Cost																											

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***

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**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**

Diagram: Interface Definition

TRL:  TRL5  
 TRL6  
 TRL7

IPT Name: Ammo Handling  
Module Name: AHR

Revision: 3.1.2.0-1

Requirements: 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~~~

Responsibility:

- Analysis
- Inspection
- Measurement
- Test
- N/A

(e.g.: IPT Name, Subcontractor, System Integrator)

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:

~~~Please Select a Method~~~

[Empty text box for verification procedure]

Data Collected:

[Empty text box for data collected]

Clear

Reset

**RL 6** Verification Method:

~~~Please Select a Method~~~

Responsibility:

[Empty text box]

(e.g.: IPT Name, Subcontractor, System Integrator)

Critical Test:

Location of Verif:

[Empty text box]

(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:

[Empty text box for verification procedure]

Data Collected:

[Empty text box for data collected]

Clear

Reset

**RL 7** Verification Method:

~~~Please Select a Method~~~

|< << >> >|

Record [ ] of [ ]

Exit

# ***Requirements Capture and Management***

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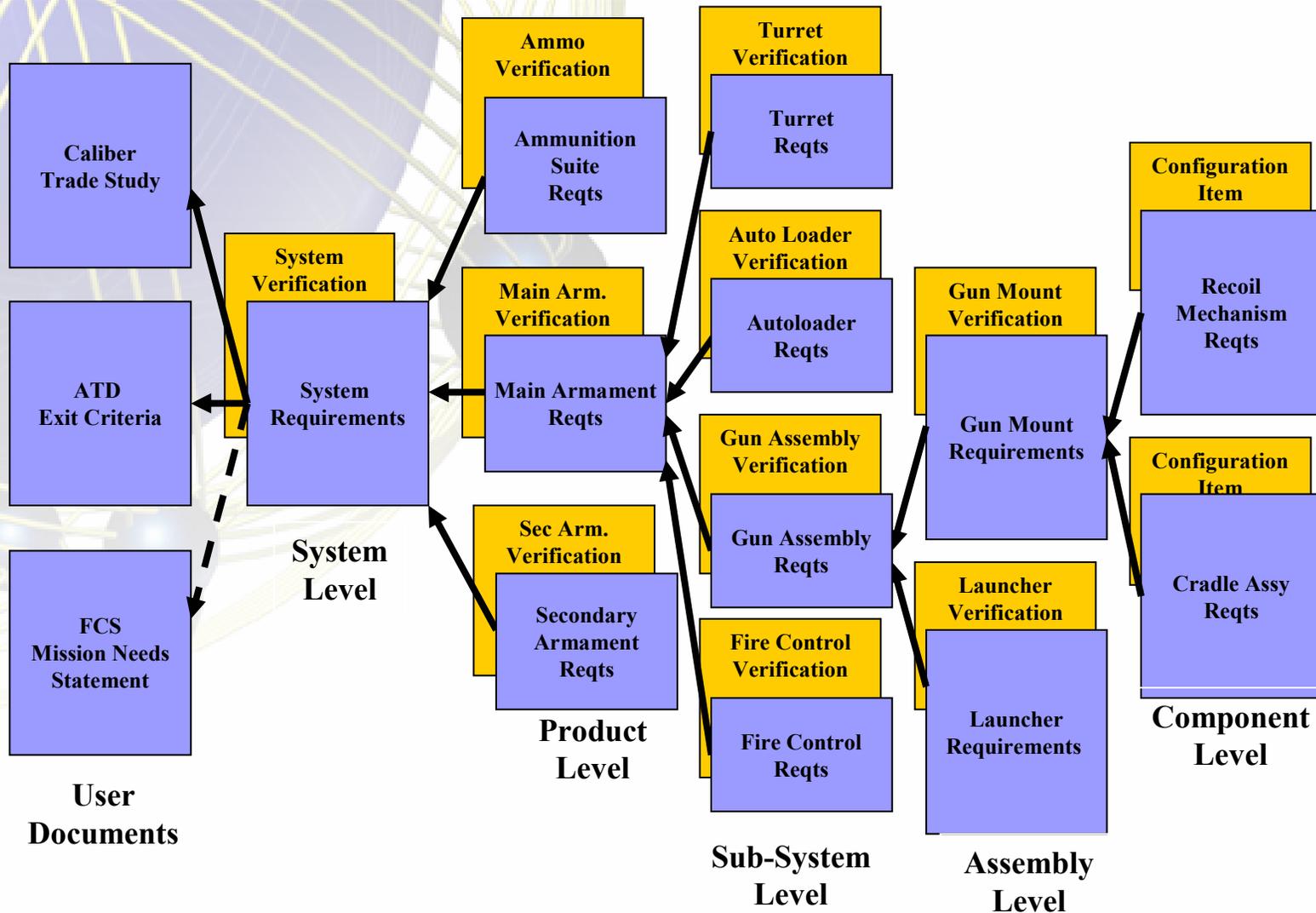
**How and where do you store the requirements?**

**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....**

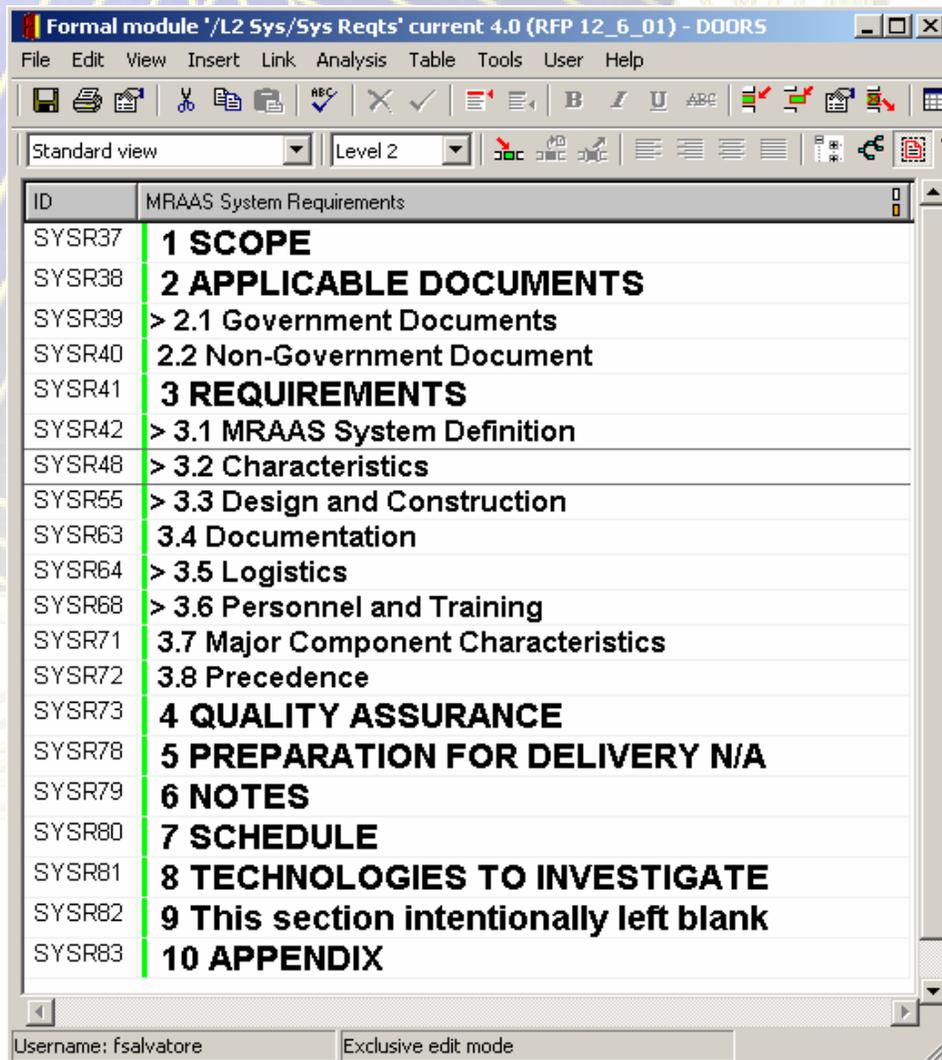
***Use Document Templates Based On Standards. Also IM is Important for Efficiency.***

# Requirements Management Specification Hierarchy



**Follows IEEE Commercial Standards**

# Document Outline is Standard Throughout Project.



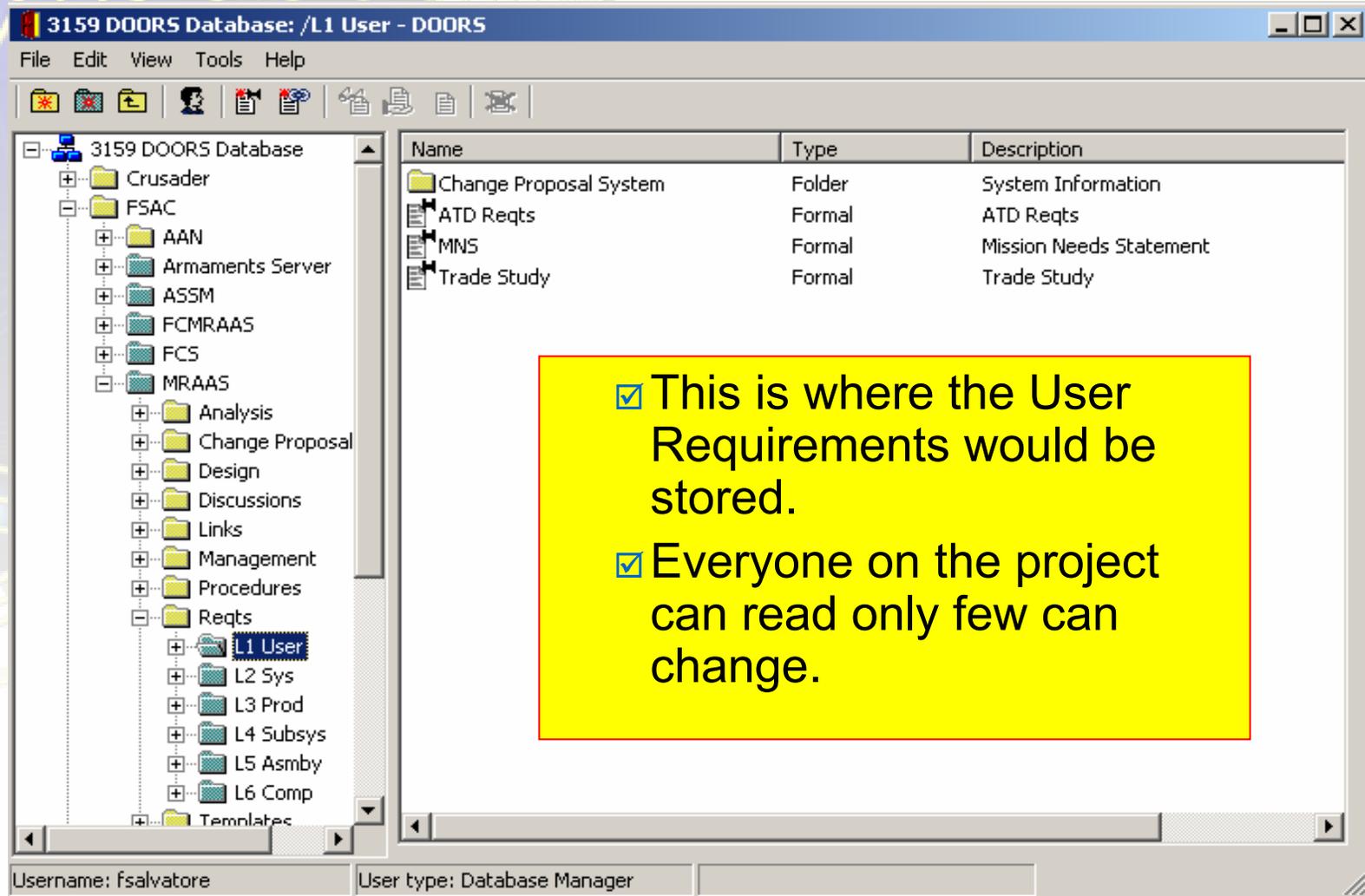
