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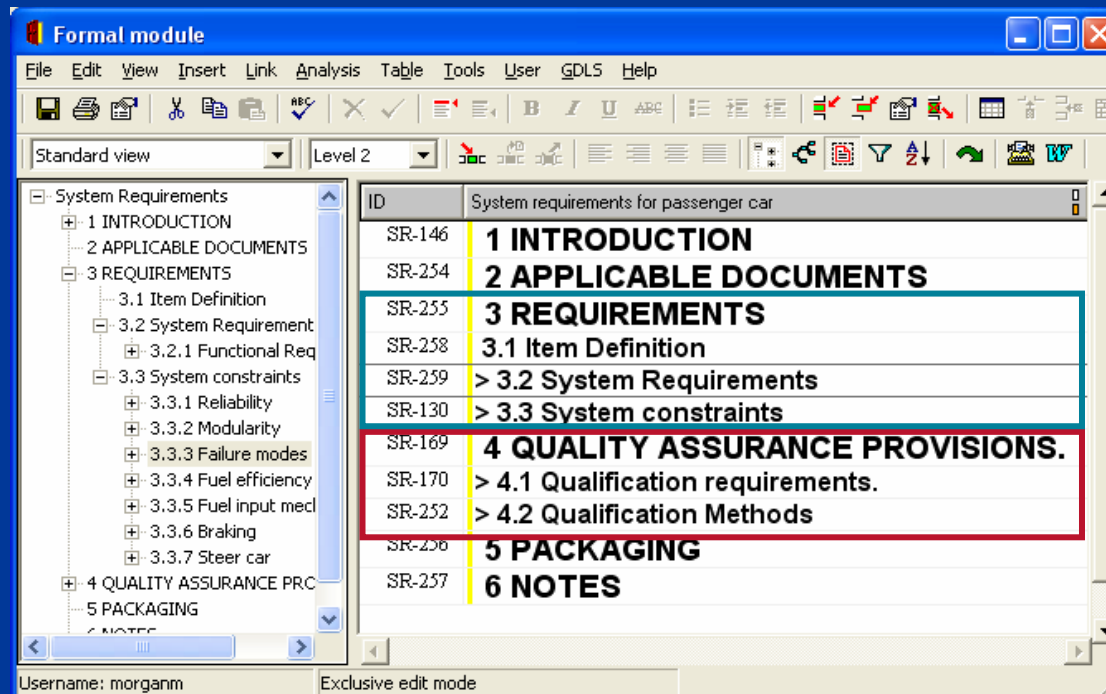## Land Systems

Automatic generation of Requirement Specifications (Verification Section) – in DOORS

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Feb 08, 2008

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Requirement Specifications

- Department of Defense requirement specifications are primarily composed of six sections (per MIL-STD-961D), including one for Requirements (Section 3) and another for Quality Assurance Provisions (aka Verification) (Section 4).

Verification Section (4.0)

- The Verification Section is composed of:

Verification Section – VCRI Matrix Template

- Within this table, the outline for Section 3 is repeated in "Section 3 Par."
- "Section 4 Par" (Qualification Methods) paragraph numbering is very similar, usually only replacing the "3." with "4.".

Verification Legend	Method					
	N/A	Not Applicable				
	A	Analysis				
	I	Inspection				
	D	Demonstration				
	T	Test				

		Method					
Section 3 Par	Requirement Title	N/A	A	I	D	T	Section 4 par

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Verification Section – Verification Methods

- Each object is covered by a plan for testing the requirement
- It may be written with a "Shall" as a test requirement.
- Structure of this section follows structure for Requirement Section (3.0)
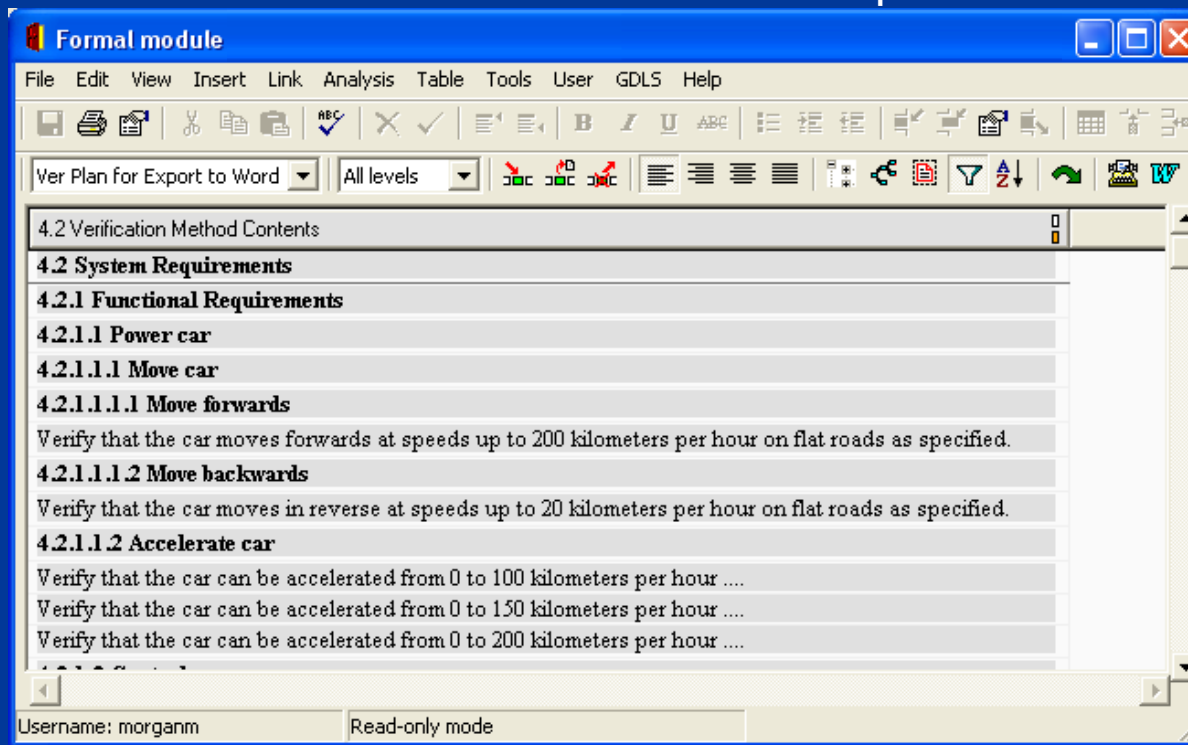
The Problem

- In the past, these documents were generated manually, initially using typewriters and more recently word-processor software.

  - ➤ Creating and maintaining the VCRI matrix using available table functions can be very cumbersome.

  - ➤ Since the VCRI table and the Verification Method section are both organized to match the structure of Section 3, their contents will be affected by any changes in structure to the requirements.

  - ➤ Some Engineers claim that the requirements and section structure are stable once populating Section 4. However, the maintenance is still required and can be very tedious when changes do occur.

  - ➤ Even when using a requirements management tool like DOORS®, a user may be tempted to directly populate their VCRI and Verification Method sections directly in Section 4.

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DOORS For Specifications

- Many corporations now require requirements to be captured into some kind of database, which allows the capability to show traceability to customer requirements.

- Our company has chosen Telelogic's DOORS®, which also allows requirements to be organized to resemble the document being published.

- The skeleton for the document is organized per specific document standards and generally a template module is created to contain the basic structure and a standardized set of attributes and views to the data.

- The template is then used for creating new modules.

Key Verification Attributes

- The "Verification Method" attribute has enumerated values to allow the user to indicate how a requirement would be verified. These values may include:
  - ➤ N/A (used for non-requirement objects, including headers)
  - ➤ Analysis
  - ➤ Inspection
  - ➤ Demonstration
  - ➤ Test
- If the attribute is set up as a multi-pick, the user should make the best single pick (there may be certain situations where two values are appropriate, but this is the exception).

