MARTIN MARIETTA

nternal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

[redacted]

Date: November 27, 1995

To: F. P. Gustavson

c: G. L. Bowers, D. P. Bryant, M. K. Morrow, R. K. Roosa
J. D. Stout, B. S. Spangler, P. R. Wasilko, A. K. Zava

From: R. C. Cawood, 9113, MS-8208, 4-1021 (RC)

Subject: **Y-12 Commitment to B61-11 Program (U)**

95-194

It is my understanding that Y-12 has verbally committed to support preproduction and production requirements for the B61-11 Program, within the constraints imposed by the lack of a design selection (design selection is expected by mid-December). Y-12's required ship date for the First Production Unit, as defined in the DOE/AL request for a preliminary cost estimate, is August 1997; a date which requires tooling design and fabrication and initiation of Process Prove-In (PPI) activities in FY 96.

As you are aware, Y-12 is hosting a Program Review Meeting on Thursday, November 30. Although I do not plan to specifically address the issues in the previous paragraph, it is likely the subject will be raised by either DOE, SNLA, or LANL. If the issue arises, it is important that I accurately state Y-12's position.

Please advise if my understanding does not represent the Plant's position.

rcc:rmh

DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW

1st Reviewer: RW Fraser (Name)
Authority: ADC ADD
Date: 4-9-96

2nd Reviewer: LB Porter (Name)
Authority: ADD
Date: 4/9/96

Determination 4 [Insert Number(s)]
1. Classification Retained
2. Classification Changed To:
3. Contains No DOE Classified Information
4. Classification Cancelled
5. Classified Information Bracketed
6. Other (Specify):

[redacted]

[redacted]

[redacted]

B61-11 Manufacturing Plan

1 Threaded Ring

1.1 *Manufacturing Concerns*

1.1.1 The requirement to produce a precision, nonstandard ACME thread

1.1.1.1 Material properties are expected to require advanced tool coating requirements to reduce tool wear. These tool coatings coupled with the nonstandard aspect of this thread design will result in longer procurement times. It should be noted that previous tool designs for this thread included compensation for plating thickness. Plating of the ACME threads is no longer a requirement. Therefore, these tools cannot be used to support this definition.

1.1.1.2 The need to assure precision threads will require internal validation of the vendor supplied cutting tools. Engineering designs will be required to support this internal validation by Dimensional Inspection.

1.1.1.3 To produce precision threads, a method must be developed to gage the thread features accurately. Previously used technology, will provide inadequate or insufficient data to allow optimum manufacture of precision threads. Coordinate Measuring Machine (CMM) thread measurement techniques have been demonstrated on the W61. These techniques combined with existing manufacturing technology will provide the information necessary to control a precision thread manufacturing process. To generate a specific CMM capability for this thread, a sample/trial part must be manufactured.

1.1.1.4 Precision horizontal turning equipment is available to accomplish this task. However, threading with this type of equipment is not done frequently. Threading will require very close timing between the spindle position and slide motion.

1.1.2 10-32 threaded holes

1.1.2.1 This component has two each #10-32 threaded holes. The toughness of the material will require some refinement of machine/automated tapping specifications. This refinement will assure that adequate geometric configurations are manufactured and reduce the potential for catastrophic tool failure during the machine tapping operation. It should be noted that manual tapping of this component has been successfully demonstrated in the past. Manual tapping, though not as repeatable as machine/automated tapping, can be easily implemented should development of the operating parameters be in conflict with manufacturing schedule requirements.

1.2 *Manufacturing Capability Refinement Plan*

1.2.1 Summary

Threaded rings from a soft material, i.e., brass, will be fabricated. In a parallel effort, rings will be fabricated from a material that is similar in machining characteristics to the production material. It should be noted that "production similar" material will be used due to the procurement lead times for the production material. It would be preferable to utilize production material. However, it is felt that the delaying initiation of this activity will not be supportive of manufacturing schedules.

1.2.2 Detail Explanation of the Summary

1.2.2.1 Manufacture of Soft Material Components

The manufacture of these components will allow Machining and Product Certification to evaluate and validate many capabilities before implementation of the production process (reference sections 1.1.1.3 and 1.1.1.4). Due to the expected lead time associated with the procurement of coated tools, manufacture of non-production type material is the only avenue to address the nonmaterial related process parameters. It should be noted that an early sample/trial part must be manufactured to develop CMM capability. CMM inspection capability is a mandatory requirement for manufacture of precision ACME threads (reference section 1.1.1.3). Because the soft material can be machined without the use of the advanced tool coatings, manufacturing can continue to identify process difficulties and be working to resolve these difficulties during cutting tool procurement.