The screenshot shows a software application window titled 'Formal module '/L2 Sys/Sys Reqts' current 4.0 (RFP 12\_6\_01) - DOORS'. The window displays a document outline for 'MRAAS System Requirements' with the following structure:

| ID     | Content  |
|--------|--|
| SYSR37 | <b>1 SCOPE</b>                                 |
| SYSR38 | <b>2 APPLICABLE DOCUMENTS</b>                  |
| SYSR39 | > 2.1 Government Documents                     |
| SYSR40 | > 2.2 Non-Government Document                  |
| SYSR41 | <b>3 REQUIREMENTS</b>                          |
| SYSR42 | > 3.1 MRAAS System Definition                  |
| SYSR48 | > 3.2 Characteristics                          |
| SYSR55 | > 3.3 Design and Construction                  |
| SYSR63 | <b>3.4 Documentation</b>                       |
| SYSR64 | > 3.5 Logistics                                |
| SYSR68 | > 3.6 Personnel and Training                   |
| SYSR71 | <b>3.7 Major Component Characteristics</b>     |
| SYSR72 | <b>3.8 Precedence</b>                          |
| SYSR73 | <b>4 QUALITY ASSURANCE</b>                     |
| SYSR78 | <b>5 PREPARATION FOR DELIVERY N/A</b>          |
| SYSR79 | <b>6 NOTES</b>                                 |
| SYSR80 | <b>7 SCHEDULE</b>                              |
| SYSR81 | <b>8 TECHNOLOGIES TO INVESTIGATE</b>           |
| SYSR82 | <b>9 This section intentionally left blank</b> |
| SYSR83 | <b>10 APPENDIX</b>                             |

At the bottom of the window, the status bar shows 'Username: fsalvatore' and 'Exclusive edit mode'.

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