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Key Verification Attributes – Cont'd

- The "Verification Plan" attribute is intended to contain a sentence or two on how the requirement is to be tested and may be written as a test requirement. This attribute is not intended for major detailed plans, as this detailed information would be handled in a separate Verification Plan document.

- Tables or Figures in section 3 can be referenced

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Key Verification Attributes – Cont'd

- Tables or Figures that are unique for testing can be included directly in Section 4.2.

- Besides indicating how each requirement will be tested, establishing values for both of these attributes also helps to isolate/correct requirements that may have not been written well (i.e. not testable).

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Key Verification Views

- Three specific views have been created to facilitate editing and reporting the values of these attributes.
  - "Verification – Editing"
  - "VCRI for export to MS Word"
  - "Ver Plan for export to MS Word"
- These 3 views provide the basic layout and a simple filter. Specific filters can be created when exporting limited requirements for a specification.

Key Views – Editing Attributes

- The "Verification – Editing" view was created to allow the user to populate verification related attributes for each of the requirements.

- Generally, it is filtered to display all the requirements in section 3, their ancestor parents and the key verification attributes listed above.

- Other verification type attributes that will be used for testing down the line may also be included in this view (status, comments, etc.)

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Key Views – Editing Attributes, Cont'd

Key Views – VCRI Matrix

- The "VCRI for export to MS Word" view is prepared to look like the intended VCRI matrix.

- Individual columns display an "X" for each of the enumerated values of the "Verification Method" attribute. This is handled by DXL layout code. While this code can be very simple and included in each column, a customized script was written that provides the following:
  - ➤ Ability for the designer to pass the attribute name and enumerated value (set up for multi-pick enumerated attributes).
  - ➤ Verification that the provided attribute name exists and if not, displays an error directly in the layout column. This error message is for the designer's sake and is not intended for receipt by a user.
  - ➤ Automatic classification of Header Objects as "N/A".

Key Views – VCRI Matrix, Cont'd

- The "Section 4 Par" column displays the paragraph structure for Section 4.2, which corresponds directly with the Section 3 paragraph structure.

- This view is exported to Microsoft Word (MS Word) as a table in a separate document and then is added to the VCRI template (as seen earlier) via a copy/paste.

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Key Views – VCRI Matrix, Cont'd

Formal module

File   Edit   View   Insert   Link   Analysis   Table   Tools   User   GDLS   Help

VCRI For Export to Word ▼   All levels ▼

Requirement Paragra	Title	N/A	A	I	D	T	Section 4 Paragraph
3.2.1.1	Power car	X					4.2.1.1
3.2.1.1.1	Move car	X					4.2.1.1.1
3.2.1.1.1.1	Move forwards	X					4.2.1.1.1.1
3.2.1.1.1.1.0-1	Move forwards					X	4.2.1.1.1.1.0-1
3.2.1.1.1.2	Move backwards	X					4.2.1.1.1.2
3.2.1.1.1.2.0-1	Move backwards					X	4.2.1.1.1.2.0-1
3.2.1.1.2	Accelerate car	X					4.2.1.1.2
3.2.1.1.2.0-1	Accelerate car					X	4.2.1.1.2.0-1
3.2.1.1.2.0-2	Accelerate car					X	4.2.1.1.2.0-2
3.2.1.1.2.0-3	Accelerate car					X	4.2.1.1.2.0-3
3.2.1.2	Control car	X					4.2.1.2
3.2.1.2.1	Switch on car	X					4.2.1.2.1
3.2.1.2.1.0-1	Switch on car				X		4.2.1.2.1.0-1
3.2.1.2.2	Control speed	X					4.2.1.2.2
3.2.1.2.2.0-1	Control speed			X			4.2.1.2.2.0-1
3.2.1.2.2.0-2	Control speed			X			4.2.1.2.2.0-2
3.2.1.2.2.0-3	Control speed				X		4.2.1.2.2.0-3

Username: morganm   Read-only mode

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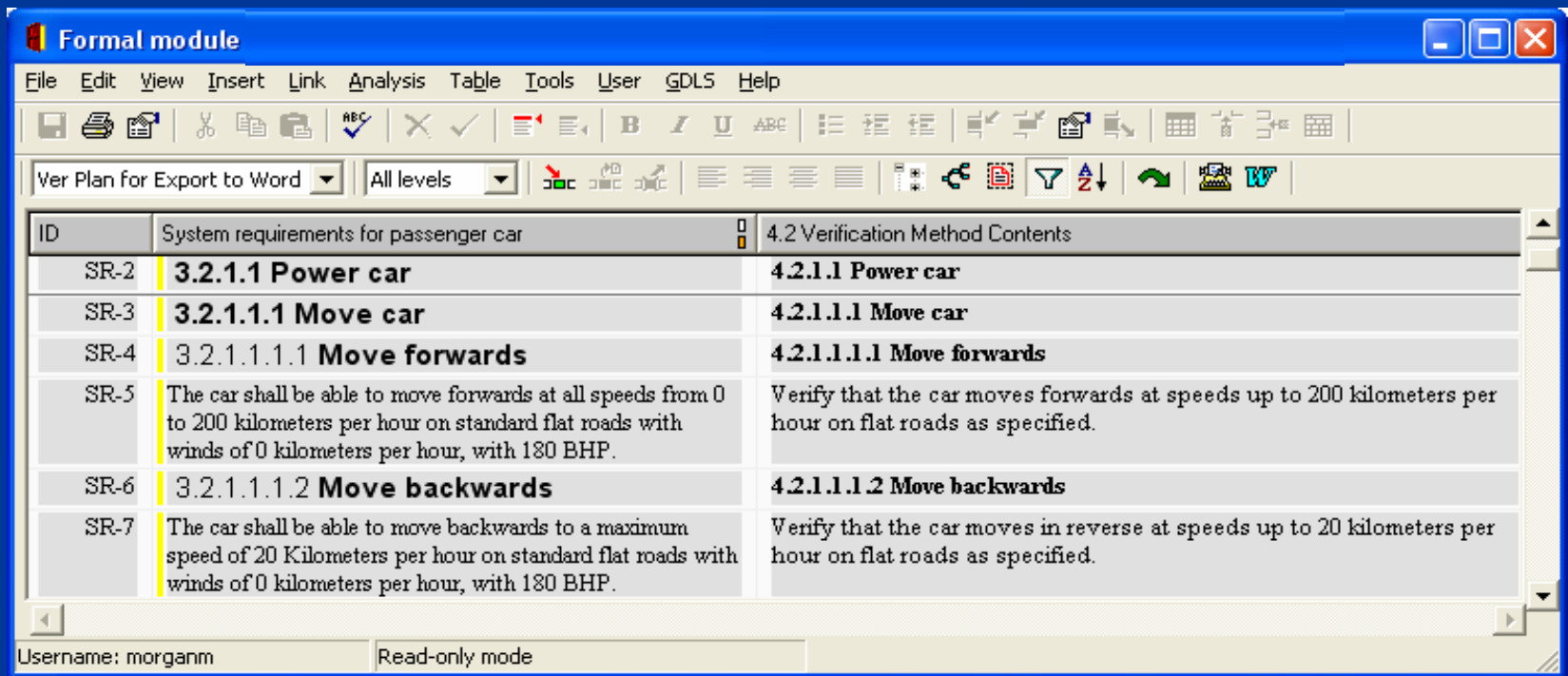
Key Views – Verification Plan

- The "Ver Plan for export to MS Word" view is prepared to look like section 3, showing all headers and text, but the text in this case displays the contents of the "Verification Plan" attribute.

  - This view can be setup to display all objects that have a value in this attribute, while skipping those that do not, and can include figures, tables and their captions.

    - The capability to display figures/captions recognizes that while figures in section 3 may be referenced, some cases require special values in the tables or figures.

Key Views – Verification Plan, Cont'd

➤ While this view displays 3 columns, the ID and requirement columns are provided for context and must be removed before exporting the view to Microsoft Word in Book format. The results of the export would be copy/pasted into section 4.2 of the Main Document.