1.2.2.2 Manufacture of "Production Similar" Material Components

The manufacture of these components will facilitate refinement of machining parameters that are sensitive to material properties. These parameters include cutting tool geometry, machining coolants, machine tool and work holding fixture rigidity. These components will be used to evaluate two work holding techniques (work holding fixture rigidity versus free state machining process theory), machine coolant and tool wear. If the manufacture of these components results in the production of five adequate components, this will facilitate the ability to maintain initial manufacturing schedules by providing rings to match fit with the first production cases.

1.2.3 Current Activities

1.2.3.1 Tooling Design and Fabrication

An initial cut at the tooling requirements for this process has been completed. Tooling to support the base line process and identified contingency processes has been ordered. Engineering has completed several gaging designs for this component. These designs will be released for procurement/fabrication by February 14, 1996. Remaining designs can probably be completed within two weeks. It is expected that all critical tooling for the base line process could be fabricated within two weeks after the designs are complete. It should be noted that this does not address the longer procurement times associated with the coated threading tool or the hydraulic expanding arbor. Initial activities with the soft material will be supported by non-coated tools which could be internally fabricated within the time frame indicated. Procurement of the coated tool, and the hydraulic expandable manderel as well as the fabrication of the non-coated tool will occur in parallel. This will facilitate the evaluation of several process variables that are independent of material properties prior to final machining of the "production similar" material.

1.2.3.2 Manufacturing Documentation - Specifications/NC Definitions

1.2.3.2.1 Work Initiation

Upon approval of this plan by DUO management, a work effort will be initiated.

1.2.3.2.2 Manufacturing Documentation - Specifications/NC Definitions

Initial development of the machining specification (Draft Copy) will be completed by the first week in March. This documentation will address the common operations associated with the soft material and the production material. The specification will include information relative to the operation of the "production similar" components up to the ACME threading operation.

1.2.3.2.3 NC Definitions

At this time, only two NC definitions are expected to be required to support the operations up to ACME threading. It is reasonable that these will be completed within one week of the completion of the draft machining specification.

1.2.4 Expected Manufacturing Readiness

Though there are significant variables associated with declaring a production readiness date, it is feasible that process development activities could be initiated as early as the second week in March. It should be noted that machining of the ACME thread will require both work holding fixtures and cutting tools to be fabricated. However, three machining operations will be executed before reaching this position. This will allow some parallel processing during the fabrication/procurement cycle.

2 Case Disassembly

2.1 *Manufacturing Concerns*

2.1.1 Component Release/Separation

The initial trials to accomplish this task were accomplished on a long bed CNC lathe. This machine tool was fitted with a milling head on the cross slide. This milling head then machined two grooves in the outer component. In discussing this with personnel that executed the task, a noise was heard at the point at which adequate material was removed. This suggests that the disassembly activity, component separation, is dependent on the stress distribution in the original blanks.

2.2 *Manufacturing Capability Refinement Plan*

2.2.1 Summary

Different processes will be developed. Though the basic methods for separation will be maintained, these processes will be developed for leblond long bed lathes and the large CNC mill in 9201-5N. The alternative process will use the large CNC mill in 9201-5N.

2.2.2 Detail Explanation of the Summary

2.2.2.1 Mill Process for Case Separation - CNC Large Mill

The CNC mill process will use an expandable fixture, i.e., four jaw chuck, to secure the part to the machine. Once both slots are milled into the part and the axial retaining load is removed, two of the four jaws will be expanded until component separation occurs. The inner component will be allowed to drop a short distance onto a soft material stop. The outer component will then be removed with a lifting fixture attached will be attached to existing threaded holes. It is expected that this operating mode will require less setup time and simplified material handling requirements.

The development of an alternative production process will provide additional latitude for the facility by providing a backup process that is totally independent of the base line process.

The use of the backup process tooling will also address the concern relative to the potential variation in forging stress patterns. The use of this machining fixture, in an off-line mode, will facilitate component separation in the event it does not occur as previously experienced in the base line process (reference section 2.1.1).

2.2.3 Current Activities

2.2.3.1 Tooling Design and Fabrication

No activities have been initiated to support this task. It is expected that design and fabrication of the CNC milling fixture could be completed within a 5-week period. An existing four jaw chuck will be used and the remaining hardware fabricated in 9201-1, chuck modifications and final assembly will be accomplished by DUO. It is expected that this approach could be accomplished in a 3-week period.

2.2.3.2 Manufacturing Documentation - Specifications/NC Definitions

Initial development of the machining specification (Draft Copy) will be completed by the third week of March.

2.2.3.3 NC Definitions

Two NC definitions will be required. It is reasonable that these will be completed within one week of the completion of the draft machining specification. Note: Previous machining efforts were not supported by NC Engineering. The long bed Leblond programming was accomplished via direct operator commands.

