NASA Conference Publication 3308

NASA-Wide Fastener Technical Interchange Meeting (TIM)

Compiled by
Wayne R. Gamwell

Summary of a meeting held
at Huntsville, Alabama
November 15–16, 1994

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Marshall Space Flight Center • MSFC, Alabama

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National Aeronautics and Space Administration
Marshall Space Flight Center • MSFC, Alabama 35812

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FOREWORD

During the last 5 years, many changes have occurred within the fastener community that affect industry, NASA, and other Government agencies. These include passage of Public Law 101-592 "Fastener Quality Act" and development of the National Institute for Standards and Testing–National Voluntary Laboratory Accreditation Program (NIST–NVLAP). These changes are evolving, and they are expected to continue to affect the fastener community by increasing regulatory requirements and production costs.

During this period, the Marshall Space Flight Center (MSFC) has been managing and conducting NASA-wide research and technology programs dealing with fastener integrity controls, metrication, installation torque requirements, cadmium coating replacements, and inspection techniques. These programs are under the aegis of Code QW/QR at NASA Headquarters. The overall objective of these programs is to establish threaded fastener management and control practices for all NASA projects. To this end, Fastener Technical Interchange Meetings are held to exchange information on current policies and practices.

On November 15–16, 1994, the second NASA-Wide Fastener Technical Interchange Meeting (TIM) was held at MSFC, Huntsville, AL. The TIM, sponsored by the MSFC Safety and Mission Assurance Office (S&MA) and the MSFC Materials and Processes Laboratory (M&P), addressed fastener testing, standardization, metrication, quality assurance, traceability, legislation, regulations, new technology developments, and laboratory accreditation. Informative briefings were presented on the Fastener Quality Act and Fastener Laboratory Accreditation, MSFC contractor fastener control plans, and various fastener related research and technology objectives and plans activities at NASA. The meeting was facilitated by Wayne Gamwell of M&P, and it was well attended by individuals representing the various NASA Centers, other Government agencies, and industry. This report documents the information from the meeting.

The M&P Laboratory and the S&MA Office wish to thank the presenters for their high-quality presentations and for their timely submittal of the written material. We wish to acknowledge Brown International Corporation, Inc., and DRD Technologies, Inc., for the professional and dedicated manner in which they coordinated, planned, and supported the meeting.

TABLE OF CONTENTS

	Page
Summary	1
NASA Fastener Integrity Program (Wayne Gamwell)	3
NASA Mechanical Parts Program Overview (Fred Mayer)	17
DOC/NIST/NVLAP Fastener Quality Act and Fastener Laboratory Accreditation Status and Overview (David Alderman)	27
DOD/DISC Fastener Qualified Manufacturers List Program (Al Capcilla and Eugene Zyblikewycz)	61
NASA/KSC Fastener Controls (Elisa Artusa)	93
NASA/GSFC Fastener Controls and Metric Fasteners Lessons Learned (Mike Barthelmy)	105
NASA/JSC Fastener Testing Program (J.T. Rucker)	113
NASA/JPL Fastener Control Program (Angel Garnica)	121
NASA/MSFC Fastener Information Management System (Dave Dobbs)	131
NASA/LeRC Fastener Controls (Rick Barrett)	151
NASA Fastener Metrication Project (Dave Dobbs)	167
NASA Noncontact Dimensional Thread Inspection Project (Ron Quinn and Cynthia Peterson)	189
NASA-Wide Torque Tension Standardization Project (Ron Quinn)	213
Boeing Commercial Airplane Group Fastener Controls (Kristinn Sigurdsson)	223
Thiokol Corporation—Space Operations Fastener Controls (Kendall Dye)	237
Lockheed (Sunnyvale, CA) Fastener Controls (E.A. Brookfield)	249
USBI Fastener Controls (Marvin Smith)	259
McDonnell Douglas Aerospace—HSV Quality Assurance (Bob Bilyou)	265
Teledyne Brown Engineering Fastener Controls (Charlie Blass)	273
TRW (Redondo Beach, CA) Fastener Controls (Don Evans)	281
Fastener Information Management System Splinter Group Minutes	299

TECHNICAL SUMMARY

The Fastener Technical Interchange Meeting (TIM) provided a forum for reviewing problems within the fastener community and covered different aspects of current fastener management and control procedures and new procedures being developed by NASA Centers and industry.

NASA representatives discussed past fastener management and control practices in accordance with NHB 5300.4 (1B, 1C, 1D2, etc.). They described NASA-wide efforts relative to Public Law 101-592 "Fastener Quality Act." Efforts noted include the formulation of Headquarters policy documents relative to inch-pound and metric fastener controls and to the torque-tension testing of fasteners; a mechanical parts program, managed by the Johnson Space Center (JSC); and a fastener integrity program, managed by Marshall Space Flight Center (MSFC). The mechanical parts program and the fastener integrity program establish the basic policies for controlling the selection, acquisition, testing, and traceability of all mechanical parts and fasteners, respectively. These efforts are all supported by Agency-wide working groups. The subject policies and programs are being pursued to: promote standardization, reduce maintenance costs, reduce proliferation of part types, make consolidated procurements feasible, facilitate the electronic use and retrieval of data as an engineering tool, and to facilitate NASA-wide peer group reviews on matters relative to mechanical parts and fasteners.

Fred Mayer (JSC/Loral) discussed the mechanical parts program (MPP). The MPP objective is to establish a NASA-wide approach to handling mechanical parts that can be directly implemented within NASA programs/projects. Elements of the program include a Headquarters policy document to establish the program, the development of a mechanical parts selection list, the development of a mechanical parts information management system (MePIMS), and a methodology to centralize acquisitions of mechanical parts.

Wayne Gamwell (MSFC) discussed the fastener integrity program (FIP). The FIP is an Agency-wide program to assure uniform compliance with fastener programs and specifications through Headquarters policy documents and Center-specific documents. Elements of the program include a Headquarters policy document to establish the program; manufacturer/supplier controls; user controls; the development of a fastener information management system (FIMS); the development of NVLAP-accredited receiving, inspection, and testing laboratories; the development of a noncontact threaded fastener inspection system; the replacement of cadmium as a fastener coating; and support of fastener standardization organizations through participation on their standardization committees.

Dave Dobbs (DRD Technologies, Inc.) described the NASA fastener metrication program. The program objective is to facilitate the transition of NASA pilot programs to the metric system relative to threaded fasteners. Transitioning issues addressed in the program include: availability of metric fastener standards, metric fastener requirements, identification of qualified metric manufacturers, availability and acquisition of metric hardware, source inspection of manufacturers, and tensile testing and torque-tension testing of metric hardware.

James Duke, representing the Industrial Fastener Institute, commented on Public Law 101-592 "Fastener Quality Act." He stated that the law represented a "no value added" response to the problems encountered within the fastener community in the late 1980's. He added that the law imposed unnecessary controls and costs to an already over regulated industry, making it difficult to compete internationally in the highly competitive fastener manufacturing environment.

Program manager, David Alderman, discussed the National Voluntary Laboratory Program (NVLAP), which is sponsored by the National Institute of Standards and Technology. He reviewed the requirement in Public Law 101-592 "Fastener Quality Act" to establish an accreditation program for laboratories testing fasteners used in critical applications, and he stated that NVLAP was the best vehicle for that purpose. He described the NVLAP, the basis for its operation, and the overall accreditation process.

Mr. Cappiella and Mr. Zyblikewycz of the Department of Defense (DOD) discussed their Defense Industrial Supply (DISC), Fastener Qualified Manufacturers/Suppliers List (QML/QSL) Program—currently a pilot program. DISC is establishing a list of manufacturers and suppliers who have in place and use process controls that provide minimum assurance that the products procured by DISC meet specification requirements. The purpose of the QML/QSL program is to reduce procurement lead times, improve quality, and reduce overall life-cycle costs. Elements of the QML/QSL program were provided. Procedures to apply for QML/QSL were described, along with the qualification process and post-award process.

Representatives from NASA Field Centers and from industry discussed fastener controls that varied from very few to very extensive. Fastener control issues of importance across Centers and contractors include selection and use of fasteners, procurement from qualified sources, proper receiving inspection of fasteners, verification of fastener compliance to technical and quality requirements, traceability of fastener lots from raw material to final assembly, inventory control of fasteners, dispositioning of nonconforming fasteners, issuance for final assembly, and handling of scrap. Various NASA and contractor representatives described how fastener control issues were being addressed at their locations. Typical examples follow: Kennedy Space Center (KSC) buys five additional fasteners with every order to perform in-house receiving and inspection operations. JSC maintains fastener lot traceability back to the original material heat. The Jet Propulsion Laboratory (JPL) maintains fully traceable fasteners with controlled storage and segregates fasteners by lot.

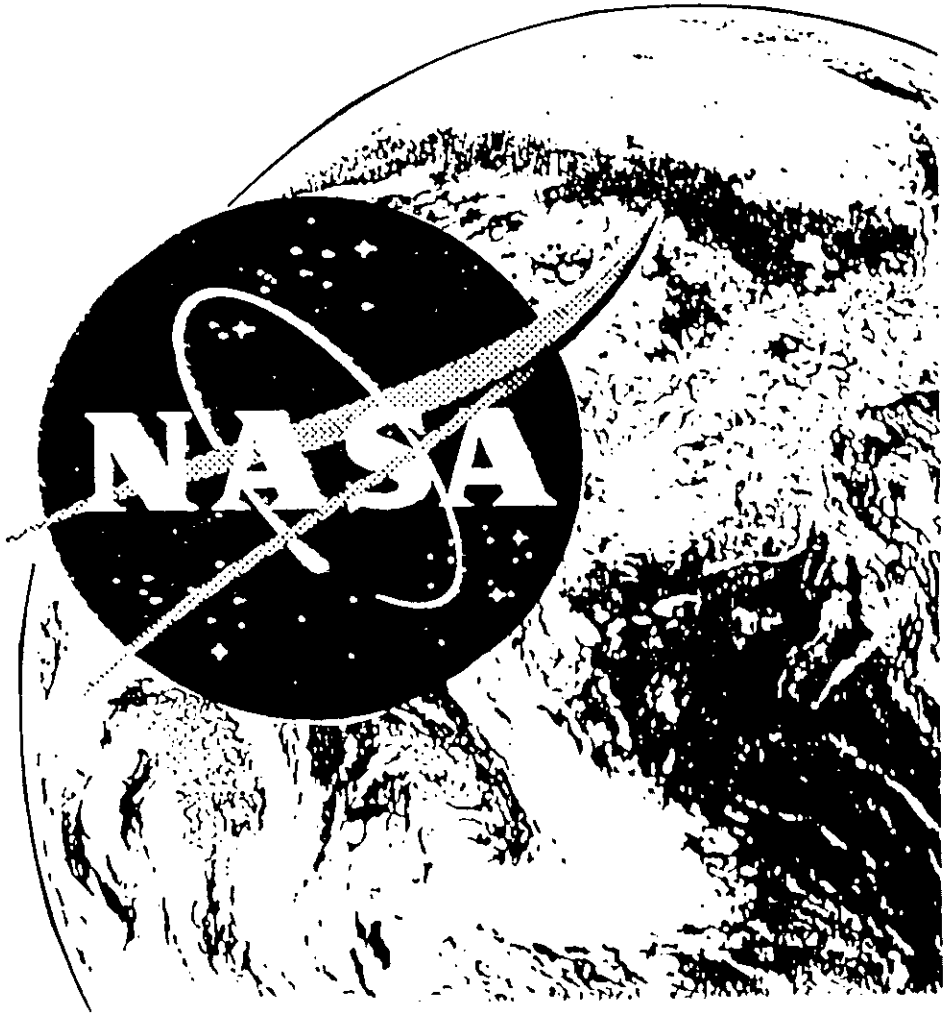
The Fastener TIM was very productive. Progress is being made within the fastener community with respect to fastener management and controls. Currently, fastener management and control practices vary across Installations. However, the NASA Installations are working closely together to formulate Agency-wide documents that will provide baseline threaded fastener policy and practices. The Department of Defense pilot program to qualify manufacturers based on their ability to supply quality products using statistical process control methods is expected to produce favorable results over the long term. The NIST NVLAP program is expected to result in the acquisition of acceptable fasteners through testing at accredited fastener testing laboratories. Contractor fastener management and control practices vary, but appear to be acceptable.

Good fastener management and control policies and practices are necessary today and will continue to be necessary in the future. The problem of counterfeiting fasteners persists. Incomplete raw data verifying fastener properties are still generated, etc. As long as the aforementioned problems and practices exist, vigilance in verifying acceptability of threaded fastener products will be necessary.

NASA Fastener Integrity Program

November 15, 1994

Wayne Gamwell
Marshall Space Flight Center



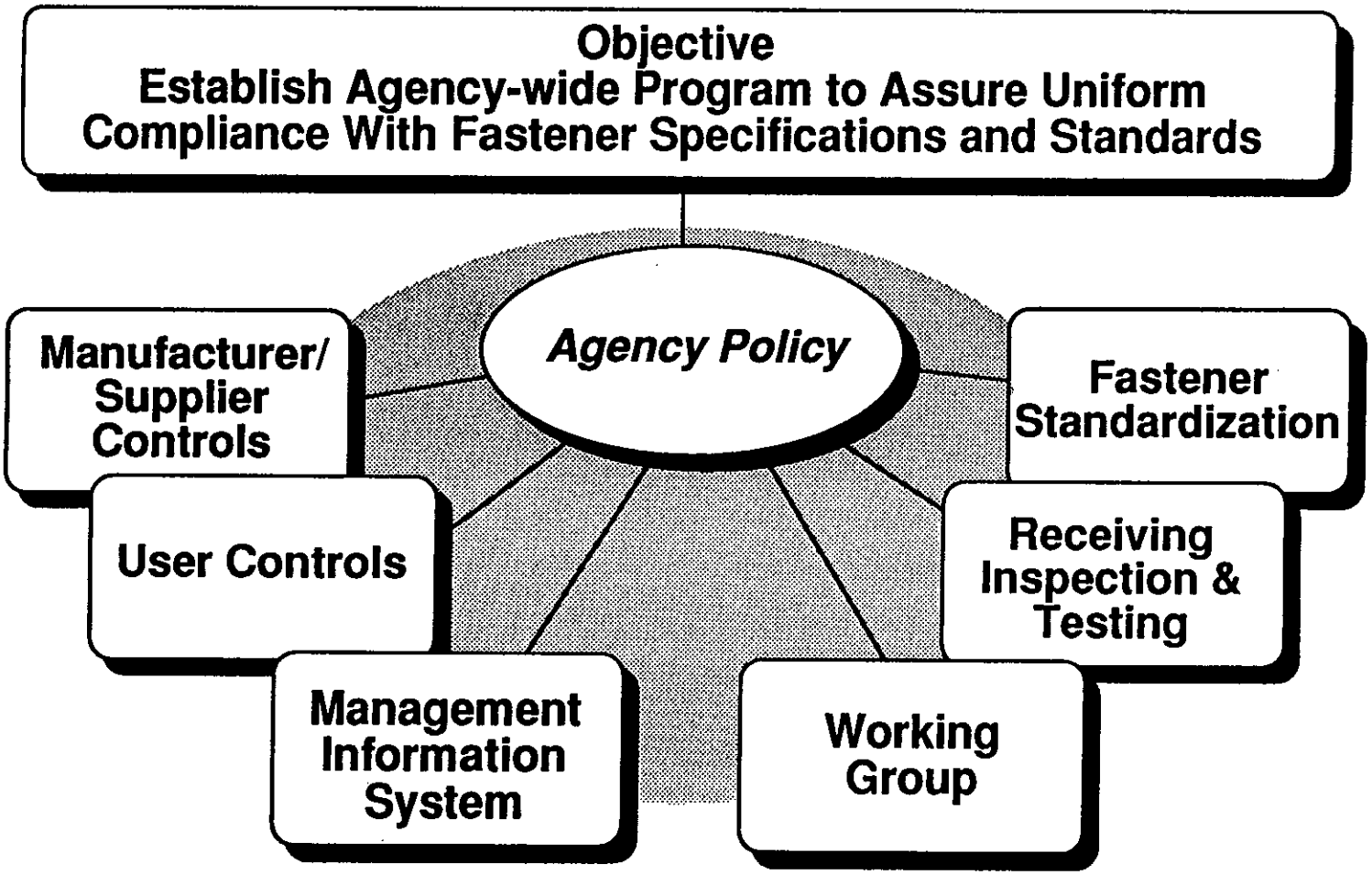
Agenda

TOPIC	PAGE No.
Introduction	3
Fastener Integrity Program	4
Policy	6
Threaded Fastener Control Plans	7
Fastener Information Management System	8
Agency-Wide Working Group	9
Fastener Receiving Inspection Test Facility	10
Fastener Standardization	11
Implementation Efforts	12

Introduction

- WHY? WHY ARE WE HERE? WHAT IS OUR REASON FOR BEING - AS A BUSINESS OR AS A FUNCTION?
- WHAT? WHAT ARE WE DOING? WHAT PRODUCTS OR SERVICES DO WE OFFER IN PURSUIT OF OUR REASON FOR BEING? WHAT NEW PRODUCTS OR SERVICES ARE WE DEVELOPING?
- HOW? HOW DO WE DO WHAT WE DO? WHAT IS THE PROCESS BY WHICH DECISIONS ARE MADE AND EXECUTED?
- HOW WELL? HOW PROFITABLY DO WE DO WHAT WE DO?

Fastener Integrity Program



Fastener Integrity Program Restart

- **New Initiative Brings Fastener Integrity Program to Operational Status Through Phased Approach**

- **Utilizes Existing Documentation and Work Completed to Date from Previous Efforts**
  - NHB5320
  - TFCP
  - FIMS Data Descriptions and Requirements Documents
  - FIMS Software (Developmental Version)
  - Testing Equipment
  - Current Working Group
  - NASC and FEAT Participation

Agency Policy

- **Agency Document: NHB5320, ~90% Completed**
  - Contains Manufacturer and User Controls
    - Installation-specific TFCPs
  - Current Version is Coordinated
  - Resolve Final Review Comments
  - Incorporate Changes
  - Review with JSC/Mechanical Parts Program
  - Maintain Document Current
- **PL 101-592**
  - Monitor Regulations and Implementation
  - NHB5320 Impact

Threaded Fastener Control Plans

- **Maintain Approved TFCPs**
- **NHB5320 Data Compilation and Reporting Requirements**
  - Coordinate and Perform FIMS Input
    - MSFC
    - Other NASA Installations
- **MePIMS**
  - Parts Usage and Data Input

FIMS

- **Element of MePIMS (JSC)**
- **Finalize and Coordinate Requirements Definition Document**
  - Code QW Software and Joint Group Review
- **FIMS Working Group (Users / Customers)**
  - Group Requirements and System Review
- **Complete Software According to Code QW Requirements**
- **FIMS Acceptance Testing**
  - Finalize Test Plan Document
  - Coordinate Testing Program and Perform Tests
  - Resolve Test Issues - Retest as Required
- **FIMS Start-Up**
  - Software Performance
- **Operate and Maintain FIMS**
  - Help Desk

Working Group

- Monthly Agency-wide Fastener Working Group
- Fastener Integrity Program Implementation Vehicle
- Open Forum for the Communication and Resolution of Generic Fastener Quality and Technical Issues
- Facilitate Working Group Interaction With Other Fastener-related RTOP Efforts
- Publish Minutes

Fastener Receiving Inspection Test Facility (RITF)

- **JSC JATL - West of Mississippi**
  MSFC RITF - East of Mississippi
- **Testing Resources**
  - Tensile / Double Shear
  - Chemistry
  - Dimensional
  - Metallurgy on as required basis
- **NVLAP Accreditation**

Fastener Standardization

- **Support Fastener Standardization Organizations**
  - National Aerospace Standards Committee (Industry)
  - Fastener Engineering Analysis Team (Government)
  - Coordinate with SAE E-25 (JSC/Tracor Applied Sciences)
- **Review Fastener Standards In Development**
- **Monitor Government Transition (MS Fasteners) to Industry Consensus Standards (NAS, ASTM, SAE E-25)**
- **Recommend New Fastener Standards or Changes to Existing Specifications, Based on FIMS and Working Group Data, Experience, and Comments**
- **NASA Sponsorship of Standards Projects**
- **NASA Perferred Fastener Selection List / FIMS Input**
  - Coordination with JSC Mechanical Parts Preferred Parts Selection List Effort

Implementation Efforts

Five Phases

- **Phase I**
  - Re-establish Fasteners Working Group
  - FIMS Users Group
  - Define Agendas
- **Phase II**
  - FIMS Software Acceptance Test / Requirements Criteria
  - Finalized FIMS Requirements and Operational Documentation
  - Final Version of NHB5320
  - Identify Required Test Fixtures and Test Procedures
- **Phase III**
  - Perform FIMS Acceptance Tests & Resolve Issues
  - Initiate FIMS Data Input per MSFC TFCP
  - Complete Test Fixtures and Test Procedures

Implementation Efforts

- **Phase IV**
  - Initiate Fastener Receiving Inspection Testing Operations
  - NVLAP Application
  - Implement All Elements of MSFC TFCP
  - Initiate MePIMS Data Input and Coordinate With JSC/ Mechanical Parts Program
- **Phase V**
  - NVLAP Accreditation of MSFC Fastener RITF
  - NHB5320 Implementation

Mechanical Parts Program

Supporting NASA Centers and Projects Through Technology and Teamwork

Mr. Fred Mayer
JSC/Loral

Presentation Overview

- Background
- Program Charter
- Part Types
- Program Objectives
- Products/Value Added
- Long Term Program Goals

Background

- Aerospace Industry has discovered substandard parts (Fasteners, Pins, Bearings, Springs)
- GIDEP continues to identify problem parts
- Industry and NASA have spent millions of dollars in identifying and resolving substandard part issues
- Surveys of Aerospace Contractors and NASA Facilities identified shortfalls within our current approach
- Multidisciplined Working group established to resolve problems/issues/concerns
  - Group represents the diverse project/program needs of the NASA Centers
- Consensus reached among Working Group - Something needs/ed to be done
- NASA Management Instruction (NMI) 5320.7 "Basic Policy For Mechanical Parts", was established through working group
  - SSF WP-2 Mechanical Parts Management Plan and Standards Manual was modeled after NMI and Draft NHB
- We must strive to assist the NASA Facilities through Quality, Engineering, Procurement, etc. to preclude these problems

Program Charter

To establish a NASA-Wide approach to handling mechanical parts which can be directly implemented within the respective programs/projects which will allow the NASA facilities to:

- Promote/maintain technical and management expertise concerning mechanical parts
- Capitalize on lessons learned from NASA and Industry
- Reduce costs
- Ensure product integrity and quality
- Reduce program/project risk
- Infuse new technology
- Assist in NASA's transition to Metric
- Standardize (policy, requirements, part types, etc)

Part Types

- Mechanical parts are hardware items acquired by NASA as vendor supplied items, normally used in the assembly of systems and/or subsystems instead of being maintained as end items. The hardware items are normally manufactured by production processes, from a variety of material, in lots much larger than single units. The function of the hardware items are generally to enable or enhance the assembly or operation of the system or subsystem. The following part types are currently considered under the program:

Fasteners	Valves
Bearings	Springs
Studs	Brackets
Pins	Clamps
Rings	Couplings
Shims	Spacers

Objectives

NASA Programs & Projects

Mechanical Parts -->Better, Faster, Cheaper
Through Policy, Standardization, & Tools

Shorter Lead Times
Fewer Purchases
Fewer Audits
Reduce Special Design Parts

Reduced Supplier Base
Only Proven Parts
Qualified Suppliers
Better Communication
Metrication

Reduce duplicate audits
Larger Buys
Less scrap from over-buys
Reduced Maintenance (tools)

Products/Value Added

PROGRAMS/PROJECTS

NMI 5320.7

- NASA Wide Effort
- Established NASA Mechanical Parts Program
- Provides top level req. for Program/Projects
- Standardization, Traceability, Testing, etc.

Mechanical Parts Selection List

- Reduce maintenance costs
- Promote standardization
- Reduce proliferation of part types
- Make consolidated procurement feasible

Implementation of Database MePIMS

- NASA Wide Electronic data retrieval
- Identify problem suppliers/parts (Nonconformances, ALERTs, etc.)
- Engineering parts selection tool

Centralized Acquisition Proposal

- Reduce supplier base
- Allow fewer purchases
- Provide cost savings through quantity purchases
- Reduce waste due to scraps

Peer Group Reviews

- Policy formulation
- Catalyst for the respective mechanical parts activities
- Review ideas/information on Advanced Technologies
- Identify applicaton issues/concerns
- Alleviate major weaknesses in NASA policies and procedures
- Provide a technical base for resolution of problems/issues.

Products/Value Added (Cont'd)

PROGRAMS/PROJECTS

Shared Lessons Learned

- Preclude future mistakes (tethered satelite)
- Identify problem areas (ALERTS)
- Share common requirements and experience (Cad.plating).

Shared Survey/ Audit Data

- Reduce cost by eliminating duplicate audits
- Identify & communicate problems with manufacturers/suppliers

Advanced Technology Parts

- Eliminate duplicate exp. and testing (Space Station - Zip Nuts)
- Share information as a NASA Team to promote new concepts
- Reduce unnecessary design work

Focal Point to Gov't & Ind.

- Ensure NASA needs are considered in new req. and specifications
- Stay abreast of new technology within industry

Part Quality

- Assist procurement to ensure proper req. are specified
- Part Integrity, receiving inspection, validation testing
- Selection of parts with adequate requirements in specifications
- Supplier rating system (track record)

Long Term Program Goals

- MePIMS utilized as intelligent parts selection tool
- Become an integral part of "Concurrent Engineering"
- Facilitate NASA Transition to Metrics
- Foster development of Quality/Engineering Teams
- Promote/facilitate responsive acquisition of Quality, Reliable, Economical Mechanical Parts for all NASA Programs
- Reduce the proliferation of parts within the NASA Facilities and strive toward consolidated stocking/storage systems

NATIONAL VOLUNTARY LABORATORY ACCREDITATION PROGRAM (NVLAP)

National Aeronautics Space Association

Mr. Dave Alderman
Program Manager

Fastener
Quality
Act
NIST
NVLAP

Fastener Quality Act
Objectives of P.L. 101-592

- Protect public safety
- Deter introduction of nonconforming fasteners into commerce
- Improve the traceability of fasteners used in critical applications
- Provide commercial and governmental customers with greater assurance that fasteners meet stated specifications

What is the FQA?

- FQA requires establishment of a NIST Laboratory Accreditation Program (Fastener LAP)
- To accredit laboratories testing fasteners used in critical applications
- Fastener LAP to use the processes of the National Voluntary Laboratory Program (NVLAP)

Fastener Quality Act
Public Law 101-592

SEC.5. TESTING AND CERTIFICATION OF FASTENERS

(b) Inspection and Testing

(1) The manufacturer of a lot of fasteners shall cause to be inspected and tested a representative sample, ..., of the fasteners in such lot to determine whether the lot conforms to the standards and specifications to which the manufacturer represents it has been manufactured.

Such inspection and testing shall be performed by a laboratory accredited in accordance with the procedures and conditions specified by the Secretary (of Commerce)

Responsibilities to NIST

Section	Summary
5(b)&(c)	Sampling Plans, Test Characteristics, and Form and Content of Test Report
6(a)(1)	NIST Fastener Laboratory Accreditation Program Approval of Private Accreditors Recognition of Testing Laboratories Accredited by Foreign Governments or Organizations
6(a)(2)	Accept Applications from Laboratories
6(b)	NIST Laboratory Accreditation Procedures
6(c)	Ensure Compliance of Private Accreditors or Laboratories Accredited by Foreign Governments or Organizations

NIST

FASTENER QUALITY ACT

- FIELDS OF TESTING
  - Chemical
  - Dimensional
  - Mechanical
  - Metallography
  - Non-destructive
  - APPLIES TO DOMESTIC AND IMPORTED FASTENERS
  - IMPLEMENTATION IN 1995
  - PROVISIONS FOR RECOGNITION OF NON-U.S. LABORATORIES

WHAT IS NVLAP

- A process for accrediting laboratories
- Established in 1976
- CFR, Part 285, Title 15
- Administered by NIST
- All fields of testing and calibration
- Available to any qualifying laboratory
- Linked to NIST research Divisions
- Based on ISO standards and guides
- Approximately 850 accredited laboratories
- Fee supported

BASIS FOR OPERATION

- CONSISTENT WITH ISO GUIDES 25 AND 58
  - ISO GUIDE 25, "General requirements for the competence of calibration and testing laboratories"
  - ISO GUIDE 58, "Calibration and testing laboratory accreditation systems - General requirements for operation and recognition"
- NIST HANDBOOK 150
  - NVLAP General Procedures and Requirements
    - A- General Information
    - B- Establishing a LAP
    - C- Accrediting a Laboratory
    - D- Conditions and Criteria for Accreditation

ACCREDITATION PROCESS

- Application from laboratory
- Review of application and quality manual
- On-site assessment
- Proficiency testing
- Panel Review
- Accreditation Recommendation
- Accreditation Action
- Issue Certificate and Scope of Accreditation

Criteria for Accreditation (Consistent with ISO Guide 25)

- Quality System
- Staff Competence and Training
- Facilities and Equipment
- Calibration and Traceability
- Test Methods and Procedures
- Recordkeeping
- Test Reports

ON-SITE ASSESSMENTS

- TYPES
  - Scheduled
  - Monitored
- ASSESSORS
  - Peer experts on contract
  - Paid by assignment
- TOOLS
  - NIST Handbook 150
  - NIST Handbook 150-x (Specific technical requirements)
  - Checklists (tailored)

On-Site Assessment

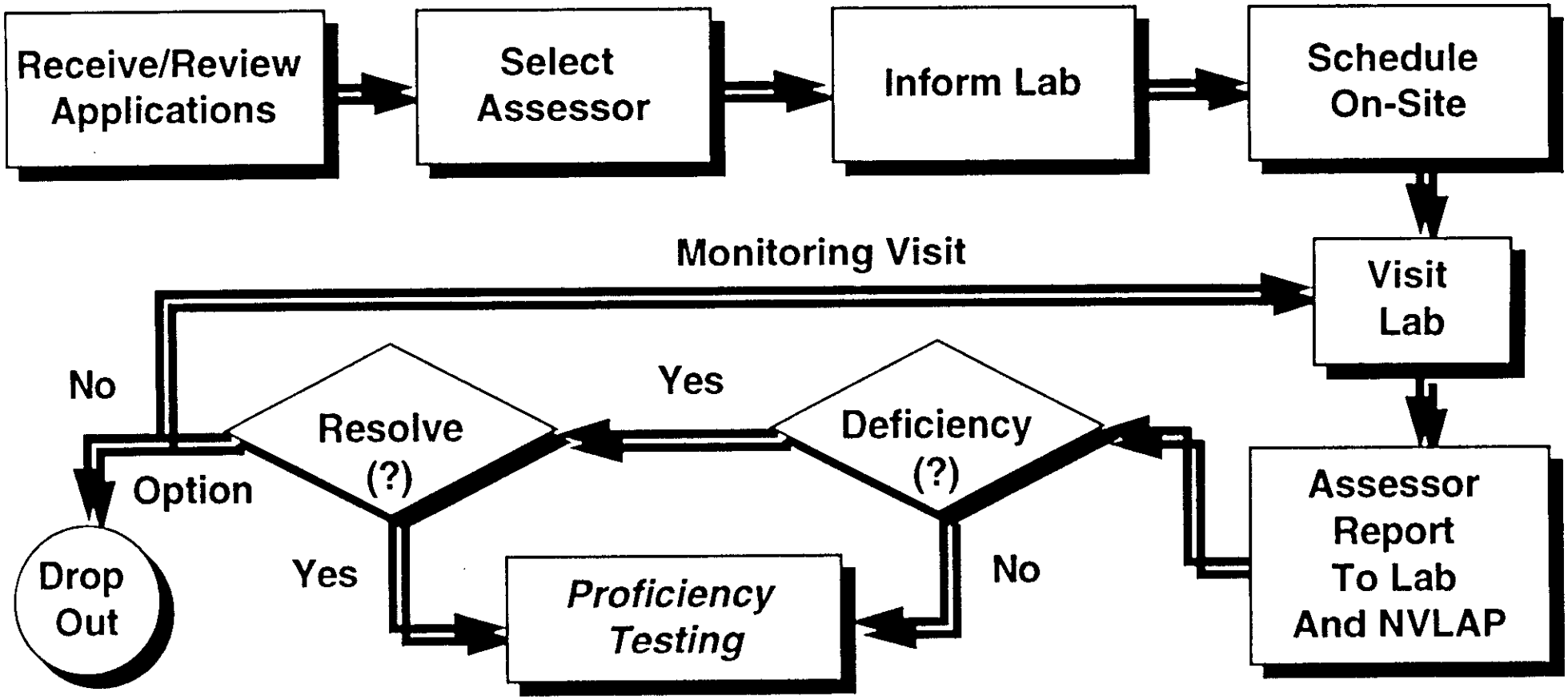
- Entry Briefing
- Review Documents & Records
- Review Quality Assurance System
- Observe Demonstrations
- Talk to Personnel
- Examine Equipment and Facilities
- Exit Briefing and Report

Proficiency Testing is

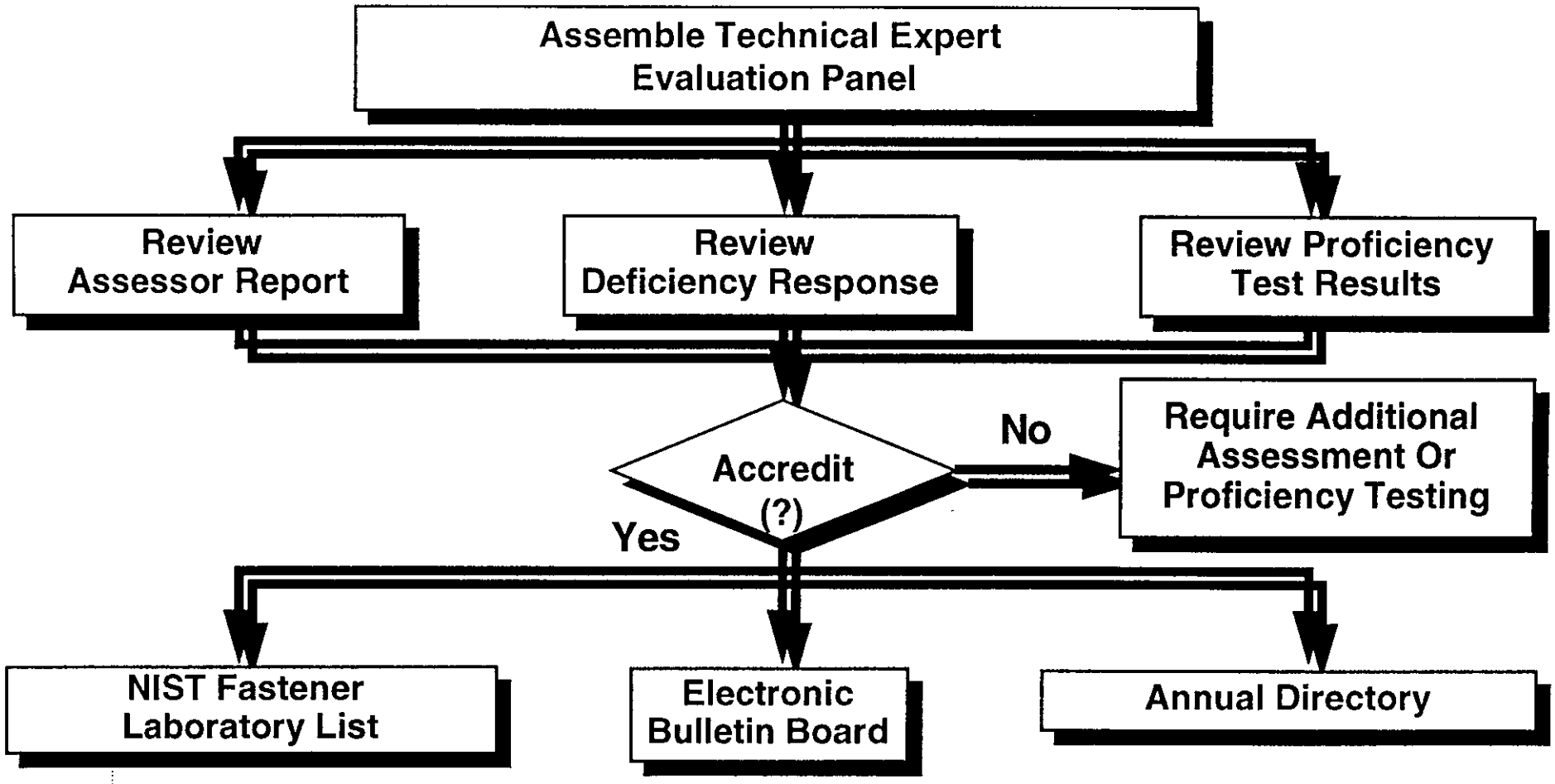
- A means of checking laboratory performance through periodic interlaboratory comparison.
- Required for initial and for continuing accreditation.
- An integral part of the laboratory accreditation process

NVLAP NIST

Perform Assessment
Laboratory On-Site Evaluation



Evaluation


Assemble Technical Expert Evaluation Panel
Review Assessor Report
Review Deficiency Response
Review Proficiency Test Results
Accredit (?)
No
Require Additional Assessment Or Proficiency Testing
Yes
NIST Fastener Laboratory List
Electronic Bulletin Board
Annual Directory

NVLAP
Accreditation Decisions

Accreditation

Denial

Suspension

Revocation

Termination

(Adverse decisions can be appealed.)

