Supplemental Manual for F-35 Tooling Maintenance

10/10/2017

Process Architecture: 04.06.03 Manage Supplier Technical Requirements

Document Owner: Director, Manufacturing Engineering & Tooling

Content Managed By: Supplier Manufacturing Engineering-Operations (SME-Ops)

Applies To: Northrop Grumman Aerospace Systems, F-35 Program
### REVISION RECORD

<table>
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<tbody>
<tr>
<td>Original Issue</td>
<td>10/10/2017</td>
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DOCUMENT OVERVIEW

This document contains pertinent information necessary for the control, maintenance, and manufacturing of F-35 Special Tooling and Special Test Equipment. The intent is to serve as a guide for tracking maintenance of Special Tooling and Special Test Equipment and for assessing the visual ratings of composite cure tools. The online version is the official version, and any copy must be verified with the online version before use. This document applies to NGAS F-35 program only.

The process owner listed on the cover sheet controls the information contained in this document. This process owner is responsible for the integrity and maintenance of the material contained herein.

Questions regarding this document should be directed to the NGAS Supplier Manufacturing Engineering Operations Team (SME-Ops).
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SECTION 1 – TOOLING MAINTENANCE/REPAIR LOG SHEETS

1.1 TRACKING REQUIREMENTS

As stated in the NGAS Supplier Tooling Manual Section 4.3, suppliers are required to maintain a record of all tool inspection and maintenance activities. The removal of tooling from production to storage does not relieve the supplier of these responsibilities. On a biannual basis, the supplier shall provide Northrop Grumman a copy of the current maintenance/repair log for all accountable F-35 Special Tooling and Special Test Equipment on contract. The requested data may be provided in a format convenient to the supplier, but shall include the following information:

a. Vendor Name  
b. Vendor Number  
c. Report Date  
d. Tool Number  
e. Tool Symbol  
f. Tool Series  
g. Tool Multiple  
h. Tool Lifetime Serial Number  
i. Maintenance/Repair Date  
j. Task Performed  
k. Notes

1.2 MAINTENANCE/REPAIR LOG SHEET TEMPLATE

The tooling maintenance/repair data should be provided in the most convenient spread sheet compatible format similar to the following (reference Figure 1):

<table>
<thead>
<tr>
<th>Tool Number</th>
<th>Tool Symbol</th>
<th>Tool Series</th>
<th>Tool Multiple</th>
<th>Tool Lifetime Serial Number</th>
<th>Maintenance/Repair Date</th>
<th>Task Performed</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NG Tool Tooling Maintenance/Repair Report
Vendor Name: FILL IN  
Vendor Number: FILL IN  
Report Date: FILL IN

Figure 1 Maintenance/Repair Log Example
SECTIONS 1 – TOOLING MAINTENANCE/REPAIR LOG SHEETS (Continued)

1.2 MAINTENANCE/REPAIR LOG SHEET TEMPLATE (Continued)

The definitions for each field are as follows:

<table>
<thead>
<tr>
<th>FIELD</th>
<th>EXAMPLE</th>
<th>Data Type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor Name:</td>
<td>Example, Inc.</td>
<td>Text</td>
<td></td>
</tr>
<tr>
<td>Vendor Number:</td>
<td>#######</td>
<td>Text</td>
<td></td>
</tr>
<tr>
<td>Report Date:</td>
<td>7/1/2016</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Tool Number</td>
<td>2CSJ12345-0001</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>Tool Symbol</td>
<td>AJFX</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>Tool Series</td>
<td>01</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>Tool Multiple</td>
<td>001</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>Tool Lifetime Serial Number</td>
<td>JN12345</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>Maintenance/Repair Date</td>
<td>xx/xx/xxxx</td>
<td>Date</td>
<td>Date supplier completed the maintenance or repair task</td>
</tr>
<tr>
<td>Task Performed</td>
<td>Replaced drill bushings</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>Notes</td>
<td>Pertinent comments to share</td>
<td>Text</td>
<td>Pertinent comments to share</td>
</tr>
</tbody>
</table>

1.3 MAINTENANCE/REPAIR LOG SHEET SUBMITTAL INTERVALS

The supplier shall submit copies of the Tooling Maintenance/Repair Log to Northrop Grumman twice annually:

1. For tooling activities from January 1st – June 30th, submit data to Purchasing Representative by July 31st.
2. For tooling activities from July 1st – December 31st, submit data to Purchasing Representative by January 31st.
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS

This section applies only to composites suppliers.