# Level 1 User Requirements



The screenshot shows the 3159 DOORS Database interface. The left pane displays a tree view of the database structure, with the 'L1 User' folder selected under the 'Reqts' folder. The right pane displays a table of requirements.

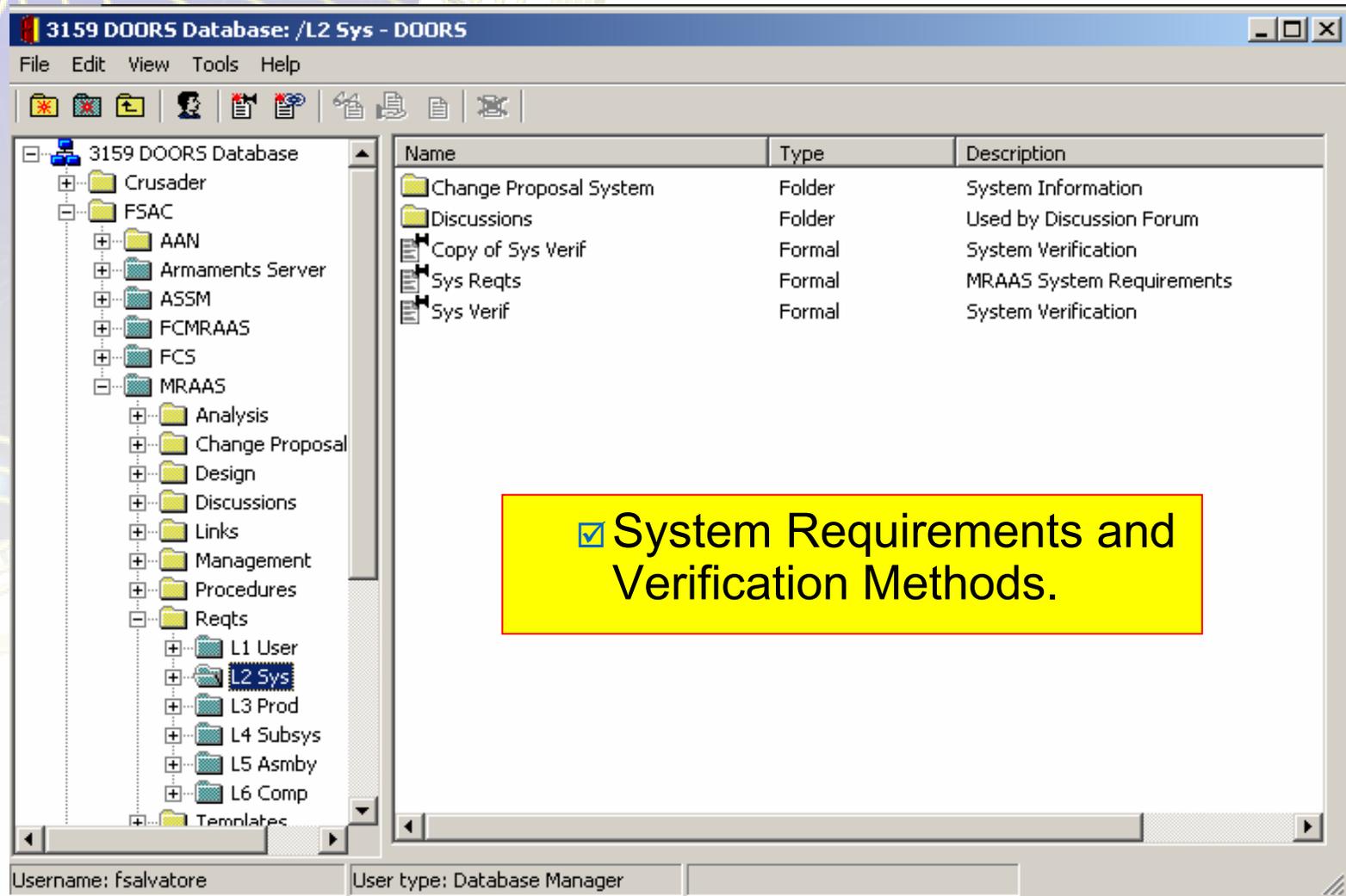
| Name                   | Type   | Description             |
|------------------------|--------|-------------------------|
| Change Proposal System | Folder | System Information      |
| ATD Reqts              | Formal | ATD Reqts               |
| MNS                    | Formal | Mission Needs Statement |
| Trade Study            | Formal | Trade Study             |

Username: fsalvatore      User type: Database Manager

This is where the User Requirements would be stored.

Everyone on the project can read only few can change.

# Level 2 System Requirements



The screenshot shows the 3159 DOORS Database interface. The left pane displays a tree view of the database structure, with the 'L2 Sys' folder under 'MRAAS' selected. The right pane shows a table of the contents of the 'L2 Sys' folder.

| Name                   | Type   | Description               |
|------------------------|--------|---------------------------|
| Change Proposal System | Folder | System Information        |
| Discussions            | Folder | Used by Discussion Forum  |
| Copy of Sys Verif      | Formal | System Verification       |
| Sys Reqts              | Formal | MRAAS System Requirements |
| Sys Verif              | Formal | System Verification       |

System Requirements and Verification Methods.

Username: fsalvatore      User type: Database Manager

# Level 3 Product Requirements

The screenshot shows the '3159 DOORS Database: /L3 Prod - DOORS' application window. The left pane displays a hierarchical tree view of the database structure, with 'L3 Prod' selected under the 'Reqt's' folder. The right pane displays a table of requirements.