2.2.4 Expected Manufacturing Readiness

This operation could be initiated as early as first week in April if the previously developed manufacturing methods were used and material is available. The start-up of the CNC milling operation is highly dependent on tooling support and the development of manufacturing documentation. Based on expected priorities the CNC milling process could be ready for execution as early as the second week in April.

3 **Beanie**

3.1 *Manufacturing Concerns - None*

3.2 *Manufacturing Capability Refinement Plan*

3.2.1 Summary

The component will be produced using a "mother-daughter" technique. Initially, the mother will be produced and dimensional certified. The final component will then be separated from the mother part and minor modifications accomplished.

3.2.2 Detail Explanation of the Summary

3.2.2.1 A component with requirements similar to the mother part is currently being produced. The same tooling design concepts will be used to manufacturing this component.

3.2.2.2 The individual components, daughter parts, will be separated from the mother via a trepanning operation. A subsequent lathe operation will be used to produce the final component geometry. Both operations are currently planned to be accomplished on manual machine tools.

3.2.3 Current Activities

3.2.3.1 Tooling Design and Fabrication

Tooling and fabrication of fixtures to support the daughter operations have been identified and requested. No activities have been requested for the manufacture of the mother component.

3.2.3.2 Manufacturing Documentation - Specifications/NC Definitions

Initial development of the machining specification (Draft Copy) for the mother component will be completed by the second week of March. Note: This completion is highly dependent of the selection and configuration of the blank to produce this component.

Design layouts of the mother part within available material blanks are currently being finalized. 3-dimensional models are being made to determine the total number of daughter parts that can be made from the mother part. Final blank selection will be highly dependent on this determination. This 3-dimensional layout will also facilitate optimizing the location and tooling design to assure that the maximum number of parts are yielded from the mother component.

3.2.3.3 NC Definitions

Seven NC definitions will be required for the manufacture of the mother part. It is reasonable that these will be completed within two weeks of the completion of the draft machining specification.

3.2.4 Expected Manufacturing Readiness

Though there are significant variables associated with declaring a production readiness date, it is feasible that actual manufacturing activities could be initiated as early as the third week in April. This production readiness estimate applies only to the mother part and assumes that some existing tooling will be available to initiate activities, i.e., certified lifting fixtures.

4 Case

4.1 *Manufacturing Concerns*

4.1.1 The requirement to produce a precision, nonstandard ACME thread

4.1.1.1 Material properties are expected to require advanced tool coating requirements to reduce tool wear. These tool coatings coupled with the nonstandard aspect of this thread design will result in longer procurement times. It should be noted that previous tool designs for this thread included compensation for plating thickness. Plating of the ACME threads is no longer a requirement. Therefore, these tools cannot be used to support this definition.

4.1.1.2 The need to assure precision threads will require internal validation of the vendor supplied cutting tools. Engineering designs will be required to support this internal validation by Dimensional Inspection.

4.1.1.3 Previously used cutting tool technology will provide inadequate or insufficient data to allow optimum manufacture of precision threads. Negotiations with D/A have suggested that shipping the Ring and the Case as matched components is acceptable. Therefore, the ability to match the components will require completion of a threaded ring before machining the thread in the Case (Manufacturing Planning and Schedule Issue).

4.1.2 1/4-28 UNJF - 3B threaded holes

This component has 10 each of these threaded holes. The 3B class fit is the tightest industrial standard thread tolerance. The toughness of the material is expected to require refinement of tapping specifications. This refinement will assure that adequate geometric configurations are manufactured and reduce the potential for catastrophic tool failure during the tapping operation. As these features must be added to the component in one of the last machining operations, there is a potential for significant product loss should this operation not be adequately addressed from a manufacturing quality point of view. Deviation of the pitch diameter for these features is not expected to be a viable alternative due to the significant consequences associated with a failure the threads.

4.1.3 100 Degree Counter Sunk Holes

Large counter sinks of this type generate significant tool pressure. This tool pressure results in the loss of geometric control of the depth of these counter sinks. This type of operation has always been a difficult task to predict appropriate parameters before execution. However, once these parameters are determined, they are typically repeatable from part to part. Parameters such as tool design, machine coolants, spindle speeds and feed rates are then controlled via administrative and/or engineering controls.

4.1.4 Contour Integrity, Positional Location Capability and Productivity

Components of this type have been previously manufactured on horizontal equipment. The original process for this component used this type of equipment. Gravitation forces, especially with this heavy part, play an important part in the ability of the machine tool to generate accurate surfaces. An advanced vertical lathe has been installed to facilitate accuracy improvement. The surfaces that can be machined with the vertical lathe represent critical datum/defining surfaces. Implementation of the additional capability of this machine will also improve productivity. The machine can use ceramic inserts (not a capability on horizontal equipment with the standard ball sets). If the component can be adequately stabilized, the use of ceramic tooling, i.e., whisker reinforced silicon nitride or coated "cermets," could reduce machine run times by 1/3.