Record keeping Requirements

- Retain for 10 years
- Test Folder contains Information Sufficient to Reproduce Test Conditions

NVLAP NIST

Subpart B
Accredited Laboratory List

- Purpose of List
- Mode of Access
- Maintaining List

Fasteners And Metals Program Testing And Inspection Methods

- Mechanical and Physical
- Metallography
- Nondestructive
- Dimensional
- Chemical

NVLAP FEE SCHEDULE (Effective 10/24/94)

PROGRAM/Field	ADMIN./ TECHNICAL SUPPORT FEE[1]	INIT. APPL. FEE[2]	ON-SITE ASSESS. FEE[3]	PROFICIENCY TESTING FEE[1]	TEST METHOD FEE
CALIBRATION[4] - STAGE 1		$1,500			
STAGE 2	$3,600 (1st field) $800 (ea. addl. field)		Variable[5]	$1,000 per field	NA
Dimensional					
Electromagnetics-DC/Low Freq.					
Electromagnetics-RF/Microwave					
Ionizing Radiation					
Mechanical					
Optical Radiation					
Thermodynamic					
Time and Frequency					
COMPUTER/ELECTRONICS	(See endnote [6])	$500	Variable[5]	NA	$150 per t.m.
GOSIP	$3,600				
POSIX	$3,600				
FCC	$2,600				
MIL-STD-462	$2,600				
DOSIMETRY	$3,000[6]	$500	$2,000	Variable[7]	$50 per t.m.
ENVIRONMENTAL	$2,600[6]	$500			
Bulk Asbestos Fiber Analysis			$2,000	$1,022	$300
Airborne Asbestos Fiber Analysis			$2,200	$4,305	$400
Bulk/Airborne Combined[8]			$2,400	$5,327	$700
FASTENERS AND METALS[9]	$3,100[6]	$500	Variable[5]	(See endnote [10])	NA
M&P/Nondestructive/Metallography					
Dimensional Inspection					
Chemical Analysis					
PRODUCT TESTING	$2,600[6]	$500			$50 per t.m.
Acoustics			$2,000	None	
Carpet and Carpet Cushion			$1,800	$ 900	
Construction			$2,000	(See endnote [11])	
Efficiency of Electric Motors			$2,400	(See endnote [10])	
Energy Efficient Lighting			$2,400	$1,000	
Paints, Paper, Plastics, Plumbing, and Seals/Sealants			Variable[5]	(See endnote [11])	
Thermal Insulation			$1,800	$ 700	
Wood Based Products			$2,200	$1,800	

1 The Administrative/Technical Support Fee and the Proficiency Testing Fee are assessed annually on a laboratory's anniversary, regardless of the laboratory's current accreditation status.

2 The Initial Application Fee is paid one time per laboratory only.

3 The On-Site Assessment Fee is due every other year. Pay this fee only for the year in which an on-site assessment is scheduled to be performed.

[4] Due to the variability of the Calibration program from one laboratory to another, application for the program is a two-stage process. See Calibration Laboratories Program-Specific application for explanation and instructions.

[5] Contact NVLAP for determination of the On-Site Assessment Fee.

[6] If more than one field of testing is selected, there is an $1,800 discount to the Administrative/Technical Support Fee for each additional field. Call NVLAP at 301-975-4016 for details.

[7] The Proficiency Testing Fee is calculated on the Dosimeter and Test Category Selection Worksheets contained in the Dosimetry Program-Specific Application package. The proficiency testing fee is due every other year. Pay this fee only when you are notified that proficiency testing is scheduled to be performed.

[8] To qualify for the combined Bulk/Airborne rate, a laboratory must have the same Authorized Representative, renewal date, and on-site assessment schedule for both Bulk and Airborne. Otherwise, an additional $800.00 Administrative/Technical Support Fee and separate On-Site Assessment Fees will be assessed.

[9] The approved fees for the Fasteners and Metals program will be effective on the date the final Fastener regulation is published in the *Federal Register*.

[10] Proficiency testing will not be initiated until an appropriate population of laboratories has enrolled in the program. Laboratories will be invoiced when proficiency testing is implemented.

[11] Proficiency tests for Construction, Paints, and Paper are conducted through outside testing services, and fees are paid by laboratories directly to the provider of service.

* To permit tests of the chemical composition of fasteners to be carried out upon raw materials, rather than upon finished lots of fasteners as required by the Act. The effect of this proposed change would be to greatly reduce the number of tests needed to verify the chemical composition of fasteners, since many lots of fasteners are usually manufactured from one "mill heat."

* To permit the sale of fasteners which, upon testing under the Act, are found to have "minor" flaws resulting in the fastener not conforming to the tolerances stated in the standards and specifications to which they were manufactured. Section 5(a) of the Act expressly prohibits the sale of fasteners which 1) do not conform to the standards and specifications to which they were manufactured, and 2) have not been inspected, tested and certified as provided under the Act. The Committee felt that many lots of fasteners that could not be sold under the Act as presently written could be sold were this amendment enacted, thus reducing manufacturer costs.

* To permit distributors to comingle fasteners from more than one lot in the same container, thus reducing warehouse costs for the distributors, despite the provisions of section 7(e) of the Act.

"Fastener" means any screw, nut, bolt, (as defined below) or stud, washer or other item included within the definition for fastener contained in section 3(5) of the Fastener Quality Act, and shall also include any category of fastener included within the definition by the Director in accordance with the provisions of section 280.5 of this part, but shall not include any category of fastener waived by the Director in accordance with the provisions of section 280.4 of these regulations.

"Screw" means an externally threaded mechanical device possessing capabilities which permit it to be inserted into holes in assembled parts, of mating with preformed internal threads or forming its own threads, and of being tightened or released by applying a torque to one end.

"Nut" means a perforated block possessing internal, or female, screw threads, intended for use on external, or male, screw threads for the purpose of tightening or holding two or more bodies in definite relative positions.

"Bolt" means a headed and externally threaded mechanical device designed for insertion through holes in assembled parts to mate with a nut and is normally intended to be tightened or released by turning that nut.

"Stud" means a rod consisting of one or more cylindrical surfaces, threaded on one or both ends or throughout its length, and designed to be used as a bolt or screw.

"Washer" means a part, usually thin, with a centrally located hole or slot and used under a nut or a bolt head which generally distributes a bearing load over a greater area.

"Load-indicating washer" means a washer or washer assembly which provides an indication, using the human senses or mechanical measuring devices, when a certain joint load has been attained.

DRAFT

Laboratory Test Reports.

(a) When performing tests for which they are accredited under this part, each laboratory accredited under Subparts C, D, or E of these regulations and currently listed in the Accredited Laboratory List shall issue test reports of its work which accurately, clearly, and unambiguously present the test conditions, test set-up, test results, and all required information. All reports must be in English or be translated into English, must be signed by an approved signatory, must employ a tamper resistant system , and contain the following information:

(1) Name and address of the laboratory;
(2) Unique identification of the test report including date of issue and serial number, or other appropriate means;
(3) Name and address of client;
(4) Fastener Description, including:
  (i) Manufacturer (name and address);
  (ii) Product family (screw, nut, bolt, washer, or stud), drive and/or head configurations as applicable;
  (iii) Head markings (describe or draw manufacturer's recorde insignia and grade identification or property class symbols);

(iv) Nominal dimensions (diameter; length of bolt, screw or stud; thickness of load bearing washer or nut); thread form and class of fit;

(v) Product specification related to the laboratory in writing by the manufacturer, importer or distributor;

(vi) Lot number and other numbers as appropriate;

(vii) Specification and grade of material;

(viii) Coating material, thickness, process applied, baking, if any, and corrosion resistance testing, if applicable;

(5) Sampling information

(i) Standard or reference for sampling scheme;

(ii) Production lot size and the number sampled and tested;

(iii) Name and affiliation of person performing the lot sampling;

(6) Test Results

(i) Actual tests required by specification;

(ii) Test results for each sample;

(iii) All deviations from the test method;

(iv) All other items required on test reports according to the test method;

(v) Where the report contains results of tests performed by sub-contractors, these results shall be clearly identified along with the name of the laboratory and accreditation information listed in paragraph 10 of this section.

(vi) A statement that the samples tested either <u>conform</u> or <u>do not conform</u> to the fastener specifications or standards and explanation of any nonconformance, except as provided for in section 280.16;

(7) A statement that the report must not be reproduced except in full;

(8) A statement to the effect that the test report relates only to the item(s) tested;

(9) Name, title and signature of approved signatory accepting technical responsibility for the tests and test report;

(10) The name of the body which accredited the laboratory for the specific tests performed which are the subject of the report, and code number assigned to the laboratory by the accreditation body, and the expiration of accreditation.

Who do I call if I have questions about the Act or Regulations?
Various parts of the Department of Commerce are involved in administering the Act and Regulations. Contacts for the involved agencies are listed below:

Questions pertaining to laboratory accreditation:

Mr. Albert Tholen, Program Manager
Laboratory Accreditation Program
Office of Standards Services
TRF Building, A162
National Institute of Standards & Technology
Gaithersburg, Maryland 20899
Phone: (301) 975-4017

...for questions pertaining to laboratories accredited directly by NIST under its NVLAP program for fasteners and metals.

Mr. John L. Donaldson, Program Manager
Standards Code & Information Program
Office of Standards Services
Administration Building, A629
National Institute of Standards & Technology
Gaithersburg, Maryland 20899
Phone: (301) 975-4029

...for questions pertaining to the approval of private sector organizations to accredit laboratories to test fasteners or for recognition of foreign laboratories to test fasteners.

Questions pertaining to recordation of fastener insignias:

Ms. Lynne Beresford
Trademark Legal Administration
Office of Assistant Commissioner for Trademarks
2121 Crystal Park #2, Suite 910
Arlington, VA 22202
Phone: (703) 305-8900

Questions pertaining to enforcement of the Act or Regulations, including interpretations of the Act or Regulations:

Mr. Frank W. Deliberti, Director
Office of Export Enforcement
Bureau of Export Administration
U.S. Department of Commerce
14th & Constitution Avenue, NW
Washington, DC 20230
Phone: (202) 482-3618

FASTENER QUALITY ACT
P.L. 101-592

Frequently Asked Questions

Note: Listed below are questions that are frequently asked by companies or persons interested in the Fastener Quality Act and its requirements. The answers are "best effort" responses intended to provide basic information and guidance for the specific circumstances mentioned. They have been prepared by NIST with input from other agencies of the Department of Commerce and from the Fastener Advisory Committee. The answers should <u>not</u> be considered as or used as "official" interpretations of the Act or Regulations.

1. **I purchase fasteners and use them in components and assemblies which I then sell to others. What are my responsibilities under the Act and Regulations?**
   The Act applies to the fasteners themselves and not to components or products which may contain fasteners. For example, if you purchase "fasteners" as defined by the Act and use them in a component or assembly and sell that product to a customer, the Act does not apply to your product. However, the "fasteners" you purchase for use must comply with the Act and Regulations, provided they were manufactured after the effective date of the Act.

2. **Are "fasteners" included in a component or product which is imported into the United States covered by the Act?**
   No, such fasteners are not subject to the Act's testing and certification requirements. However, fasteners which have been incorporated into components and which carry performance and manufacturers' marks should meet the applicable specifications which their marks imply.

3. **How do I know when I have "significantly altered" a fastener within the meaning of the Act?**
   Any alteration of a fastener which could weaken or otherwise materially affect its performance or capabilities as it was originally manufactured and tested is considered a "significant alteration". Alterations <u>**not**</u> considered "significant" include:
   a) the application of adhesives, sealants, or locking elements;
   b) cutting-off of threads, except as noted below;

c) provisions for lock wires; or
d) coating and plating of parts with a specified minimum tensile strength of less than 150,000 psi

The practice of purchasing finished threaded studs, rods, and bars and cutting them to produce individual fasteners for resale is not considered a significant alteration However, the individual fasteners cut from threaded studs, rods, and bars and offered for resale must be individually marked with the grade or property class identification marking appearing on or accompanying the threaded studs, rods, and bars from which the fasteners were cut

4. **Who is responsible for assuring that the requirements of the Act are followed when "significant alterations" are made to a fastener, the "alterer" or the "owner" of the fastener, if the two are different persons?**

The person or persons who owned the fastener at the time the "significant alteration" was carried out is responsible for assuring adherence to the Act and Regulations

5. **What are my responsibilities under the Act and Regulations as a "significant alterer" of fasteners?**

As a "significant alterer" of fasteners you take on responsibilities under the Act that are almost the same as those of the original manufacturer You must mark the fasteners with your registered insignia if the standard they were originally manufactured to requires head marking You must assign a new lot number to the fasteners You have two options in meeting the Act and Regulations with respect to retesting the altered fasteners First, you may have the altered fasteners inspected and retested In this case, you must treat the fasteners as though they were newly manufactured and all tests required under the applicable standard and specification have to be carried out If the significant alteration is only electroplating of fasteners with a specified minimum tensile strength of 150,000 psi or greater, the marking requirement is waived, and testing must be performed as required by the plating specification Second, you may choose not to retest the fasteners and may, instead, deliver such fasteners to the purchaser accompanied by a written statement noting the original lot number and the new lot number you assigned to the fasteners, disclosing the subsequent alteration, and warning that such alteration may affect the dimensional or physical characteristics of the fasteners.

6. **What is the difference between a "grade mark" and a "raw material mark" in terms of application of the Act?**

A grade mark is placed on a fastener to indicate that the material, strength properties, or performance capabilities of the fastener conform to a specific standard A raw material mark (e.g., "304" or "316" on stainless steel fasteners) indicates the base material used and is not considered a grade identification mark for purposes of the Act and Regulations, unless the mark is required by the standard to identify specific conformance.

7. **When a new "lot number" is assigned to a quantity of purchased fasteners by a distributor or significant alterer, must the manufacturer's original "lot number" be transferred along with the new "lot number" to subsequent purchasers?**
No, provided the distributor or significant alterer assures that their lot number is on each container of fasteners and it is readily traceable back to the manufacturer's original lot identification number.

8. **I am an Original Equipment Manufacturer (OEM) that purchases and uses fasteners covered by the Act in the assembly of my products. I also sell these fasteners to my authorized dealers as replacement or service parts. What are my responsibilities under the Act?**
Your responsibility is to ensure that any subsequent sale of these fasteners meets the requirements of the Act. You are free to commingle fasteners that you use in assembling your products or that you sell to your authorized dealers for use in assembling or servicing products that you produce. You do not have to mark containers of fasteners with lot numbers for sale to your authorized dealers. However, if one of your authorized dealers makes a retail sale of fasteners that you provide to him and these fasteners are to be used with a product that you do not produce, then the containers of fasteners must be marked with the number of the lot from which the fasteners were taken in accordance with the requirements of section 7(f) of the Act. In this latter case, it would be the authorized dealer's responsibility to mark such containers and to make sure that the lot numbers were traceable back to the original manufacturer's lot number.

9. **I am an OEM Authorized Dealer and am frequently asked to sell individual fasteners to repair shops or others for purposes of repairing or performing maintenance on a vehicle or a product produced by my OEM. Do I have to label containers of fasteners with lot numbers for these type of sales?**
No, you do not have to label such containers with the lot numbers provided that the fasteners are sold for the purpose of repairing or performing maintenance on a vehicle or product produced by your OEM as indicated above. You do have to label containers with lot numbers when the fasteners are sold to be used with products that are not produced by your OEM.

10. **I am a purchaser and user of fasteners in my business and I do not resell such fasteners as part of my business. What are my responsibilities under the Act and Regulations?**
You have no responsibilities under the Act or Regulations. The Act pertains to individuals who manufacture, distribute, or import quantities of fasteners for resale to others and not to purchasers and user of fasteners.

11. **My hardware store purchases fasteners covered under the Act and Regulations for subsequent sale at retail to individual consumers. We also sell such fasteners "at wholesale" to contractors. What are my responsibilities under the Act?**
Fasteners offered for sale at retail for the purpose of maintenance, repair, or the customer's personal use are exempt from the lot identification and commingling requirements under the Act and Regulations, unless the customer requests such lot identification In such case, you must supply that identification Containers of fasteners offered for sale at wholesale and containers sold at retail for the purpose of assembling components for products or structures that will be sold to government, industry, or other customers shall be conspicuously marked with the number of the lot from which they came. This number may be the original lot number specified by the manufacturer or the number assigned by the importer, wholesaler, or retailer For example, you can commingle fasteners that you sell to an individual retail consumer that he/she buys for personal use If you sell the same fasteners to a contractor for use in assembling a product or assembly that is going to be sold to someone else, the fasteners have to be sold in containers marked with number of the lot from which they were taken

12 **Do fasteners manufactured before the effective date of the Act have to be retested and certified as being in compliance with the Act once the law takes effect?**
No, only fasteners manufactured after the effective date of the Act are subject to the requirements of the law Fasteners manufactured before the effective date of the Act should already comply with the standards and specifications under which they are offered or exposed for sale

13. **Is it possible to certify fasteners manufactured before the effective date of the Act as being in conformance with the Act?**
Yes, providing it is possible to document that lot integrity has been preserved and that all other requirements of the Act have been fulfilled For example, tests required by the applicable standard or specification must be carried out by a laboratory listed by NIST as being accredited to test fasteners under the Act The requirements pertaining to certification and record keeping must also be met

14 **Does the Act require that containers (packages) of fasteners be marked as being in compliance with the law?**
There is no requirement under the Act or Regulations that containers (packages) of fasteners be marked as being in compliance with the law Requirements for marking of containers pertain to the marking of the lot number from which the fasteners were taken

15. **As a manufacturer of fasteners, what documentation do I have to provide to my customers to comply with the Act and Regulations?**
You must supply a written certificate that the fasteners have been manufactured according to the requirements of the applicable standards and specifications and have been inspected and tested by an accredited laboratory. The written certificate must also indicate that the

original test report covering the fasteners is on file and available for inspection. Copies of applicable laboratory test reports or certificates of conformance must be furnished upon request to any subsequent purchaser of your fasteners.

16. **Must an individual certificate of conformance be provided with each lot of fasteners sold?**
In order to reduce paperwork, you need provide only one certificate of conformance per shipment of fasteners, even if that shipment contains fasteners from more than one lot. The certificate need not be a separate piece of paper, it may be included as part of the shipment's invoice. However, the certificate must provide brief information on each lot or portion thereof included in the shipment as well as the location where the customer can see an original laboratory testing report for each lot or portion thereof included in the shipment.

17 **I sell fasteners to several customers who request that I deliver the fasteners and place them in bins at their place of business. In doing so, the fasteners become commingled. Am I doing something that violates the anti-commingling provision of the Act?**
This kind of "just-in-time" delivery and stocking of customers' bins is becoming very commonplace in the fastener industry, and it is not the intent of the Act to prohibit such practices. However, a few common sense business practices should be considered so as to prevent problems. First, there should be something in writing that clearly requests you to enter your customer's place of business and to place fasteners in bins as part of your overall sales agreement. Second, you should ensure that the fasteners you deliver are in segregated lots and are not commingled until placed in the bins on the customer's premises. Third, you might ask your customers to provide written permission for you to commingle fasteners when stocking bins at their place of business.

18. **What records must be kept to comply with the Act, by whom, and how long must they be retained?**
Manufacturers, importers, private label distributors, and persons who make significant alterations to fasteners must retain all records concerning the inspection, testing, and certification of fasteners for a period of 10 years. Laboratories which perform inspections and testing under the Act must retain all records pertaining to such for a period of 10 years. Businesses or individuals who sell certified fasteners at wholesale or retail must maintain records of lot numbers so as to be able to trace the fasteners they sell back to the manufacturer's original lot number. User of fasteners who do not offer them for sale are not required to maintain records of such fasteners under the Act.

19. **How will I know which laboratories have been accredited to test fasteners under the Act?**
All laboratories that have been accredited to test fasteners will be listed by NIST in a publication that will be made available to all interested persons. The listing of accredited

laboratories will be updated regularly, and only those laboratories that have been "listed" are accredited to test fasteners under the Act

20. **Who do I call if I have questions about the Act or Regulations?**
Various parts of the Department of Commerce are involved in administering the Act and Regulations Contacts for the involved agencies are listed below:

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Washington, DC 20230
Phone: (202) 482-3618

BRVI

QUALIFIED MANUFACTURERS/SUPPLIERS LIST

QML / QSL

Mr. Al Cappeilla

BRVI

CONCEPT

Establish a List of Manufacturers and Suppliers who have in place, and use, process controls that provide maximum assurance that the products procured by the Defense Industrial Supply Center meet specification requirements

BRVI

PURPOSE

Improve Customer Support

√ Reduce Lead Time
- Complements DVD
- Reduce Test/Inspection Time

√ Improve Quality
- Process Control Orientation

√ Reduce Overall Life Cycle Costs
- Eliminate Source Inspection
- Eliminate Destination Inspection
- Minimize Rework
- Minimize Depot Storage

BRVI

QML/QSL ELEMENTS

DEFENSE LOGISTICS AGENCY

- √ Engineering Criteria
- √ Application Form / QA Manual
- √ Survey
- √ Basic Agreement
- √ Audit Process

BRVI

DEVELOP CRITERIA

- √ Product Characteristics
- √ Industry Characteristics
- √ Site Visits
- √ Customer Participation
- √ Review & Comment
- √ Commercial Practices

BRVI

FASTENER QML CRITERIA ELEMENTS

DEFENSE LOGISTICS AGENCY

- √ Quality Control Program
- √ Auditing System
- √ Records Control/Maintenance
- √ Document Controls
- √ Raw Material Inspection
- √ Process Controls
- √ Test / Equipment / Tooling Controls
- √ Product Traceability
- √ Lot Control / Marking
- √ Non-conforming Material / Corrective Action
- √ Statistical Process Controls (SPC)
- √ Personnel Training
- √ Product Manufactured from Components

QML/QSL

HOW TO APPLY

- OBTAIN & REVIEW CRITERIA/PROVISIONS (QML or QSL)
- CAGE CODE PREREQUISITE
- OBTAIN AND COMPLETE APPLICATION
  - IDENTIFY COMMODITY SPECIALTIES
  - INCLUDE RECENT AUDIT REFERENCES
- SUBMIT APPLICATION ALONG WITH QA MANUAL TO DISC-EEP

QML/QSL

QUALIFICATION PROCESS

- APPLICATIONS REVIEWED BY DISC-EEP
- QA MANUAL EVALUATED AGAINST QML/QSL CRITERIA
- REFERENCES VALIDATED OR SITE SURVEY CONDUCTED
- QUALIFICATION APPROVAL OR CORRECTIVE ACTION LETTER
- NO FEE INVOLVED

QML/QSL

POST-AWARD

- QML/QSL AUDIT
  - UNANNOUNCED/SHORT NOTICE
  - VERIFY CONTRACT PAPER TRAIL
  - INCLUDES FACILITY REVIEW
  - MAY INVOLVE TEST SAMPLES
  - ASSURANCE THAT "QUALIFIED" PROCESS STILL BEING PERFORMED

BRVI

STATUS

DEFENSE LOGISTICS AGENCY

√ Bulk Metals

- 13,500 NSNs covered now
- 106 Suppliers Qualified
- Since Jun 94--All Awards are QSL

$45M Sales
107K Requisitions

√ Fasteners

- 43,100 NSNs in process for Class 3 fasteners
- Draft QML / QSL criteria developed
- Pre-Qualification Conference Conducted (28 Sep 94)
- Industry feedback being evaluated
- Application processing begins 1 Nov 94
- Target for initial QML / QSL awards 1 Feb 95

$47M Sales
750K Requisitions

Future Activity FY 95

BRVI

DEFENSE LOGISTICS AGENCY

- √ Rivets — 25K NSNs; $34M Sales 166K Requisitons
- √ Electrical Wire/Cable — 12K NSNs; $45M Sales 100K Requisitions
- √ Gaskets/Seals — 26K NSNs; $19M Sales 200K Requisitons
- √ Bearings — 62K NSNs; $35M Sales 120 K Requisitions
- √ Developing QML/QSL Master Plan

QML/QSL

EMPHASIS POINTS

- SUPPLIER OBLIGATED TO DELIVER PRODUCT MEETING SPECIFICATION
- MAXIMUM ASSURANCE THAT QUALITY PRODUCT(S) ARE DELIVERED TO CUSTOMER
- FULL TRACEABILITY IS ESSENTIAL
  - QSL MUST SHOW PRODUCT CAME FROM APPROVED QML
- EACH FACILITY MUST BE QUALIFIED
- RE-QUALIFICATION AT 3-YEAR INTERVALS

DEFENSE INDUSTRIAL SUPPLY CENTER
(DISC)

Qualified Manufacturers List
(QML)
for
Class 3 Threaded Fasteners

Criteria
and
Provisions

Mr. Eugene Zyblikewycz

01 Nov 1994
DISC-EEP

QML/QSL PROGRAM

KEY ASPECTS

- EMPLOYING A DOCUMENTED QUALITY ASSURANCE PROGRAM (QML/QSL)
- NO COMMINGLING OF PRODUCTS (QML/QSL)
- USING STATISTICAL PROCESS CONTROL IN MANUFACTURING OPERATIONS (QML)
- SOLD PRODUCTS PRODUCED BY QML LISTED MANUFACTURERS (QSL)
- SOLD PRODUCTS ARE NOT ALTERED PRODUCTS (QSL)

QML/QSL CRITERIA

QUALITY ASSURANCE PROGRAM

DOCUMENTED IN

↓

QUALITY ASSURANCE MANUAL

APPLIED AT

↓

QUALIFIED FACILITY

APPLIES TO BOTH QML & QSL PROGRAMS

QML/QSL CRITERIA

AUDITS

- INTERNAL (QML/QSL)
  - CONDUCTED AT LEAST ANNUALLY
  - CONDUCTED BY IMPARTIAL TEAM OR PERSON
  - VERIFY COMPLIANCE WITH REQUIREMENTS IN QA MANUAL
  - VERIFY EFFECTIVENESS OF QA PROGRAM

QML/QSL CRITERIA

AUDITS

- EXTERNAL (QML)
  - CONDUCTED ON SUBCONTRACTORS
  - CONDUCTED AT APPROPRIATE INTERVALS
  - VERIFY THAT ONLY APPROVED SUBCONTRACTORS WERE AWARDED CONTRACTS
  - VERIFY THAT SUBCONTRACTED PRODUCTS OR PROCESSES CONFORMED TO SPECIFICATIONS

QML/QSL CRITERIA

RECORDS (QML/QSL)

- PRODUCT VERIFICATION RECORDS KEPT FOR 10 YEARS
  - MATERIAL CERTIFICATIONS
  - TEST REPORTS
  - INSPECTION RECORDS
  - CERTIFICATES OF CONFORMANCE
  - RECORDS PERTAINING TO SPECIFIC ORDER OR CONTRACT
- OTHER PRODUCT VERIFICATION RECORDS KEPT FOR 4 YEARS
- RECORDS CONTROL SYSTEM SHALL INCLUDE:
  - STORAGE
  - RETRIEVAL
  - REPRODUCTION
  - DISTRIBUTION
  - DISPOSAL

QML/QSL CRITERIA

DOCUMENT CONTROL (QML/QSL)

ENSURES THAT ONLY CURRENT OR APPLICABLE SPECIFICATIONS, DRAWINGS, AND ELECTRONIC DATA ARE AVAILABLE TO OPERATING PERSONNEL

QML/QSL CRITERIA

INSPECTION

- DOCUMENTED PROCEDURES SHALL EXIST FOR ALL INSPECTION OPERATIONS (QML/QSL)
- RECEIVING INSPECTION - PRODUCT OR MATERIAL VERIFIED PRIOR TO USE
  - VERIFICATION OF MATERIAL CERTIFICATIONS (QML/QSL)
  - RANDOM TESTING OF RAW MATERIAL SAMPLES (QML)
  - VERIFICATION OF TEST REPORTS (QML/QSL)
- EFFECTIVE CONTROL OF INSPECTION STAMPS AND DEVICES (QML/QSL)
- INSPECTION RECORDS SHALL BE MAINTAINED (QML/QSL)

QML/QSL CRITERIA

PROCESS AND TESTING CONTROL (QML)

- DOCUMENTED PROCESS CONTROLS SHALL EXIST FOR ALL MANUFACTURING OPERATIONS AND COMPLY WITH PRODUCTION PLAN DOCUMENTS AND INSTRUCTIONS
- IN-PROCESS CONTROL LEVELS, FREQUENCY AND SAMPLE SELECTION SHALL BE PLANNED AND DOCUMENTED
- TESTING PROCEDURES SHALL BE DOCUMENTED AND TRACEABLE TO THE MATERIAL OR PRODUCT
- TESTING AND INSPECTION ACCEPTANCE CRITERIA SHALL BE DOCUMENTED
- SUBCONTRACTED TESTING SHALL BE PERFORMED BY ACCREDITED LABORATORIES
- PROCESS CONTROL AND TESTING RECORDS SHALL BE MAINTAINED

QML/QSL CRITERIA

INSPECTION/TEST EQUIPMENT AND TOOLING

- EQUIPMENT SHALL BE UNIQUELY IDENTIFIED (QML/QSL)
- EQUIPMENT SHALL BE ROUTINELY CALIBRATED (QML/QSL)
- CALIBRATION SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE STANDARDS (QML/QSL)
- CALIBRATION STANDARDS AND EQUIPMENT SHALL BE TRACEABLE TO NIST (QML/QSL)
- CALIBRATION PROCEDURES SHALL BE DOCUMENTED (QML/QSL)
- CALIBRATION RECORDS FOR ALL EQUIPMENT SHALL BE MAINTAINED (QML/QSL)
- PERIODIC INSPECTION OF TOOLING SHALL BE PERFORMED (QML)

QML/QSL CRITERIA

TRACEABILITY

- RAW MATERIAL - MAINTAINED THRU MILL CERTIFICATIONS (QML)
- IN-PROCESS - MAINTAINED TRAIL THRU ALL PROCESSING STAGES BACK TO THE RAW MATERIAL (QML)
- MANUFACTURER - PRODUCT SUPPLIED BY MANUFACTURER OR DISTRIBUTOR SHALL BE MARKED WITH QML MANUFACTURER'S IDENTIFICATION SYMBOL (QML/QSL)
- DISTRIBUTOR'S PURCHASE ORDER TO QML MANUFACTURER (QSL)
- DISTRIBUTOR SHALL NOT ALTER PRODUCTS SUPPLIED BY QML MANUFACTURERS (QSL)

QML/QSL CRITERIA

LOT CONTROL AND MARKING (QML/QSL)

- LOT IDENTIFIERS SHALL ASSURE HOMOGENEOUS GROUPING OF MATERIAL TRACEABLE TO RAW MATERIAL (QML) OR QML MANUFACTURER (QSL)
- FOR SUBDIVIDED LOTS DOCUMENTATION SHALL EXIST TO ASSURE TRACEABILITY
- NO COMMINGLING OF LOTS IS PERMITTED
- PIECE PART MARKING SHALL CONFORM TO SPECIFICATION REQUIREMENTS
- LABELS ON SHIPPING CONTAINERS SHALL COMPLY WITH FEDERAL LAWS

QML/QSL CRITERIA

NONCONFORMING PRODUCT AND CORRECTIVE ACTIONS (QML/QSL)

- PROMPT DETECTION AND DISPOSITION
- CLEAR IDENTIFICATION
- ADEQUATE HOLDING AREA
- SYSTEM FOR NOTIFYING CUSTOMERS
- IDENTIFICATION OF CONDITION OR CAUSE
- CORRECTIVE ACTION DOCUMENTED AND REPORTED

QML/QSL CRITERIA

STATISTICAL METHODS (QML)

- STATISTICAL PROCESS CONTROL (SPC) SHALL BE USED DURING MANUFACTURING OPERATIONS
- SPC DATA SHALL BE MAINTAINED

QML/QSL CRITERIA

PERSONNEL TRAINING (QML/QSL)

- ENSURE QUALIFIED PERSONNEL PERFORM TASKS
- TRAINING RECORDS SHALL BE MAINTAINED

QML/QSL CRITERIA

PRODUCT MANUFACTURED FROM COMPONENTS (QML)

ANY PRODUCED PART THAT BECOMES A COMPONENT OF THE END ITEM MUST BE ACQUIRED FROM A MANUFACTURER LISTED ON THE QML.