| Name                   | Type   | Description                      |
|------------------------|--------|----------------------------------|
| Change Proposal System | Folder | System Information               |
| Discussions            | Folder | Used by Discussion Forum         |
| ASR                    | Formal | Ammo Suite Requirements          |
| ASV                    | Formal | Ammo Suite Verification          |
| MAR                    | Formal | Main Armaments Requirements      |
| MAV                    | Formal | Main Armament Verification       |
| SAR                    | Formal | Secondary Armaments Requirements |
| SAV                    | Formal | Secondary Armament Verification  |

Username: fsalvatore      User type: Database Manager

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

# Level 4-6 Subassembly to Component Requirements

The screenshot shows the '3159 DOORS Database: /AS - DOORS' application window. The left pane displays a tree view of the database structure, including folders like FSAC, AAN, Armaments Server, ASSM, FCMRAAS, FCS, MRAAS, and various subfolders under 'Reqts'. The right pane shows a table of requirements with columns for Name, Type, and Description.

| Name                   | Type   | Description                      |
|------------------------|--------|----------------------------------|
| Change Proposal System | Folder | System Information               |
| AKR                    | Formal | Adv KE Reqts                     |
| AKV                    | Formal | Adv KE Verification              |
| PR                     | Formal | Propulsion Assembly Requirements |
| PV                     | Formal | Propulsion Verification          |
| SSR                    | Formal | Smart Suite Reqts                |
| SSV                    | Formal | Smart Suite Verification         |
| WHR                    | Formal | Warhead Reqts                    |
| WHV                    | Formal | Warhead Verification             |

Username: fsalvatore      User type: Database Manager

**Key Points:**

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

# ***Requirements Traceability***

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**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***

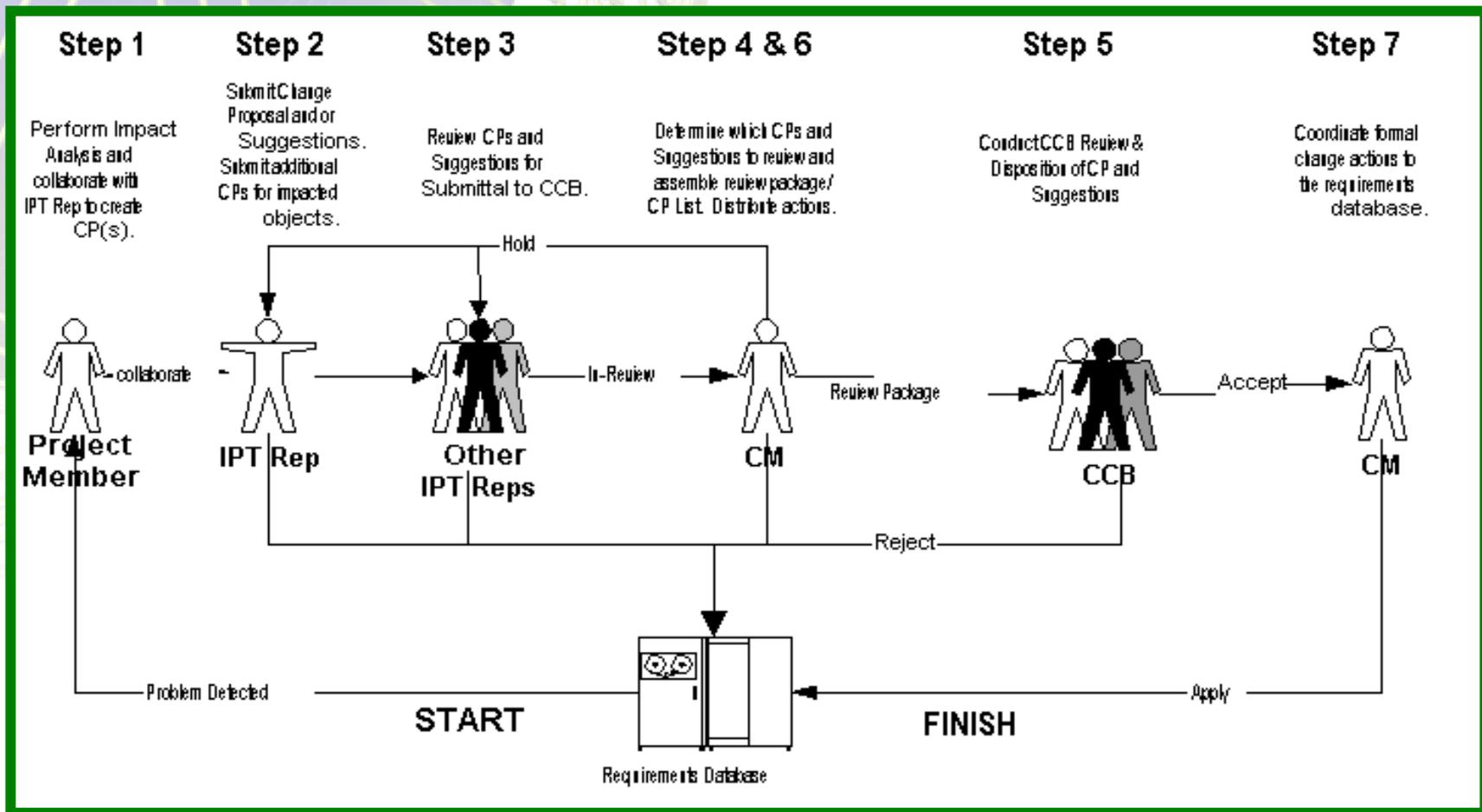
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**If a Requirement is changed, how do we determine effects on other Requirements, Verifications or Schedule Events?**

- 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**

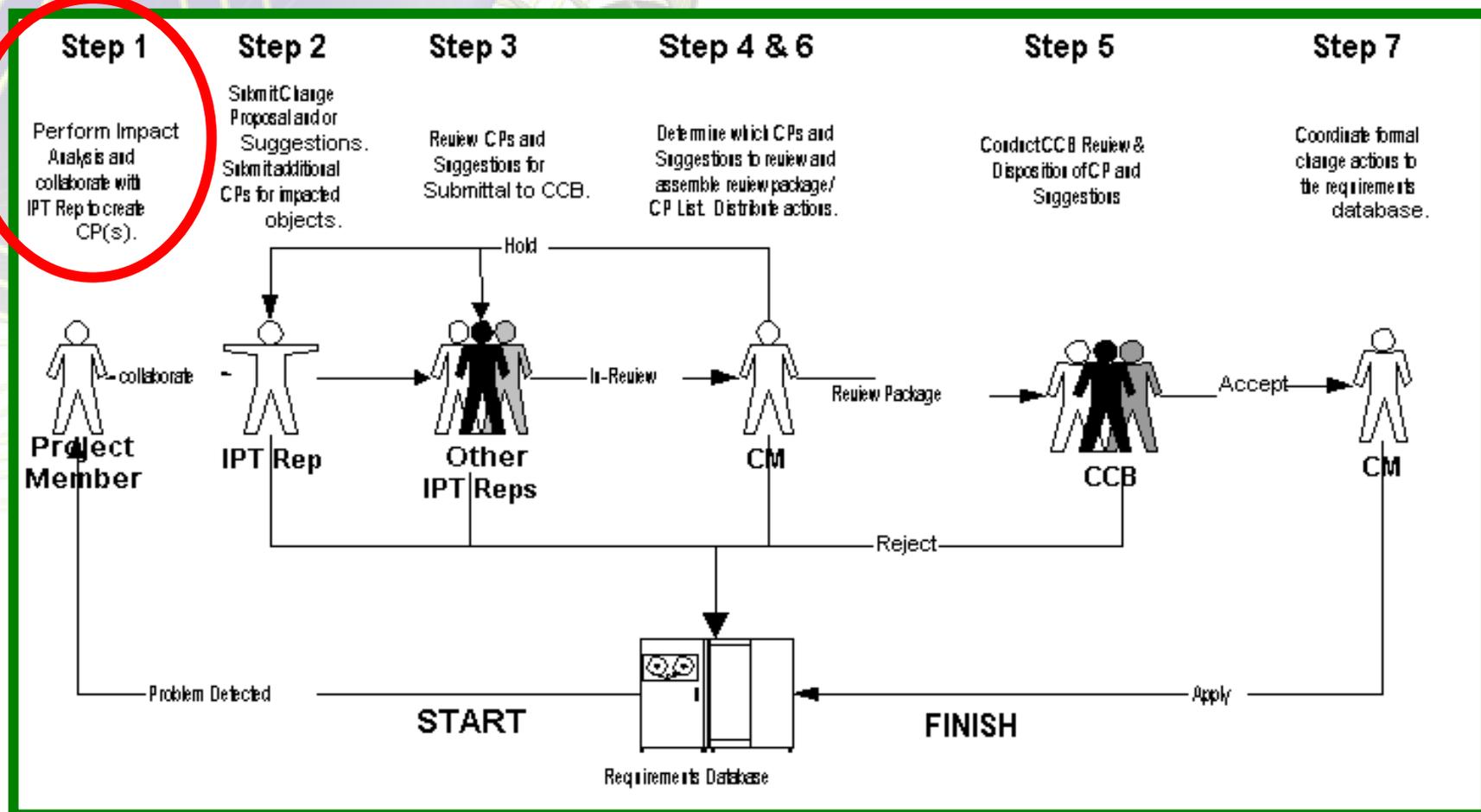
**If you choose to PURSUE the potential change:**

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

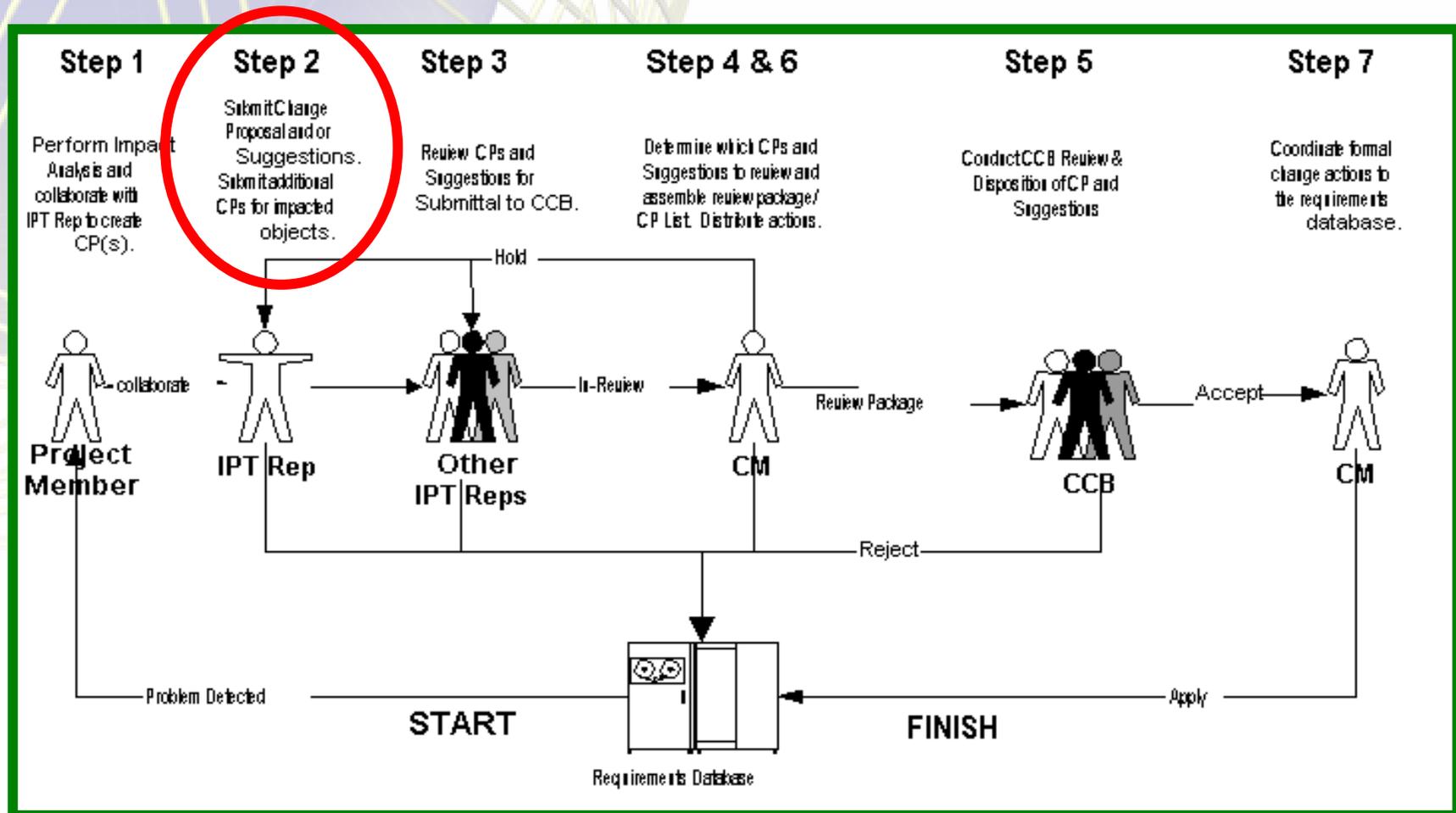
**COMMUNICATE !!!**

# 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.

Change Proposal for module 'LAR' - DOORS

Change proposal for object: LAR360 In-links: 0  
Pending change proposals for this object: 1 Out-links: 1

Current

Object Heading

Object Text

The muzzle brake shall not generate a muzzle exit pressure above 12ksi.

Proposed

Object Heading

Object Text

The muzzle brake shall not generate a muzzle blast overpressure above TBD. (Driven by muzzle exit pressure of 12 ksi)

Show attribute: ATD/0

ATD

Reason for change:

Muzzle blast overpressure is correct term. Muzzle Brake will be designed to minimize blast overpressure.

Other impacted requirements are:

Change type:  Priority:

Submit

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.

**Suggestion for project 'MRAAS' - DOORS**

Suggestion:

[r-ibs.] [The total Gun Assembly imbalance is equal to 6063 r-ibs. [Gun Mount is 63 r-ibs.] - ATD/Objective Attribute = ATD, TRL Attribute = TRL 7. Link requirement to GAR new requirement 1.

GAR242: The Gun Assembly shall have an imbalance of no more than 1.011 x e7 N-mm. (7457 ft-lbs.) - Change TRL Attribute to read TRL 5 & 6 Only. De-link from MAR 281, MAR282, MAR283, MAR284 (Weapon Pt. Errors), MAR89 (The Main Armament shall be capable of elevating and depressing at a rate of 400 mils/sec), MAR133 (The Main Armament shall be capable of elevation in the range of -10 to 55 degrees.) and link to MAR new requirement 1 below.

GAR new requirement 1: GAR242: The Gun Assembly shall have an imbalance of no more than 8.22 x e6 N-mm. (6063 ft-lbs.) - ATD/Objective Attribute = ATD, TRL Attribute = 7. Link requirement to MAR new requirement 2.

MAR new requirement 1: The Gun Assembly shall have an imbalance of no more than 1.011 x e7 N-mm. (7457 ft-lbs.)

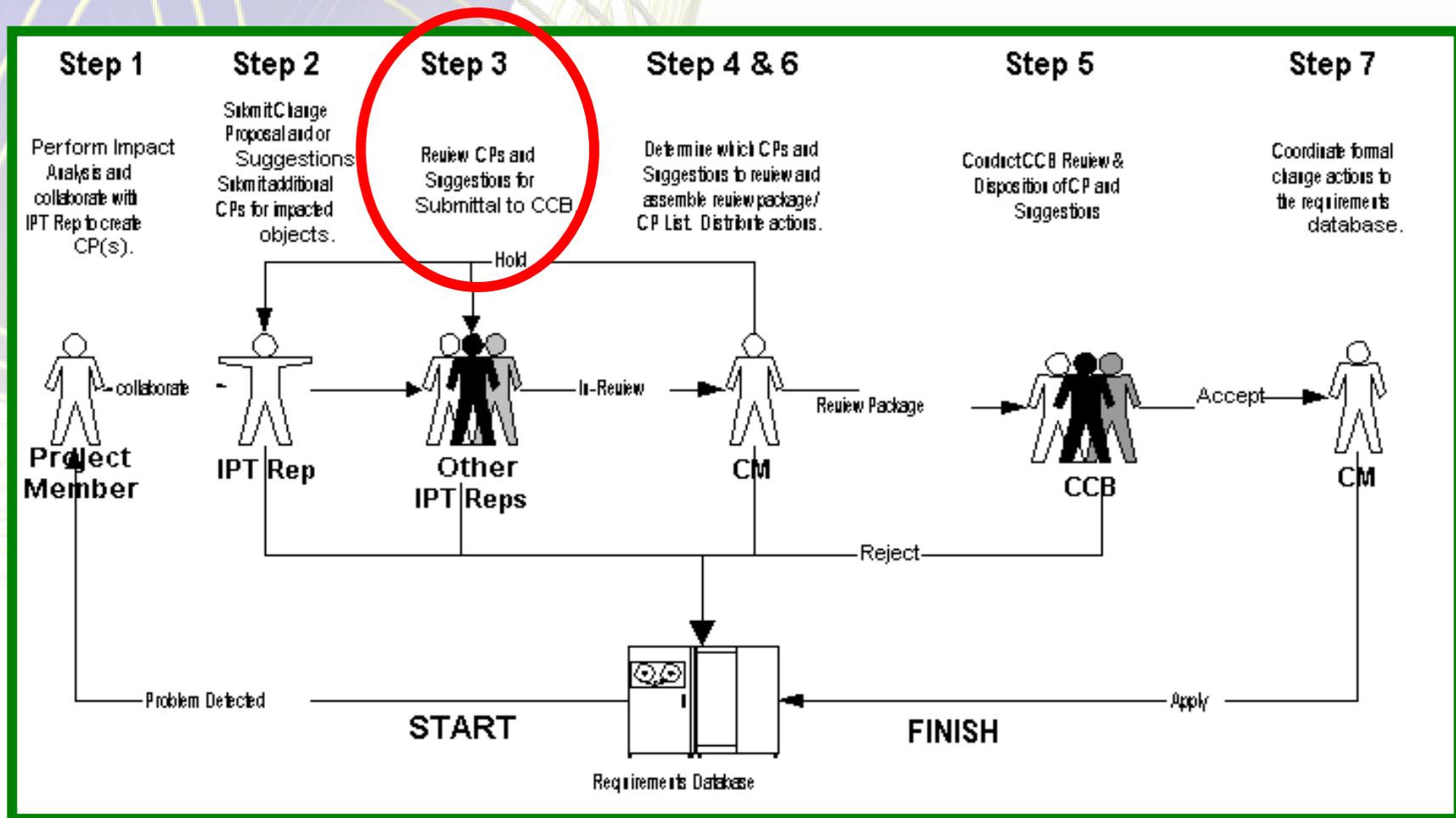
Reason for change:

Currently the imbalance requirement (LAR 335) of 7394 ft-lbs for Launcher is the same for TRL 5, 6, 7. Need a different imbalance requirement for TRL 7 of 6000 ft-lbs. Need to flow up the new requirement to GAR and MAR. The old requirement must also flow-up to MAR. Need imbalance requirement in MAR to link gun imbalance to FC requirements.

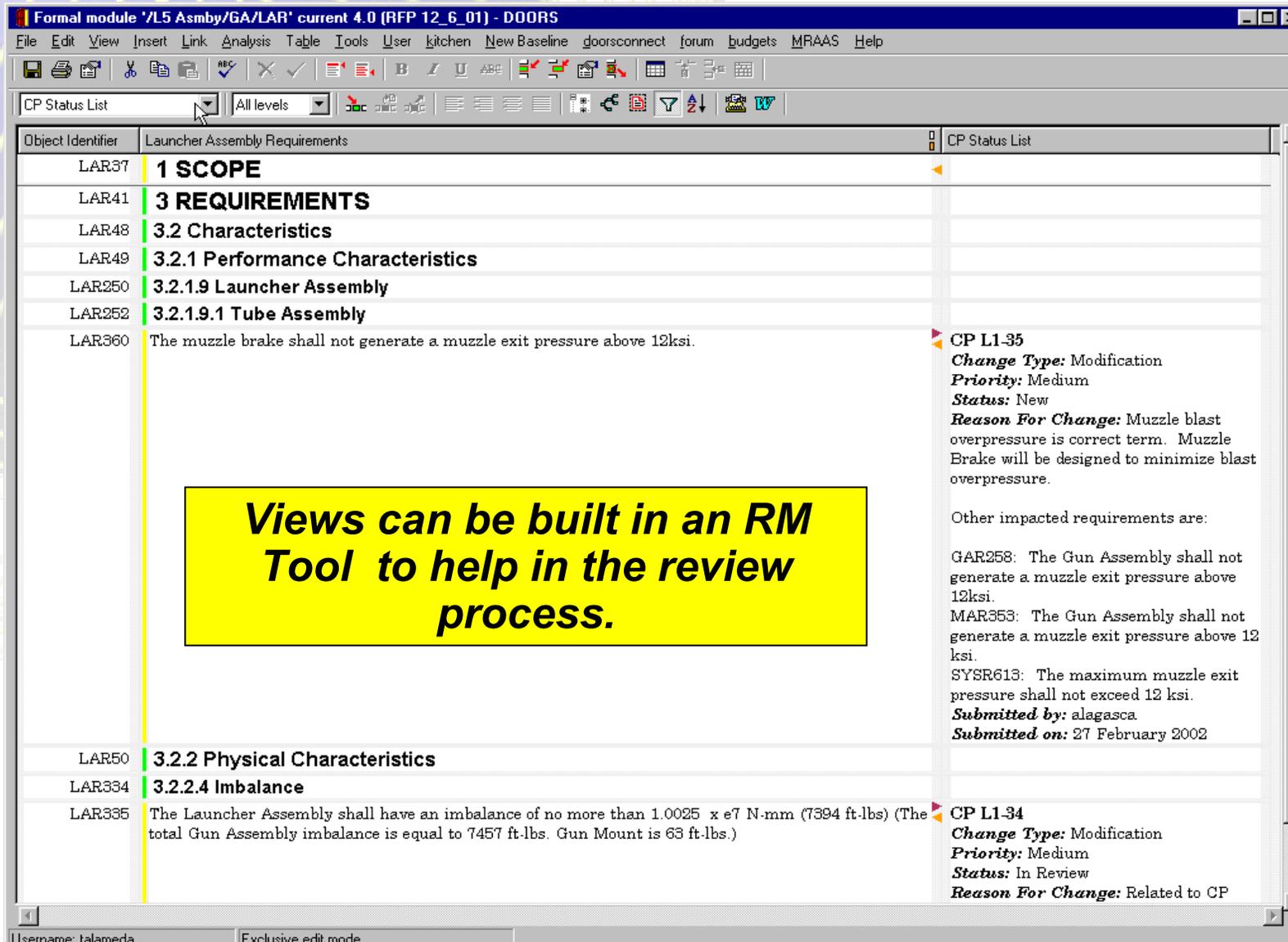
Suggestion type:  Priority:

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