Key Views – Verification Plan, Cont'd

- The Export to Word function can be extended to display this column with the same styling as the Object Text/Object Heading column, instead of being exported as attributes of Object Text.

Ready for Export

- A specification is handled by 3 separate exports:
  - ➤ Main Document, which includes the contents in Sections 1-6
  - ➤ VCRI Matrix
  - ➤ Verification Plan
- The export can be handled:
  - ➤ Manually - manually merged and polished
  - ➤ Semi-automated - A single script could be developed that performs the exports and merges. Some manual polishing will be required afterwards.

Export Templates

● In preparation for the exports, MS Word template files (.dot files) have been created to direct the exports, provide headers/footers, a cover page, a Table of Contents and style formatting for the whole document. They also provides caption styles for Table and Figure captions.

➤ **Document contents and Section 4.2 contents:**

■ Draft Release for the document contents (only for internal reviews)

■ Official Release for the document contents

➤ **VCRI Matrix:**

■ Verification Template

Exporting a Specification

Contents	View Name	Export Template	Book/Table
Main Document	CIDS Export to MS Word	Official Release	Book
VCRI	VCRI for export to MS Word	Verification	Table
Verification Plan	Ver Plan for export to MS Word	Official Release	Book (1)
	Ver Plan for export to MS Word	Official Release	Table (2)

Notes: (1) Verification Plan exported via an extended Export to Word function

(2) Verification Plan exported via the "Out of the Box" Export to Word function

Exporting the Main Document

- A view, such as "CIDS Export to Word" would include only the main column (Object Text and Object Heading)

- The view can be extended with the desired filter based on allocation attributes, if necessary

- The results of this export will be the working copy towards a completed specification. The VCRI and Verification Plan exports will be merged into this document within Section 4. The resulting MS Word document will be referred to as the "Main Document".

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# Exporting the Main Document - View

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Exporting the VCRI Matrix

- The matrix is supplied via a view like the "VCRI for export to MS Word", which can be tailored for specific specifications.

- The view is filtered to only show requirements and headers in Section 3, normally starting at 3.2.

- The view is exported as a MS Word Table.

- Selecting to use a specific export template like "Verification Template.dot" will provide an empty VCRI table at the top of the file with desired formatting for columns.

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Exporting the VCRI Matrix, Cont'd

- Running the Export to Word function:
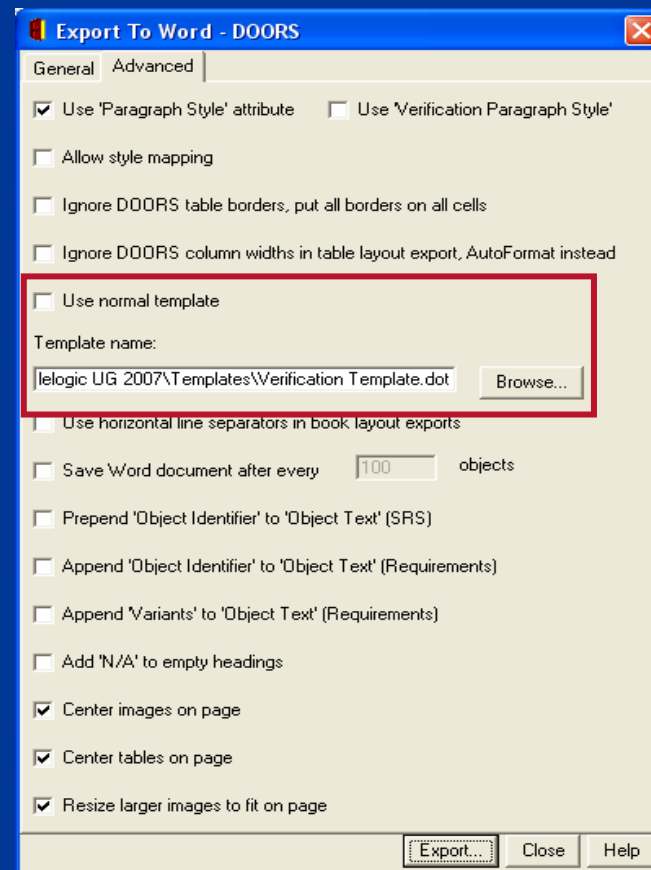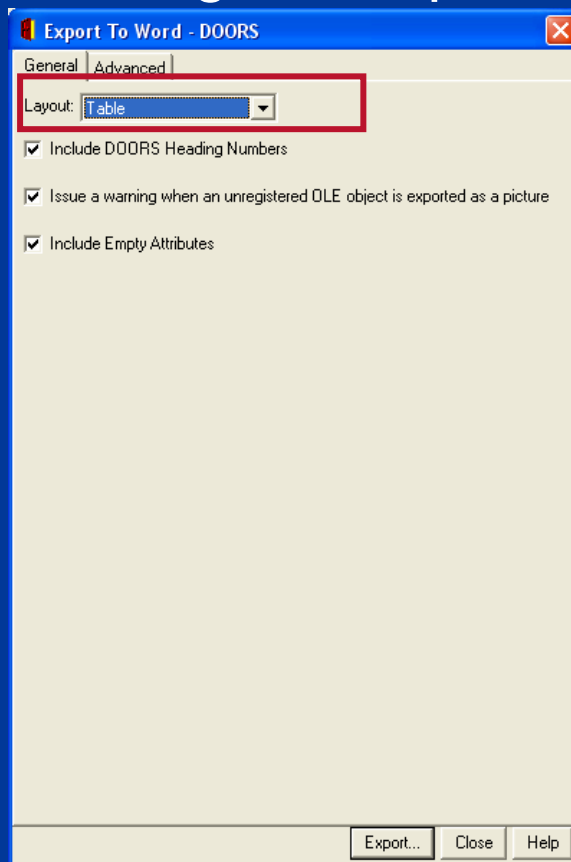
Exporting the Verification Plan

- The Verification Plan contents is supplied via a view like the "Ver Plan for export to MS Word", which can be tailored for specific specifications.

- The view is filtered to show requirements and headers in Section 3, normally starting at 3.2.

- The Verification Plan export needs some special handling. Exporting in Book format normally leads to undesired effects, listing the column as an attribute for each requirement object.

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Exporting the Verification Plan, Cont'd

- The Export to Word script can be extended to export this column as if it were the main column, which would then assign styles to Headers and captions if tables/figures are included.

- The final results of this export are in a new MS Word document and need to be merged in to the Main Document under Section 4.2.

Verification Plan – Better Effects as Book

- Exporting via "Extended" Export to Word function.

Summary

- While there may be some overhead on the export, the end result leads to a full document, without the maintenance drawbacks of needing to keep the section 4 structure current with Section 3. Some overhead can be diminished by automating the process.

- While the requirements should be stable once Section 4 is being populated, there is still the opportunity for change and re-arrangement.

- Therefore, some form of automation for Section 4 is a worthwhile endeavor to be setup by the DOORS team for any company that needs to provide consistent exports of specifications.

Appendix – Steps to Exporting a Document

- The following steps are provided for exporting requirements as a specification in more detail.
- While a script can be prepared to automate these exports, this exercise will be covering the manual approach
- We have a customized version of the Export to Word function provided by Telelogic. Therefore snapshots may show extra features that won't be seen for the original function.

Export from DOORS to Word – GDLS Specific Options

- GDLS Extras include the following features:
  - ➤ Append the Object identifier on requirements
  - ➤ Append Variant names when the requirement is not Common?
  - ➤ Add N/A for empty sections
  - ➤ Browsing for a customized template starts at the desired folder, instead of the default Microsoft folder.
  - ➤ Capability to print Verification Plan information in document format for section 4.3.n

Export a CIDS – Export Main Document

- Export the document body from the DOORS module, including all headers and requirement objects within sections 1 through 6 satisfying the required filter.