QML/QSL PROGRAM

BOTTOM LINE

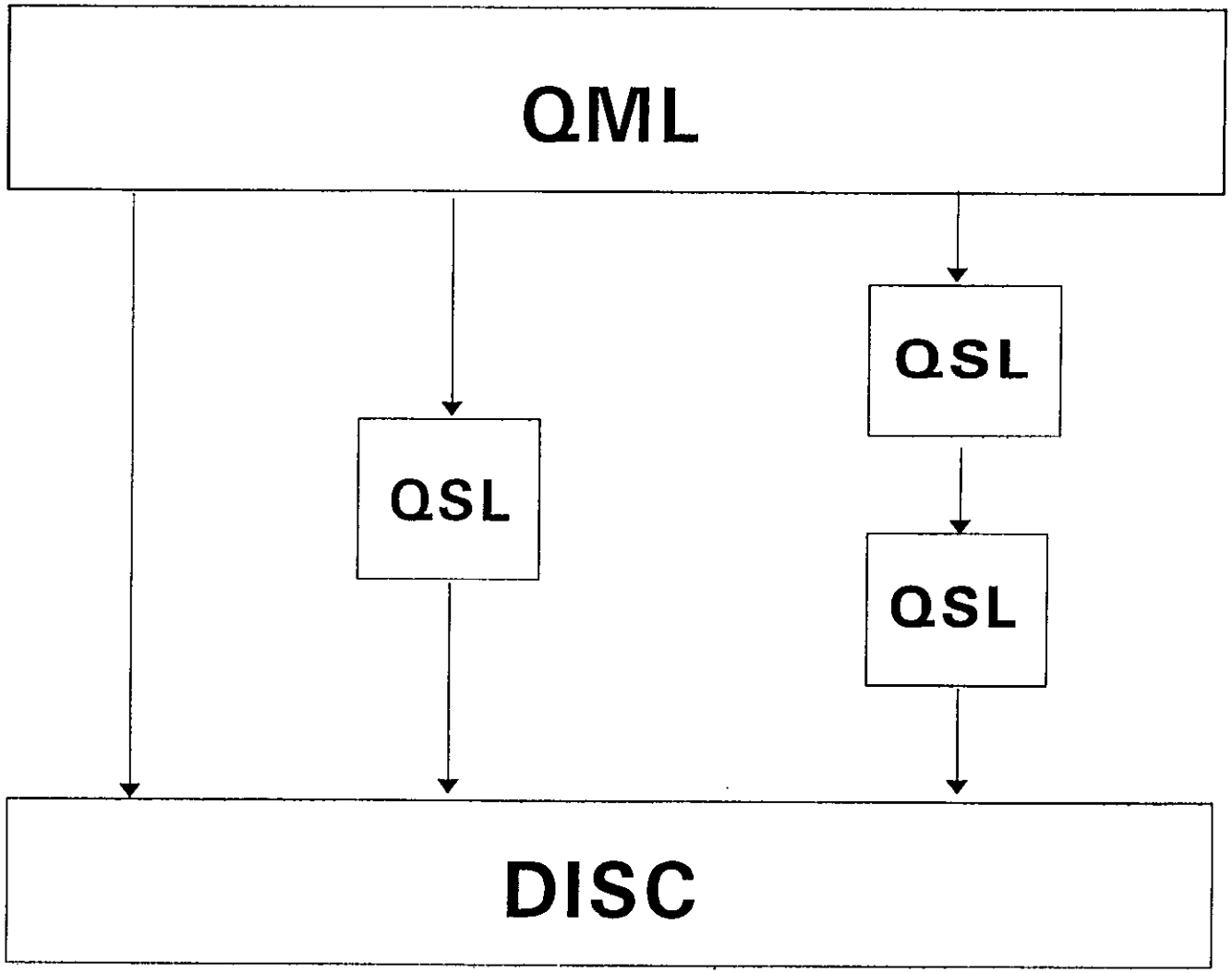
QML LISTED MANUFACTURER

- USES A DOCUMENTED QA PROGRAM
- CONTROLS MANUFACTURING PROCESSES
- USES SPC
- PRODUCES PRODUCTS CONFORMING TO SPECIFICATION
- MAINTAINS TRACEABILITY RECORDS
- DOES NOT COMMINGLE PRODUCTS

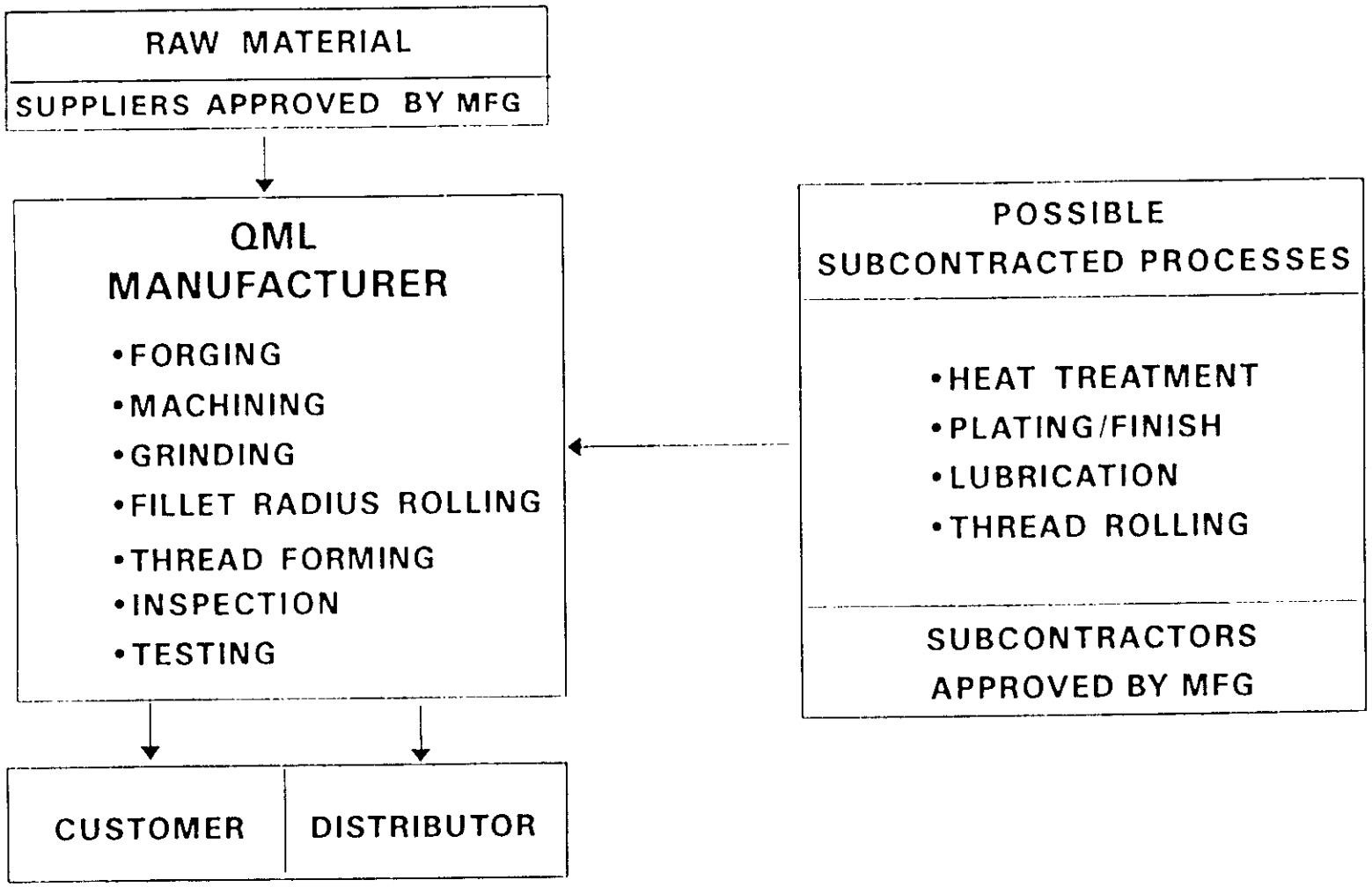
QSL LISTED DISTRIBUTOR

- USES A DOCUMENTED QA PROGRAM
- SELLS PRODUCTS PRODUCED BY QML MANUFACTURERS
- SELLS PRODUCTS CONFORMING TO SPECIFICATIONS
- DOES NOT SELL ALTERED PRODUCTS
- MAINTAINS TRACEABILITY RECORDS
- DOES NOT COMMINGLE PRODUCTS

QML/QSL PROGRAM



QML/QSL PROGRAM



National Aeronautics and
Space Administration

John F. Kennedy Space Center

ENGINEERING
DEVELOPMENT
DIRECTORATE

KSC FASTENER CONTROLS

Fastener Technical Interchange Meeting
Marshall Space Flight Center
November 15, 1994

Elisa A. Artusa
Kennedy Space Center

KSC FORM 21-447 (REV. 5/93) PREVIOUS EDITIONS MAY BE USED

AGENDA

- KSC SUPPLY AND LOGISTICS ORGANIZATION
- BASE OPERATIONS
- SHUTTLE PROCESSING
- PAYLOAD GROUND OPERATIONS
- HISTORY
- CURRENT PROCEDURES
- SUMMARY

KSC SUPPLY AND LOGISTICS ORGANIZATION

- THREE SEPARATE AND INDEPENDENT INVENTORIES BY CONTRACT:
  - BASE OPERATIONS (BOC)
  - SHUTTLE PROCESSING (SPC)
  - PAYLOAD GROUND OPERATIONS (PGOC)
- KENNEDY INVENTORY MANAGEMENT SYSTEM (KIMS)
- SEPARATE RECEIVING, MANAGEMENT, AND CONTROL FUNCTIONS
- SEPARATE INSPECTION PROCEDURES FOR GENERAL USE FASTENERS
- CENTERWIDE INSPECTION PROCEDURE FOR CLASS 3 FASTENERS

KSC FORM 21-447 (REV. 5/93) PREVIOUS EDITIONS MAY BE USED

BASE OPERATIONS

- GENERAL USE FASTENERS (PRIMARILY INCH-POUND) FOR NASA, BOC, AND KSC SUBCONTRACTORS
- SUPPLIERS:
  - DEFENSE LOGISTICS AGENCY (DLA)
  - COMMERCIAL SOURCES
- NONCRITICAL FASTENERS INSPECTED FOR:
  - PART NUMBER
  - GENERAL PHYSICAL CONFIGURATION
  - VISUAL DAMAGE
- MINIMAL FASTENER PROBLEMS TO DATE

SHUTTLE PROCESSING

- FLIGHT AND NON-FLIGHT HARDWARE
- PRIMARILY INCH-POUND FASTENERS
- APPROVED LIST OF SUPPLIERS
- FASTENER INSPECTION
  - NONCRITICAL FASTENERS: INSPECTED USING NORMAL RECEIVING METHODS AND OPERATIONS
  - CRITICAL/CLASS 3 FASTENERS: CENTERWIDE INSPECTION AND TEST PROCEDURE

KSC FORM 21-447 (REV. 5/93) PREVIOUS EDITIONS MAY BE USED

PAYLOAD GROUND OPERATIONS

- FLIGHT AND NON-FLIGHT HARDWARE
- METRIC AND INCH-POUND FASTENERS
- FLIGHT FASTENER INVENTORIES MAINTAINED USING MAXIMUM/MINIMUM LEVELS
- PGOC QUALITY ENSURES APPLICABLE QUALITY CLAUSES INCLUDED IN ALL PURCHASE REQUESTS
- FASTENER INSPECTION
  - NONCRITICAL FASTENERS: INSPECTED USING NORMAL RECEIVING METHODS AND OPERATIONS
  - CRITICAL/CLASS 3 FASTENERS: CENTERWIDE INSPECTION AND TEST PROCEDURE

PAYLOAD GROUND OPERATIONS (continued)

- VENDOR-SUPPLIED FASTENERS
  - HIGH-STRENGTH/CRITICAL: NASA-APPROVED LIST OF U.S. SUPPLIERS
  - OTHER: PGOC-APPROVED LIST OF U.S. SUPPLIERS
  - INTERNATIONAL VENDORS
- CUSTOMER-SUPPLIED FASTENERS
  - DOD AND OTHER NASA CENTERS
  - U.S. COMMERCIAL
  - INTERNATIONAL: EUROPEAN, RUSSIAN

KSC FORM 21-447 (REV. 5/93) PREVIOUS EDITIONS MAY BE USED

ENGINEERING
DEVELOPMENT
DIRECTORATE

HISTORY

- 1988 – GIDEP REPORTS INDICATED NONCONFORMING/COUNTERFEIT FASTENERS IN DOD/DISC INVENTORIES

  RESULT: KSC IMPLEMENTED MATERIAL AND DIMENSIONAL SCREENING OF FASTENERS

- 1989 – GAUGE MANUFACTURER PERFORMED A STOCK SWEEP AT KSC

  RESULT: SIGNIFICANT NONCONFORMANCE RATE REPORTED

  MAJOR CAUSE: STORAGE/HANDLING

HISTORY (continued)

- JULY 1991: DOD RELEASES MIL-S-8897C AND MIL-S-7742D, WHICH DEFINE VERIFICATION REQUIREMENTS FOR CLASS 3 A/B FASTENERS
- NOVEMBER 1992 – MAY 1993: KSC INTEGRATED TEAM ADDRESSED THE DIMENSIONAL VERIFICATION ISSUE
  - STOCK SURVEY PERFORMED
  - KSC MATERIAL SCIENCE LABORATORY IDENTIFIED NONCONFORMING PRODUCTS
  - INTERPRETATIONS OF SPECIFICATIONS VARIED
  - KSC TEAM EVENTUALLY CONCLUDED THAT NO NONCONFORMING PRODUCTS WERE FOUND
  - PERIODIC AUDITS USING VARIABLES GAUGING CONSIDERED FOR PROGRAM ENHANCEMENT

KSC FORM 21-447 (REV. 5/93) PREVIOUS EDITIONS MAY BE USED

HISTORY (continued)

- JUNE – AUGUST 1993: DIRECTIVE FROM CODE M/ ASSOCIATE ADMINISTRATOR FOR SPACE FLIGHT (J.W. PEARSON III)
  - ALL PROCUREMENTS OF CLASS 3 FASTENERS WILL USE REQUIREMENTS OF MIL-S-8879C AND MIL-S-7742D FOR INSPECTION (METHOD B)
  - KSC MANAGEMENT DIRECTS IMPLEMENTATION OF VARIABLES GAUGING FOR CLASS 3 FASTENERS

CURRENT PROCEDURES

- SINCE DECEMBER 1993, MOU IN EFFECT FOR SAMPLE TESTING OF NEW NASA PROCUREMENTS OF CLASS 3 FASTENERS FOR SHUTTLE AND PAYLOADS
  - 5 ADDITIONAL FASTENERS PURCHASED WITH EVERY ORDER FOR SAMPLE TESTING AND INSPECTION
  - ALL DIMENSIONAL GAUGING PERFORMED BY SHUTTLE PROCESSING CONTRACTOR (SPC)
  - ALL MATERIAL TESTING DONE BY NASA KSC MATERIAL SCIENCE LABORATORY
    - CHEMICAL COMPOSITION
    - HARDNESS AND TENSILE STRENGTH (DESTRUCTIVE TESTING)

KSC FORM 21-447 (REV. 5/93) PREVIOUS EDITIONS MAY BE USED

SUMMARY

- TO DATE, NO DIMENSIONAL OR MATERIAL NON-CONFORMANCES DETECTED FOR GENERAL USE AND CLASS 3 FASTENERS AT KSC
- FOR CRITICAL FASTENERS, CENTERWIDE INSPECTION AND TESTING POLICY IN EFFECT THAT RESPONDS TO THE LATEST DOD AND NASA RECOMMENDATIONS

KSC FORM 21-447 (REV. 5/93) PREVIOUS EDITIONS MAY BE USED

Goddard Space Flight Center Fastener Controls

and

Metric Fastener Lessons Learned

Michael Barthelmy

November 15, 1994

--Fastener Control at GSFC is Per S-313-100, "GSFC Fastener Integrity Requirements"

- Addresses All Flight Hardware and Critical GSE Fasteners
- Includes Bolts, Screws, Nuts, Rivets, Shear Pins, Cylindrical and Helical Inserts, Setscrews
- Referenced in GSFC Standard Payloads Assurance Requirements Document

--Approved Manufacturer's Products Are Required for Single Point Failure/Safe Life External Thread Fasteners

- Procurement of Other Fasteners Unrestricted With Respect to Manufacturer and Distributor

--No Restrictions on Fastener Part Numbers Provided Material, Finish, and Lubricant Complies With MSFC-SPEC-522 Table I and MSFC-HDBK-527

--Manufacturer's Material Test Report Required for:

- Nuts and Bolts #10 (5 mm) and Larger
- Rivets 3/16 Inch (5 mm) Diameter and Larger

--Verification Inspection/Testing Performed on Each Lot

TABLE I FASTENER PROCUREMENT, DOCUMENTATION, AND SCREENING REQUIREMENTS FOR FLIGHT HARDWARE

FASTENER TYPE (1)	APPROVED MANUFACTURER'S PRODUCT REQUIRED	OBTAIN TEST REPORT	SCREEN
Bolt (2) Single point failure or safe life (3)	Y	Y	Y
Nut Single point failure or safe life (3)	N	Y	Y
Bolt (2) or nut Redundant load path or fail safe			
#10 (5mm) and larger	N	Y	Y
#8 (4mm) and smaller	N	N	Y
Rivet 3/16" (5mm) dia. and larger	N	Y	Y
<3/16" (5mm) dia.	N	N	Y
Shear Pin	N	N	Y
Helical or Cylindrical Insert	N	N	Y
Setscrews	N	N	Y

(1) Exempt: washers, spring pins, cotter pins, retaining rings, ties, safety wire, and non-metallic fasteners.

(2) Category includes bolts, shoulder bolts, screws, HiLoks, HiTigues, and lockbolts.

(3) Usage shall be #10 (5mm) or larger. Use of size #8 (4mm) or smaller must be approved by GSFC.

TABLE II FASTENER DOCUMENTATION AND SCREENING REQUIREMENTS FOR GROUND SUPPORT EQUIPMENT FASTENERS

FASTENER TYPE	OBTAIN TEST REPORT	SCREEN (1)
Critical bolt(2) or nut(3)	Y	Y
Noncritical fastener	N	N

(1) Applicable screening tests are given in Table III.

(2) Category includes bolts, shoulder bolts, screws, HiLoks, HiTigues, and lockbolts.

(3) Specialized critical fasteners shall be treated per section 3.7.

TABLE III SCREENING SUMMARY FOR FLIGHT HARDWARE AND CRITICAL GROUND SUPPORT EQUIPMENT FASTENERS

FASTENER TYPE	CATEGORY	SCREENING (1)
Bolt or nut	Single point failure or safe life (2, 3)	visual tensile 100% NDE 100% hardness 100% dimensional
Bolt or nut	Redundant load path or fail safe	
	#10 (5mm) or larger	visual tensile (4) dimensional
	#8 (4mm) or smaller	visual
Rivet, Shear Pin		visual hardness (5) dimensional
Helical Insert		visual
Cylindrical Insert, Setscrews		visual dimensional

(1) Inspections/tests are on a lot sampling basis unless otherwise indicated. See sect. 4.2 for supplemental information.

(2) Proof testing is an acceptable substitute for tensile, NDE, and hardness. See section 4.2.7.

(3) Usage shall be #10 (5mm) or larger. Use of size #8 (4mm) or smaller must be approved by GSFC.

(4) Acceptable to substitute hardness testing on bolts or screws if they are too short to tensile test (when the length is less than 4 times the diameter) or on fail safe or redundant load path nuts.

(5) Hardness test waived on <3/16" (5mm) diameter and on all blind rivets.

--Traceability Required Into and Including Stores for Nuts, Bolts, and Rivets

--Storage is in Bonded Stores for Most Fasteners

--Disposition of Nonconformances is the Responsibility of the Cognizant Engineer, Supplemented by Inspection and Materials Branch Personnel

GSFC NONCONFORMING FASTENERS, 9-92 to 9-94

--42 Lots Nonconforming of a Total of 240 Inspected = 18%

NONCONFORMANCE	NO. OF LOTS
Dimensional (Threads)	8
Wrong Material or Finish	6
Mismarked or No Marking	5
Lot Integrity	4
Cracked	4
Workmanship	4
Dimensional (Non Thread)	2
Running Torque	2
Missing Features	2
Damaged	2
Fastener Cut to Length	1
Nutplate Inserts Fall Out	1
Failed Tensile	1

TRMM PROJECT METRIC FASTENER LESSONS LEARNED

--Sufficient NASC SI Drawings Exist for Medium Strength (1100 MPa) Nuts and Bolts, Solid Aluminum Rivets, Washers, etc. To Build Payloads

--Vendors Have Good Lines of Hi-Loks, Cylindrical and Helical Inserts in Metric

--Metric Blind Rivets Are Not Available

--High Metric Nutplate Bids Forced Project to Utilize One PN Instead of the Desired Three.

- Inch Nutplates Are Available From Distributor Stock

--Selected Fastener Costs On TRMM:

- NA0045 Hex Bolts, 6 mm, Qty. 100 $13 Each
- NA0045 Hex Bolts, 6 mm, Qty. 200 $ 7 Each
- NA0034C Hex Nuts, 5-8 mm, Qty. 250 $14 Each
- NA0179 Washers, 6 mm, Qty. 1000 $ 2 Each
- Solid Rivets, 4-6 mm Dia., Qty. 1000 $ 1 Each

JSC Fastener Testing Program

J. T. Rucker, Manager

SRM&QA Contract / NASA-JSC

Testing Requirements

- All Space Flight and Critical GSE
  - » # 8 and greater
  - » Smaller sizes if structural
- Lot Homogeneity
  - » Traceability to the heat

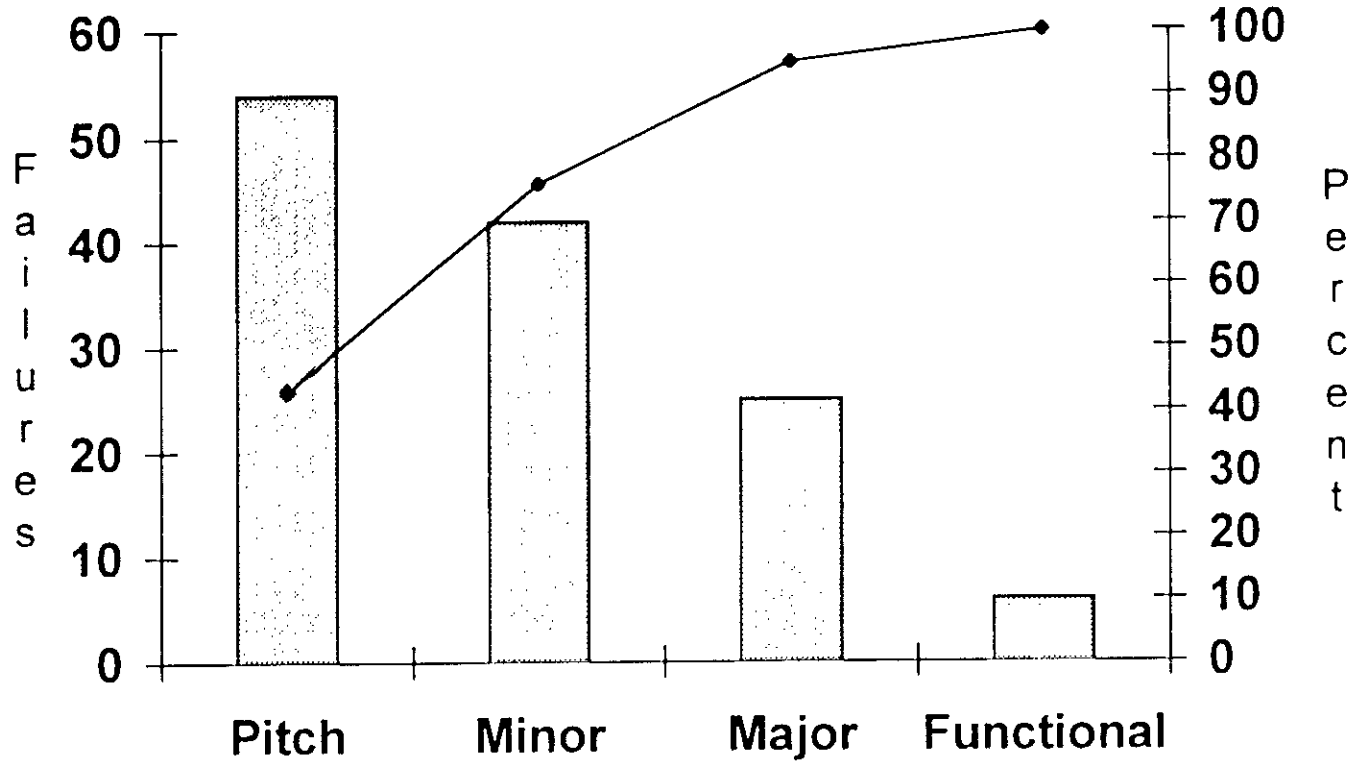
Tests Performed

- Tensile test for peak load
- Hardness test
  - » Sizes 1/4 inch in diameter and greater are cross-sectioned first
- Chemical analysis
  - » Optical emission spectrometry

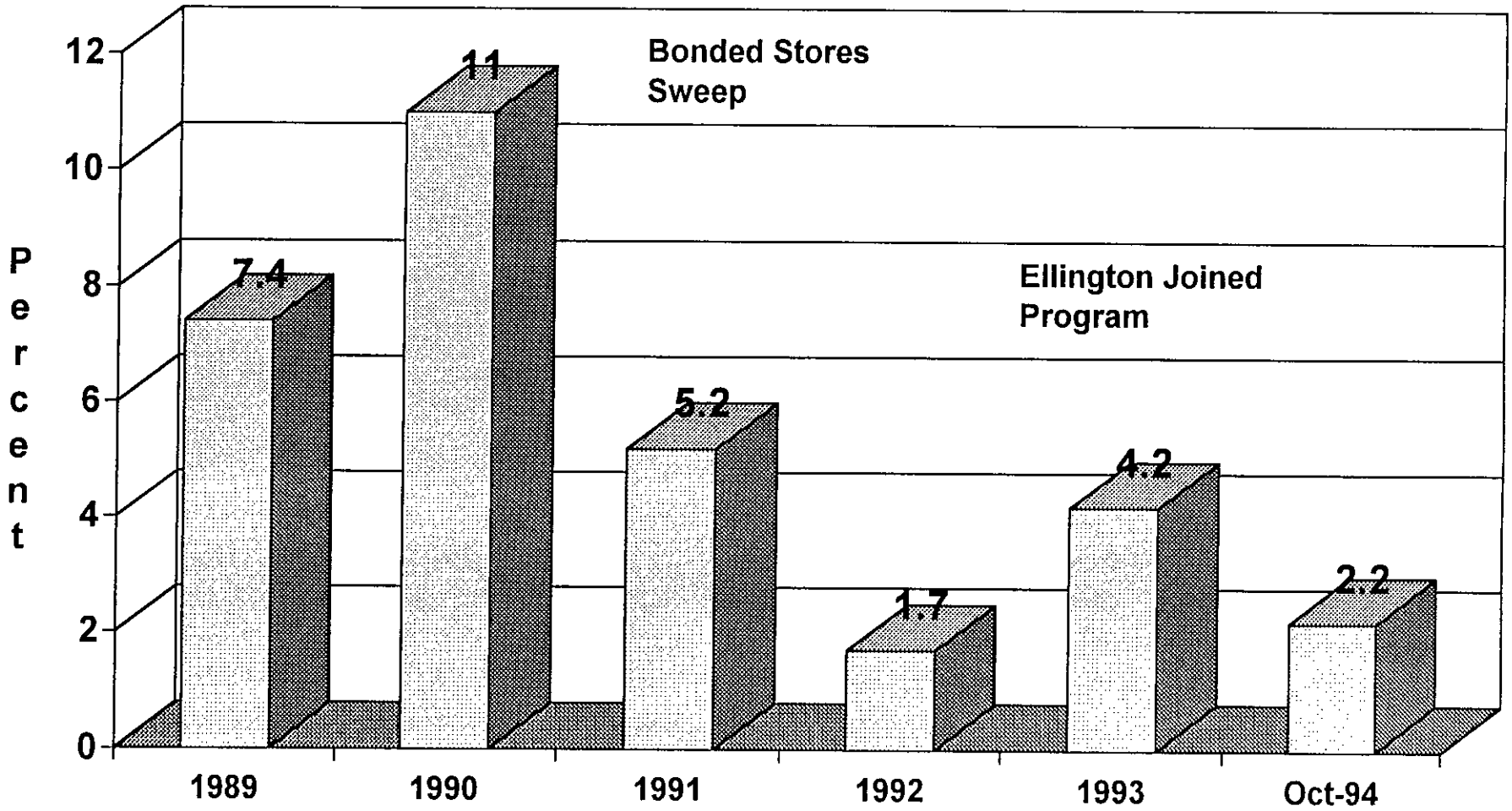
Test Experience

- Failure rate dropped from a peak of 11% to present 2 %
- Majority of failures are “mixed lots”
- Bulk of chemical failures related to MIL-S-18732
  - » Material no longer manufactured
  - » Required by MIL-B-6812

Thread Failures



Fastener Failure Rate



Trends

- Substituition of commercial parts
  - » OIG and Local JSC distributors cooperating to identify fraud
  - » Passivation test is useful to help distinguish between commercial and MIL-SPEC Parts
- Antiquated specifications
- Lot traceability will continue to be issue of concern

JPL Fastener Control Program

Presented at the

Second

NASA Fastener Technical Interchange Meeting

at

Marshall Space Flight Center

by Angel Garnica

JPL Fastener Specialist

November 15, 1994

Outline

JPL maintains a stock of fully traceable aerospace quality fasteners to support the fabrication, maintenance, assembly, and integration of flight projects, instruments, and ground support equipment. There are many operations, processes, and policies in effect to control and assure the quality of these threaded fasteners. This presentation will cover these quality control measures for topics outlined below.