2.1 TRACKING REQUIREMENTS

Northrop Grumman Corporation has established a visual rating system for evaluating the condition of composite cure tools with BMI face sheets (Tool Symbol: CTB) at our suppliers. This visual rating system has been integrated into our sustaining Tool Maintenance Program. The visual rating is used in conjunction with autoclave cycle counts to forecast major tool repairs and replacements. By extending this strategy to Special Tooling (ST) located at our suppliers, Northrop Grumman Corporation will be able to budget for these major repairs and replacements. This proactive approach will reduce downtime and production impacts when funding for repairs and replacement tools is needed.

On a biannual basis, the supplier shall provide Northrop Grumman updated visual ratings for all of the CTBs located at the supplier’s manufacturing facility. This visual rating update may be done in conjunction with the Periodic Tool Inspection (PTI) specified in the Supplier Tooling Manual, section 7.3. A Visual Rating Report template is outlined in the following section.

2.2 CTB VISUAL RATINGS CRITERIA

All F-35 composite cure tools (Tool Symbol: CTB) shall be assigned a visual rating between 1 and 10. The definition of each numerical rating is as follows:

1 - 3: New to lightly used tool.

4 - 6: Some wear is seen in the tool; however, the wear has not caused rework to production parts. (i.e. scribe lines at or outside excess boundary line.) This tool may require some minor tooling maintenance (such as polishing) prior to next use. May have had rework performed in the past (patches), but does not affect production parts. These should be investigated and corrective actions implemented to prevent further damage to the tool.

7 - 9: This tool has features which are now affecting part fabrication (causing rework, alternate method processing, custom bagging location, etc.) Further use of tool is prohibited without rework. In addition, tools in this condition should be investigated and corrective action implemented in order to prevent further damage to the tool. This rating requires immediate initiation of an RC/I requesting direction for the necessary rework.

10: This tool can no longer be used to fabricate a conforming part and must be removed from production. This rating should immediately initiate an RC/I requesting disposition for the tool.

2.3 EXAMPLES OF POSSIBLE CTB FAILURES

There are several reasons why a composite cure tool may fail to fabricate a conforming part. The following list includes examples of possible tool failures. This list is not all-encompassing:

- **Cure cycle quantity** has reached its complete lifecycle and results in loss of vacuum integrity. (Reference 500 cycle ROM estimate).
- **Surface damage** caused during part breakout (scrapping, gouging).
- **Tooling hole leaks** due to excessive tool hole drilling depth.
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.3 EXAMPLES OF POSSIBLE CTB FAILURES (Continued)

- **Tooling pad leaks** due to use of pin removal tool.
- **Impact damage** affecting vacuum integrity (forklift handling).
- **Complex tool** contours causing difficulty in the use of the tool.
  - Contours resulting in breakout challenges, aged tools exhibit localized deterioration of surface finish, resin build-up, or localized tool wear.
  - Contours resulting in partial separation of face sheet from eggcrate due to inherent stresses. Periodic Inspection (PTI) results yield unacceptable surface profile range.

2.4 CTB VISUAL RATINGS EXAMPLES

The following are examples of some CTB visual ratings:

**CTB Rating – 1.** Brand new tool face sheet surface. (Reference examples in Figure 2 and 3).
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

Figure 3 Example CTB Rating - 1
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

CTB Rating – 3. This tool shows light marks from use. Surface is smooth and free of nicks, scratches and gouges. No patches have been applied. No polishing/rework is needed. (Reference example in Figure 4).

Figure 4 Example CTB Rating - 3
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

CTB Rating – 5. There are shallow scratches seen in face of the CTB near tooling hole locations due to repetitive resin removal and tool release build-up. This condition can be felt by hand but is “positive” to tool surface, not “negative”. In other words, this is a buildup and not a gouge in the surface of the tool. (Reference examples in Figures 5, 6, 7, and 8).