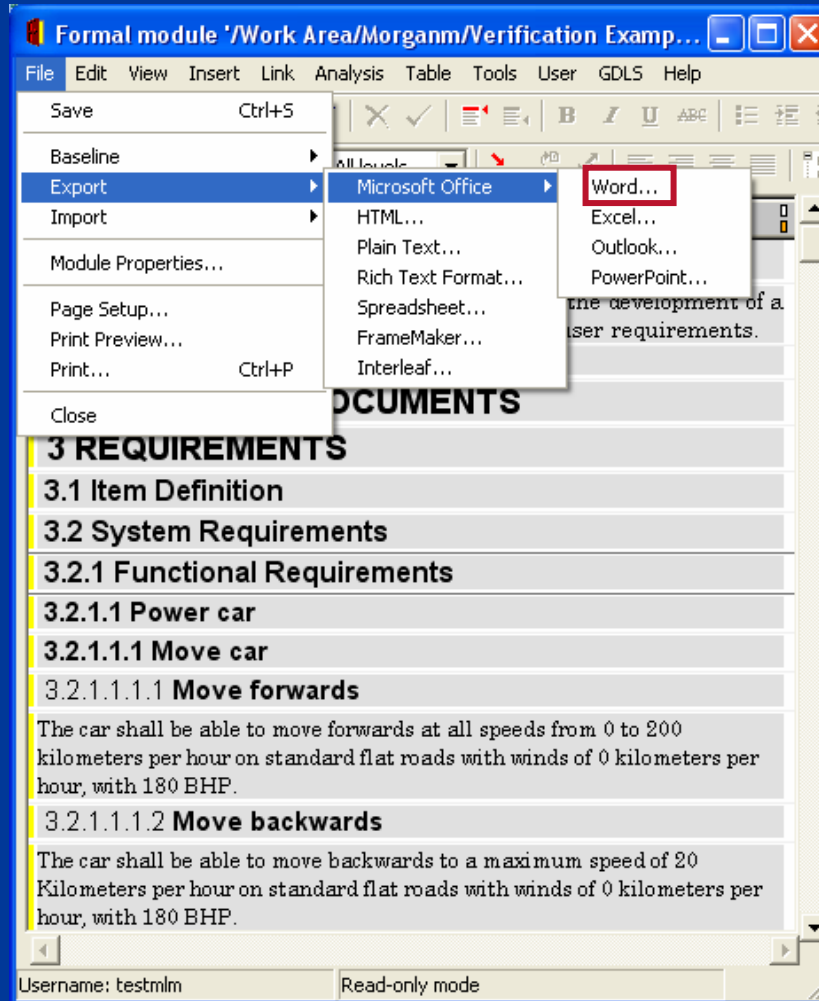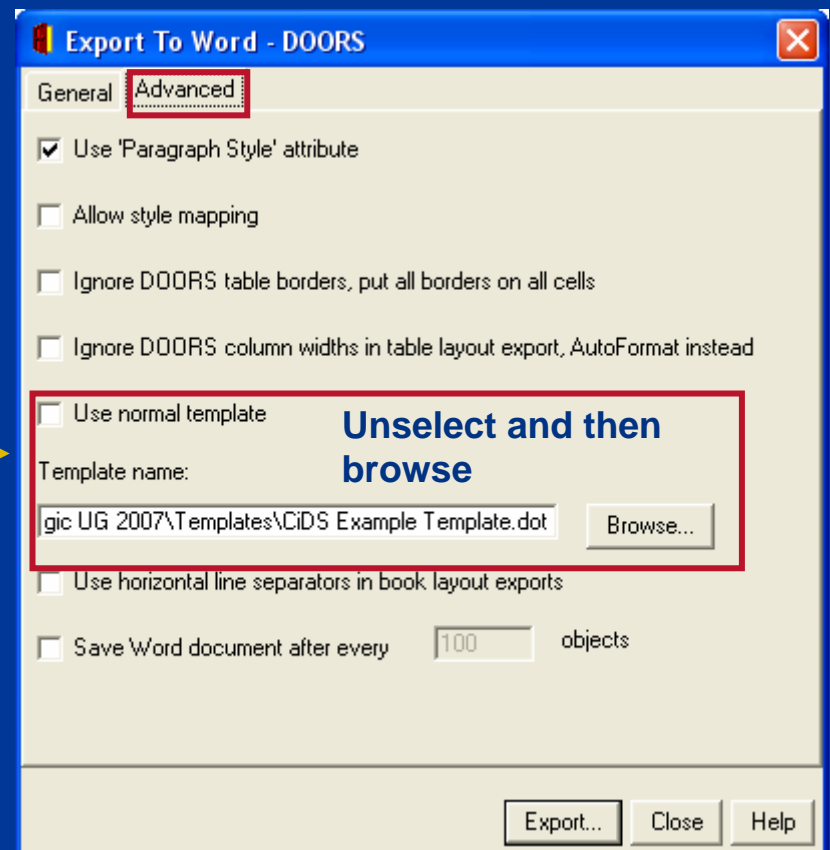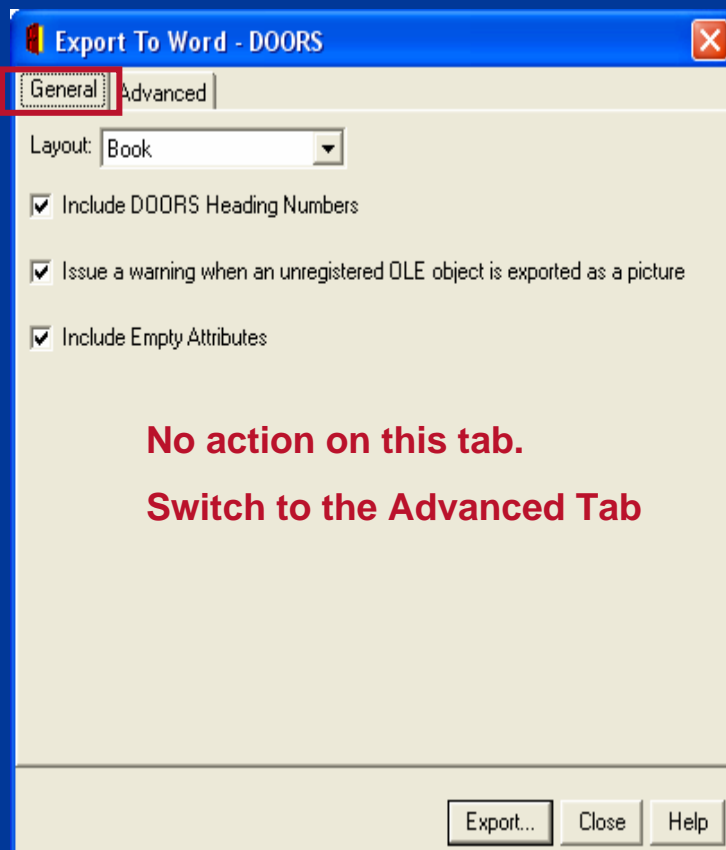- Only export the column containing the heading and object text attributes.
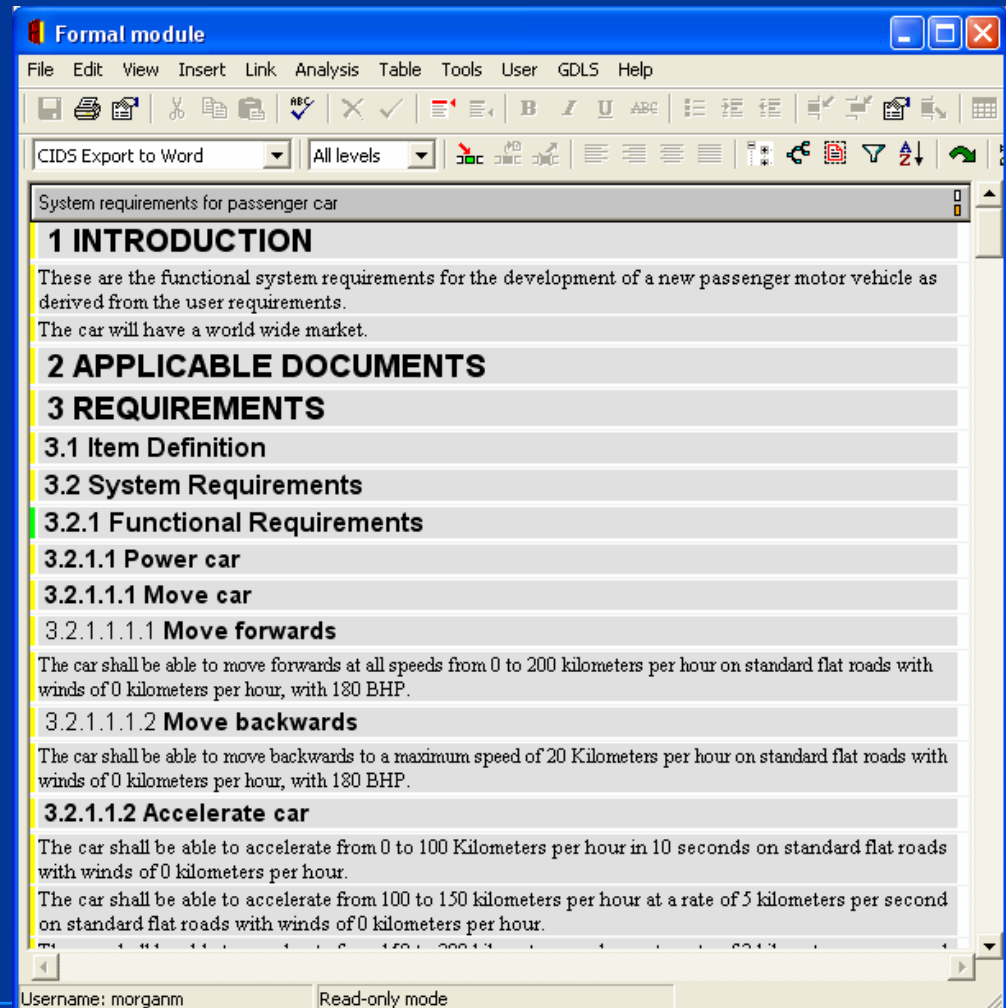
Export a CIDS – Export Main Document, Cont'd