- **Procurement**
- **In-House Receiving, Inspection, and Acceptance**
- **Flight Fastener Store Operation**
- **Quality Controls on the Use and Installation of Fasteners**
- **Fracture Critical Program**

Procurement

- **Vendor audits and resurveys per NHB5300.1B & JPL QAP 39.3**
  - *Conducted by QA Engineer and, on occasion, Fastener Specialist*
  - *Have participated on NASA surveys*
- **JPL maintains parochial part standards & procurement specifications**
- **Procure externally threaded fasteners from JPL QA Approved Vendor List**

In-House Receiving, Inspection, & Acceptance

- All incoming parts are inspected by JPL Mechanical Quality Inspection Group
- Sample inspected per MIL-STD-105, LEVEL II, AQL 1.5
- Any & all non-conformities are recorded on JPL QA Inspection Reports (IR)
- IR's are dispositioned and closed by Fastener Specialist with concurrence from a JPL QA Engineer

In-House Receiving, Inspection, & Acceptance (Cont'd)

- **Internally threaded parts are processed with a Part Acceptance Tag (PAT) per QAP 30.18.**
  - *PAT certification is a JPL document which contains all vital information to trace parts back to Purchase Order and hence vendor certification. This certification remains with stock for its life cycle and then is permanently filed when stock is depleted.*

- **Externally threaded parts are processed with a Fastener Acceptance Tag (FAT) or PAT .**
  - *FAT certification is also a JPL document that contains all vital information to trace parts back to Purchase Order and vendor certifications. This certification remains with stock for its life cycle and then is permanently filed when stock is depleted.*

Flight Fastener Store Operation

- Fasteners stored and segregated by lot
- When fasteners are released they are packaged with PAT or FAT tag and sealed in bag with flight QA sticker
- Issuing of parts is maintained on database
- Stock list is maintained
  - Annual inventory of stock
  - Monthly inventory report

Quality Controls on the Use and Installation of Fasteners

- **JPL Preferred Fastener List (PFL) (inch & metric)**
  - *Inch PFL predominantly consist of JPL parts and also NAS, MS, and vendor parts*
  - *Metric PFL consists primarily of NA part standards*
  - *Fastener materials consist of A-286 & 300 series CRES with some Titanium 6AL-4V and MP35N*

- **JPL Torque Specification (inch & metric)**
  - *Require that all flight fasteners are torqued with calibrated torque wrenches*
  - *Torquing of fasteners must be witnessed by QA Inspector*

- **Maintain Installation Procedures for various fasteners**
  - *Threaded Inserts*
  - *Lock bolts*
  - *Blind Rivets*
  - *Blind Nuts*
  - *Press Nuts*

Quality Controls on the Use and Installation of Fasteners (Cont'd)

- GIDEP and other fastener alerts are reviewed and dispositioned by Fastener Specialist
- All flight hardware drawings with fasteners are reviewed and signed off by Fastener Specialist

Fracture Critical Program

- **Critical certification of fasteners for use on the National Space Transportation System (NSTS) in fracture critical applications require FAT certification plus special screening tests.**
  - *Successful completion of these tests upgrade FAT fasteners to "fracture critical".(FCAT, QAP141.30) certification. These fasteners are reidentified with dyed heads (HYSOL, M-series).*

- **The Structures and Materials Safety Review Committee (SAM-RC) review all JPL designed hardware to be flown on the NSTS for fracture critical fasteners.**

Fracture Critical Program (Cont'd)

- **Once fasteners are deemed to be fracture critical they undergo special screening test in which they are proof tested to 75% of their average Ultimate Tensile Strength (UTS).**
  - *Extensive testing, at JPL, has proven that proof loading A286 CRES bolts to 75% of the UTS determines a safe fatigue life for the number of cycles encountered on the various launch vehicles used for JPL spacecraft.*
  - *This proof test procedure is based on the fracture mechanics concept that the higher the proof load a bolt survives, the smaller the largest flaw is, and therefore, the longer its demonstrated cyclic fatigue life, will be, after proof test.*

Fastener Information Management System (FIMS) Users Guide

January 5, 1995

Revision B

Prepared for:
George C. Marshall Space Flight Center
Materials and Processes Laboratory/EL3

Prepared by:
Brown International Corporation
DRD Technologies

Table of Contents

SECTION 1 FIMS Overview 1

1.1 Main Menu 1

1.2 Floating Palette 2

SECTION 2 Engineering and Parts Management 3

2.1 Preferred Threaded Fastener Selection List 3

2.2 Expert Assist Fastener Selection 4

SECTION 3 Quality Assurance Testing 6

3.1 Quality Assurance Test Requirements 6

3.1.1 Public Law 7

3.1.2 Certification Validation Test/Sampling Requirements 8

3.2 Fastener Part Standards 9

3.3 Alerts, Advisories, Problem Reports 9

3.4 Problem Reporting And Corrective Action (PRACA) 10

3.5 Input Certification Validation Test Results 12

SECTION 4 Logistics and Procurement 13

4.1 Approved Manufacturers 13

4.2 Purchase Order Requirements 14

4.3 Fastener Inventory by Location 15

4.4 Trend Analysis 17

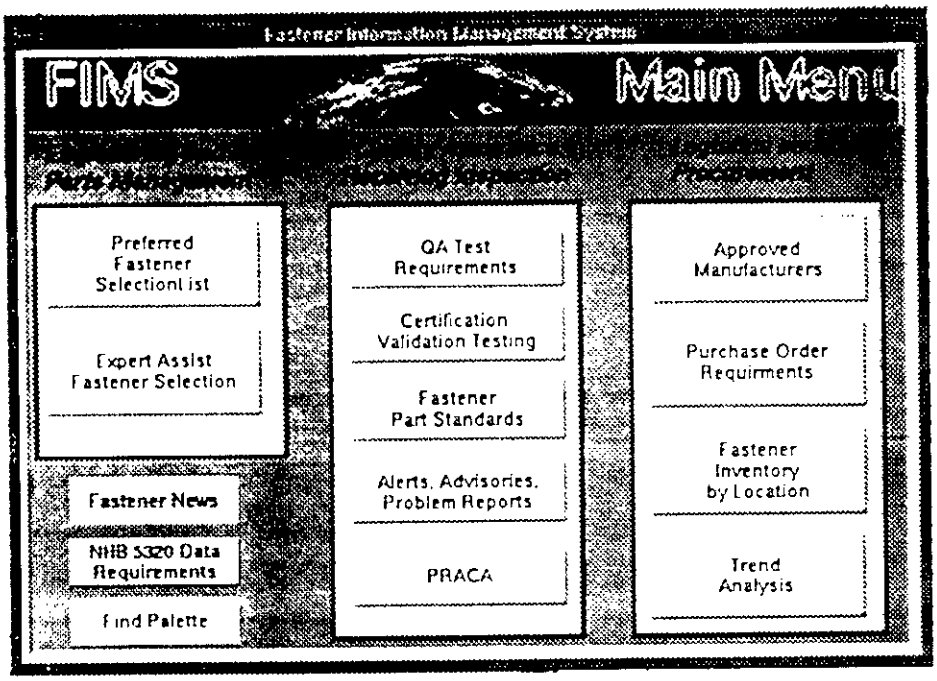
SECTION 1

FIMS Overview

1.1 Main Menu

The Fastener Information Management System (FIMS) is designed to provide a database of fastener requirements and experience relative to fastener testing and procurement.

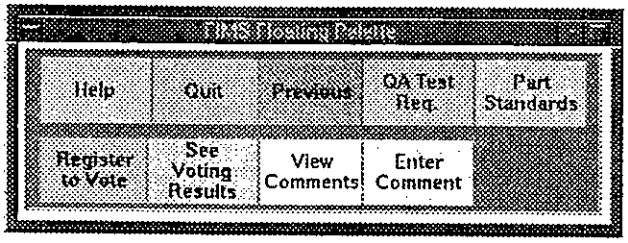
FIMS is comprised of three major components, categorized by the job functions they support: Engineering and Parts Management, Quality Assurance Receiving Inspection, and Logistics and Procurement.



To launch a function listed here on the Main Menu, "left-click" (depress the left mouse button) on the desired button. The frame for that function will open.

FIMS utilizes Ingres Relational Data Base Management System and Ingres Windows 4GL products. It resides on a Sun SPARCStation IPC running SunOS 4.1.1 operating system and uses X11R4 window management system.

1.2 Floating Palette



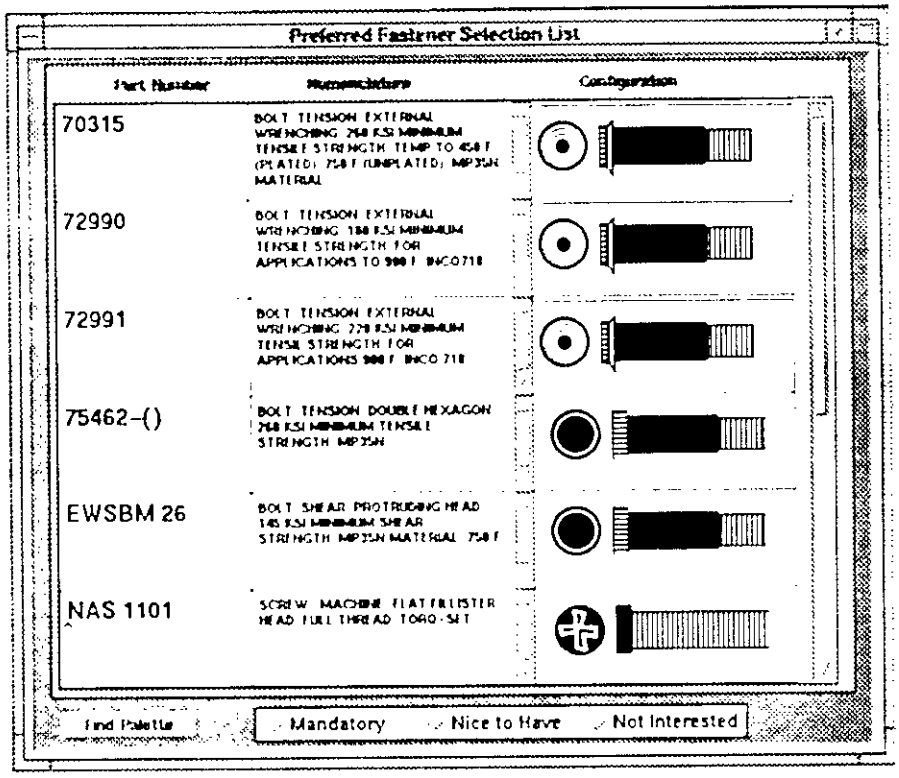
We have centralized all the common functions here rather than repeating them on each frame. When you chose a function by clicking a button on the palette, it applies to the last frame you opened. For instance, you can get help on the last frame you opened by clicking on the "Help" button located on the palette.

Should the palette ever become "buried," each frame has a "Find Palette" button that will bring the palette to the front of your screen.

SECTION 2

Engineering and Parts Management

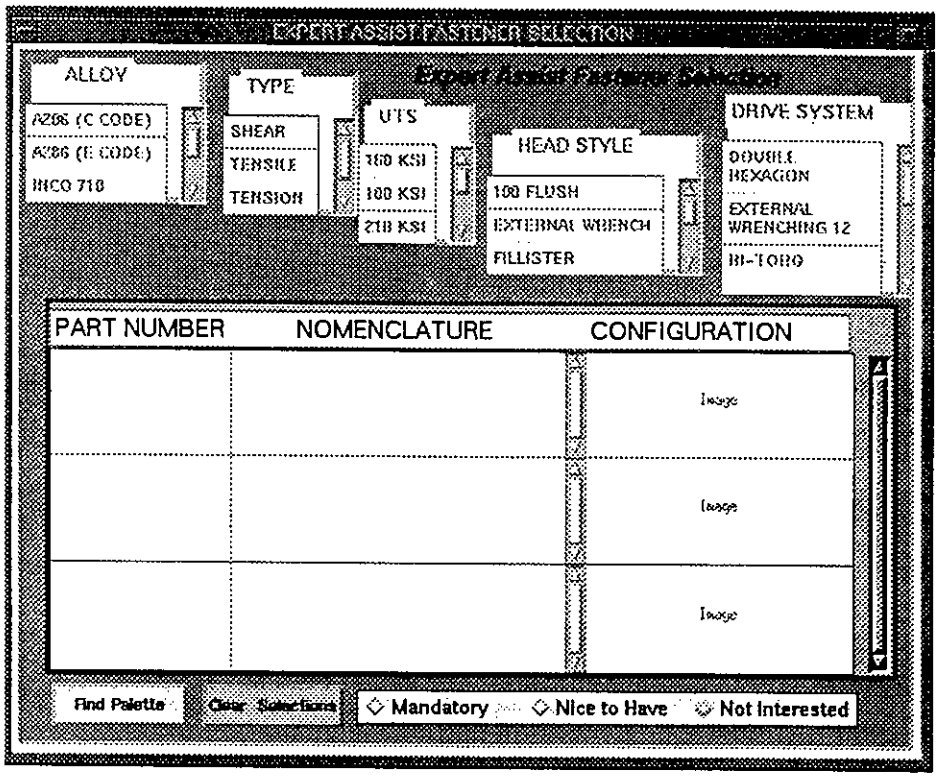
2.1 Preferred Threaded Fastener Selection List



From this list, you may select a fastener by "left-clicking" the mouse on the desired fastener, highlighting that row. You may then choose to see the Quality Assurance Test Requirements by clicking the QA TEST REQ button on the floating palette.

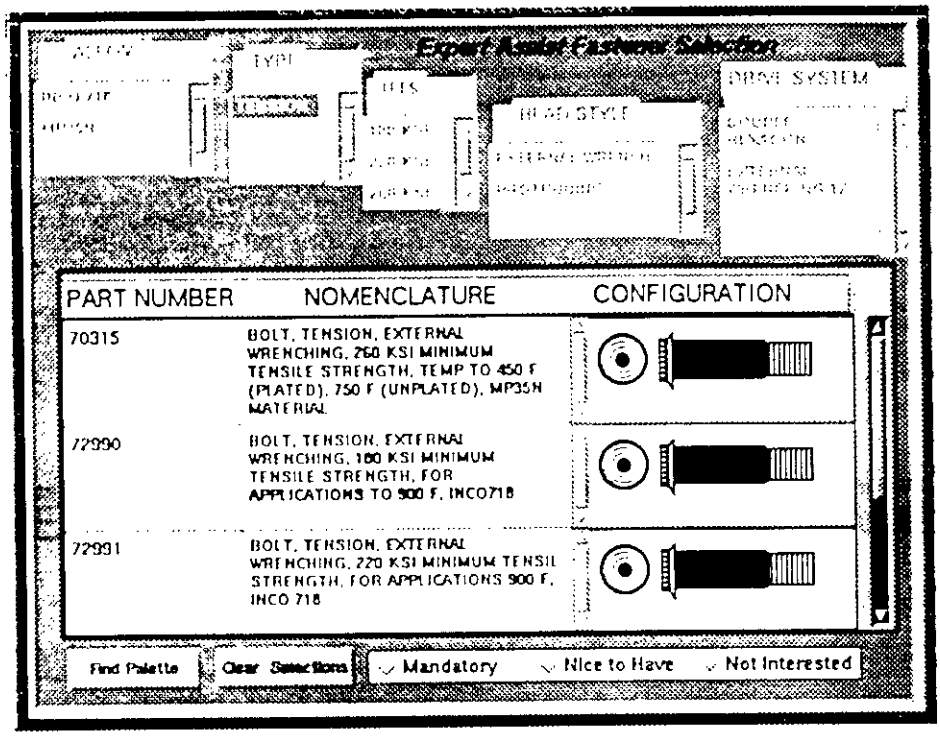
We would like to have similar functionality for part standards where clicking on the Part Standards button would open a frame containing the part standard for the selected fastener.

2.2 Expert Assist Fastener Selection



This frame is designed to aid in the selection of fasteners. One or more attributes from the five listed across the top of the screen may be selected. FIMS will respond with all fasteners meeting the selected criteria.

For example, "tension" was selected from the second attribute "type.". The system responded with the listing of fasteners that are of the type tension as illustrated on the next page.



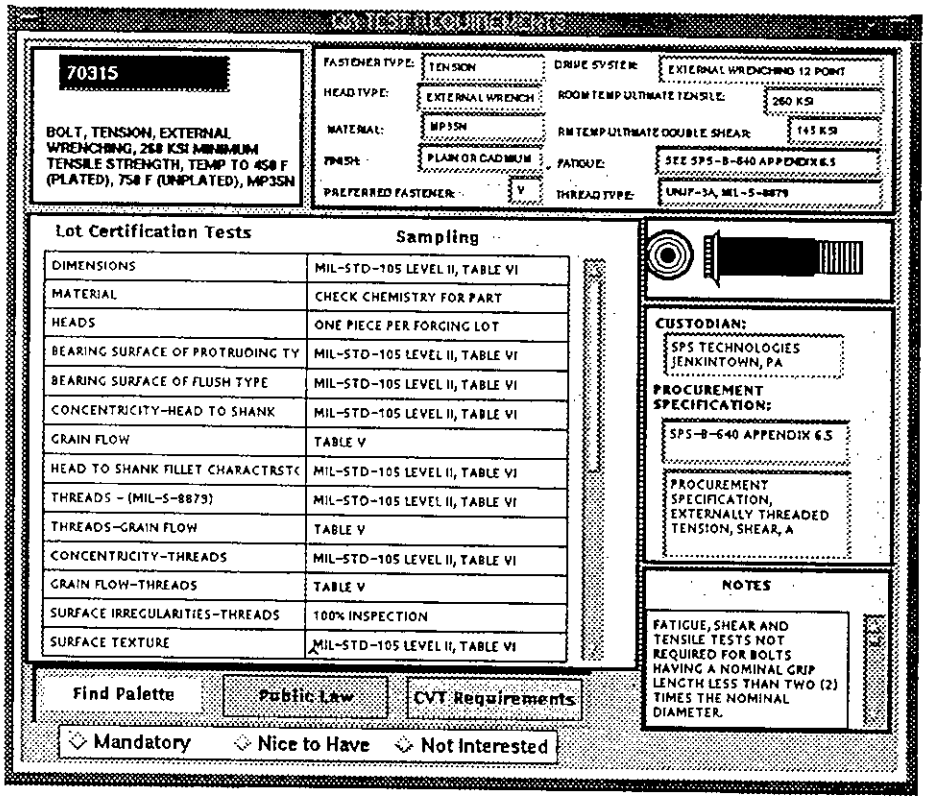
As you can see, the PART NUMBER - NOMENCLATURE - CONFIGURATION matrix has been filled with part numbers meeting the selected tension type criteria.

You can view the QA Test Requirements for a fastener by clicking the QA Test Req button on the floating palette. Remember to select a fastener first by clicking on the appropriate row.

SECTION 3

Quality Assurance Testing

3.1 Quality Assurance Test Requirements

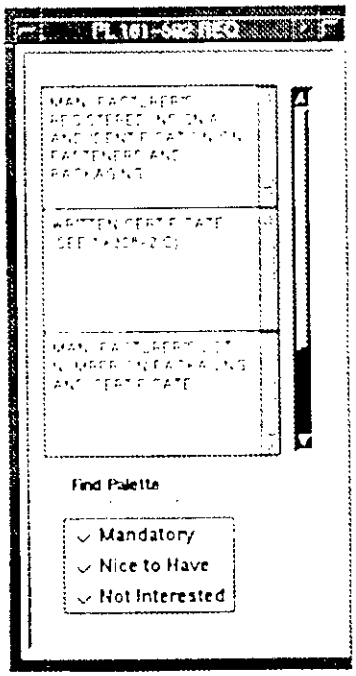


This frame integrates custodian information, procurement specifications, Quality Assurance acceptance test requirements, and fastener configuration.

Applicable public law and in-house certification validation test requirements can also be viewed by clicking on the appropriate button on the bottom of the screen.

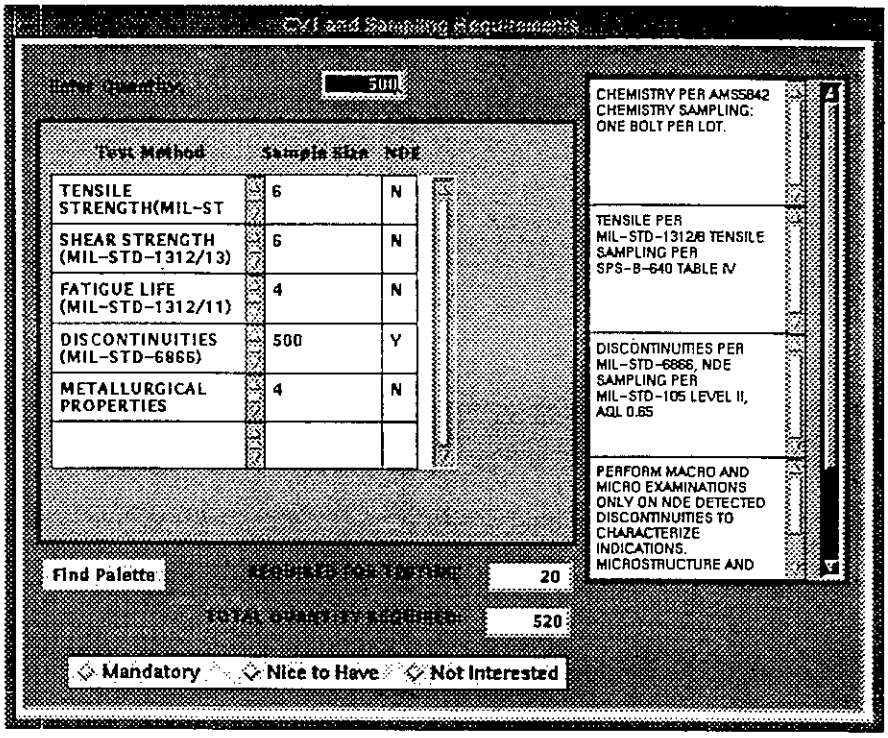
Note: There may be more test and sampling requirements than can fit on the table at the center of the screen. There is a scroll bar to the right which can be used to move the entries up and down by clicking at either end of the bar on the little arrows.

3.1.1 Public Law



This is the frame that is opened when you click on the Public Law button from the QA Test Requirements frame. Here are requirements specified within Public Law 101-592.

3.1.2 Certification Validation Test and Sampling Requirements

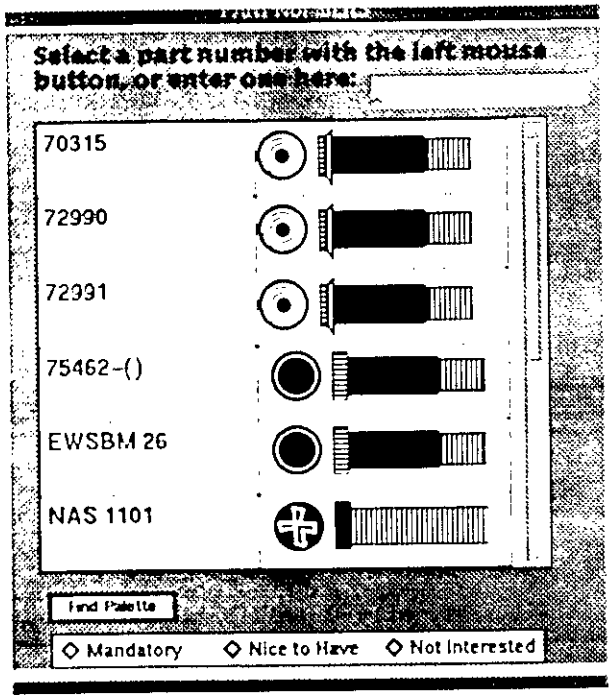


This is the frame that is opened when you click the CVT Requirements button from the QA Test Requirements frame.

This can be used to determine the in-house test methods and their corresponding sampling sizes.

Enter the number of fasteners required at the top of the frame next to "Enter Quantity." FIMS will look up the test and sampling requirements and tell you the total number of fasteners required after testing.

3.2 Fastener Part Standards

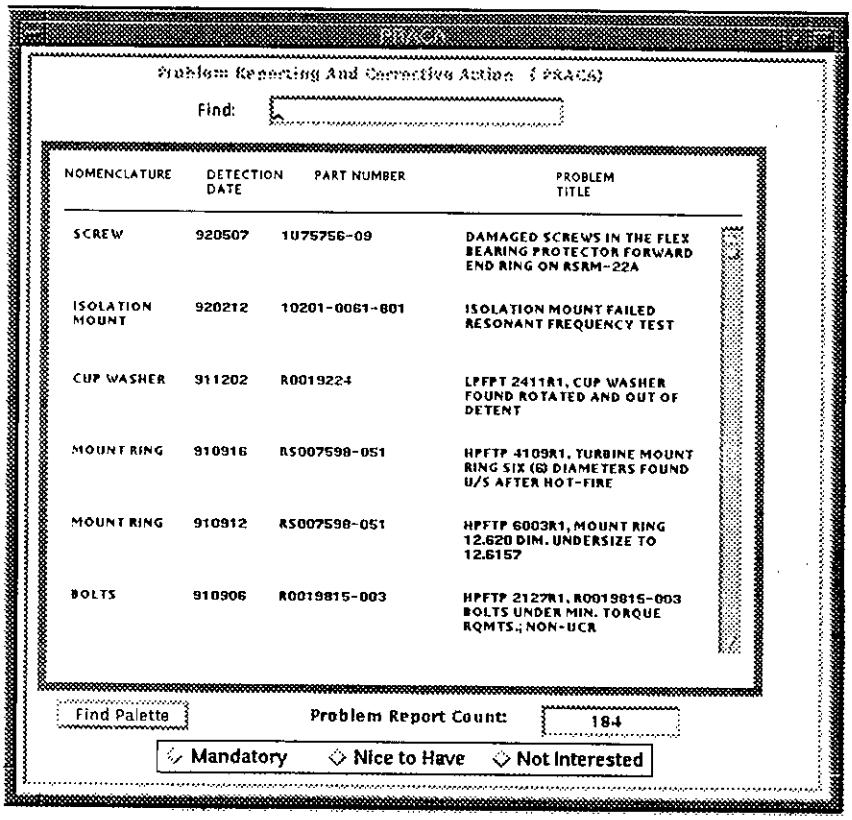


This is the frame that is opened when you select either Fastener Part Standards or QA Test Requirements from the Main Menu. It is a means of selecting or entering a part number. What we would like is to be able to bring up the part standard for a fastener once the part number has been determined from either here or other frames.

3.3 Alerts, Advisories, Problem Reports

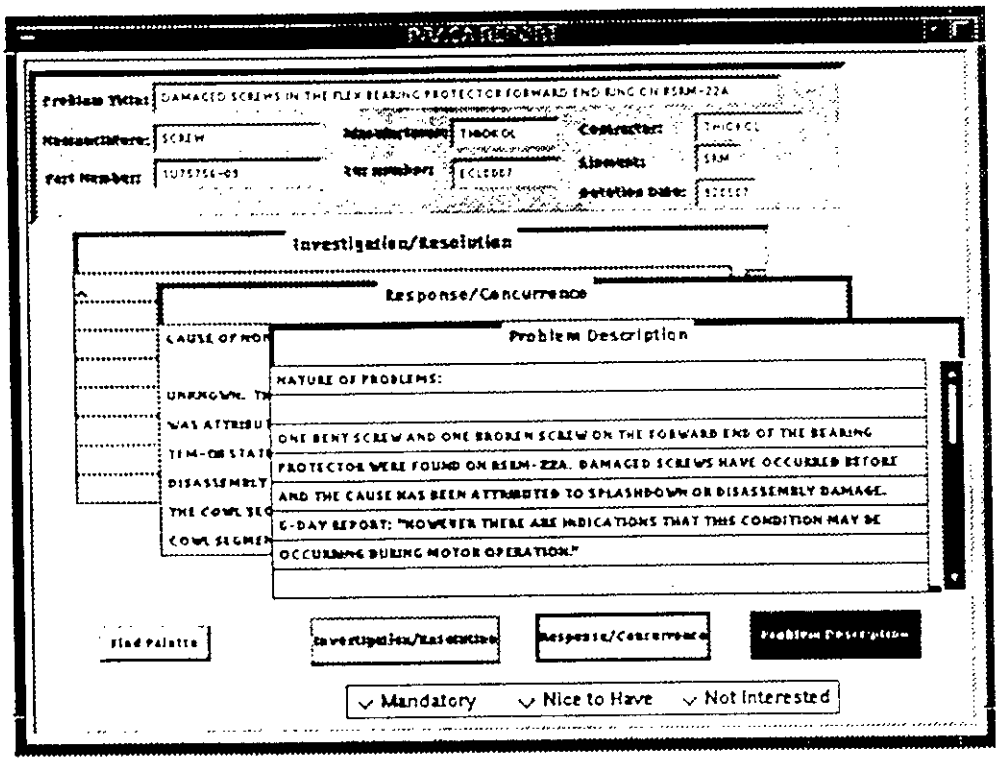
This function has been developed for both EPIMS (Electrical Parts Information Management System) and NARS (NASA Alert Reporting System). When FIMS is made available from the NASA Assurance Systems network, this existing software can then also be utilized by FIMS.

3.4 Problem Reporting And Corrective Action (PRACA)



This is a listing of all fastener-related problem reports from MSFC PRACA. You have the option of scrolling through all records or entering search criteria (text or part number) for a smaller set of problem reports. The wildcard character is % which means the % will match anything where you enter it in a search definition. For example, NAS% will match all part numbers starting with NAS.

Click on a line to see the expanded information on any one problem as illustrated on the next page.



To bring one of the subjects to the front, click on the corresponding button. For example, if you would like to see the Investigation/Resolution, click on that button on the bottom of the frame.

This is a test to see how useful this information is to you. If it is decided to be included in FIMS, this will be replaced with data from the Program Compliance Assurance and Status System (PCASS) which includes MSFC, JSC, and KSC problem reporting information.