The screenshot displays a software window titled "Formal module 'L5 Asmby/GA/LAR' current 4.0 (RFP 12\_6\_01) - DOORS". The interface includes a menu bar (File, Edit, View, Insert, Link, Analysis, Table, Tools, User, kitchen, New Baseline, doorsconnect, forum, budgets, MRAAS, Help) and a toolbar with various icons. A "CP Status List" window is open, showing a table of requirements and change proposals.

| Object Identifier | Launcher Assembly Requirements  | CP Status List  |
|-------------------|---|---|
| LAR37             | <b>1 SCOPE</b>  |   |
| LAR41             | <b>3 REQUIREMENTS</b>   |   |
| LAR48             | <b>3.2 Characteristics</b>  |   |
| LAR49             | <b>3.2.1 Performance Characteristics</b>  |   |
| LAR250            | <b>3.2.1.9 Launcher Assembly</b>  |   |
| LAR252            | <b>3.2.1.9.1 Tube Assembly</b>  |   |
| LAR360            | The muzzle brake shall not generate a muzzle exit pressure above 12ksi.   | <b>CP L1-35</b><br><b>Change Type:</b> Modification<br><b>Priority:</b> Medium<br><b>Status:</b> New<br><b>Reason For Change:</b> Muzzle blast overpressure is correct term. Muzzle Brake will be designed to minimize blast overpressure.<br><br>Other impacted requirements are:<br><br>GAR258: The Gun Assembly shall not generate a muzzle exit pressure above 12ksi.<br>MAR353: The Gun Assembly shall not generate a muzzle exit pressure above 12 ksi.<br>SYSR613: The maximum muzzle exit pressure shall not exceed 12 ksi.<br><b>Submitted by:</b> alagasca<br><b>Submitted on:</b> 27 February 2002 |
| LAR50             | <b>3.2.2 Physical Characteristics</b>   |   |
| LAR334            | <b>3.2.2.4 Imbalance</b>  |   |