- Initiate the "Export to Word" function

Export a CIDS – Export Main Document, Cont'd

Export To Word - DOORS

General | Advanced

Layout: Book

☑ Include DOORS Heading Numbers

☑ Issue a warning when an unregistered OLE object is exported as a picture

☑ Include Empty Attributes

No action on this tab.

Switch to the Advanced Tab

Export... | Close | Help

Export To Word - DOORS

General | Advanced

☑ Use 'Paragraph Style' attribute

☐ Allow style mapping

☐ Ignore DOORS table borders, put all borders on all cells

☐ Ignore DOORS column widths in table layout export, AutoFormat instead

☐ Use normal template   **Unselect and then browse**

Template name:

gic UG 2007\Templates\CiDS Example Template.dot   Browse...

☐ Use horizontal line separators in book layout exports

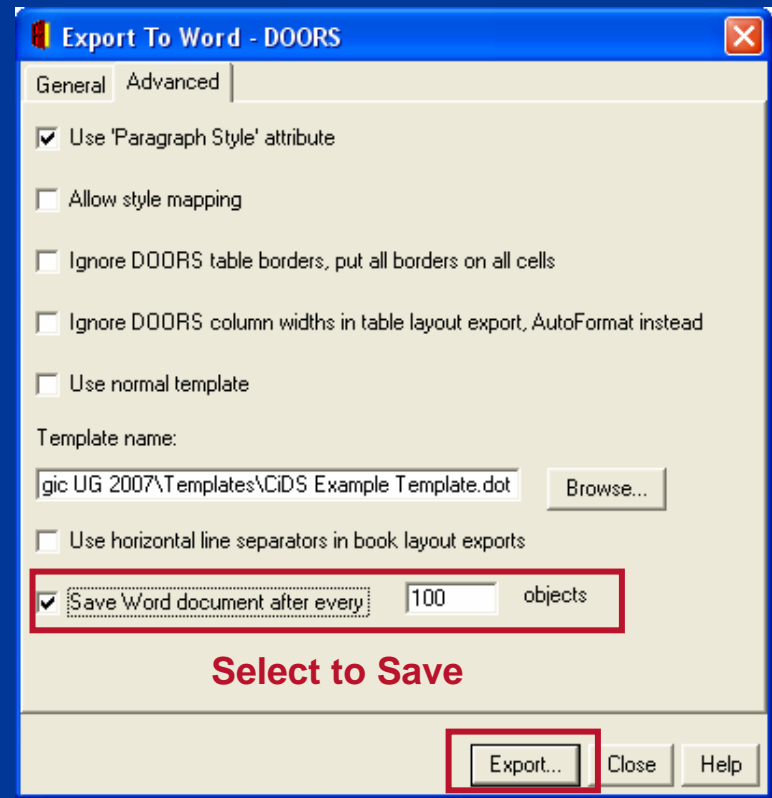☐ Save Word document after every [100] objects

Export... | Close | Help

Export a CIDS – Export Main Document, Cont'd

- For large documents, its helpful to select "Save document after every 100 objects". When this option is selected, provide a file name once prompted (see next page for file name specifics).

  •Click the **Export** button. Minimize the Microsoft Word window once it appears on screen (This process slightly speeds up the export as it doesn't have to keep refreshing the window)

  •If you get a prompt about a style not available, click **OK**.

Export To Word - DOORS

General | Advanced

☑ Use 'Paragraph Style' attribute

☐ Allow style mapping

☐ Ignore DOORS table borders, put all borders on all cells

☐ Ignore DOORS column widths in table layout export, AutoFormat instead

☐ Use normal template

Template name:

gic UG 2007\Templates\CiDS Example Template.dot   [Browse...]

☐ Use horizontal line separators in book layout exports

☑ Save Word document after every [100] objects

Select to Save

[Export...] [Close] [Help]

DOORS

The Word style name 'CaptionTable' does not exist in this template
Standard mappings will be used for unknown styles

[OK]

Export a CIDS – Export Main Document, Cont'd

- Save the file twice (The file name should include the DOORS module being exported and the date that it was exported from DOORS):

  - Save the newly generated Word document as a raw (untouched) file in your working directory:
  - Save again, but as a working file to contain the final CIDS document as follows.

- The working document will now be referred to as the "Main Document". Minimize this window for later usage.

Export a CIDS – Export VCRI Matrix

- Export the VCRI matrix from the DOORS module, including all headers and requirement objects within sections 3.0, starting at 3.2, satisfying the required filter.

- Change to the view: "VCRI Export To Word"

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Export a CIDS – Export VCRI Matrix, Cont'd

Select "VCRI Export To Word" view

Set via the Verification Editing view

Export a CIDS – Export the VCRI Matrix, Cont'd

- Then select to export to Word using Table option on the General tab

Export a CIDS – Export the VCRI Matrix

- Switch to Advanced Key

- De-select to "Use normal template", and browse to select the "Verification Template" in its place.