3.5 Input Certification Validation Test Results

NASA - MSFC Fastener Certification Validation Test Results

Part Number: 70315 | Date Received: 12/28/94 | Quantity Received: 800

Lot Number: test | Date Manufactured: 3/1/94 | Quantity Rejected: 0

Manufacturer:

Test Methods	Sample Size	NDE	Accept/ Reject	Defective	Comments
TENSILE STRENGTH(MIL-STD-1312/8)		N	0 1		
SHEAR STRENGTH (MIL-STD-1312/13)		N	0 1		
FATIGUE LIFE (MIL-STD-1312/11)		N	0 1		
DISCONTINUITIES (MIL-STD-6866)	8	Y	0 1		100% Inspection
METALLURGICAL PROPERTIES		N	0 1		

Find Palette

Required for Testing: 24

Quantity Available for Inventory: 776

Update

◇ Mandatory ◇ Nice to Have ◇ Not Interested

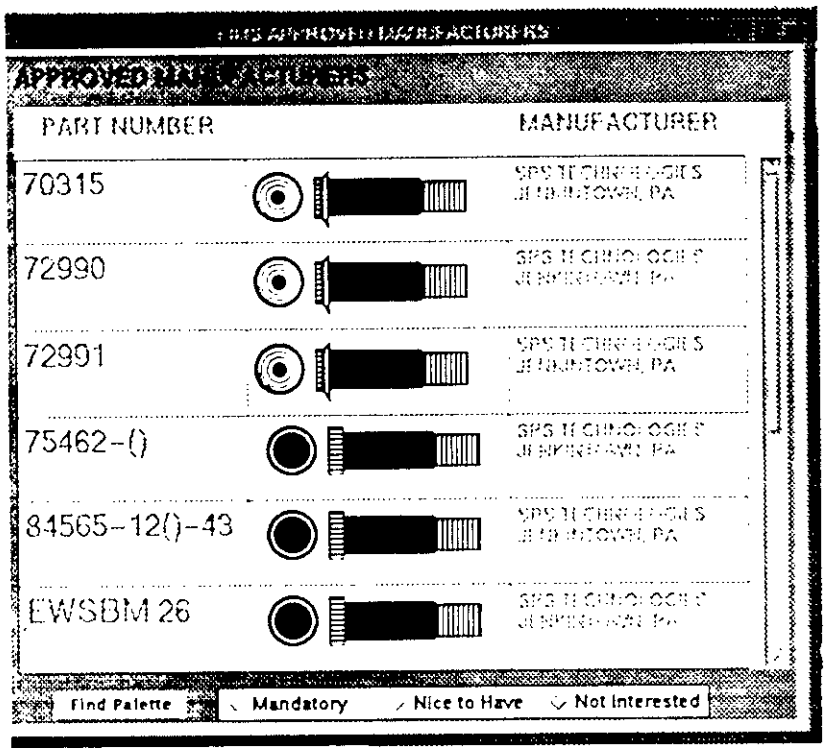
This is a sample input form for Receiving Inspection to input test results. Once the value of Quantity Received has been set, FIMS responds with the Certification Validation Test requirements and sampling sizes. Data entered here is fed to both the Inventory function and the CVT/Manufacturer Trend Analysis function.

One suggestion is to be able to click on any Test Method and have the step-by-step procedures displayed and available for printing.

SECTION 4

Logistics and Procurement

4.1 Approved Manufacturers



From this frame you can select a fastener (by clicking on it) and then view the QA Test Requirements by clicking the QA Test Req.'s button on the palette.

Notice the scroll bar to the right of the matrix. This is to view parts not fitting on the frame.

4.2 Purchase Order Requirements

THREADED FASTENER PROCUREMENT QUALITY ASSURANCE REQUIREMENTS

Purchase orders for threaded fasteners shall include requirements for test results and data submission with the threaded fastener hardware at threaded fastener delivery. The threaded fastener quality assurance data package (QADP) requirements shall include, but is not limited to:

1. Public Law 101-592 Requirements Conformance Statement (as defined in 1X309-1)
2. Manufacturer's Identification
3. Part number and Procurement Specification
4. Quantity Delivered
5. Manufacturer's Lot Number
6. Original Manufacturer's Lot Number (if differed from 1X307-4)
7. Certification and Quality Assurance Inspection and Test Report (as defined in Public Law 101-592, Section 5-a, and 1X309)
8. Certification and Quality Assurance Test Sample Size for Each Test
9. Certification and Quality Assurance Test Procedures for Each Test
10. Laboratory Accreditation Status
11. Threaded Fastener Certification (as defined in Public Law 101-592, Section 7-a and 1X309)

PUBLIC LAW 101-592, "FASTENER QUALITY ACT" PROVISIONS

Public Law 101-592, "Fastener Quality Act" establishes minimum testing, traceability, documentation, and documentation retention requirements for fasteners sold in the United States. The TFCP shall include procurement and receiving inspection procedures which establish and inspect for the following data requirements in accordance with Public Law 101-592.

1. Procurement -- All procurements of threaded fasteners shall clearly indicate on Purchase Orders that all fastener hardware shall be furnished in accordance with Public Law 101-592, with the exception that NASA program threaded fastener manufacturing lots shall not be commingled.

2. Receiving Inspection -- In addition to the QADP requirements specified in 1X307, Receiving Inspection organizations shall inspect to ensure that threaded fastener hardware is delivered with the following Public Law 101-592 requirements.

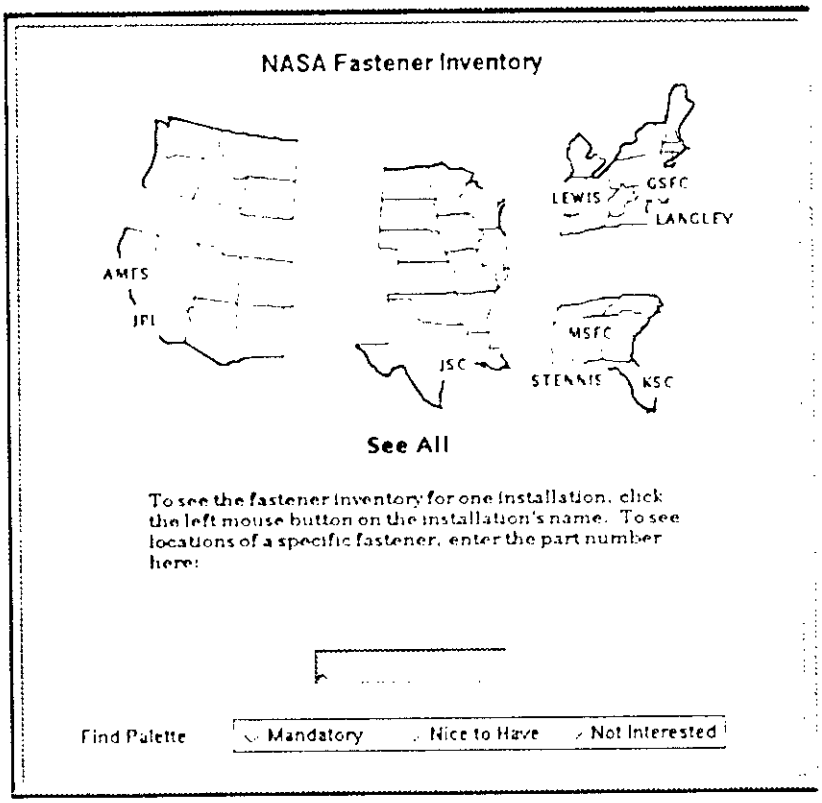
   a. Registered Manufacturer's identification and insignia clearly marked on fasteners and packaging.
   b. Manufacturer lot number clearly marked on fastener package and Certificate of Conformance.
   c. Public Law 101-592 Certificate of Conformance stating that

   "The fasteners have been manufactured according to the requirements of the applicable standards and specifications and have been inspected and tested by a laboratory accredited in accordance with the procedures and conditions specified by the U.S. Department of Commerce Secretary under Section 6 of Public Law 101-592 and that an original laboratory testing report described in Section 5(c) of Public Law 101-592 is on file with the manufacturer, or under such custody as may be prescribed by the U.S. Department of Commerce Secretary, and are available for inspection."

Find Palette | ◇ Mandatory | ◇ Nice to Have | ◇ Not Interested

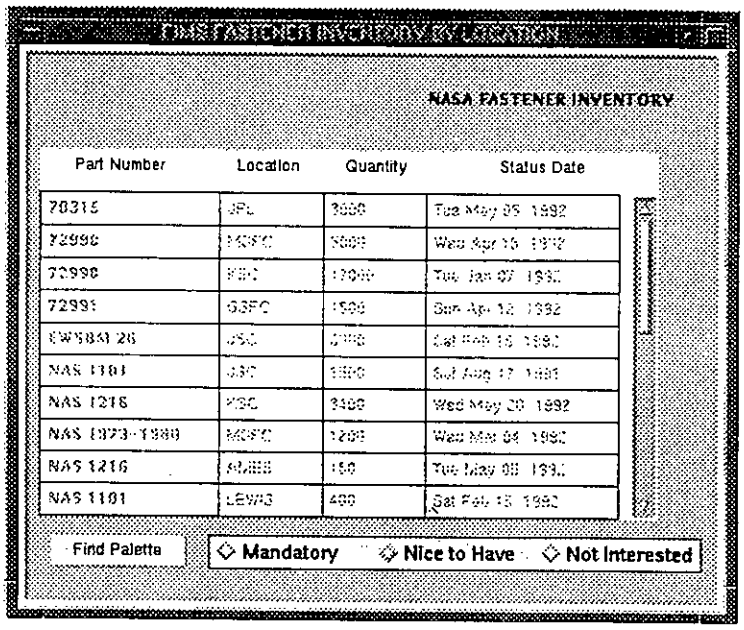
This frame defines NASA standard contract terms and conditions for procuring fasteners.

4.3 Fastener Inventory by Location



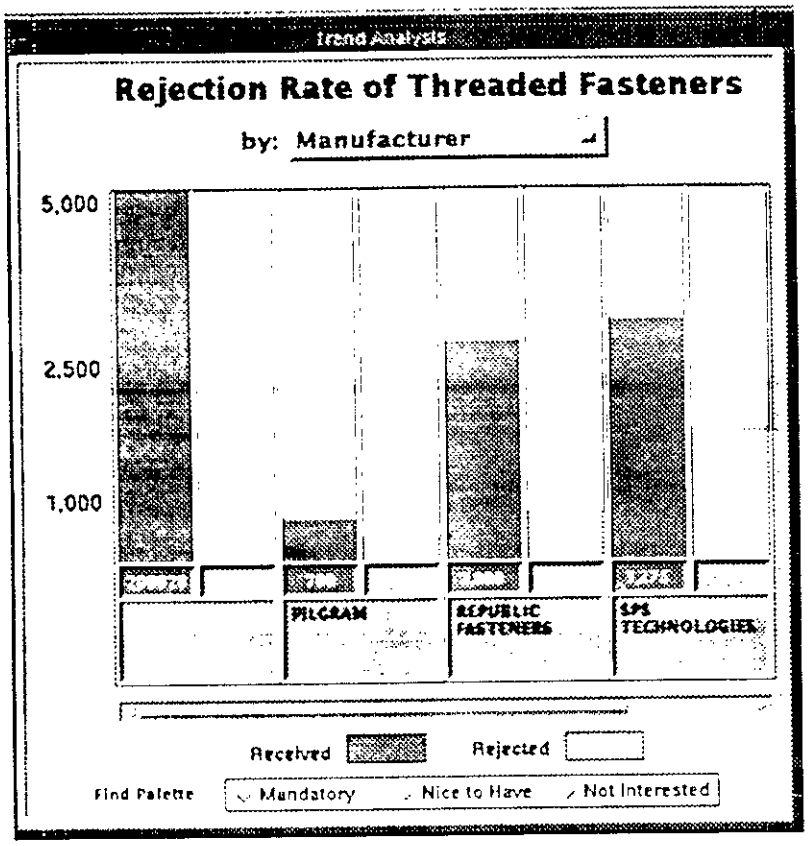
The Fastener Inventory screen represents the location of fasteners by center. You can click on any one center to see that center's fastener inventory or search for a particular part number. FIMS responds to a part search by displaying the number of fasteners found at each center matching that part number. The third option, See All, will display the entire fastener inventory listing for all centers.

The initial source of this information is intended to be the Certification Validation Test results. What needs to be determined is a methodology to update this information as stores at each center are used.



This report lists data captured from the Input Certification Validation Test Results frame. This frame is opened from the Inventory Map frame when you click on a center to request to see more inventory data or click on See All.

4.4 Trend Analysis

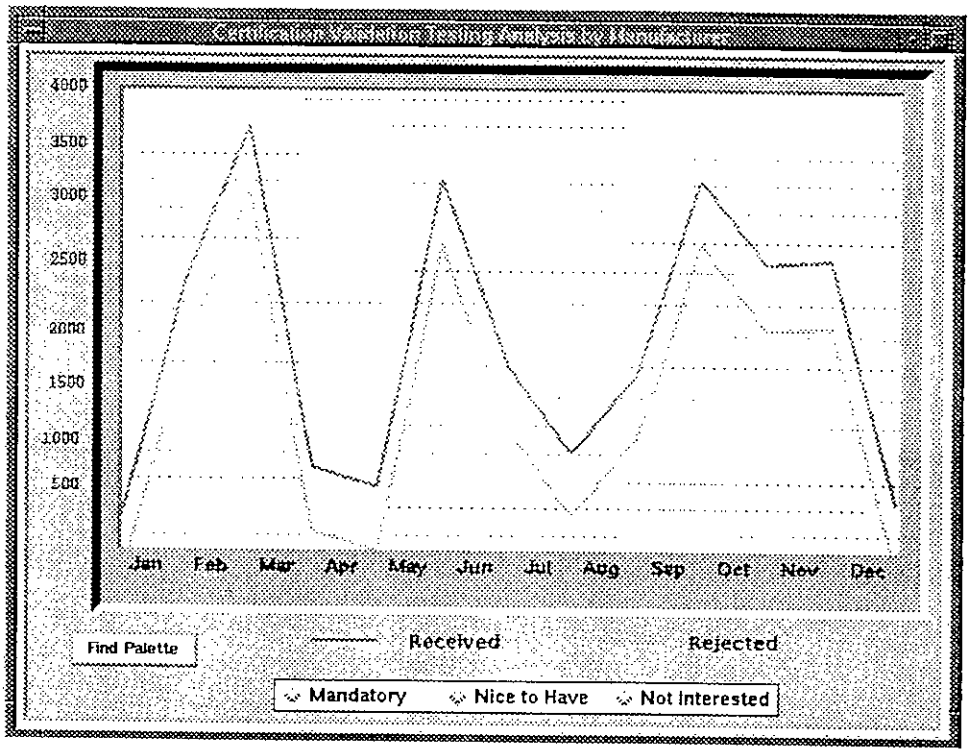


This is one solution for displaying the information captured from Receiving Inspection.

Click on the button next to Manufacturer to select the other options: by Part Number, by Date Manufactured, and by Year and Manufacturer.

Click on the bottom of each bar to call a frame displaying line graph data.

This is NOT REAL DATA.



This is just another possibility for displaying trend analysis data.

Again, this is not real data.

FASTENER PROCUREMENT AND TORQUE/TENSION TESTING AT LEWIS RESEARCH CENTER

Rich Barrett
Lewis Research Center
November 15, 1994

EXCELLENCE BY DESIGN

ENGINEERING DIRECTORATE

Lewis Research Center

Federal Specifications: FF-S-85C

Screw, Cap, Slotted & Hexagon

Materials: Grade 2 - low carbon steel
Grade 5 - medium carbon steel
Grade 8 - alloy steel
Grade 9 - optional alloy steel (170 Ksi)
Austenitic Stainless (300 series)
Martensitic Stainless (400 series)

Non-ferrous Materials
- Various bronzes
- Aluminum
- Nickel-Copper
- Nickel-Copper-Aluminum

Federal Specifications: FF-S-85C (cont'd)

Screw, Cap, Slotted, & Hexagon (cont'd)

Head Types:
- Round - slotted
- Flat - slotted
- Fillister - slotted
- Hexagon

EXCELLENCE BY DESIGN

ENGINEERING DIRECTORATE

Lewis Research Center

Federal Specifications: FF-S-85C (cont'd)

Screw, Cap, Slotted, & Hexagon (cont'd)

- Protective Coatings
  - Passivation (for stainless steel)
  - Cadmium plating
  - Zinc plating
  - Anodizing (for aluminum)
  - Phosphate
  - Black oxide
  - Uncoated

Hydrogen Embrittlement Relief (give applicable specification or baking time and temperature)

Federal Specifications: FF-S-85C (cont'd)

Typical Drawing Callout

- Fasteners shall be flat head, grade 8, cadmium-plated alloy steel, per FF-S-85C. *Fasteners shall be baked at 375 ± 25°F for 4 to 23 hours within 0.25 to 4 hours after plating to relieve hydrogen embrittlement.

*As deemed necessary by the design engineer.

EXCELLENCE BY DESIGN

ENGINEERING DIRECTORATE

Lewis Research Center

Federal Specifications: FF-S-86E

Materials:

- Alloy Steel (170 Ksi)
- Austenitic Stainless Steel (300 series)
- Various Non-ferrous materials (Bronzes, etc.)

Head Types:

- Hexagon Socket
- Multiple Spline Socket

Federal Specifications: FF-S-86E (cont'd)

Protective Coatings
- Passivation
- Cadmium Plating
- Zinc Plating
- Phosphate
- Black Oxide
- Uncoated

Hydrogen Embrittlement Relief (give applicable specification or specify a baking time and temperature)

Federal Specification FF-N-836D (Nuts)

- Materials
  - Steel - Low carbon and alloy
  - CRES
  - Brass
  - Aluminum
  - Bronze
  - Plastic
- Finishes
  - Cadmium
  - Zinc
  - Phosphate
  - Passivated
  - Black Oxide

TABLE VII. MINIMUM PROOF LOADS OF STEEL AND CORROSION RESISTING STEEL NUTS - FINE THREAD

NOM SIZE DIA OF THD (IN.)	THREADS PER INCH UNF	STRESS AREA OF MATING EXTERNAL THREADS (SQ. IN.)	PROOF LOADS - POUNDS, MIN 1/ 2/									
			GRADE A		GRADE B		GRADE C		GRADE D		300 SERIES ALL NUTS	400 SERIES ALL NUTS
			HEX & SQUARE	HEAVY AND THICK	HEX & SQUARE	HEAVY AND THICK	HEX & SQUARE	HEAVY AND THICK	HEX & SQUARE	HEAVY AND THICK		
.250	28	0.0364	2,912	3,280	3,970	4,368	----	----	4,914	5,460	2,750	3,650
.3125	24	0.0580	4,640	5,220	6,322	6,960	----	----	7,830	8,700	4,350	5,800
.375	24	0.0878	7,024	7,900	9,570	10,536	----	----	11,853	13,170	6,590	8,780
.4375	20	0.1187	9,500	10,680	12,940	14,244	----	----	16,025	17,800	8,900	11,870
.500	20	0.1599	12,792	14,390	17,430	19,188	20,790	23,000	21,586	23,980	12,000	15,990
.5625	18	0.203	16,240	18,270	22,130	24,360	26,400	29,232	27,405	30,450	15,250	20,300
.625	18	0.256	20,480	23,040	27,900	30,720	33,300	36,900	34,560	38,400	19,200	25,600
.750	16	0.373	29,840	33,510	40,660	44,760	48,500	53,700	50,355	55,950	27,980	37,300
.875	14	0.509	40,720	45,810	55,480	61,080	66,200	73,300	68,715	76,350	38,180	50,900
1.000	12	0.663	53,040	59,670	72,267	79,560	86,200	95,500	89,505	99,450	49,725	66,300
1.125	12	0.856	68,480	77,040	80,464	89,900	111,300	123,300	115,560	128,400	64,200	85,600
1.250	12	1.073	85,840	96,570	100,882	112,665	139,500	154,500	144,885	160,950	80,480	107,300
1.375	12	1.315	105,200	118,350	123,610	138,075	171,000	189,400	177,525	197,250	98,650	131,500
1.500	12	1.581	126,480	142,300	148,614	166,000	205,500	227,700	213,435	237,150	118,580	158,100
1.750	12	2.190	175,200	219,000	205,860	229,950	284,700	315,400			164,250	219,000
2.000	12	2.890	231,200	289,000	271,660	303,450	375,700	416,200			216,750	289,000
2.250	12	3.690	295,200	369,000	346,860	387,450	479,700	531,400			276,750	369,000
2.500	12	4.600	368,000	460,000	432,400	483,000	598,000	662,400			345,000	460,000
2.750	12	5.590	447,200	559,000	525,460	586,960	726,700	805,000			419,250	559,000
3.000	12	6.690	535,200	669,000	628,860	702,450	869,700	963,400			501,750	669,000
3.250	12	7.890	631,200	789,000							591,750	789,000
3.500	12	9.180	734,400	918,000							688,500	918,000
3.750	12	10.570	845,600	1,057,000							792,750	1,057,000
4.000	12	12.060	964,800	1,206,000							904,500	1,206,000

1/ Strengths of slotted and castle nuts shall be assumed as 67 percent of the tabulated loads. Strengths of jam nuts shall be assumed as 50 percent of the tabulated loads.

2/ Proof-loads shown above are based on stress areas shown and minimum tensile strengths specified. (See Table IV for carbon steel nuts and 3.1.2 for cres. nuts.)

Aerospace Fasteners

- Ordered by Engineers
- Kept in bonded storage (each project is separate).
- No checking by LeRC inspection

TORQUE/TENSION TESTING AT LEWIS RESEARCH CENTER

Table 1

Tensile test results of bolt in threaded fixture

Metric Size	stress area (mm sq)	Minimum load for 1104 MPa (N)	test results metric: measured load (N)	test results metric: calculated tensile (MPa)	Minimum load for 160,000 psi (LBS)	test results English: measured load (LBS)	test results English: calculated tensile (PSI)
5 x 0.8	14.2	15,669	22,400	1,577	3,522	5,035	228,633
6 x 1.0	20.1	22,179	28,550	1,420	4,986	6,418	205,871
8 x 1.0	36.6	40,386	54,160	1,492	9,078	12,174	216,310
10 x 1.25	58.0	64,000	85,460	1,474	14,386	19,210	213,700
12 x 1.25	84.3	93,021	119,700	1,420	20,910	26,910	205,900
14 x 1.5	115.0	-	-	-	-	-	-

Table 2

Tensile test results of bolt / nut combination

Metric Size	stress area (mm sq)	Minimum load for 1104 MPa (N)	test results metric measured load (N)	test results metric calculated tensile (MPa)	Minimum load for 160,000 psi (LBS)	test results English measured load (LBS)	test results English calculated tensile (PSI)
5 x 0.8	14.2	15,669	20,490	1,443	3,522	4,606	209,206
			nut threads stripped				
6 x 1.0	20.1	22,179	27,400	1,363	4,986	6,159	197,607
			bolt broke				
8 x 1.0	36.6	40,386	51,440	1,417	9,078	11,563	205,436
			nut threads stripped				
10 x 1.25	58.0	64,000	76,720	1,323	14,386	17,245	191,808
			nut threads stripped				
12 x 1.25	84.3	93,021	102,700	1,219	20,910	23,090	176,700
			nut threads stripped				
14 x 1.5	115.0	126,897	138,600	1,204	28,524	31,155	174,555
			nut threads stripped				

Table 3

Tensile test results of bolt / insert combination

Metric Size	stress area (mm sq)	Minimum load for 1104 MPa (N)	test results metric measured load (N)	test results metric calculated tensile (MPa)	Minimum load for 160,000 psi (LBS)	test results English measured load (LBS)	test results English calculated tensile (PSI)
5 x 0.8	14.2	15,669	21,700 bolt broke	1,528	3,522	4,878	221,529
6 x 1.0	20.1	22,179	28,130 bolt broke	1,400	4,986	6,323	202,972
8 x 1.0	36.6	40,386	52,110 insert stripped	1,424	9,078	11,713	206,451
10 x 1.25	58.0	64,000	81,200 bolt broke	1,400	14,386	18,252	202,972
12 x 1.25	84.3	93,021	-	-	20,910	-	-
14 x 1.5	115.0	126,897	-	-	28,524	-	-

Table 4
Summary of Torque-Tension test results
comparing actual against theoretical loads for selected torque values

		Bolt/Washer/Nut						Bolt/Washer/Insert						
		Lubricated nuts			non-lubricated nuts				Lubricated inserts			non-lubricated inserts		
Metric Size	selected torque in-lbs	theoretical load	actual load	% low	theoretical load	actual load	% low	selected torque in-lbs	theoretical load	actual load	% low	theoretical load	actual load	% low
5 x 0.8	120 ~~40~~	4,061	2,600	36%	3,046	2,340	23%	120 ~~40~~	4,061	2,160	47%	3,046	2,170	29%
6 x 1.0	-	-	-	-	-	-	-	300	8,475	5,800	32%	6,356	4,310	32%
8 x 1.0	400	8,466	5,240	38%	6,349	3,670	42%	340	7,196	3,470	52%	5,397	2,100	61%
10 x 1.25	460	7,783	5,830	25%	5,838	4,140	29%	460	7,783	4,460	46%	5,838	3,160	46%
12 x 1.25	500	7,062	5,590	21%	5,297	4,560	14%	-	-	-	-	-	-	-
14 x 1.5	540	6,534	3,940	40%	4,900	2,940	40%	520	6,050	3,310	45%	4,719	3,640	23%

Theoretical load based on formula

load = t / k d
t = torque
k = friction coefficient (0.15 for lubricated)
(0.20 for non-lubricated)
d = bolt diameter

NASA Transition to Metric Threaded Fasteners

Project Overview

for the

Second NASA Fastener Technical Interchange Meeting
Marshall Space Flight Center
Huntsville, Alabama

November 16, 1994

by

DRD Technologies, Inc.
200 Clinton Ave.
Suite 403
Huntsville, AL. 35801

DRD TECHNOLOGIES

Information on this page was prepared to support an oral presentation and cannot be considered complete without the oral discussion

Topics

- PROJECT OBJECTIVES
- PROJECT ELEMENTS
- STATUS
- LESSONS LEARNED / RESULTS
- SUMMARY

DRD TECHNOLOGIES

Information on this page was prepared to support an oral presentation and cannot be considered complete without the oral discussion

Project Objectives

Facilitate the transition of NASA pilot programs to the Metric system relative to threaded fasteners.

Provides the basis for the uniform implementation of the Metric Act throughout NASA per Executive Order No. 12770 (July 25, 1991)

- Agency-wide Metric Fastener Requirements
- Fastener Standards
- Qualified Metric Fastener Manufacturers
- Installation Torques
- Traceability Control Throughout User Operations

NASA Headquarters Code QW Sponsored Project
Marshall Space Flight Center Managed

DRD TECHNOLOGIES

Information on this page was prepared to support an oral presentation and cannot be considered complete without the oral discussion

Project Objectives

- **Support NASA Metrication Pilot Program efforts**
  - TRMM - QUICK LIS / LIS - Mars Pathfinder - TSS
  - Droplet Combustion Experiment - SSFF - CM-1
- **Provide a baseline of metrication requirements and methods to facilitate the transition of other NASA projects and parts to the metric system and identify generic issues for the transition of other hardware piece parts.**
- **Develop metric transition funding, programmatic issues, and schedule requirements based on actual project.**
- **Define possible transition limiting issues such as increased hardware lead times and technical issues.**

DRD TECHNOLOGIES

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Project Elements

- **Working Group - 31+ Members (Quality Assurance, Design, Engineering, Procurement)**
  - NASA (9 installations)
  - Department of Defense
  - Department of Energy - National Laboratories
  - Industry (Users and Manufacturers - Industrial Fasteners Institute)
- **Agency-wide Compilation of Metric Fastener Requirements**
- **Standards Development - Agency and Industry Coordination**
  - AIA - NASC / ISO Design and Standardization Protocols
- **Identification of Qualified Domestic Manufacturers**
  - NASA-wide Assessment Criteria
  - Multi-Installation Assessment Team (Assessment in January/ February 1995)
- **Acquisition of Metric Hardware**
  - Availability and Combined Procurements
  - Test Hardware
- **Source Inspection of Metric Fastener Hardware**
- **Torque-Tension Testing - NASA lubricants**
- **Lessons Learned to Date**

DRD TECHNOLOGIES

Information on this page was prepared to support an oral presentation and cannot be considered complete without the oral discussion

Agency-Wide Compilation of Metric Fastener Requirements

- Solicit Input from Centers for metric threaded fastener requirements
  - Define Part Configuration/ Material
  - Define Strength Level /Lubricant
- Establish a Requirements Data Base
- The Working Group Defines the Priority Level for Each Part in the Data Base

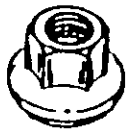
DRD TECHNOLOGIES

Information on this page was prepared to support an oral presentation and cannot be considered complete without the oral discussion

NASA METRIC THREADED FASTENER REQUIREMENTS DATA BASE

PART NUMBER /SERIES	NOMENCLATURE	MATERIAL	STRENGTH LEVEL	LUBRICANT	REMARKS	PART CONFIGURATION
NASA REF NO. 055 **4184-XCNV-XXXX** HELI-COIL *PRIORITY* 1	Heli-Coil Insert, Screw Lock, Metric, Course REQUESTING ORGANIZATION(S) GSFC, MSFC	• CRES 300 Series		• Ag Plate	• Need procurement and part standard • Need MJ thread requirements • Locking torque to ISO2320	
NASA REF NO. 001 **DOD-W-70336/1** (PA-Army) *PRIORITY* 1	Washer, Lock Spring, Helical, Regular Series, Metric REQUESTING ORGANIZATION(S) MSFC - LIS	• CRES 300 series or • Carbon steel				
NASA REF NO. 002 **DOD-W-70336/2** (PA - Army) *PRIORITY* 1	Washer, Lock Spring, Helical, Light Series, Metric REQUESTING ORGANIZATION(S) MSFC - LIS	• CRES 300 series • Carbon steel				
NASA REF NO. 003 **HLMJ40K94K** Hi-Lok *PRIORITY* 1	Hi-LOK PIN, (MJ Metric Series), Protruding Head, Shear Head, A-286 High Temperature Alloy, 1mm Grip Variations, CRES 300 Series Metric Collars (5mm - 10mm nominal diameter) REQUESTING ORGANIZATION(S) GSFC	• A286 • CRES 300	660 MPa Shear Minimum (HT)	Lubeco 905		

DRD TECHNOLOGIES

PART NUMBER /SERIES	NOMENCLATURE	MATERIAL	STRENGTH LEVEL	LUBRICANT	REMARKS	PART CONFIGURATION
NASA REF NO. 004 **NA0001-0006** (NASC) *PRIORITY* 1	Rivet, Solid - Universal Head Aluminum and Aluminum Alloy, Metric REQUESTING ORGANIZATION(S) GSFC	• 2117-T4				
NASA REF NO. 005 **NA0013-0018** NASC *PRIORITY* 1	Rivet, Solid- Countersunk, 100° Head, Aluminum and Aluminum Alloy, Metric REQUESTING ORGANIZATION(S) GSFC	• 2117-T4				
NASA REF NO. 006 **NA0033/NA0034** (NASC) *PRIORITY* 1	Nut, Self-Locking, Hexagon, Extended Washer, 1100 MPa, Metric, 235°C, 425°C (Qualification testing to NA0044) REQUESTING ORGANIZATION(S) GSFC, MSFC, JPL	• A286	• Ag plate per AMS2410 Dry Film			
NASA REF NO. 007 **NA0045** (NASC) *PRIORITY* 1	Bolt, Close Tolerance, Hex Head, A286 CRES, 1100 MPa, Metric REQUESTING ORGANIZATION(S) GSFC, MSFC	A286	1100 MPa	Bare		

NASA METRIC THREADED FASTENER REQUIREMENTS DATA BASE

PART NUMBER /SERIES	NOMENCLATURE	MATERIAL	STRENGTH LEVEL	LUBRICANT	REMARKS	PART CONFIGURATION
NASA REF NO. 008 **NA0059** *PRIORITY* 1	Bolt, Close Tolerance, Spline Drive, Metric REQUESTING ORGANIZATION(S) JPL	A286	1550 MPa	Passivated Dry Film HD No. 2	• Manufactured • System 22 gaging • Limited shelf stock	
NASA REF NO. 009 **NA0065** *PRIORITY* 1	Nut, Thin, With Optional Lockwire, Metric REQUESTING ORGANIZATION(S) JPL, MSFC			Ag Plate Ag Plate + Dry Film Dry Film	No usage experience to date	
NASA REF NO. 010 **NA0069** *PRIORITY* 1	Screw, Cap, Socket Head, Full Thread, A286, Metric (12mm diameter needed) REQUESTING ORGANIZATION(S) GSFC, MSFC, JPL	A286	1100 MPa	Passivated	• System 22 gaging • Stock is available from selected manufacturers • Need self-locking version NAS1351	
NASA REF NO. 011 **NA0070** *PRIORITY* 1	Screw, Machine, 100° Flush Head, Offset Cruciform, Full Thread, A286 REQUESTING ORGANIZATION(S) GSFC, MSFC	A286	1100 MPa	Passivated	• System 22 gaging • Ribbed offset cruciform and traditional offset cruciform is used per NA0025	