Figure 5 Example CTB Rating – 5
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

Figure 6 Example CTB Rating - 5
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

Figure 7 Example CTB Rating - 5
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

Figure 8 Example CTB Rating – 5
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

CTB Rating – 7. There are deep scribe lines (extreme case shown) seen in face of the CTB at part edges. This may be due to production plies being trimmed on tool surface without using metallic shim stock as blade back-up. (Reference example in Figure 9).

Figure 9 Example CTB Rating - 7
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

CTB Rating – 7. There are deep gouges or scratches seen in face of the CTB near tooling hole locations. This is likely due to metallic tools (putty knives) being used in breakout area. Noticeable grooves may be felt by hand. Metallic tools shall not be used on CTBs. (Reference examples in Figures 10 and 11).

Figure 10 Example CTB Rating - 7
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

Figure 11 Example CTB Rating - 7
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

**CTB Rating – 8.** There are deep scribe lines or scratches seen in face of the CTB at the part edges. This is likely due to metallic tools (putty knives) being used in breakout area. Noticeable grooves may be felt by hand. Grayish look on surface indicates sanding has likely been done to tool surface to remove grooves. The tool shows signs that plastic body filler has been used in repairs (reference the brown colored area). (Reference examples in Figures 12 and 13).

![Figure 12 Example CTB Rating - 8](image-url)
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

Figure 13 Example CTB Rating - 8
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

CTB Rating – 9. There are deep scribe lines or scratches seen in face of the CTB as well as previously repaired surfaces. The tool already shows signs that plastic body filler has been added (reference the brown colored area). This tool is not suitable for production use. (Reference Figures 14, 15, 16, and 17).

![Figure 14 Example CTB Rating - 9](image-url)
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.4 CTB VISUAL RATINGS EXAMPLES (Continued)

Figure 17 Example CTB Rating – 9
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.5 CTB VISUAL RATINGS SHEET TEMPLATE

The CTB visual rating data to be provided by the supplier shall include the following information:

a. Vendor Name  
b. Vendor Number  
c. Report Date  
d. Tool Number  
e. Tool Symbol  
f. Tool Series  
g. Tool Multiple  
h. Tool Lifetime Serial Number  
i. Visual Rating  
j. Visual Rating Date  
k. Cure Cycle Counts  
l. First Production Run Date  
m. Any notes/observations about the condition of the CTB

The visual rating data shall be provided in the format below. (Reference Figure 18).

<table>
<thead>
<tr>
<th>NG Tool Visual Rating Report</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vendor Name:</strong> FILL IN</td>
</tr>
<tr>
<td><strong>Vendor Number:</strong> FILL IN</td>
</tr>
<tr>
<td><strong>Report Date:</strong> FILL IN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tool Number</th>
<th>Tool Symbol</th>
<th>Tool Series</th>
<th>Tool Multiple</th>
<th>Tool Lifetime Serial Number</th>
<th>Rating</th>
<th>Rating Date</th>
<th>Cure Cycle Counts</th>
<th>First Production Run Date</th>
<th>Notes / Observations</th>
<th>Part Number</th>
<th>Variant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Figure 18 Visual Rating Report
SECTION 2 – COMPOSITE CURE TOOLS VISUAL RATINGS (Continued)

2.5 CTB VISUAL RATINGS SHEET TEMPLATE (Continued)

The format for each field of the visual rating data is as follows:

<table>
<thead>
<tr>
<th>FIELD</th>
<th>EXAMPLE</th>
<th>Data Type</th>
<th>To be Completed By</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor Name:</td>
<td>Example, Inc.</td>
<td>Text</td>
<td>Vendor</td>
<td></td>
</tr>
<tr>
<td>Vendor Number:</td>
<td>#######</td>
<td>Text</td>
<td>Vendor</td>
<td></td>
</tr>
<tr>
<td>Report Date:</td>
<td>7/1/2016</td>
<td>Date</td>
<td>Vendor</td>
<td></td>
</tr>
<tr>
<td>Tool Number</td>
<td>2CSJ12345-0001</td>
<td>String</td>
<td>Vendor</td>
<td></td>
</tr>
<tr>
<td>Tool Symbol</td>
<td>AJFX</td>
<td>String</td>
<td>Vendor</td>
<td></td>
</tr>
<tr>
<td>Tool Series</td>
<td>01</td>
<td>String</td>
<td>Vendor</td>
<td></td>
</tr>
<tr>
<td>Tool Multiple</td>
<td>001</td>
<td>String</td>
<td>Vendor</td>
<td></td>
</tr>
<tr>
<td>Tool Lifetime Serial Number</td>
<td>JN12345</td>
<td>String</td>
<td>Vendor</td>
<td></td>
</tr>
<tr>
<td>Rating</td>
<td>#</td>
<td>Number</td>
<td>Vendor</td>
<td>CTB Visual Rating based on the 1 to 10 rating system provided by NGAS</td>
</tr>
<tr>
<td>Rating Date</td>
<td>xx/xx/xxxx</td>
<td>Date</td>
<td>Vendor</td>
<td>Date supplier completed the rating for each line item</td>
</tr>
<tr>
<td>Cure Cycle Counts</td>
<td>###</td>
<td>Number</td>
<td>Vendor</td>
<td>Number of cure cycle counts tool has</td>
</tr>
<tr>
<td>First Production Run Date</td>
<td>MM/YYYY</td>
<td>Date</td>
<td>Vendor</td>
<td>The date first part was produced on the tool at the supplier</td>
</tr>
<tr>
<td>Notes / Observations</td>
<td>Pertinent comments to share</td>
<td>Text</td>
<td>Vendor</td>
<td>Pertinent comments to share</td>
</tr>
<tr>
<td>Part Number</td>
<td>2CSH12345-0001</td>
<td>String</td>
<td>NGAS</td>
<td>Part numbers produced by tool</td>
</tr>
<tr>
<td>Variant</td>
<td>CTOL</td>
<td>Text</td>
<td>NGAS</td>
<td>Variant tool supports</td>
</tr>
</tbody>
</table>

2.6 CTB VISUAL RATINGS SHEET SUBMITTAL INTERVALS

The supplier shall submit copies of the current CTB visual ratings data to Northrop Grumman twice annually:

1. For tooling activities from January 1st – June 30th, submit data to Purchasing Representative by July 31st.
2. For tooling activities from July 1st – December 31st, submit data to Purchasing Representative by January 31st.
SECTION 3 – REFERENCE DOCUMENTS/GLOSSARY

This manual will be used in conjunction with but not limited to the following applicable documents. Applicable documents listed can be found on the NGAS OASIS website. Contact the SME-Field Support or SME-Operations Representative if a conflict arises between the Purchasing Document, content of this manual, or any of the specific program specifications and documents listed below:

3.1 DESIGNED AND NON-DESIGNED TOOL SPECIFICATIONS

1) TPS 1200.1 – Composite Prepreg Tools (Export)
2) TPS 1217 – Tool Process Specifications
3) Northrop Grumman Aerospace Systems Supplier Tooling Manual

3.2 LIST OF FIGURES

The following is a list of the figures and page numbers that have been referenced throughout this manual:

Figure 1 Maintenance/Repair Log Example .............................................................. 5
Figure 2 Example CTB Rating - 1 ........................................................................... 8
Figure 3 Example CTB Rating - 1 ........................................................................... 9
Figure 4 Example CTB Rating - 3 ........................................................................... 10
Figure 5 Example CTB Rating - 5 ........................................................................... 11
Figure 6 Example CTB Rating - 5 ........................................................................... 12
Figure 7 Example CTB Rating - 5 ........................................................................... 13
Figure 8 Example CTB Rating - 5 ........................................................................... 14
Figure 9 Example CTB Rating - 7 ........................................................................... 15
Figure 10 Example CTB Rating - 7 ....................................................................... 16
Figure 11 Example CTB Rating - 7 ....................................................................... 17
Figure 12 Example CTB Rating - 8 ....................................................................... 18
Figure 13 Example CTB Rating - 8 ....................................................................... 19
Figure 14 Example CTB Rating - 9 ....................................................................... 20
Figure 15 Example CTB Rating - 9 ....................................................................... 21
Figure 16 Example CTB Rating - 9 ....................................................................... 21
Figure 17 Example CTB Rating - 9 ....................................................................... 22
Figure 18 Visual Rating Report .............................................................................. 23
SECTION 3 – REFERENCE DOCUMENTS/GLOSSARY (Continued)