- Click the Export button. Minimize the MS Word file once it appears on screen (This process slightly speeds up the export as it doesn't have to keep refreshing the window)
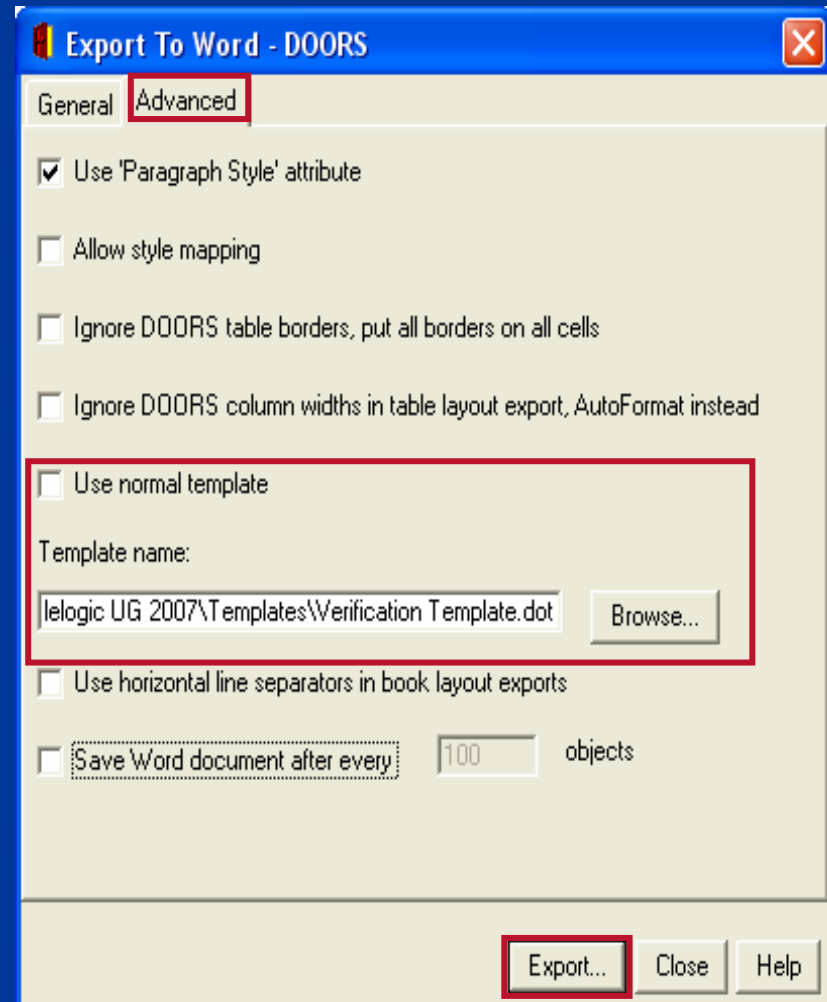
Export a CIDS – Export VCRI Matrix, Cont'd

- The resulting MS Word document includes:
  - the VCRI table template as an MS Word table. Optionally, it may be divided in two with the legend as separate from rest of table.
  - the exported VCRI contents, in a separate MS Word table.
- Save the file as a raw file in your selected working folder
- Scroll down to the exported table
- Delete the top row that contains the column header

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Export a CIDS – Export VCRI Matrix, Cont'd

- Select all columns but not the right most control character column and select to Copy (CTRL-C). Do this by moving cursor to top of table, turning to black arrow and dragging across rows.

Do

Don't

Export a CIDS – Export VCRI Matrix, Cont'd

● Scroll back to top and paste the VCRI contents from the clipboard into the leftmost cell of the first empty row in the VCRI table.
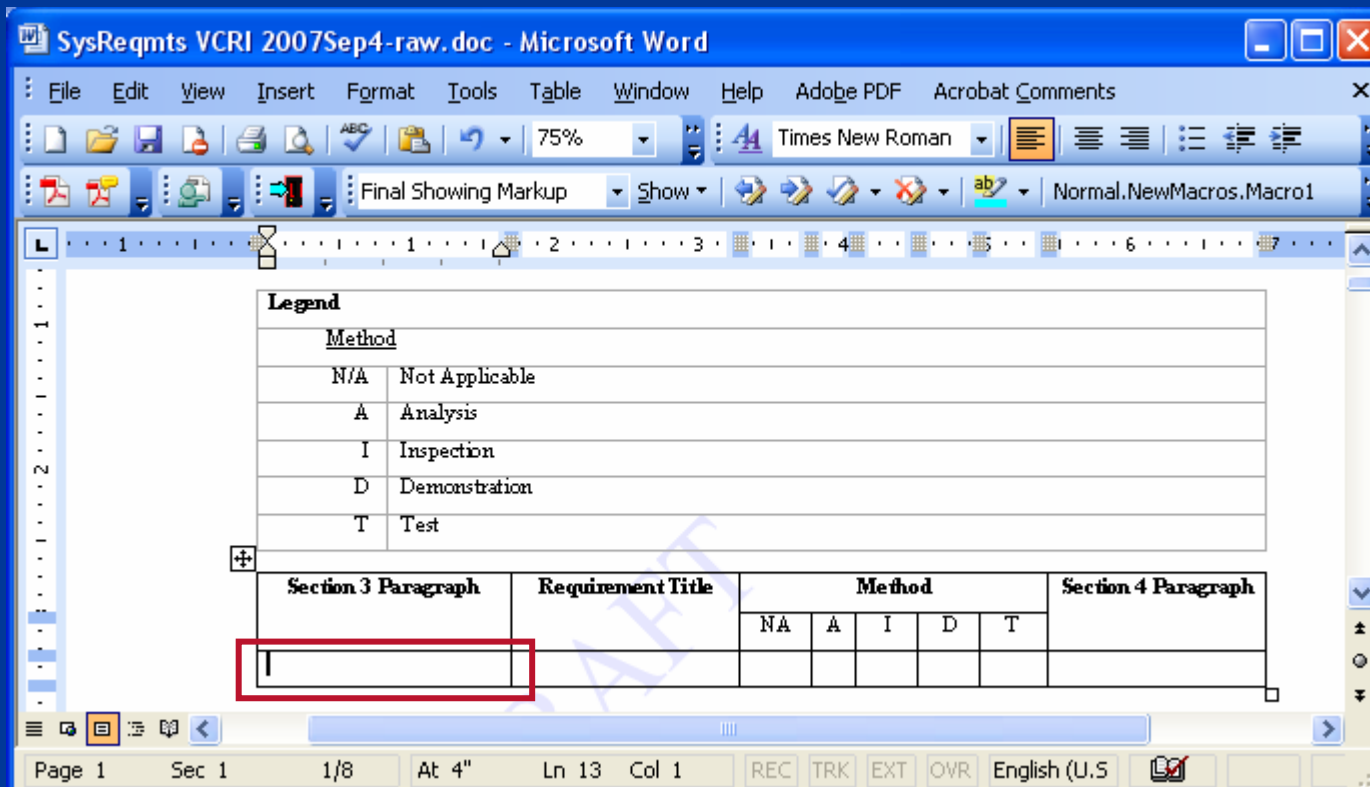
Export a CIDS – Export VCRI Matrix, Cont'd