DRD TECHNOLOGIES

NASA METRIC THREADED FASTENER REQUIREMENTS DATA BASE

PART NUMBER /SERIES	NOMENCLATURE	MATERIAL	STRENGTH LEVEL	LUBRICANT	REMARKS	PART CONFIGURATION
NASA REF NO. 012 **NA0179** *PRIORITY* 1	Washer, Plain and Countersunk, Metric REQUESTING ORGANIZATION(S) MSFC, GSFC	A286	For use with 1100 MPa fastening systems	Passivated	• Manufactured	
NASA REF NO. 013 **NA0252** (NASC) *PRIORITY* 1	Bolt, Shoulder, Hexagon Head, A286 CRES, 1100 MPa Tensile, Metric REQUESTING ORGANIZATION(S) GSFC, MSFC	• A286	1100 MPa			
NASA REF NO. 014 **No Standard** (to NASC) *PRIORITY* 1	Screw, Cap, Socket Head, Full Thread, 300 Series CRES, 550 MPa FTU, Metric REQUESTING ORGANIZATION(S) LeRC, MSFC	CRES 300 series	550 MPa	• Passivated	Draft Standard	
NASA REF NO. 015 **No Standard** (to NASC) *PRIORITY* 1	Bolt, Close Tolerance, Hexagon Head, 300 Series CRES, 550 MPa FTU, Metric REQUESTING ORGANIZATION(S) LeRC	CRES 300 Series	550 MPa	• Passivated	Draft Standard	

Standards Development - Agency and Industry Coordination

Project #	Description	Status
P0845NASA	Standard Practice - Nut Design Elements, Metric	Reviewing and Incorporating Comments from First Review Cycle (Oct. 1994)
P1162-4NASA	Metric Five Year Review of NA Standards for Upgrading or Inactivation	Out for Review in the NASC (Jan. 1995)
P1230NASA	Revision of NA0069, Metric Socket Head Cap Screw	Out for Review in the NASC (Jan. 1995)
P1272NASA	Procurement Specification, Metric Fasteners, CRES 300 Series, External Threaded, 550 MPa Tensile, 308 MPa Shear	In Preparation for Review
P1273NASA	Hexagon Head Bolt, Pan Head Screw, Socket Head Cap Screw, CRES 300 Series, 500 MPa Tensile, Metric Standards	Out for Review in the NASC (Nov. 1994)

DRD TECHNOLOGIES

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Aerospace Industries Association

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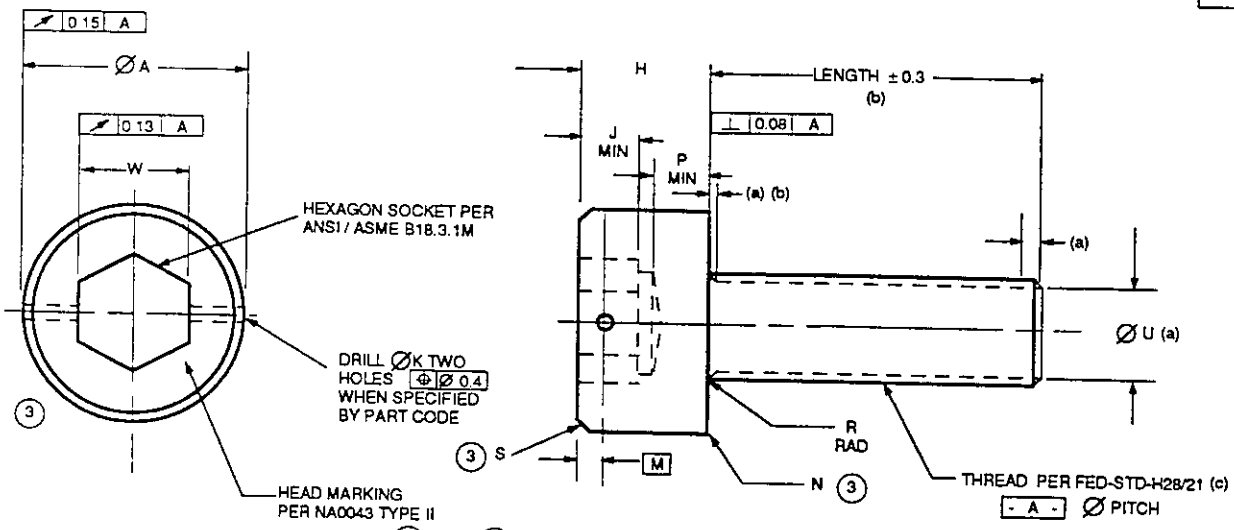

DIA CODE	THREAD 4h6h	ØA	H	S MAX (3)	N MAX (3)	J MIN	P MIN (2)	M BASIC	ØK (2)	R RAD	ØU (a)	W SOCKET SIZE	TENSILE FORCE N MIN
016	MJ1.6 X0.35	3.00 2.87	1.60 1.52	0.16	0.08	0.8	0.54	—	—	0.3 0.1	1.1 0.6	1.545 1.520	1 630
020	MJ2 X0.4	3.80 3.65	2.00 1.91	0.20	0.08	1.0	0.68	—	—	0.3 0.1	1.4 0.9	1.545 1.520	2 620
025	MJ2.5 X 0.45	4.50 4.33	2.50 2.40	0 25	0.08	1.25	0.85	—	—	0.3 0.1	1.9 1.4	2.045 2.020	4 210
030	MJ3 X 0.5	5.50 5.32	3.00 2.89	0.30	0.13	1.5	1.0	0.75	1.14 1.00	0.4 0.2	2.3 1.8	2.560 2.520	6 160
040	MJ4 X 0.7	7.00 6.80	4.00 3.88	0.40	0.13	2.0	1.5	1.23	1.14 1.00	0.4 0.2	3.0 2.5	3.071 3.020	10 900
050	MJ5 X 0.8	8.50 8.27	5.00 4.86	0.50	0.13	2.5	1.9	1.3	1.14 1.00	0.5 0.3	4.0 3.5	4.084 4.020	17 400
060	MJ6 X 1	10.00 9.74	6.00 5.85	0.60	0.20	3.0	2.3	1.4	1.54 1.40	0.7 0.5	4.7 4.2	5.084 5.020	24 800
080	MJ8 X 1	13.00 12.70	8.00 7.83	0.80	0.20	4.0	3.2	1.4	1.54 1.40	0.7 0.5	6.7 6.2	6.095 6.020	46 600
100	MJ10 X 1.25	16.00 15.67	10.00 9.81	1.0	0.20	5.0	4.0	1.5	1.74 1.60	0.8 0.6	8.4 7.9	8.115 8.025	72 900

(a) Incomplete threads in accordance with FED-STD-H28 / 21. Point shall be flat and chamfered 45° approximately from U diameter.

(b) Screws 40 mm or less in length shall have complete threads to within two thread pitches of head bearing surface. Longer screws shall have a minimum complete thread of 35 mm. Diameter of unthreaded portion of screw shall not be less than minimum pitch diameter nor more than maximum major diameter of thread.

(c) Acceptability of screw threads shall be in accordance with FED-STD-H28 / 20 System 22.

DRAFT NASA - MSFC
Metric RTOP Standard
Revision: 9-27-94

3

LIST OF CURRENT SHEETS					
SHEET	1	1	2	2	
REV.	2	3	1	3	

CUSTODIAN NATIONAL AEROSPACE STANDARDS COMMITTEE

THIRD ANGLE PROJECTION

PROCUREMENT SPECIFICATION

NA0026 EXCEPT AS NOTED

TITLE

SCREW, CAP, SOCKET HEAD, FULL THREAD, A-286 CRES, 1100 MPa, METRIC

CLASSIFICATION
STANDARD PART

NA0069

SHEET 1 OF 2

APPROVAL DATE DECEMBER 1979 REVISION (1) 25 APRIL 1991 (2) 22 OCTOBER 1993 (3)

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MATERIAL	A-286 CRES PER PROCUREMENT SPECIFICATION
HEAT TREAT	1100 MPa MINIMUM ULTIMATE TENSILE (1)
FINISH	PASSIVATE PER QQ-P 35
CODE	FIRST THREE NUMBERS DESIGNATE NOMINAL THREAD SIZE AS TABULATED SECOND THREE NUMBERS DESIGNATE NOMINAL LENGTH IN EVEN NUMBER INCREMENTS SEE TABLE II FOR RECOMMENDED LIMITS (1) DRILL CODE LETTER 'H' FOLLOWING BASIC PART NUMBER DESIGNATES DRILLED HEAD
EXAMPLE OF PART NUMBER	NA0069-030016 SCREW, M3 x 0.5 THREAD, 16mm LONG (1) NA0069H040026 SCREW, M3 x 0.5 THREAD 16mm LONG, DRILLED HEAD (1)
NOTES	1 SURFACE TEXTURE PER WITH ANSI/ASME B46.1 BEARING SURFACE OF HEAD, HEAD TO SHANK FILLET RADIUS SHANK AND ALL THREAD ELEMENTS 0.8um MAXIMUM ALL OTHER SURFACES 3.2 um MAXIMUM (1) 2 MAGNETIC PERMEABILITY SHALL BE LESS THAN 2.0 (AIR = 1.0) FOR A FIELD STRENGTH H OF 16kA / m USING A MAGNETIC PERMEABILITY INDICATOR PER MIL-I-17214 3 SCREWS SHALL BE FREE FROM BURRS AND SLIVERS BREAK SHARP EDGES 0.1 TO 0.4 4 DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SPECIFIED (1) 5 DIMENSIONING AND TOLERANCES PER ANSI Y14.5M (3) 6 DIMENSIONING OF THE RADIUS ON THE SOCKET HEAD PER ANSI B18.3.1M
PROCUREMENT SPECIFICATION	NA0026, EXCEPT SHEAR AND FATIGUE TESTING ARE NOT REQUIRED

TABLE II
NOMINAL LENGTHS

DIAMETER CODE	LENGTH CODE*	
	MIN	MAX
016	004	022
020	004	026
025	004	036
030	004	042
040	006	056
050	008	070
060	010	084
080	010	112
100	014	140

*CODE NUMBERS REPRESENT LENGTH IN WHOLE MILLIMETERS SPECIFY LENGTHS IN 2 mm INCREMENTS THROUGH 100 mm SPECIFY IN 4 mm INCREMENTS IF LENGTH LONGER THAN 100 mm IS REQUIRED

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Metric RTOP Standard
Revision: 9-27-94

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APPROVAL DATE DECEMBER 1970 REVISION (1) 25 APRIL 1991

NA0069

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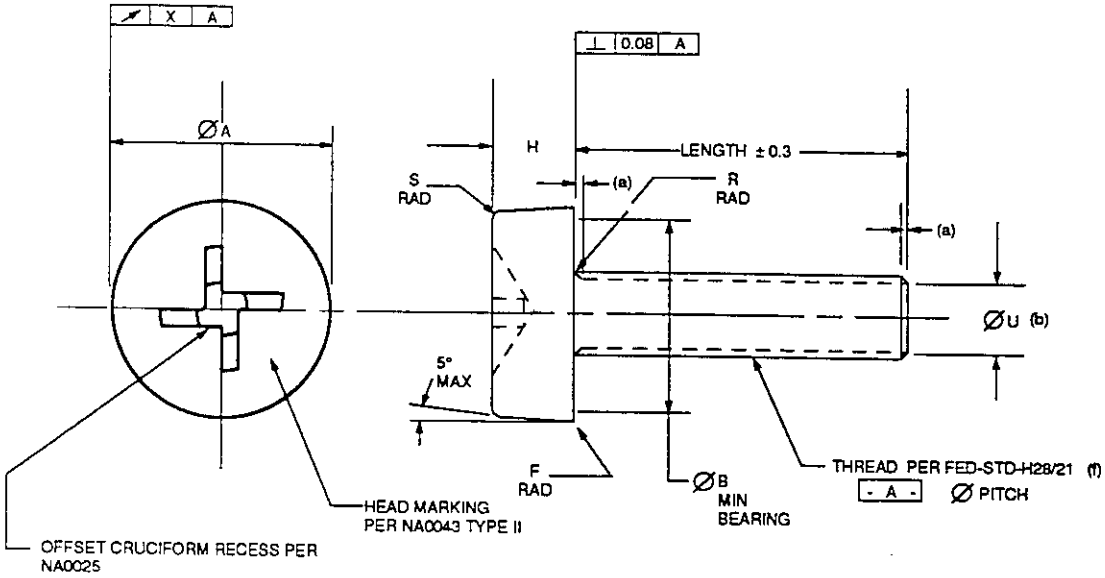

DIA CODE	THREAD 4h6h	ØA	ØB BEARING MIN	F RAD	H	R RAD	S RAD MIN	ØU	X FIM	OFFSET CRUCIFORM RECESS NO. (INCH-LB)	OFFSET CRUCIFORM RECESS INSPECTION TORQUE N • m
030	MJ3X0.5	6.0 5.7	5.1	0.5 0.2	1.8 1.6	0.4 0.2	1.2 0.3	2.3 1.8	0.11	4	1.8
040	MJ4X0.7	8.0 7.7	7.1	0.5 0.2	2.4 2.2	0.4 0.2	1.6 0.4	3.0 2.5	0.14	8	4.2
050	MJ5X0.8	10.0 9.7	9.1	0.5 0.2	3.0 2.8	0.5 0.3	2.0 0.5	4.0 3.5	0.18	10	5.6
060	MJ6X1	12.0 11.7	11.1	0.5 0.2	3.6 3.3	0.7 0.5	2.4 0.6	4.7 4.2	0.21	1/4	14
080	MJ8X1	16.0 15.7	14.7	0.5 0.2	4.8 4.5	0.7 0.5	3.2 0.8	6.7 6.2	0.28	5/16	28
100	MJ10X1.25	20.0 19.7	18.7	0.5 0.2	6.0 5.7	0.8 0.6	4.0 1.0	8.4 7.9	0.35	3/8	48

(a) Incomplete threads in accordance with FED-STD-H28 / 21.

(b) Point shall be flat and chamfered 45° approximately from U diameter.

(c) Screws 40 mm or less in length shall have complete threads to within two thread pitches of head bearing surface. Longer screws shall have a minimum complete thread of 35 mm. Diameter of unthreaded portion of screw shall not be less than minimum pitch diameter nor more than maximum major diameter of thread.

(d) Fillet radius to be cold worked on screws with unthreaded portion.

(e) Recess shall be torque tested in both installation and removal directions with driver per NA0025 with axial end pressure not exceeding 66 N. Screws are rejectable if minimum torque values specified cause fracture of fastener or distortion which results in raised metal at edge of recess exceeding 0.15 mm above surrounding head areas. Sampling shall be per MIL-STD-105, 4% AQL, Level S-1.

(f) Acceptability of screw threads shall be in accordance with FED-STD-H28 / 20 System 22.

LIST OF CURRENT SHEETS			
SHEET	1	2	
REV.	New	New	

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Metric RTOP Standard
Revision: 8-19-94

CUSTODIAN NATIONAL AEROSPACE STANDARDS COMMITTEE

THIRD ANGLE PROJECTION

PROCUREMENT SPECIFICATION

TBD

TITLE

SCREW, PAN HEAD, OFFSET CRUCIFORM RECESS DRIVE, FULL THREAD, CRES, 500 MPa FTU, METRIC

CLASSIFICATION
STANDARD PART

NA00TBD

SHEET 1 OF 2

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MATERIAL — CRES 321, 347, or 316 in accordance with procurement specification

HEAT TREAT — None

FINISH — Passivate per QQ-P-35

CODE — Basic drawing number followed by a dash and three digits to indicate nominal diameter as tabulated and a second three digits to designate nominal length See Table II for limits

EXAMPLE OF PART NUMBER — NA00TBD-060012

- Length Code 012 = 12 mm long See Table II
- Diameter Code 060 = 6 mm diameter M6X1 thread
- Screw Pan Head Offset Cruciform Recess Full Thread CRES 500 MPa, Metric

NOTES

1. Surface texture in accordance with ANSI/ASME B46.1 Bearing surface of head head to shank fillet and all thread segments 0 8um maximum All other surfaces 3 2um maximum
2. Screws shall be free from burrs and slivers Break sharp edges 0 1 to 0 4
3. Dimensions in millimeters unless otherwise specified
4. Recess shall be torque tested in both the installation and removal directions with the appropriate driver and 66 N maximum axial force Fastener fracture or raised metal more than 0 15 over the recess edge shall be cause for rejection Sample per MIL-STD-105 4% AQL Level S-1
5. Dimensioning and tolerances per ANSI Y14 5M and NAC156
6. Magnetic permeability shall be less than 2 0 (A r = 1 0) for a field strength H of 16KA/m using a magnetic permeability indicator per MIL-I-17214

PROCUREMENT SPECIFICATION — To be determined

TABLE II
NOMINAL LENGTHS

DIAMETER CODE	LENGTH CODE*	
	MIN	MAX
030	004	042
040	006	056
050	008	070
060	010	084
080	010	112
100	014	140

*Code numbers represent length in whole millimeters e g 012 code is equivalent to 12 mm length Specify lengths in 2 mm increments through 100 mm and in 4 mm increments over 100 mm

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Metric RTOP Standard
Revision: 8-19-94

NA00TBD

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Acquisition of Metric Hardware

- Providing Metric Hardware to NASA Centers
  - Availability of Test Certified/Traceable Metric Fasteners in Stock (Over 4000 Parts in Stock)
  - Informing Centers of RFQ^{s} / PO^{s}, through the Working Group, to promote combined hardware purchases
- Providing Test Hardware
- Establishing a Baseline of Commonly Used Metric Hardware, Pricing, and Delivery
  - Provide Information on Bulk Procurement of Metric Hardware
  - Comparison of Inch-Pound /Metric Hardware

DRD TECHNOLOGIES

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GFE - Metric Hardware

PART NUMBER	DESCRITPION	QUANTITY
NA0252-060018	SHOULDER BOLTS	70
NA0179BL0050	WASHERS	143
NA0179B050	WASHERS	138
NA0179B-050C	WASHERS	143
NA0179BL060	WASHERS	141
NA0179B-060C	WASHERS	146
NA0179BL080	WASHERS	140
NA0179B080C	WASHERS	140
NA0179BL100	WASHERS	139
NA0179B-100C	WASHERS	140
NA0179BL120	WASHERS	140
NA0179B-120C	WASHERS	140
NA0179BL140	WASHERS	139
NA0179B140C	WASHERS	140
NA0045-050024	HEX HEAD BOLTS	42
NA0045-060042	HEX HEAD BOLTS	56
NA0045-080046	HEX HEAD BOLTS	56
NA0045-100050	HEX HEAD BOLTS	56
NA0045-120098	HEX HEAD BOLTS	55
NA0045-140094	HEX HEAD BOLTS	49
NA0069-040014	SOCKET HEAD CAP SCREW	45
NA0069-050020	SOCKET HEAD CAP SCREW	70
NA0069-060018	SOCKET HEAD CAP SCREW	70
NA0070-050015	FLAT HEAD SCREWS	62
NA0034C050	HEX NUTS LOCKING	56
NA0034C060	HEX NUTS LOCKING	56
NA0034C080	HEX NUTS LOCKING	56
NA0034C100	HEX NUTS LOCKING	56
NA0034C120	HEX NUTS LOCKING	70
NA0034C140	HEX NUTS LOCKING	56
4184-4CNV0060	HELICAL INSERTS	90
4184-4CNV0080	HELICAL INSERTS	79
4184-5CNV0050	HELICAL INSERTS	90
4184-5CNV0075	HELICAL INSERTS	90
4184-5CNV0100	HELICAL INSERTS	79
4184-6CNV0120	HELICAL INSERTS	79
4184-6CNV0090	HELICAL INSERTS	91
5255-8CNV0120	HELICAL INSERTS	80
5255-8CNV0160	HELICAL INSERTS	79
5649-10CNV0150	HELICAL INSERTS	79
5649-12CNV0180	HELICAL INSERTS	78
5145-14CNV0210	HELICAL INSERTS	80
NS0028C040	NUT PLATES SELF LOCKING	5
NS0028C050	NUT PLATES SELF LOCKING	70
NS0028C060	NUT PLATES SELF LOCKING	71
NS0028C080	NUT PLATES SELF LOCKING	70

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TECHNOLOGIES

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Status

- 50,000+ metric "aerospace" fasteners in fabrication or delivered
- Four domestic manufacturer assessments completed and qualified to Agency-wide fastener quality requirements
- 5 NA metric fastener standards in development / coordination
- NASA Metric Threaded Fastener Requirements Compilation - Second Revision Released
- Torque-tension testing
- QA Source Inspection resource established to facilitate additional metric fastener fabrication
- Coordinated procurement methods under evaluation
- Transition limiting issues and cost comparison study results

DRD TECHNOLOGIES

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Lessons Learned to Date*

- Designer Training in Use of SI / ISO Protocols
- Large purchases reduces price
- Consensus Standards Promotes Competitiveness
- Source Inspection Reduces Receiving Inspection Issues
- Pre-Procurement Assessment of Suppliers Identifies Capable Sources
- Multiple Installation Assessment Teams
- Design Guideline Documents
- Use Fastener Selection Lists to Focus Part Usage
- Thorough Review of Metric Standards Before Fabrication is Required
- Hi-Lok Installation Issues
- Unique Metric Identifier (Color, Marking)

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Results to Date

- **Limiting Issues**
  - Many metric standards have not been fabricated
  - Some metric standards cannot be produced - NA0028
  - Nut plate availability and variety is limited
  - Torque-tension testing results are not widely available
  - Small part quantities are not readily available and drive costs higher

- **Significant Issues**
  - Design guideline confusion
  - Lower strength "aerospace" quality fasteners are not available with certifications - no NA or E25 standards available
  - DIN availability
  - Ultra-high strength fasteners and standards are not available
  - No internally threaded fastener design guideline document is available

- **Other Issues**
  - Most manufacturers convert to inch-pound units for fabrication and testing purposes, and then convert back to SI system for reporting
  - Manufacturer quality system recognition of SI system

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Summary

- NASA metrication pilot projects provides functional approach to defining metric fastener requirements
- NASA metric fastener project establishes Agency-wide resource for each pilot project and Agency fastener selection / development
- 50,000+ metric "aerospace" fasteners are in use by NASA
- Agency-wide metric fastener requirements: ~50 categories
- Utilization of domestic manufacturers and source inspection
- Limiting Issues to Date: Producible standards and costs
- NASA fastener requirements developed using ISO/NASC/E-25 consensus design and standards protocols
- Coordinated acquisitions provide metrication economy

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NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

- Introduction and Overview by Ron Quinn, Brown International Corporation ✓
- Threaded Fastener Measuring Instrument Selection Criteria
- Methods - General Description
- Measurement Instrument Component Characteristics Evaluated
- Description of Apeiron Laser Thread Measurement System (LTMS)
- Video of TESA Profile30 Measuring System
- Progress to date
- Open Discussion

Brown International Corporation

NASA
SECOND FASTENER TECHNICAL
INTERCHANGE MEETING

DRD
TECHNOLOGIES

NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Threaded Fastener Measuring Instrument Criteria

A SYSTEM MEETING OUR SELECTION CRITERIA MUST DEMONSTRATE IT'S ABILITY TO MEASURE:

Safety Critical Thread Parameters

- "GO" Functional Diameter Size
- Pitch Diameter Size
- Major Diameter Size
- Minor Diameter Size
- Root Radius
- Flank Angle
- Lead (including helix variations)
- Circularity
- Taper
- Runout
- Surface Roughness

Threaded Fastener Measuring Instrument Criteria

Fastener Size

- Diameter (Externally Threaded):0.1120 inches (2.845 mm) nominal diameter to 6 inches (152.4 mm) nominal diameter.
- Length: Minumium of 0.100 inches (2.54 mm) to maximum of 12 inches (304.8 mm).

Threaded Fastener Measuring Instrument Criteria

Thread Types

- MIL-S-8879
- MIL-S-7742
- FED-STD-H28/2
- FED-STD-H28/4
- FED-STD-H28/21
- ANSI B1.21M

NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Methods

- Optical Triangulation
- White Light / CCD Camera
- Capacitive Probes
- Interferometry
- Measuring Microscopes
- Magnetic Imagery

allowed us to analyze the effects of ~~[illegible]~~ compound 16 pcs on a reflective type A [illegible].

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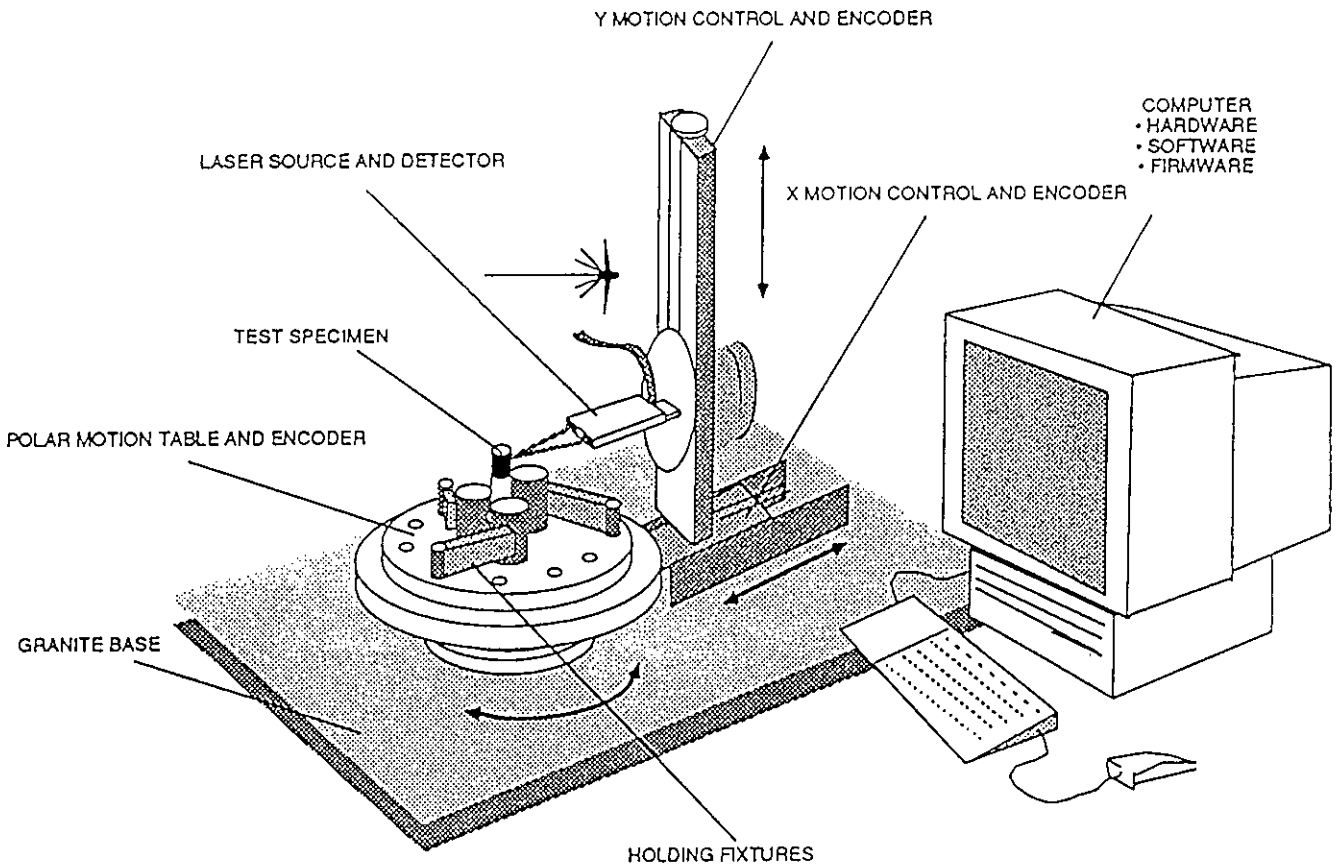
NASA
SECOND FASTENER TECHNICAL INTERCHANGE MEETING

DRD TECHNOLOGIES

NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Measurement System Configuration



NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Measurement Instrument Component Characteristic Evaluated

Positioning
- x-y-z axis linear positioners
- rotary stages

Fixturing Devices
- Three jaw chuck
- Where the part is held
- Part size limitations

Light Source
- IR laser
- White light

Detector
- Lateral-effect photo detector
- CCD

Optics
- scanning
- imaging

Calibration and Alignment
- Procedures necessary
- Traceable to NIST

Software
- Does not demand great technical skill for the practical user
- Provides and environment for analysis by expert users
- Image Processing
- Visualization of Results
- Data storage
- Utilizes "templates" of standard fasteners

Repeatability
- Operator-to-operator
- Machine-to-machine

Accuracy

Speed

Cost

Availability

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NASA
SECOND FASTENER TECHNICAL INTERCHANGE MEETING

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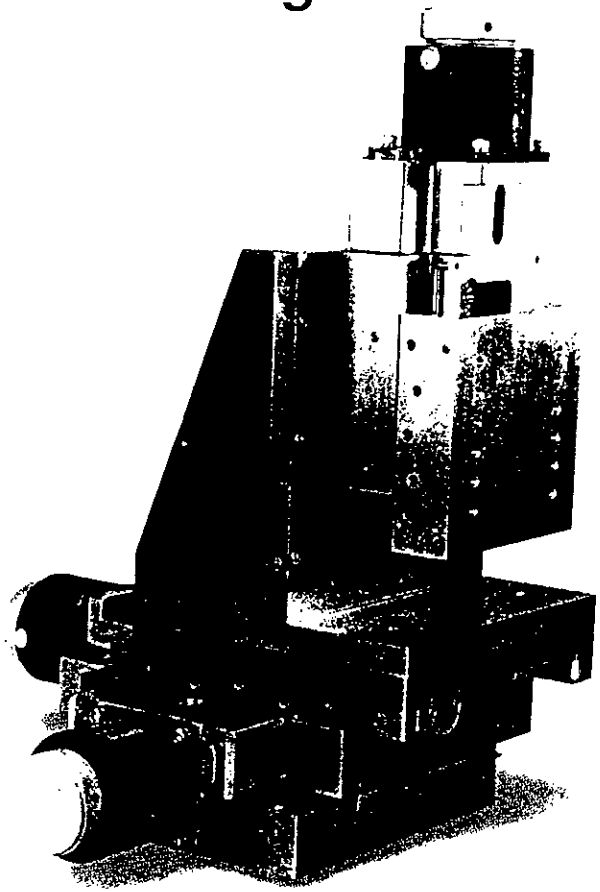
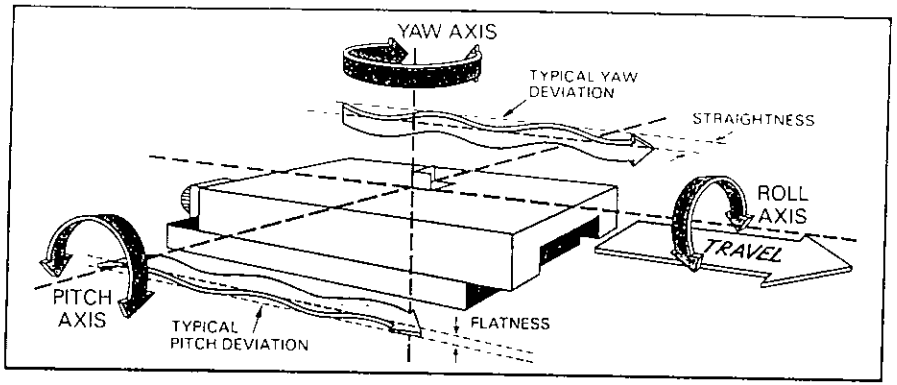
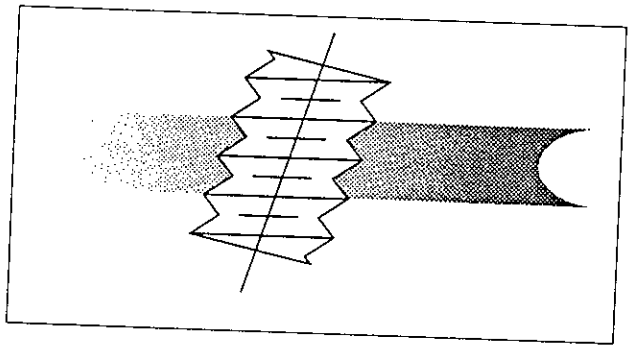
NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Positioning