| LAR335            | The Launcher Assembly shall have an imbalance of no more than $1.0025 \times e7$ N-mm (7394 ft-lbs) (The total Gun Assembly imbalance is equal to 7457 ft-lbs. Gun Mount is 63 ft-lbs.) | <b>CP L1-34</b><br><b>Change Type:</b> Modification<br><b>Priority:</b> Medium<br><b>Status:</b> In Review<br><b>Reason For Change:</b> Related to CP   |

Views can be built in an RM Tool to help in the review process.

Username: talameda | Exclusive edit mode

# Forms Can Also Help

**Review Change Proposals - DOORS**

CP L1-35 submitted by 'alagasca' on 27 February 2002.

**Current**

Object Heading:

Object Text:

Show attribute:

**Proposed**

Object Heading:

Object Text:

Show attribute:

Reason for change:

Priority:

Status:

Reviewer comments:

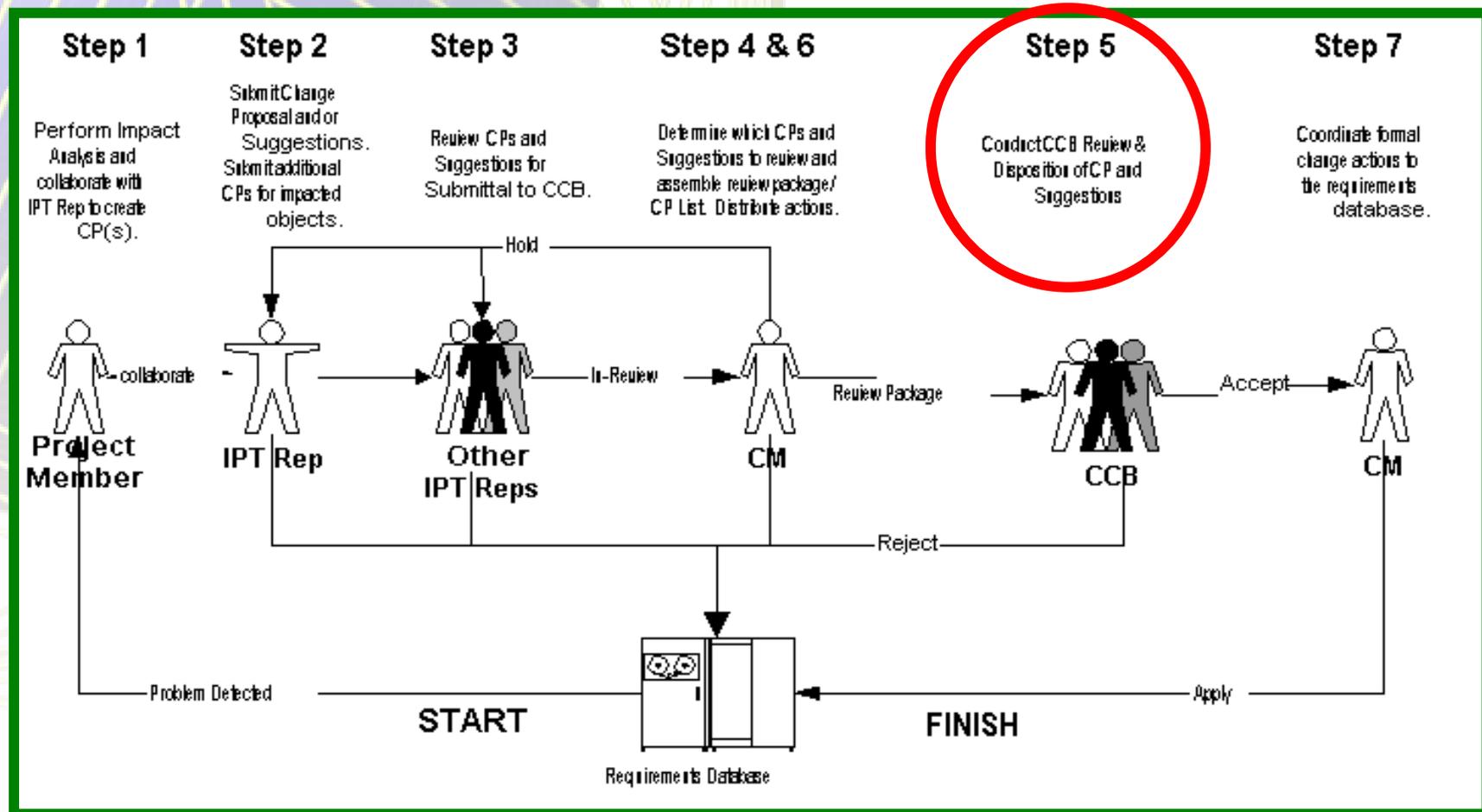
Commit Change

Show proposals:

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



# 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

|                      |  |
|----------------------|--|
| <b>Source</b>        | Who specified this requirement?                        |
| <b>Priority</b>      | What is the priority of this requirement?              |
| <b>Verifiability</b> | Is the requirement verifiable?                         |
| <b>Accepted</b>      | Has this requirement been accepted by the developers?  |
| <b>Review</b>        | Review status of this requirement                      |
| <b>Safety</b>        | Is this a safety-critical requirement?                 |
| <b>Comments</b>      | Any comments on the requirement to clarify its meaning |
| <b>Questions</b>     | 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***

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**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?**