4.1.5 Tooling Availability

Though initially thought to be adequate, the tooling for both contouring operations will require modification. These modifications are attributed to the design changes in the final product definition. Both shifting of the center of gravity and modifications to the lug configurations were introduced with the design change. The production tooling for this component is very expensive and requires significant time to fabricate. There is no internal capability to support detail design and fabrication of this type of fixture. It is expected that a three-month procurement cycle will be required for any new tooling of the quality desired for production applications. (Refer to section 4.2.3.1.)

4.1.6 Blank Geometry

Due to the finished part design changes, there are additional/more precision alignment requirements for this component. Alignment of the OC of the component in the horizontal orientation will complicate the setup and lead to additional manufacturing and quality problems. The modifications to the outer surfaces of the component have resulted in a significant reduction of material allowances. The manufacturing plan for the W61 Case secured a nominal material allowance of approximately .200. The decision to utilize the W61 blanks for this application has reduced the nominal material allowance to approximately .016. With the applicable tolerances and capability to align these components, there is a potential issue in that some of the W61 blanks will not yield an adequate product for the B61-11.

4.2 *Manufacturing Capability Refinement Plan*

4.2.1 Summary

A work effort will be initiated. This effort will include the fabrication of Cases from production material. This effort will be executed in a parallel mode with the modification of the existing fixtures. These units will be used to assure appropriate machining parameters are implemented on the milling operation before actual production implementation of this operation. The initial turning operations will use the previously defined process with changes implemented as identified by the design modifications.

Tooling Design activities will continue. These activities are to determine the feasibility of using the vertical equipment and also the modifications necessary to implement the originally planned production process.

It is expected that implementation of the production process will be accomplished in three sequential stages. The stages will be the resurrection of the previous method (for milling prove-in only), horizontal lathe usage and finally the implementation of the vertical lathe.

4.2.2 Detail Explanation of POA Summary

4.2.2.1 Initial manufacture of production material components

The manufacture of these components will facilitate refinement and control of manufacturing parameters (reference sections 4.1.1, 4.1.2 and 4.1.3.). This activity will be executed while production tooling rework and fabrication are being implemented. The primary purpose for this activity will be to prove-in the auxiliary feature manufacturing capability. Should production tooling be available to support this effort, it will be implemented in lieu of the alternative techniques.

4.2.2.2 Horizontal Turning Capability.

Due to several unknowns concerning the vertical lathe, this method will be planned and implemented as necessary. There is no significant cost increase to implement this operation as no additional fixture modification will be required. Because the vertical lathe represents a unique capability, within DUO, the development of this process is also desirable to assure that a functional "back up" method exists to support production.

It is highly recommended that all parts be evaluated for available material on the outer surfaces. The use of horizontal turning methods does not lend itself to precision alignment capabilities. Blanks should be inspected to assure that only those blanks with the maximum amount of material are designated for this type of processing (reference section 4.1.6)

4.2.2.3 Vertical Turning Capability

This effort will be worked parallel to the horizontal turning capability. If implementing this capability is possible, this is the preferred method. Based on dimensional evaluations performed by S. G. Jessing, this method should be adequate without independent dimensional inspection validation (reference section 4.1.6 and 4.1.4).

4.2.3 Current Activities

4.2.3.1 Tooling Design and Fabrication

An initial cut at the tooling requirements for this process has been completed. Tooling to support the base line process has been ordered. Engineering has completed several gaging and fixture modification designs for this component (reference section 4.1.5). Arrangements are being made with the original equipment supplier to rework the finish inner contour work holding fixture on an accelerated schedule.

4.2.3.2 Manufacturing Documentation - Specifications/NC Definitions

4.2.3.2.1 Work Initiation

Upon approval of this plan by DUO management, a work effort will be initiated.

4.2.3.2.2 Manufacturing Documentation - Specifications/NC Definitions

Initial development of the machining specification (Draft Copy) will be completed by the second week of March. This specification will only address the manufacture of the initial components.

4.2.3.2.3 NC Definitions

At this time, only two NC definitions are expected to be required to support the operations up to milling. It is reasonable that these will be completed within two weeks of the completion of the draft machining specification. The milling operations will require additional NC preparation time. It si expected that approximately three weeks should be allocated for this task. However, this task can be worked in parallel with the turning of the first two components.

4.2.4 Expected Manufacturing Readiness

It is expected that manufacturing activities for the first five components could be initiated as early as the last week in March. Based on past optimum performance, it is expected that the first part will be available for milling process prove-in two weeks after starting, i.e., first week in April.