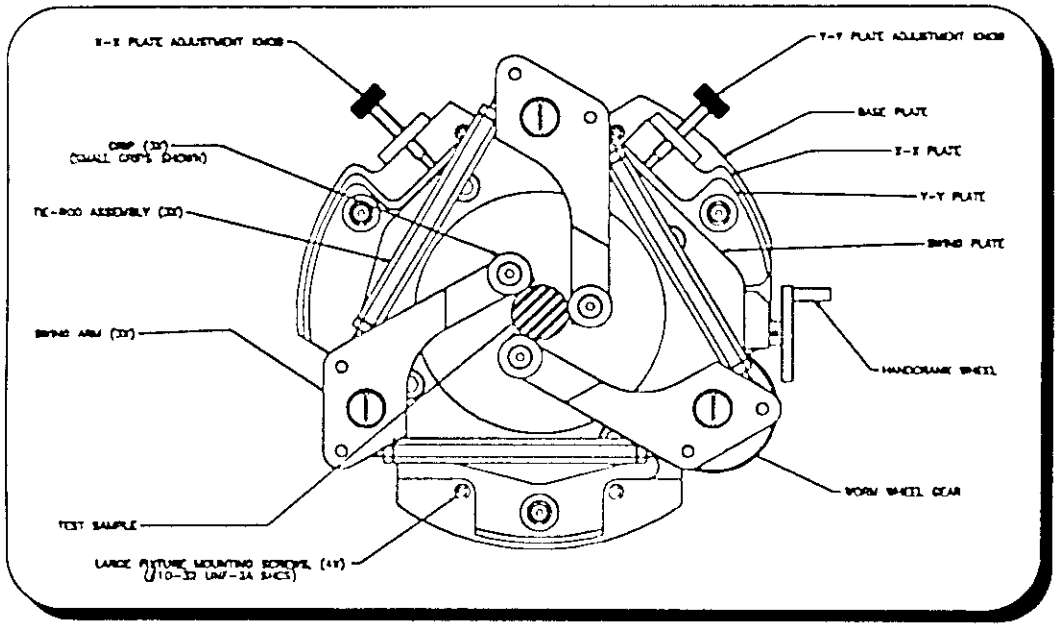


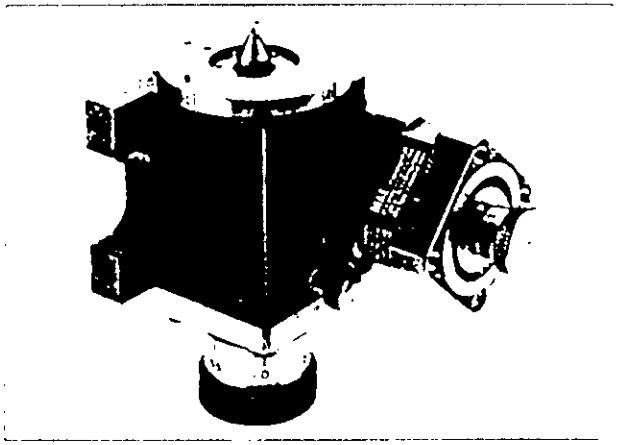


Sources of error:
- Positioning Accuracy
- Repeatability
- Resolution
- Abbe Error
- Thermal Expansion
- Cosine Error

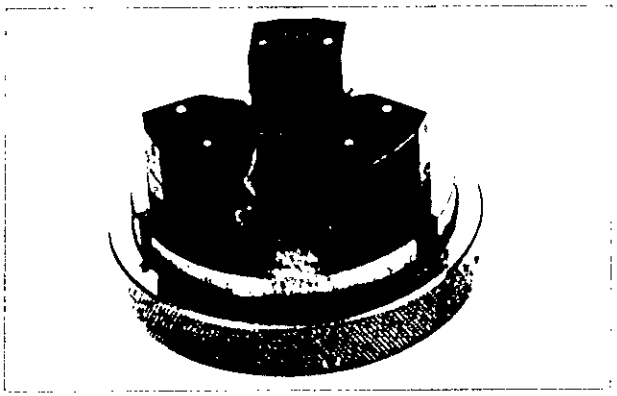
NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Fixturing Devices





ROTATION HEADSTOCK



GRIPPER MECHANISM

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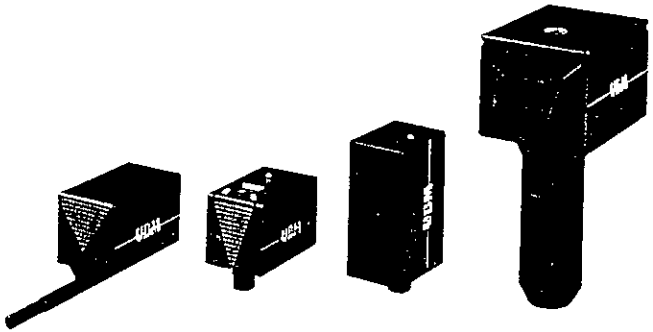
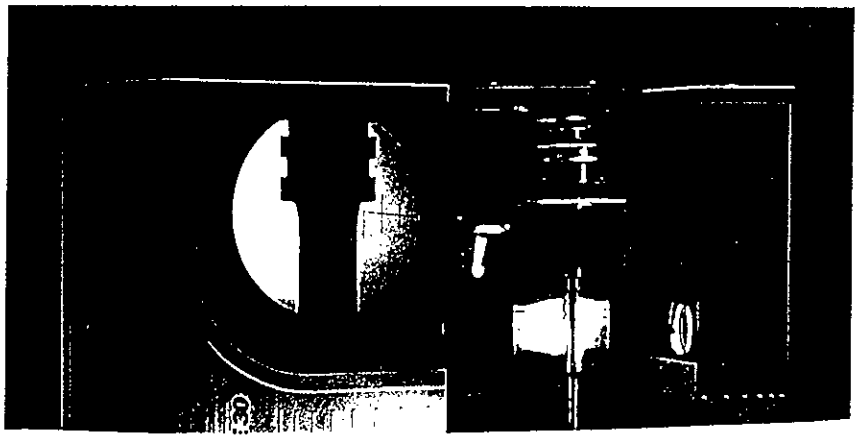
NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Sensors

Point Range Sensors are used in a variety of manufacturing processes such as aerospace, automotive, electronics, machining and medical industries worldwide. The sensors also have several research and development applications.

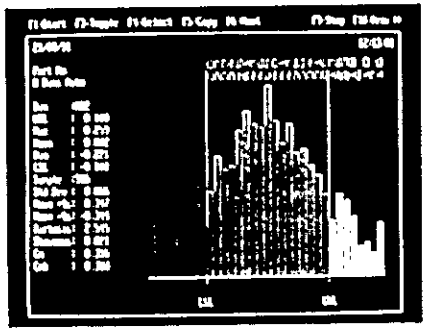


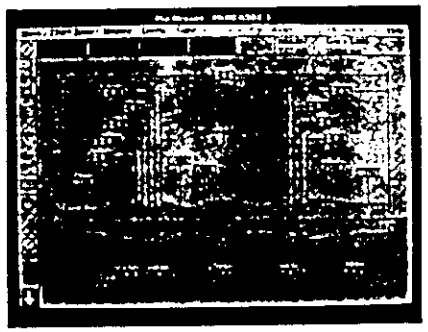
UBM Sensor family

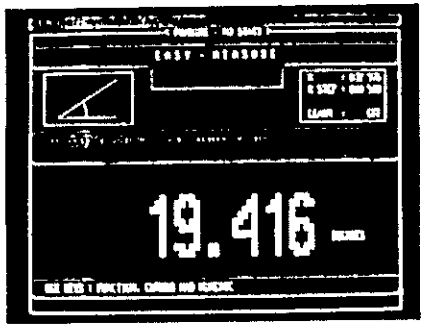


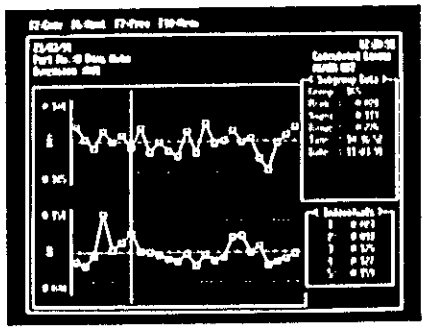
NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

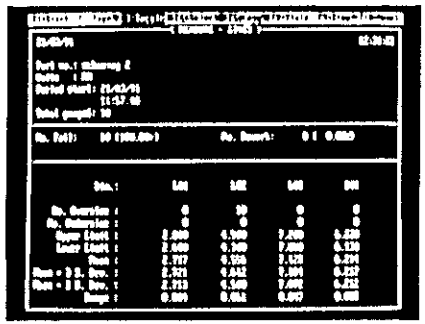
Software

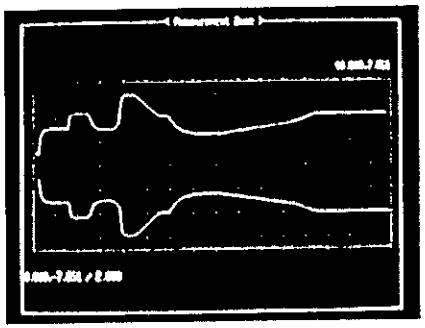


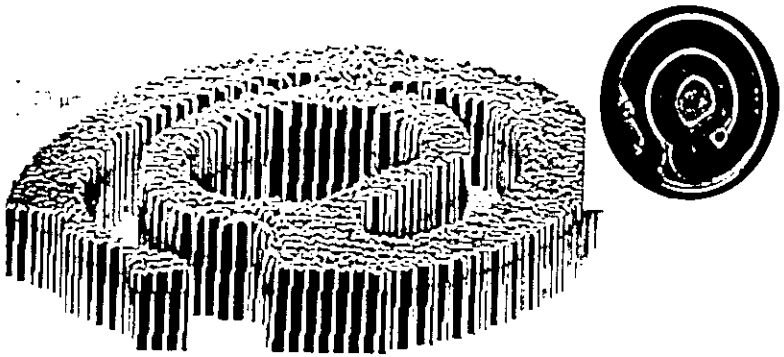




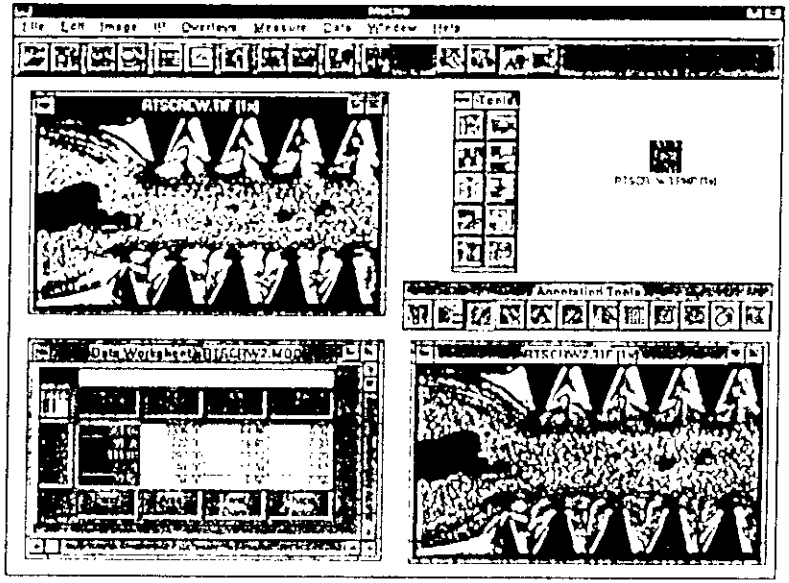








Fuel pump core
surface profile



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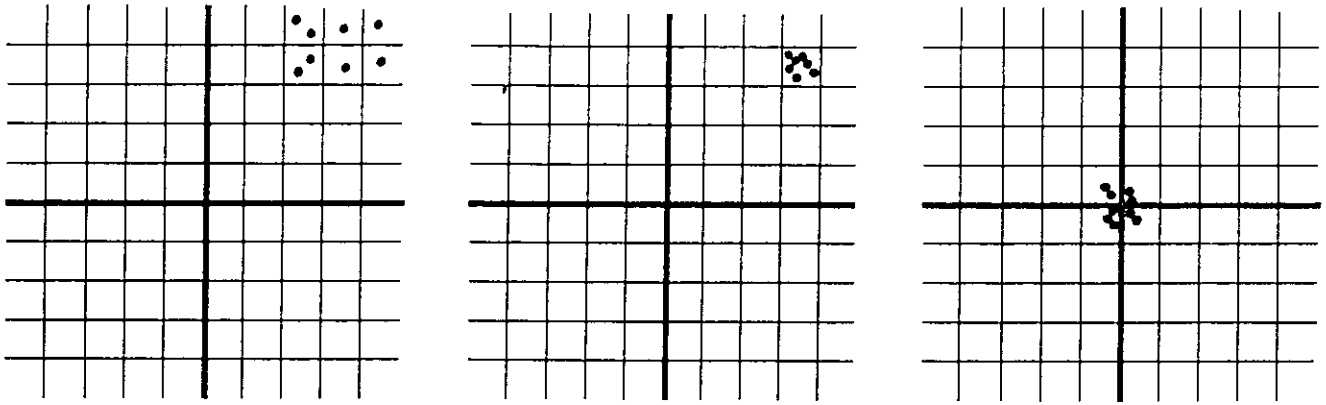
NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Repeatability and Accuracy

machine to machine



Low Accuracy
Low Repeatability

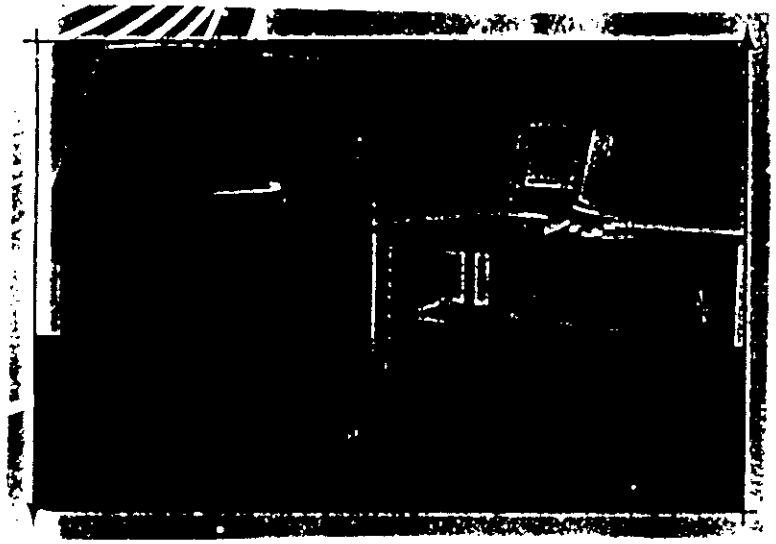
Low Accuracy
High Repeatability

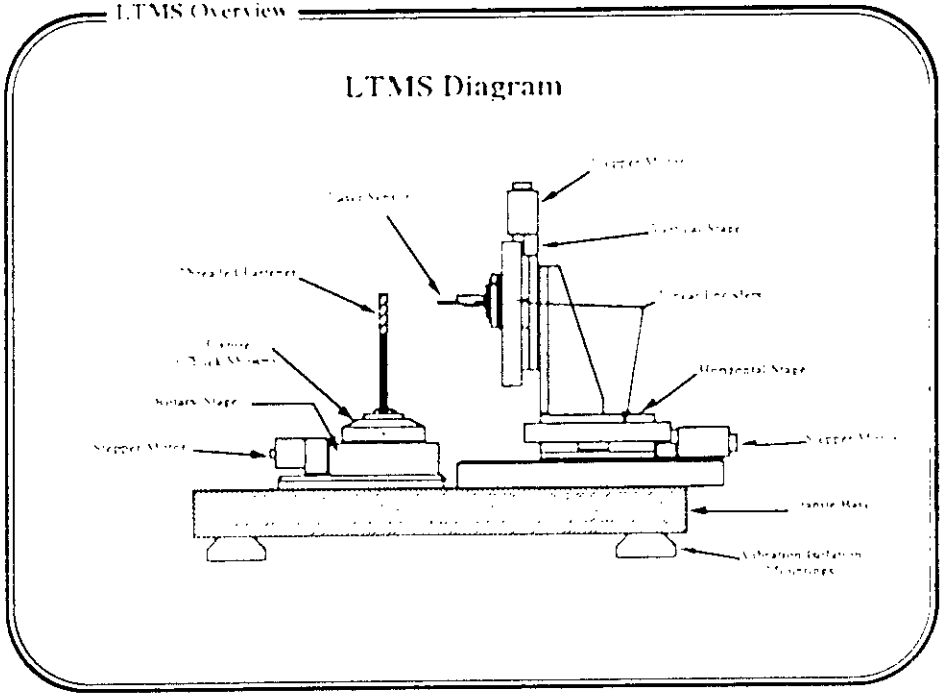
High Accuracy
High Repeatability

NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Description of Apeiron Laser Thread Measurement Systems (LTMS)

APEIRON





NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Description of Apeiron Laser Thread Measurement Systems

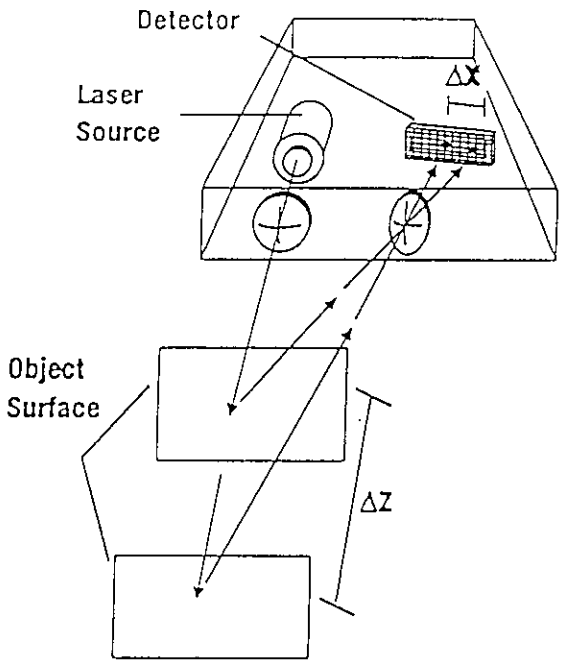
Laser Triangulation

A point of light is projected from the laser diode to the object being measured.

The light scatter from the object is imaged onto a light sensitive detector.

As the distance from the sensor to the surface changes by ΔZ, the light reflected on the surface is imaged to a new position on the detector, ΔX.

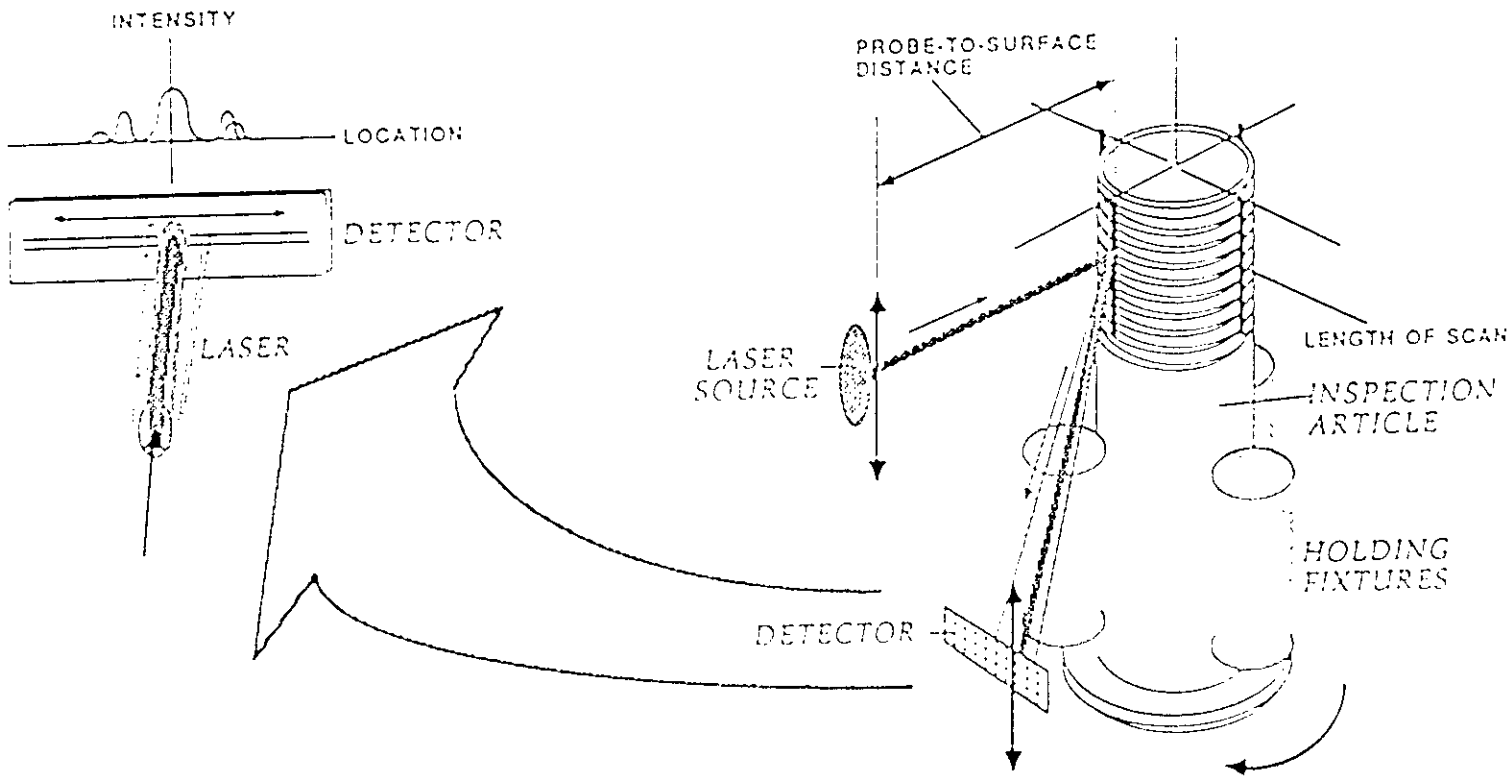
This position on the detector can then be correlatd to an accurate Z measurement.



NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Description of Apeiron Laser Thread Measurement Systems

Laser Triangulation Inspection (Externally Threaded)



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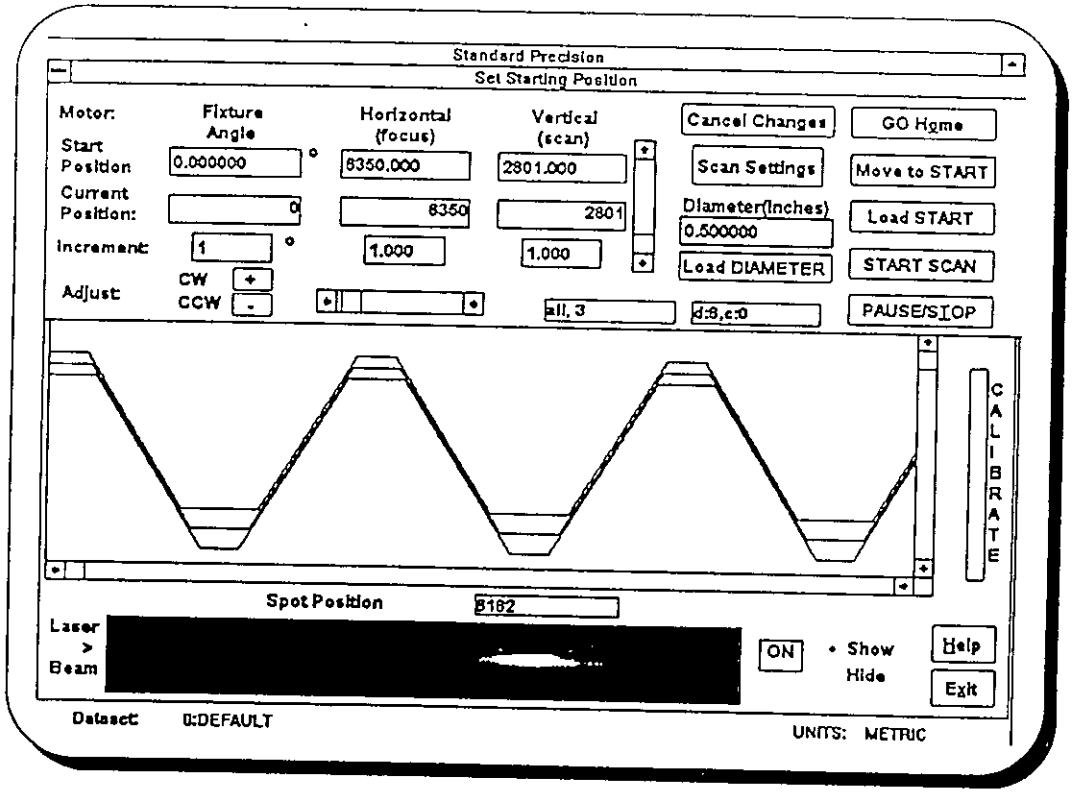
NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Description of Apeiron Laser Thread Measurement Systems



- Across the top of the screen are the motor controls for positioning the stages and taking measurements.
- In the middle of the screen is a small graph on which the LTMS plots the data points that the laser sensor sees during a scan.
- When the Calibration program is active, the Calibrate command button appears to the right of the graph.
- The laser sensor display appears across the bottom of the screen.

NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

FIT GAGE DATA VS APEIRON 18 OCT 94 DATA
NAS 1581AT14

	A	B	C	D	E	F	G	H	I
1	NAS 1581AT14								
2									
3			FIT POS 1			APEIRON	AP-FIT 1		
4	Go Functional Dia. Size		0.4661			0.4688	0.0027		
5	Pitch Dia. Size		0.4657			0.4659	0.0002		
6	Major Dia.		0.4967			0.4962	-0.0005		
7	Minor Dia.		0.4385			0.4387	0.0002		
8	Root Radius		0.0080			0.0085	0.0005		
9	Flank Angle		NA						
10	Flank Angle A					29 2'			
11	Flank Angle B					29 56'			
12	Included Angle					59 18'			
13	Lead		NA						
14	Cumulative Lead					0.5999			
15	Cumulative Lead Error					0.0002			
16	Circularity		0.0005						
17	Taper		0.0002			0.0021	0.0019		
18	Runout		0.0004			0.0008	0.0004		
19	Surface Roughness		32.0000						
20	Eccentricity					0.0002			
21	Root to Crest					0.0284			
22	Helical Deviation					0.0044			
23	Pitch					0.0500			
24									

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NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

FIT GAGE DATA VS APEIRON 18 OCT 94 DATA
NAS 1580C6T13

	A	B	C	D	E	F	G	H	I
1	NAS 1580C6T13								
2									
3			FIT POS 1			APEIRON	AP-FIT		
4	Go Functional Dia. Size		0.3466			0.3500	0.0034		
5	Pitch Dia. Size		0.3464			0.3467	0.0003		
6	Major Dia.		0.3708			0.3708	0.0000		
7	Minor Dia.		0.3254			0.3261	0.0007		
8	Root Radius		0.0070			0.0080	0.0010		
9	Flank Angle		NA						
10	Flank Angle A					30 6'			
11	Flank Angle B					30 10'			
12	Included Angle					60 49'			
13	Lead		NA						
14	Cumulative Lead					0.5002			
15	Cumulative Lead Error					0.0003			
16	Circularity		0.0002						
17	Taper		0.0003			0.0014	0.0011		
18	Runout		0.0004			0.0016	0.0012		
19	Surface Roughness		32						
20	Eccentricity					0.0001			
21	Root to Crest					0.0219			
22	Helical Deviation					-NAN			
23	Pitch					0.0417			
24									

NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

FIT GAGE DATA VS APEIRON 18 OCT 94 DATA
NAS 1959C38X

	A	B	C	D	E	F	G	H	I
1	NAS 1959C38X								
2									
3			FIT POS 1			APEIRON	AP-FIT 1		
4	Go Functional Dia. Size		0.5249			0.5276	0.0027		
5	Pitch Dia. Size		0.5247			0.5246	-0.0001		
6	Major Dia.		0.5572			0.5574	0.0002		
7	Minor Dia.		0.4971			0.4973	0.0002		
8	Root Radius		0.0100			0.0105	0.0005		
9	Flank Angle		NA						
10	Flank Angle A					30 11'			
11	Flank Angle B					30 9'			
12	Included Angle					60 20'			
13	Lead		NA						
14	Cumulative Lead					0.6663			
15	Cumulative Lead Error					0.0006			
16	Circularity		0.0005						
17	Taper		0.0002			0.0008	0.0006		
18	Runout		0.0008			0.0008	0.0000		
19	Surface Roughness		32						
20	Eccentricity					0.0002			
21	Root to Crest					0.0298			
22	Helical Deviation					0.0018			
23	Pitch					0.0555			
24									

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NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

FIT GAGE DATA VS APEIRON 18 OCT 94 DATA
NAS 1956-18D

	A	B	C	D	E	F	G	H	I
1	NAS 1956-18D								
2									
3			FIT POS 1			APEIRON	AP-FIT 1		
4	Go Functional Dia. Size		0.3472			0.3498	0.0026		
5	Pitch Dia. Size		0.3463			0.3465	0.0002		
6	Major Dia.		0.3699			0.3698	-0.0001		
7	Minor Dia.		0.3242			0.3234	-0.0008		
8	Root Radius		0.0070			0.0068	-0.0002		
9	Flan Angle		NA						
10	Flanl Angle A					29 26'			
11	Flanl Angle B					29 8'			
12	Inclu ded Angle					58 34'			
13	Lead		NA						
14	Cumulative Lead					0.4995			
15	Cumulative Lead Error					-0.0009			
16	Circularity		0.0004						
17	Taper		0.0004			0.0022	0.0018		
18	Runout		0.0006			0.0016	0.0010		
19	Surface Roughness		32						
20	Eccentricity					0.0001			
21	Root to Crest					0.0226			
22	Helical Deviation					-0.0057			
23	Pitch					0.0416			
24									

NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

FIT GAGE DATA VS APEIRON 18 OCT 94 DATA
NAS 1006-16A

	A	B	C	D	E	F	G	H	I
1	NAS 1006-16A								
2									
3			FIT POS 1			APEIRON	AP-FIT 1		
4	Go Functional Dia. Size		0.3470			0.3499	0.0029		
5	Pitch Dia. Size		0.3467			0.3468	0.0001		
6	Major Dia.		0.3586			0.3701	0.0115		
7	Minor Dia.		0.3255			0.3251	-0.0004		
8	Root Radius		0.0070			0 0076	0.0006		
9	Flank Angle		NA						
10	Flank Angle A					29 58'			
11	Flank Angle B					30 17'			
12	Included Angle					60 15'			
13	Lead		NA						
14	Cumulative Lead					0.5012			
15	Cumulative Lead Error					0.0024			
16	Circularity		0.0001						
17	Taper		0.0006			0.0012	0.0006		
18	Runout		0.0004			0 0014	0.0010		
19	Surface Roughness		32						
20	Eccentricity					0.0002			
21	Root to Crest					0.0217			
22	Helical Deviation					0.0012			
23	Pitch					0.0418			
24									

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NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

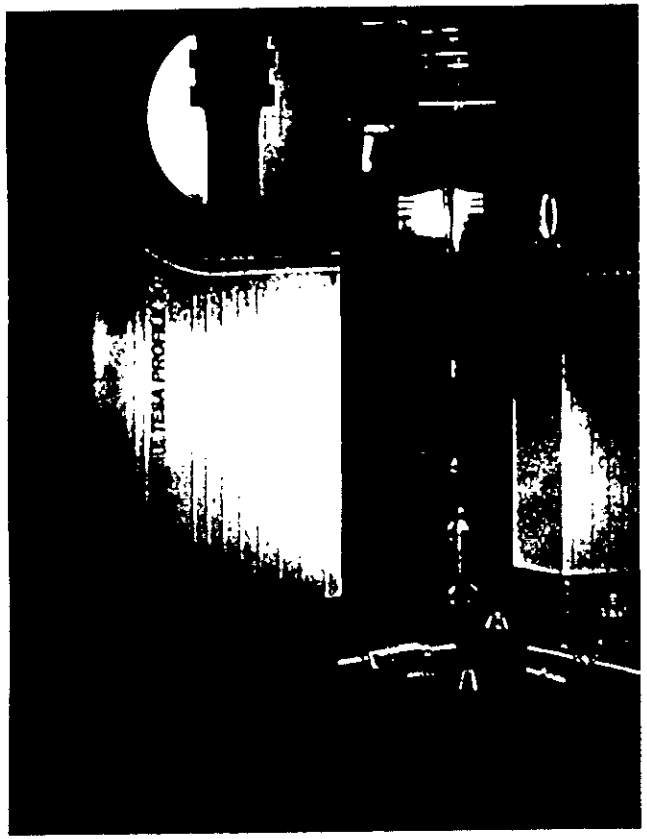
FIT GAGE DATA VS APEIRON 18 OCT 94 DATA
NAS 1578C5T20

	A	B	C	D	E	F	G	H	I
1	NAS 1578C5T20								
2									
3			FIT POS 1			APEIRON	AP-FIT1		
4	Go Functional Dia. Size		0.2839			0.2850	0.0011		
5	Pitch Dia. Size		0.2839			0.2845	0.0006		
6	Major Dia.		0.3092			0.3089	-0.0003		
7	Minor Dia.		0.2634			0.2629	-0.0005		
8	Root Radius		0.007			0.0075	0.0005		
9	Flank Angle		NA						
10	Flank Angle A					30 9'			
11	Flank Angle B					30 10'			
12	Included Angle					60 19'			
13	Lead		NA						
14	Cumulative Lead					0.4999			
15	Cumulative Lead Error					-0.0002			
16	Circularity		0.0005						
17	Taper		0.0003			0.0015	0.0012		
18	Runout		0.0005			0.0022	0.0017		
19	Surface Roughness		32						
20	Eccentricity					0.0002			
21	Root to Crest					0.0223			
22	Helical Deviation					-0.0023			
23	Pitch					0.0417			
24									