● Select the newly populated VCRI formatted table and select to copy
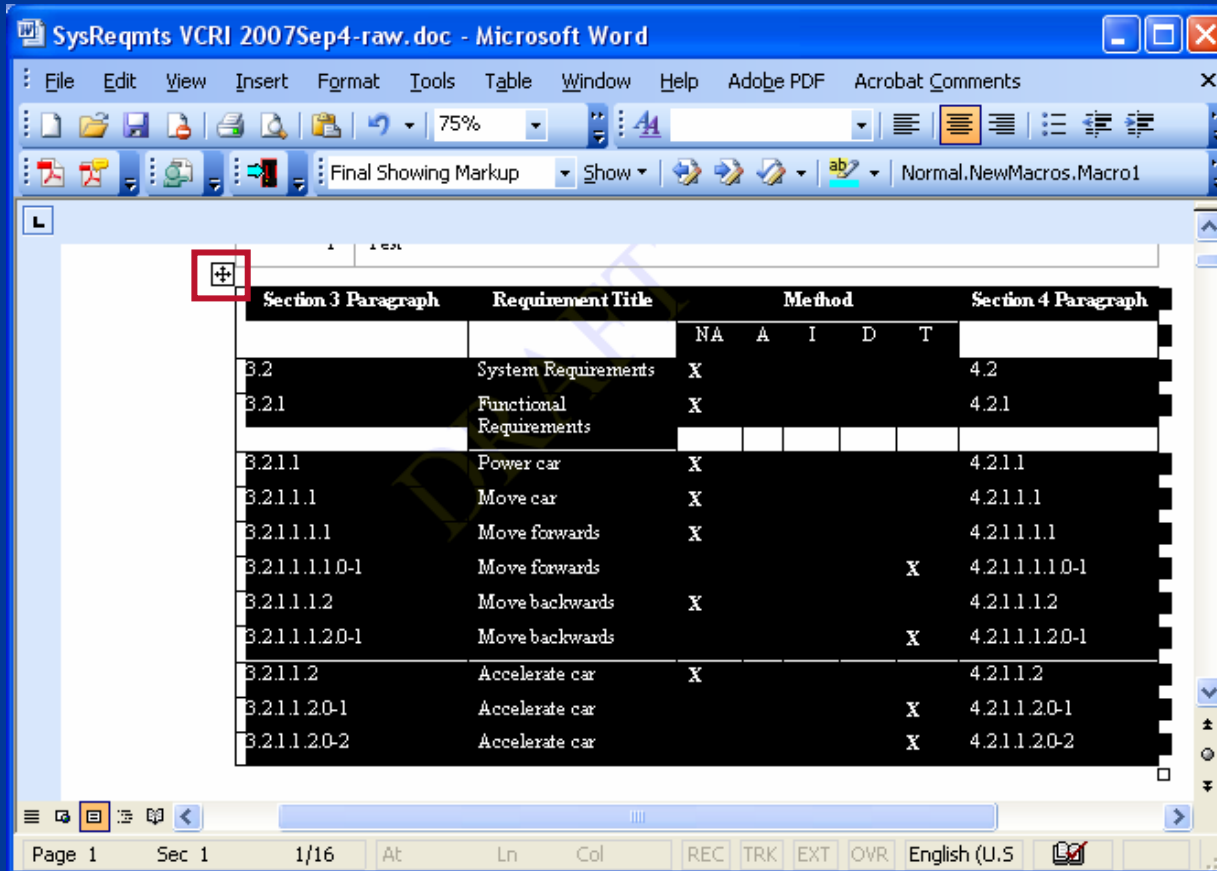
Export a CIDS – Export VCRI Matrix, Cont'd

- Maximize the Main Document and move down the existing stub VCRI matrix. Select the stub VCRI and select Paste (CTRL-V).
- If the Legend is separate, Copy/Paste it also from the VCRI document to above this new table, keeping as a separate table.

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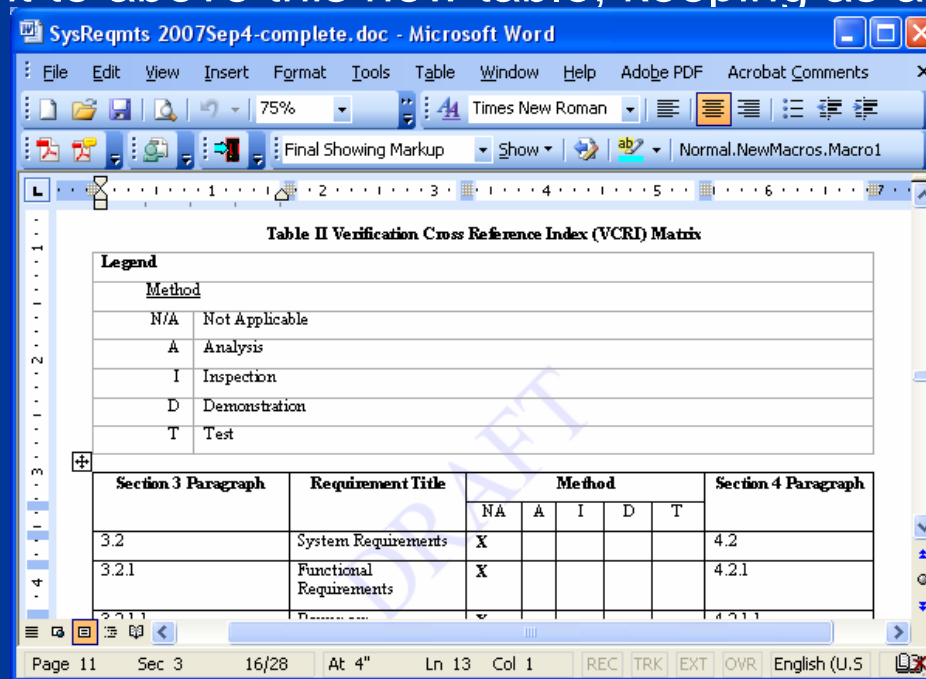
Export a CIDS – Export VCRI Matrix, Cont'd

- Note, the new table now follows the Table Caption but did not replace the stub table.

- Scroll to the end of the new table. Delete the stub table and the italicized instructions that follow.

- If the heading row does not already repeat, select the first two rows and select Heading Rows Repeat from the Table pull-down menu. May need to click to unselect and then again to select (as a toggle).

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Exporting the VCRI Matrix, Cont'd

● Delete the instruction text in the main document and the VCRI template block.

Export a CIDS – Export Verification Plan

- Change to the **"Ver Plan for Export to Word"** view. This not only sets up the columns, but filters on Section 3 only, where the Verification Plan attribute is not empty.

- Delete the Object ID and Section 3 columns before exporting, Leaving only the **"4.3 Verification Method Contents"** column only.

Export a CIDS – Export Verification Plan, Cont'd

- Select Export to Word, via an extended version of the function.
  - ➤ General tab: no actions
  - ➤ Switch to the Advanced tab;
  - ➤ Select "Use 'Verification Paragraph Style" feature.
  - ➤ Uncheck "Use normal template"
  - ➤ Browse and select the same template you used for the Main Document to apply same styles to headers and text.
  - ➤ Export. A new MS Word document will be opened.

Export To Word - DOORS

General | Advanced

☑ Use 'Paragraph Style' attribute   ☑ Use 'Verification Paragraph Style'

☐ Allow style mapping

☐ Ignore DOORS table borders, put all borders on all cells

☐ Ignore DOORS column widths in table layout export, AutoFormat instead

☐ Use normal template

Template name:
gic UG 2007\Templates\CiDS Example Template.dot   Browse...

☐ Use horizontal line separators in book layout exports

☐ Save Word document after every [100] objects

☐ Prepend 'Object Identifier' to 'Object Text' (SRS)

☐ Append 'Object Identifier' to 'Object Text' (Requirements)

☐ Append 'Variants' to 'Object Text' (Requirements)

☑ Add 'N/A' to empty headings

☑ Center images on page

☑ Center tables on page

☑ Resize larger images to fit on page

Export...   Close   Help

Export a CIDS – Export Verification Plan, Cont'd

- Save the newly generated Word document as a raw (untouched) file in your selected working folder
- Scroll down to the text containing the Verification Plan sections, select all of sections from 4.3.1 to the last section and copy (CTRL-C).
- Maximize the Main Document window, paste (CTRL-V) starting after the header, "4.2 Qualification Method".
- Remove the italicized instructions, if not removed during previous instructions for the VCRI table export.

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Export a CIDS – Export Verification Plan, Cont'd

Replaces *Italic* Text

Alternative Exports for Verification Plan

- Besides the capability of extending the Export to Word function, the following methods described in the following slides:
  - ➤ Export as a Table
  - ➤ Export as a Book (Undesired results, not recommended)

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Verification Plan –Effects as Table

- The "4.2 Verification Method Contents" column could be exported as a Table to MS Word and then converted to text.
  - No styles are provided for Headers and would have to be applied by hand.
  - Can be done easily via the Style Formatting, but still takes time.