3.3 GLOSSARY OF TERMS

ACCOUNTABLE TOOLS: The terms Tools, Tooling, Special Tooling are used synonymously and refer to Special Tooling (ST) or Special Test Equipment (STE) as defined in this manual. When the term ST is used, it excludes STE and likewise when the term STE is used, it excludes ST. These tools are subject to the accountability requirements of the affected contract and will be accounted for, or called out, on the Purchasing Document. These tools must be available for return to the customer upon request or contract completion / termination.

DUPLICATE / MULTIPLE TOOL: A tool that is identical to an existing tool used for rate purposes or multi-spindle machines. Duplicate tools are used to perform the identical function as the original tool.

PURCHASING DOCUMENT: Relates to Purchase Orders, Subcontracts, Tooling Purchase Orders, Contract Letters, etc. and attachments thereof.

PURCHASING REPRESENTATIVE: Relates to the Buyer, Subcontract Administrator, or their delegated representative; i.e. Supplier Manufacturing Engineering Representative, etc.

REQUEST FOR CHANGE/INFORMATION: The Request for Change/Information (RC/I) form (P0-F030) is used by suppliers to request information from the applicable Business Area regarding contractual or technical requirements.

SPECIAL TEST EQUIPMENT (STE): Consists of either single or multipurpose integrated test units engineered, designed, fabricated, or modified to accomplish special purpose testing in performing a contract. STE consists of items or assemblies of equipment including standard or general-purpose items or components that are interconnected and interdependent so as to become a new functional entity for special testing purposes. STE does not include material, special tooling, facilities (except foundations and similar improvements necessary for installing special test equipment) and plant equipment items used for general plant testing purposes.

SPECIAL TOOLING (ST): Consists of jigs, dies, fixtures, molds, patterns, gages, or other equipment and manufacturing aids. This includes all components and replacement of these items that are of such a specialized nature that without substantial modification or alteration their use is limited to the development or production of particular supplies or parts thereof or to the performance of particular services. ST does not include material, special test equipment, facilities (except foundations and similar improvements necessary for installing special tooling), general or special machine tools, or similar capital items. ST also does not include NC Programming/Digital Data, which is not accountable, although it may be reportable when contractually required by program.

SUPPLIER MANUFACTURING ENGINEERING - FIELD SUPPORT (SME-FS): Global Supply Chain Representative responsible for supplier technical issues. SME-FS Representatives provide on-site technical support for Domestic and Canadian suppliers.

SUPPLIER MANUFACTURING ENGINEERING - OPERATIONS (SME-Ops): Manufacturing Engineering and Tooling Representative responsible for supplier technical issues. SME-Ops Representatives reside at each site and provide liaison services between the programs and suppliers as well as on-site technical support for International suppliers.
SECTION 3 – REFERENCE DOCUMENTS/GLOSSARY (Continued)

3.4 ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTB</td>
<td>Composite Cure Tool (BMI)</td>
</tr>
<tr>
<td>NGAS</td>
<td>Northrop Grumman Aerospace Systems</td>
</tr>
<tr>
<td>OASIS</td>
<td>On-line Automated Supplier Information Systems</td>
</tr>
<tr>
<td>PO</td>
<td>Purchase Order</td>
</tr>
<tr>
<td>PTI</td>
<td>Periodic Tool Inspection</td>
</tr>
<tr>
<td>RC/I</td>
<td>Request for Change/Information</td>
</tr>
<tr>
<td>SME-FS</td>
<td>Supplier Manufacturing Engineering – Field Support</td>
</tr>
<tr>
<td>SME-Ops</td>
<td>Supplier Manufacturing Engineering – Operations</td>
</tr>
<tr>
<td>ST</td>
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3.5 ADDITIONAL REFERENCES

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