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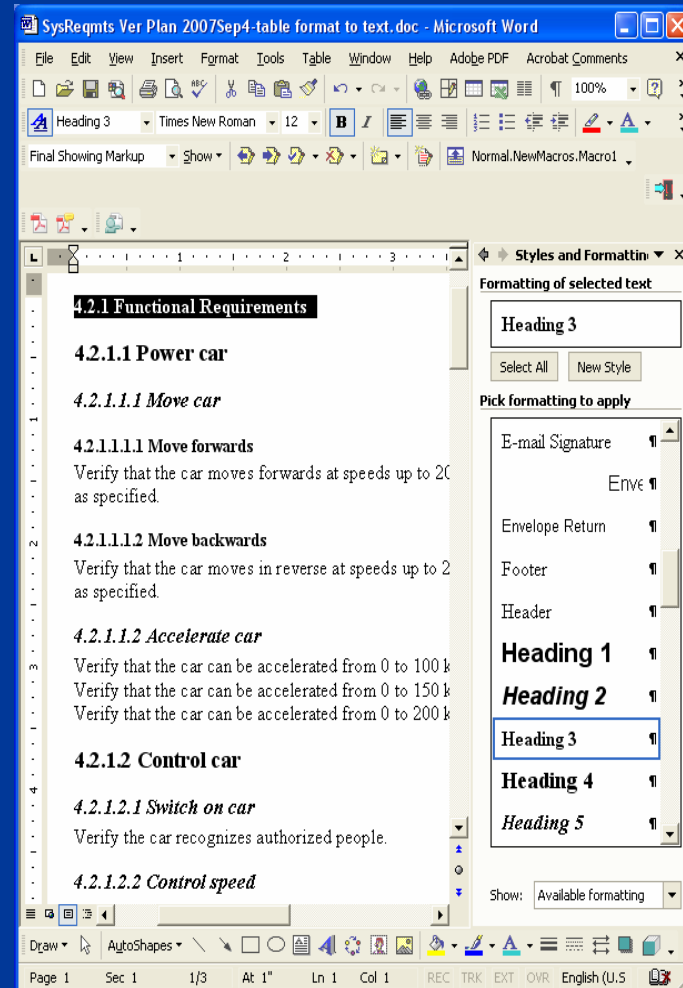# Verification Plan –Effects as Table

- Exporting via "Out of the Box" Export to Word function as a Table.
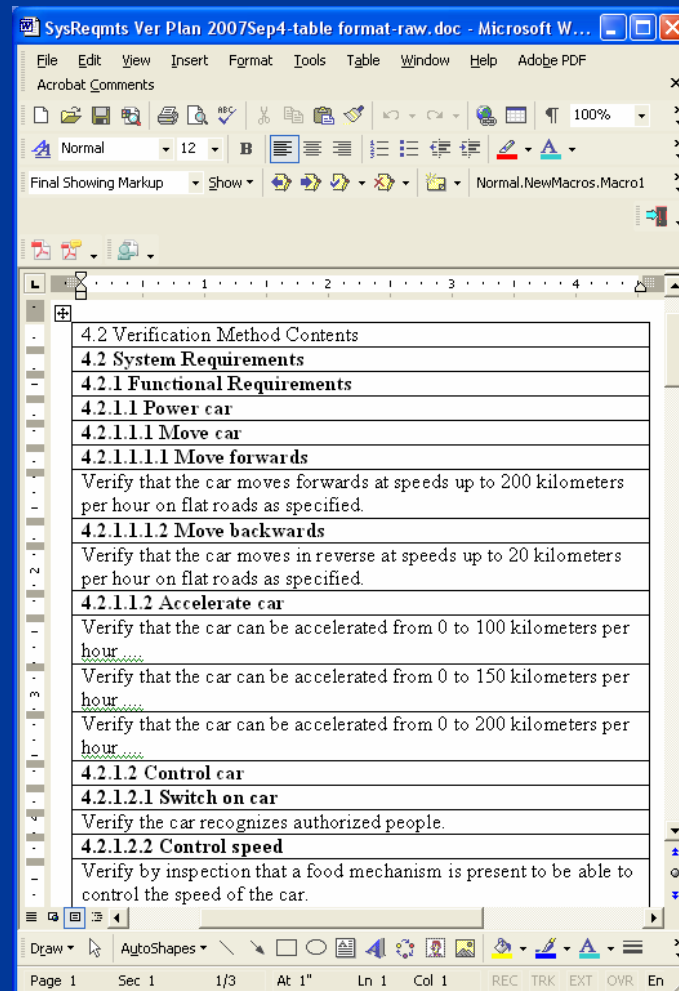
Verification Plan –Effects as Table

● Headers need to be formatted as MS Word Heading styles

Verification Plan – Undesired Effects as Book

- Exporting via "Out of the Box" Export to Word function.
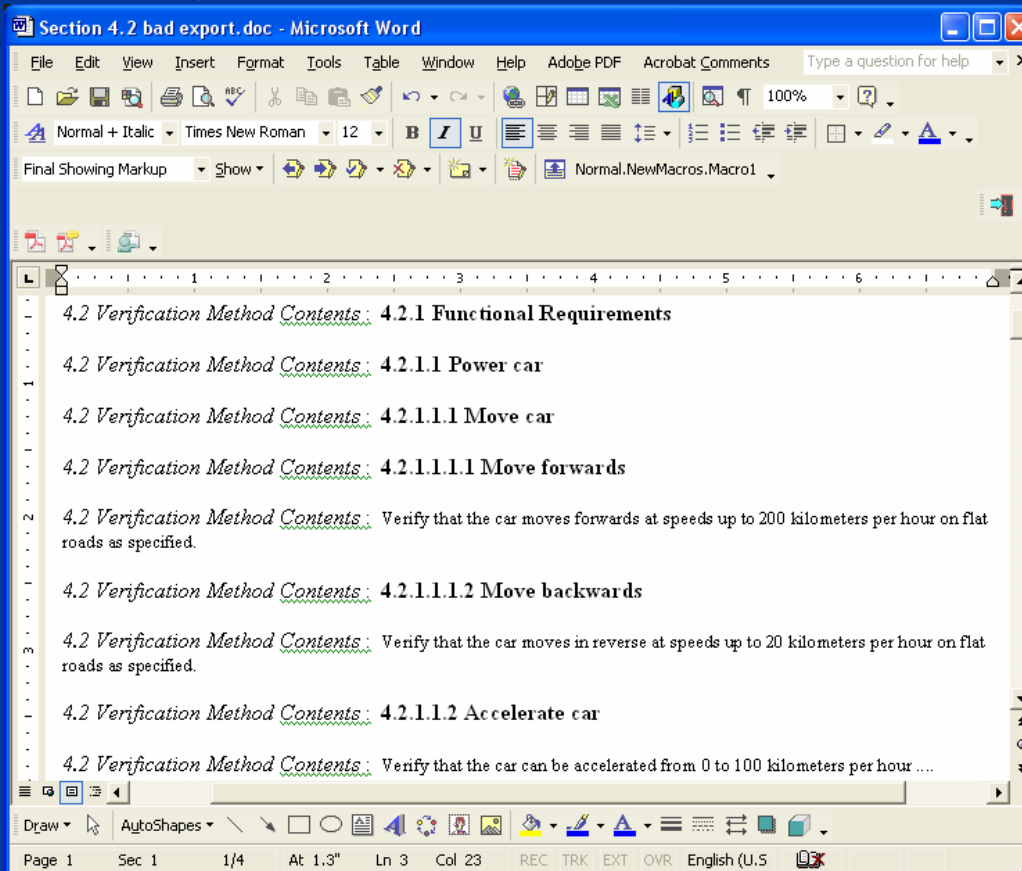
Export a CIDS – Remaining Tasks

- Prepare Front Page supplying info for the following items:
  - Subsystem/component name for module
- Update the page headers for unique MS Word sections to include name of subsystem/component represented (e.g. engine)

Export a CIDS – Remaining Tasks, Cont'd

- For Tables and Figures: Captions should be on the same page as the table or figure: table caption before the table; figure captions after the table. If possible, keep the referencing object with the table/figure and caption, allowing all 3 objects to be on one page. This can be handled by manual page breaks or setting the paragraph style for the referencing requirement to be "Keep with Next".

- Update the Table of Contents, Table of Tables and Table of Figures as one of last steps.

- Switch to the Advanced Tab, no changes on General tab.

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