NON-CONTACT DIMENSIONAL INSPECTION OF THREADED FASTENERS

Video of TESA Profile30 Measuring System

A Brown & Sharpe Group Company



PROFILE 30 SPECIFICATION

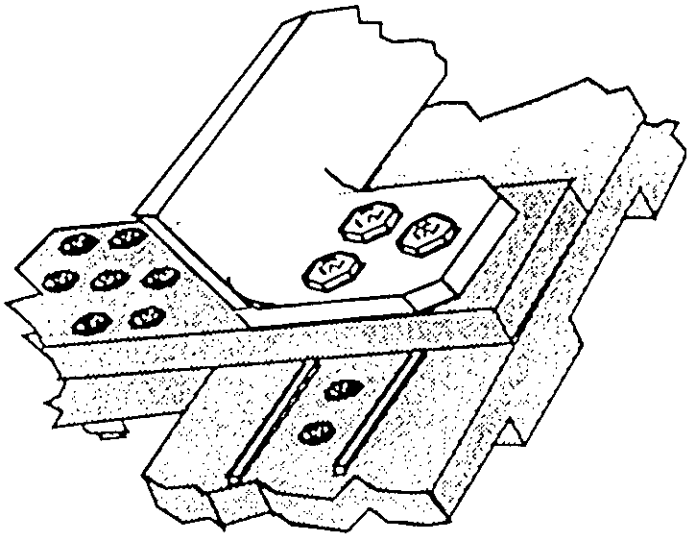
Performance		Metric	Inch
Resolution:	Diameter	0.0002mm	0.00001"
	Length	0.001mm	0.00004"
Repeatability: (+/- 2σ = 95%)	Diameter	+/-0.001mm	+/-0.00004"
	Length	+/-0.0025mm	+/-0.0001"
Accuracy: (Error of mean measured value)	Diameter	1.5+0.01Dμm	(0.06+0.01D)/1000"
	Length	7+0.01Lμm	(0.28+0.01L)/1000"
		D and L in mm	D and L in inches
Speed: (without rotation)	Edge measurement:	1s	
	Diameter measurment	1s	
	Typical cycle time (10 features)	20-30s	
Capacity:	Measurement		
	Diameter	30mm	1.2"
	Length	200mm	8"
	Component		
	Diameter	59mm	2.3"
	Length	225mm	9"
Weight:	Measuring Unit:	35kg	75lbs
	Computer	20kg	45lbs
Dimensions: (HxWxD)	Measuring Unit:	525x540x330mm	20.5x21.3x13"
	Computer System:	650x200x500mm	25.5x7.8x19.7"
Operating Conditions:	Temperature Range:	10°C-40°C	50°F-104°F
	Relative Humidity.	10-80%	
Electrical Service:		100/110/220/240vAC	50/60Hz

Progress to Date

- **Noncontract Thread Dimensional Inspection - Lasers**
  - Completed literature search
  - Established interface with DOC-NIST Metrology Laboratory
  - Completed Industry Survey
  - Technology evaluation completed
  - Selected Apeiron Model LTMS-SP for further evaluation
  - Coordinating evaluation of Apeiron unit through NASA Fasteners Working Group with LaRC, JSC and JPL
  - Apeiron completed measurements on Method 23 gaged NASA type fasteners (Manufacturer's Gaging)
  - Following on acceptance tests of NASA, LaRC LTMS-SP unit at Langley
  - MSFC scheduled to perform Method 23 gaging on fasteners measured by Apeiron

Torque-Tension Standard

NASA-Wide Torque Tension Standard Development



Torque-Tension Standard

Background

- **Fastener Installation Requires Use of Specific Torque Values**
  - Nominal Diameter
  - Lubricants
  - Washer Placement
  - Fastener Combination
- **Proliferation of Fastener Types Requires Significant Data**
- **Installation Parameters and Quality Assurance Criteria Vary**
  - Torque-Tension Testing Procedures (Methods, Sampling)
  - Data Analysis Methods
  - Inspection Criteria
- **Although Current NASA Practice Allows Determination of Installation Values From Analysis, Testing is Preferred for Higher Fidelity Values**
- **No Current 'Single Source" Exists for Torque-Tension Data**

Common R&T Task Issues

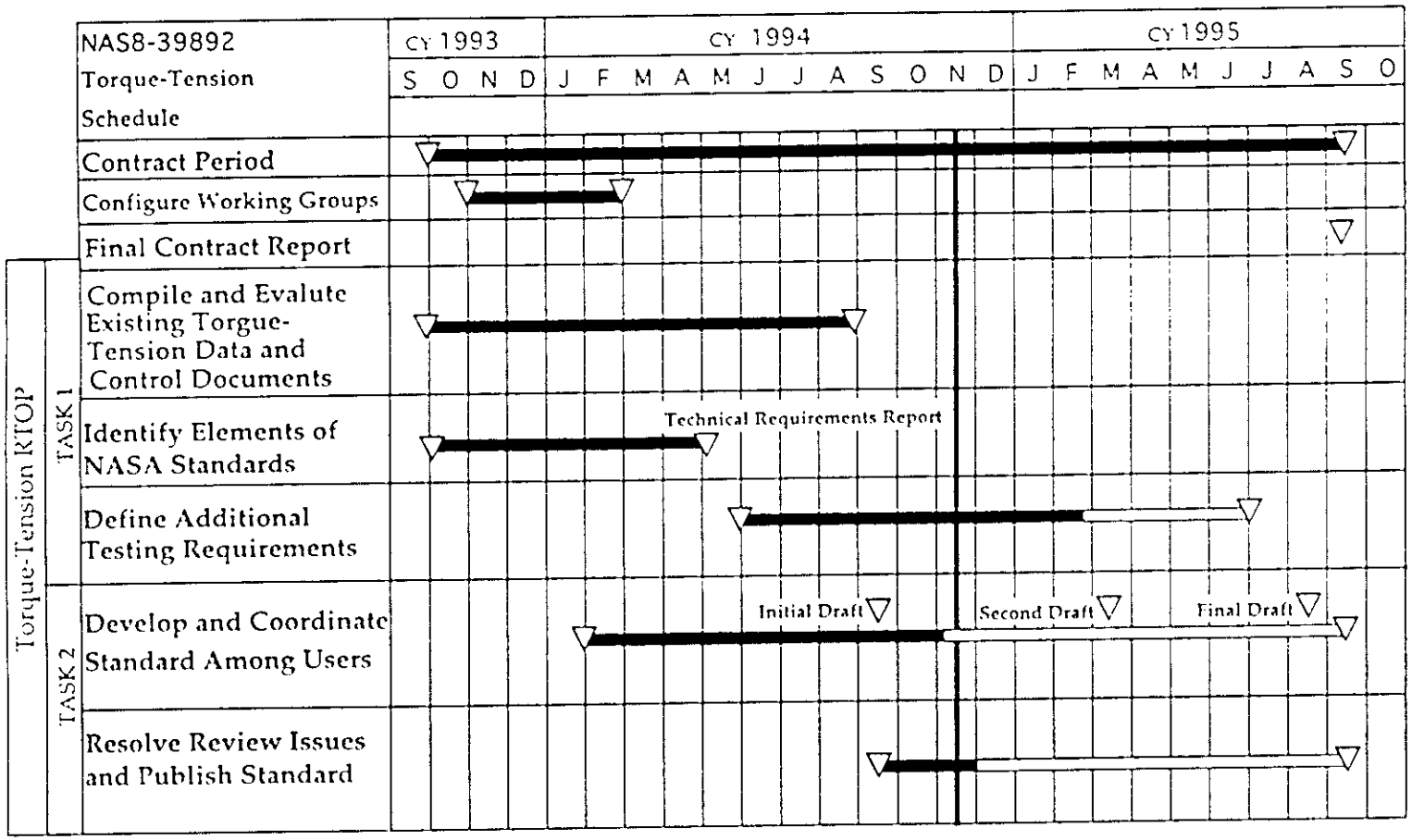
- Work Methodology Based on Established NASA TQM and CI Principles and Tools
- Utilizes NASA Working Groups to Derive Specific 'Customer' Requirements
  - The NASA Centers Are The Customer (Users)
  - NASA Mechanical Parts / Fasteners Working Group
- Coordination Among Relevant NASA Efforts, Industry Groups and Government Agencies
  - Bolting Technology Council
  - MIL-HDBK-60

Torque-Tension Standard

Project Work Plan Summary

- **Compile and Evaluate Existing Torque-Tension Data and Control Documents**
  - Agency and Industry Survey
  - Discrete installation torque data and testing methods
  - Quality controls for torquing equipment and installation inspection
- **Identify Elements of NASA Standard**
  - Data and data reporting requirements
  - Equipment (wrenches, calibrators)
  - Inspection protocols
  - Torque-tension testing methods, sampling and data analysis requirements
- **Define Additional Testing Requirements**
- **Develop and Coordinate Standard Among Users**
- **Resolve Review Issues and Publish Standard**

Torque-Tension Standard Development Schedule



Torque-Tension Standard

Torque-Tension Standard Development

- **Initially Based on MSFC-STD-486B and STP-401 (KSC)**
- **Compiled and Reviewed Torque-Tension Data From Other Sources**
  - Torque vs. Preload Plots Where Possible
  - Data Analysis Methods
- **Preliminary Outline Developed**
  - Washer Placement
  - Torque Side
  - Testing Procedures
  - Pre and Post Quality Assurance Criteria
  - Tools
  - Calibration Protocols

Torque-Tension Standard

Dimensionless Torque Parameter

$$T^* = \frac{T}{D\,A_s\,F_{TX}}$$

where:

T^* = Dimensionless torque parameter

T = Torque

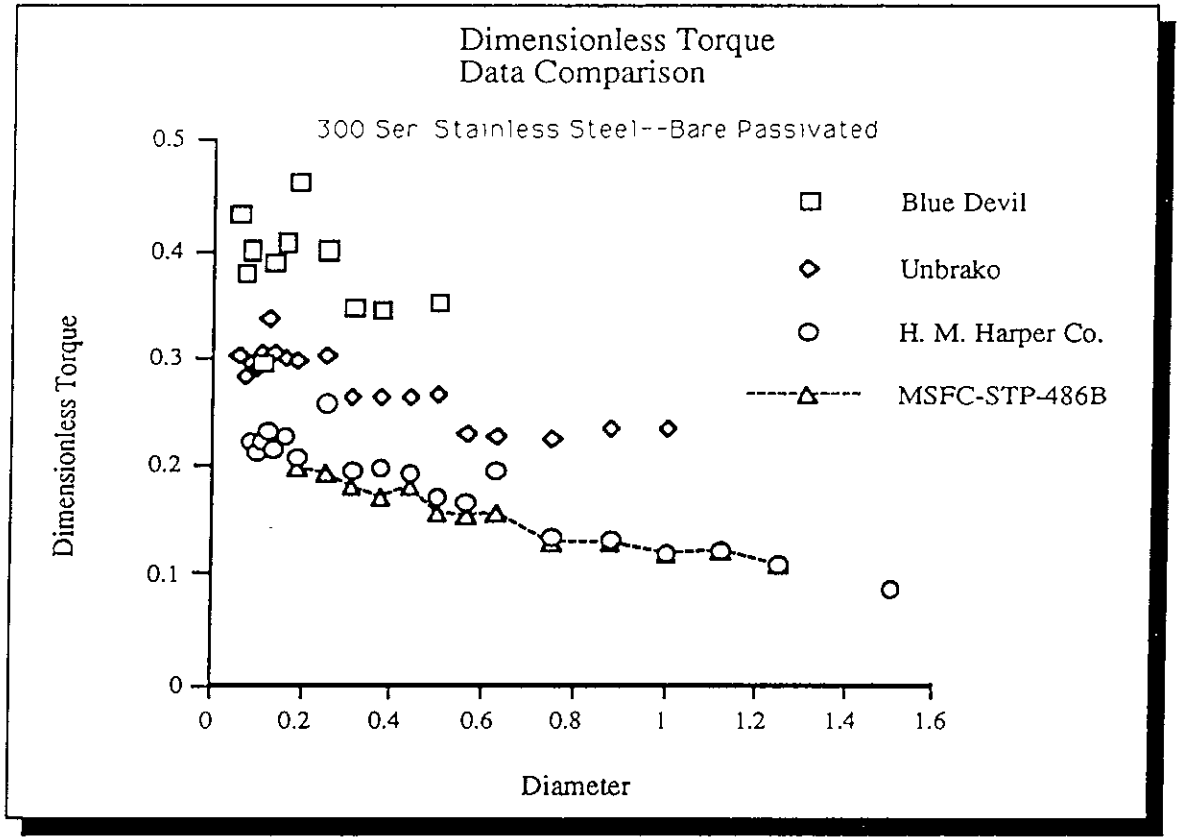
D = Diameter

A_s = Fastener stress area

F_{TX} = Material tensile strength property

Torque-Tension Standard

Dimensionless Torque Parameter Comparison



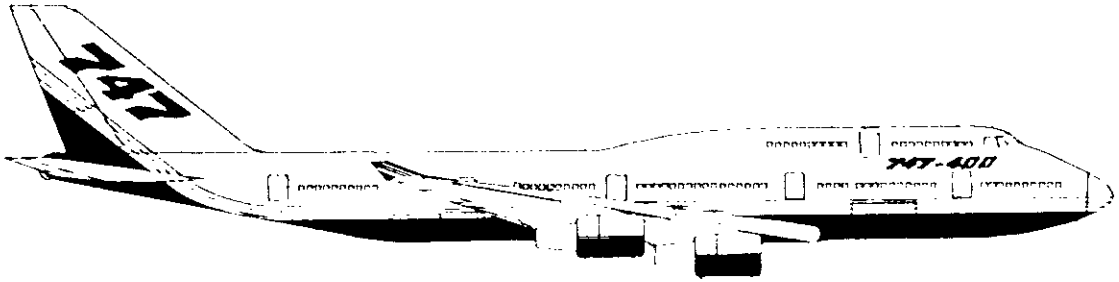
Summary

- Industry and Government Data Survey Completed
- Coordinating Standard Development through NASA Working Group
- Completed Assessment of Data Analysis Methods
- Developed Preliminary Standard Outline
- Incorporating New Torque Tension Data
  - MSFC Metric Fastener Data
  - JPL Data
- Incorporating Suggested Changes by Working Group Members and Contractors

BOEING

FASTENER QUALITY IMPROVEMENT PLAN

Mr. Kristinn Sigurdsson



Evolution of Boeing Fastener Controls

- *Prior to 1988*
  - *Engineering Qualification*
  - *Receiving Inspection*
- *1988*
  - *Imposed Basic Quality System Requirements (D1-8000)*
  - *BCAG & BD&SG*
- *1992 Current Plan*

1992

- *Concerns About Quality of Fasteners*
  - *Manufacturers Not Using Correct Specification Revisions*
  - *Improper Testing Procedures*
  - *Poor or Nonexisting Quality Procedures*
  - *Unacceptable Testing Equipment*
- *Action Plan to Audit 8 Fastener Manufactures*

FASTENER QUALITY IMPROVEMENT

1992 (continued)

- *Special Fastener Audits*
  - *Team Audit*

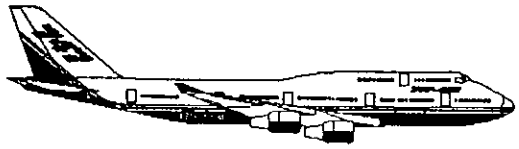
    BCAG, BD&SG

    Procurement Quality, Engineering, Receiving Inspection

    Technical Specialists

    1 Week per Company (200 Hours)
  - *Audit Results*

    8 out of 10 Companies on Probation



1992 (continued)

- *Special Fastener Audits (continued)*
  - *Audit Findings*

    Heat Treatment

    Metallurgical & Mechanical Testing Laboratory Practices

    Poor Understanding of Boeing Requirements

    MRB & Lot Control Insufficient

    Questionable Management Ethics

    Quality Systems Inadequate
- *Audit the Remaining 18 Fastener Suppliers*

1992 (continued)

- *Fastener Steering Committee*
  - *Quality Directors*
  - *Engineering*
  - *Procurement*
  - *Mission*

    "To develop a Boeing program specific to the fastener industry that assures contract technical requirements are continually imposed within the fastener supplier facilities"

1992 (continued)

- *December 1992 Fastener Symposium*
  - *Supplier Performance*
  - *Special Fastener Audits*

    12 Probations

    3 Disapproved
  - *Expectations*
  - *Future Plans*
  - *Supplier Feedback*

Fastener Quality Improvement Plan

- *D1-9000 Quality System Implementation*
  - *Advanced Quality System Approval*
  - *Variability Reduction*

    Process Control

    Key Characteristics

Fastener Quality Improvement Plan (continued)

- *Increased Surveillance*
  - *Quarterly CQI Plan Reviews*
  - *Monthly Supplier Visits*

Technical & Quality System

Fastener Quality Improvement Plan (continued)

- *Control of Nonconforming Fasteners*
  - *FAA Concern*
  - *Rejected Parts Reappearing at Boeing & Subcontractors*
  - *Contractually Imposed Process for Accountability and Control of Nonconforming Fasteners*

Fastener Quality Improvement Plan (continued)

- *D1-4426 Process Approvals*
  - *Procurement Specification*
  - *Manufacturing of Fasteners to Boeing Specifications Requires Approval*
  - *Process Compliance*
  - *Auditable*

Fastener Quality Improvement Plan (continued)

- *Source Acceptance & Delegation*
  - *Selected Suppliers*
  - *Boeing Team at Supplier for 3 to 6 Months*
  - *Leads to Delegation of Inspection*

Fastener Quality Improvement Plan (continued)

- *Specification Improvements*
  - *Meetings with Suppliers on Specific Products*

Fastener Quality Improvement Plan (continued)

- *1994 Fastener Symposium*
  - *Supplier Base Managment*
  - *Compliance*
  - *FAA Issues*

SPACE SHUTTLE

Solid Rocket Motors
Thiokol Corporation

Fastener Technical Interchange Presentation

Presented by
Kendall Dye, Supervisor
Component Procurement Quality Assurance

November 14-15, 1994

Thiokol CORPORATION

SPACE OPERATIONS

P.O. Box 707, Brigham City, UT 84302-0707 (801) 863-3511

Publications No. 950439

1989 Fastener Acceptance Criteria

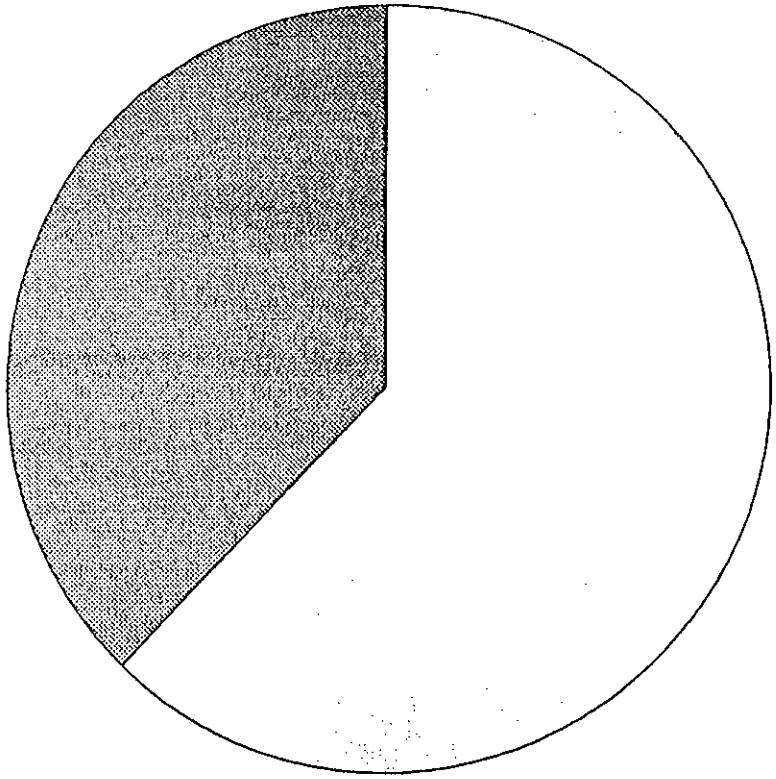
- Integrity verified through:
  - Certification and test reports
  - Random physical testing
- No instances of fastener functional failure
- System revisions required through general knowledge of decreasing fastener quality

Current Acceptance Practices

- Review of supplier certification and test reports
- Integrity testing of flight, GSE/tooling and MS/NAS fasteners
    - Nine occurrences of fastener failure since implementation of testing
        - Tensile and/or hardness
        - One supplier disqualification
- Activity in past 12 months
    - 178 Fastener procurements
    - 21 Suppliers

Procurement Sources

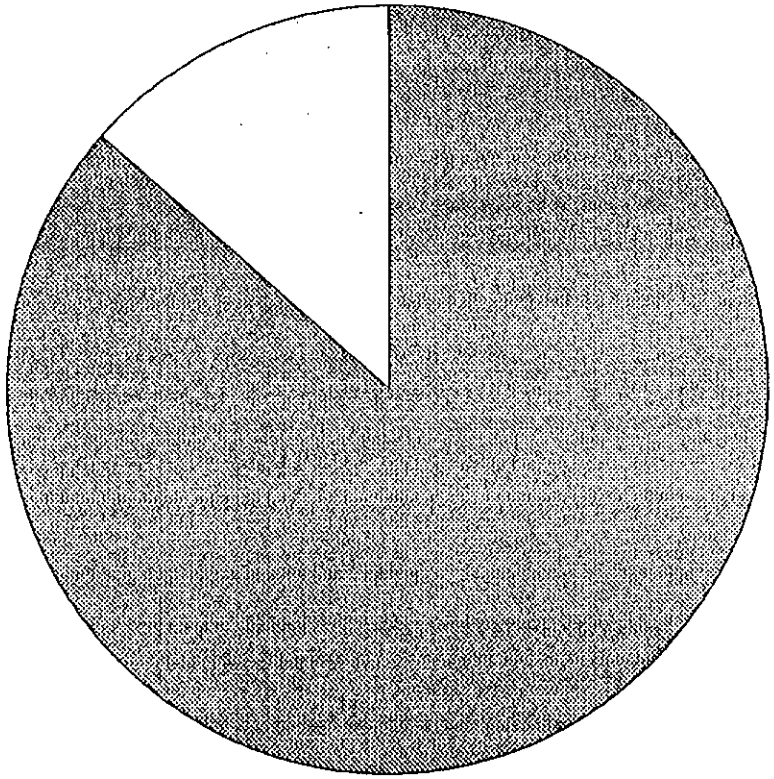
All Fasteners



Manufacturers (37.9%)

Distributors (62.1%)

Flight Fasteners



Manufacturers (86.4%)

Distributors (13.6%)

A040905a

Current Procurement Practices for Fasteners

- Quality requirements
  - Purchase order review
  - Pre-procurement review for all fasteners
    - Resolve issues/disconnects
  - Pre-manufacture coordination
    - Communicate/highlight special requirements, previous issues, and nonconformances
  - Procurement Data List (PDL) for flowdown of supplier requirements
    - Engineering requirements
      - Drawings/specifications
      - Quality/reliability program flowdown
      - Special requirements (e.g.,packaging)
    - Vendor Inspection Plan (VIP)
      - Certification/test and inspection requirements

Current Procurement Practices for Fasteners

- Inspection requirements
  - Source inspection
  - Receiving inspection
    - Identification and markings
    - 100 percent inspection on features with critical applications
    - 100 percent inspection on small lots
    - Visual inspection
    - Documentation package review
  - Sample inspection (per MIL-STD-105)
    - Procurement Quality Engineering procedure on sample plans
      - Defining AQL for use in minor and major applications

Verification Testing

- Supplier requirements
  - Nondestructive examination
    - Visual examination
    - Dye penetrant
    - Dimensional inspection
      - Sample plans approved by Thiokol
    - Magnetic particle inspection
    - Stress durability
    - Chemical analysis
  - Destructive testing
    - Ultimate tensile strength and shear strength

Verification Testing

- Independent laboratory test requirements
    - Certificate of conformance
    - Chemical analysis
    - Mechanical analysis
- Integrity testing on all flight, tooling, and MS/NAS fasteners
    - Sole source independent test laboratory

Procurement Source Selection

- Criteria for selection, qualification, and retention
  - Contract with manufacturers where possible
  - Establishment of approved suppliers
    - Qualified Products List (QPL)
      - Supplier and part number specific
    - Approved Vendor List (AVL)
      - Quality system approved
        - Multifunctional team tailored to product and the supplier
    - Waivers
      - Small-volume, low-dollar contract
      - Use history
      - Last resort

Lessons Learned

- Appropriate use of sampling plans
- Value of pre-manufacture communication with supplier
- Need to identify critical features of fasteners
- Need to reduce fastener procurements from distributors
- Need for special packaging
- Value of supplier PPIAs

Conclusions

- System will segregate defective lots of fasteners
- More emphasis must be placed on direct manufacture procurements
- Current program in place pending release of NASA Fastener Integrity Program

Lockheed
Missiles & Space Company, Inc.
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FASTENER TECHNICAL INTERCHANGE MEETING

NASA MARSHALL SPACE FLIGHT CENTER
15 - 16 NOVEMBER 1994

PRESENTED BY:
LOCKHEED MISSILES & SPACE COMPANY
SUNNYVALE, CALIFORNIA

Lockheed
Missiles & Space Company, Inc.
1111 Lockheed Way PO Box 3504 Sunnyvale CA 94089

CONTROL OF FASTENERS AT LOCKHEED MISSILES & SPACE COMPANY

- MISSILES SYSTEMS DIVISION (MSD)
- SPACE SYSTEMS DIVISION (SSD)

Lockheed
Missiles & Space Company, Inc.
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SELECTION AND CONTROLS

- ENGINEERING
- SURVEILLANCE AND AUDITS
- RECEIVING / RECEIVING INSPECTION
- CONCERNS
- ACCOMPLISHMENTS

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ENGINEERING REQUIREMENTS

- SOURCE CONTROL DRAWINGS (SCDs)
- STANDARD PARTS
  - SELECTED NATIONAL AEROSPACE STANDARDS (NAS), MILITARY STANDARDS (MS), NAS-METRIC (NA) DRAWINGS
- PROGRAM SPECIFIC REQUIREMENTS ARE DEFINED ON OUR DRAWINGS
- PREFERRED PARTS HANDBOOK (PPH)
  - SSD ONLY
- SUPPORT SOURCE SELECTION

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FASTENER SURVEILLANCE & AUDITS

- MSD / SSD EVERY 2 YEARS
  - RESULTS SHARED WITHIN LOCKHEED CORPORATION
  - JOINT AUDITS BY PRODUCT ASSURANCE & MATERIALS AND PROCESS ENGINEERING
- MSD URGING NADCAP TO COVER FASTENER SUPPLIER PROCESSES

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Missiles & Space Company, Inc.
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FASTENER RECEIVING/RECEIVING INSPECTION

- RECEIVING INSPECTION
  - USE SSD LOCKHEED AUTOMATED INSPECTION REQUIREMENTS SYSTEM (LAIRS) AND MSD INSPECTION INSTRUCTION (II's)
- I D AND DAMAGE
- CERTIFICATE OF CONFORMANCE
- PHYSICAL DIMENSION
- WORKMANSHIP
- SCREENING OF TEST DATA

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FASTENER RECEIVING/RECEIVING INSPECTION - Con't

- LAB VERIFICATION TESTS
  - NONDESTRUCT TESTS
    - » PASSIVATION TESTING
    - » MAGNETIC PERMEABILITY
  - DESTRUCT TESTS
    - » MATERIAL, FINISH, LOCKING TORQUE, BREAKAWAY TORQUE, TENSILE STRENGTH, AND SHEAR STRENGTH

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FASTENER RECEIVING/RECEIVING INSPECTION - Con't

- PROGRAM UNIQUE REQUIREMENTS
  - SAMPLE OF ALL CAD PLATED PARTS
  - VERIFY TYPE OF SOLID FILM LUBRICANT

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CONCERNS

- MSD
  - CAD PLATE THICKNESS SOLUTIONS
    - » TESTING BY DISTRIBUTORS
    - » IMPROVE INSPECTION CONTROLS AT MANUFACTURERS
- SSD
  - INSTALLATION AND BREAKAWAY TORQUE OF NAS AND MS FASTENERS

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ACCOMPLISHMENTS

- REDUCED REJECTION RATE FROM 80% TO LESS THAN 20%
- IMPROVED SOURCE SELECTION PROCESS
  - PROCUREMENT COMMODITY TEAMS
    - » ENGINEERING (M&P)
    - » BUYER
    - » PRODUCT ASSURANCE

FASTENER TECHNICAL INTERCHANGE MEETING

George C. Marshall Space Flight Center

November 15 - 16, 1994

UNITED TECHNOLOGIES USBI

Marvin Smith

Fastener Controls

- Current Procurement Practices for Fasteners
- Receiving Inspection of Fasteners
- Verification Testing
- Qualified Suppliers

Fastener Controls

- Current Procurement Practices

  — Procurement of Fasteners 1/4 and larger are controlled by Threaded Fastener Inspection Plan USBI-SR&QA-001.

  — Quality Clause 64 is applied to all Fastener Procurements
    - Requires Manufacturer's Certification
    - Requires Lot Traceability
    - Required actual Chemical and Physical Test Results
    - Requires objective evidence that all Processing, Heat Treatment, and Testing has been performed.
    - Requires data on ULT Tensile, Shear, Hardness and Penetrant Inspection Results.

  — Source Inspection is performed on all Flight Fastener Procurements.
    - Source Inspection Plan defines inspections to be performed.
    - Source Inspection performs 100% Visual Inspection

UNITED TECHNOLOGIES USBI

Marvin Smith

Fastener Controls

- Receiving Inspection of Fasteners

  — Receiving Inspection of Fasteners per Receiving Inspection Instructions.

    - Requires 100% verification of certifications and test data.
    - Requires lot control verifications.
    - Requires sample inspection of each lot for:
      - Head Marking
      - Head Logo

- Verification Testing

  — A random sample is selected from each lot of fasteners at Receiving Inspection for verification test.

    - Tensile
    - Double Shear
    - Penetrant

Fastener Controls

- Fastener Suppliers
  - — Selection
    - On Site Survey of Manufacturer which includes:
      - Vendor Quality
      - M&P Engineering
      - Procurement
    - Qualification
      - Must be a manufacturer
      - Must pass Fastener Survey Checklist requirements.
    - Retention
      - Vendor Rating System
      - Resurvey annually

UNITED TECHNOLOGIES USBI

Marvin Smith

Fastener Controls

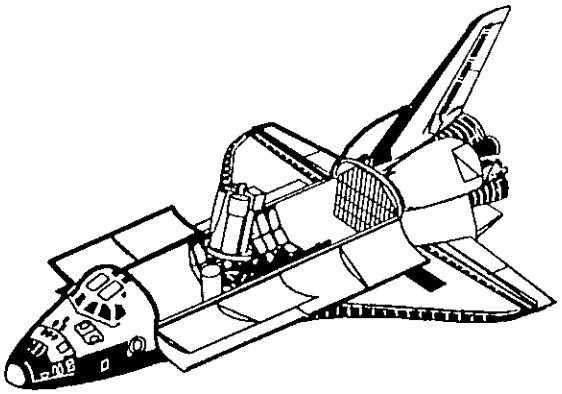
- Qualified Fastener Suppliers
  - — B&B Specialities
    Anahiem, CA
  - — Fairchild Aerospace Fastener Division
    Torrance, CA
  - — Fairchild Screw Corp Division
    City of Industry, CA
  - — Hi Shear Corp.
    Torrance, CA
  - — Huck International
    Carson, CA
  - — SPS Technologies Aerospace
    Jenkin Town, PA
  - — Sonic Industries Inc.
    Gardena, CA

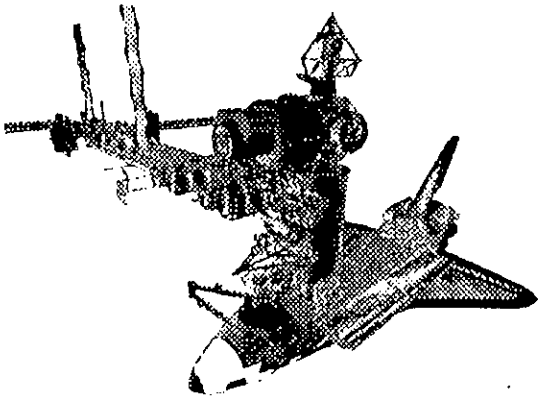
Fastener Technical Interchange Meeting

Bob Bilyou

MDA-HSV Quality Assurance

Fastener Technical Interchange Meeting

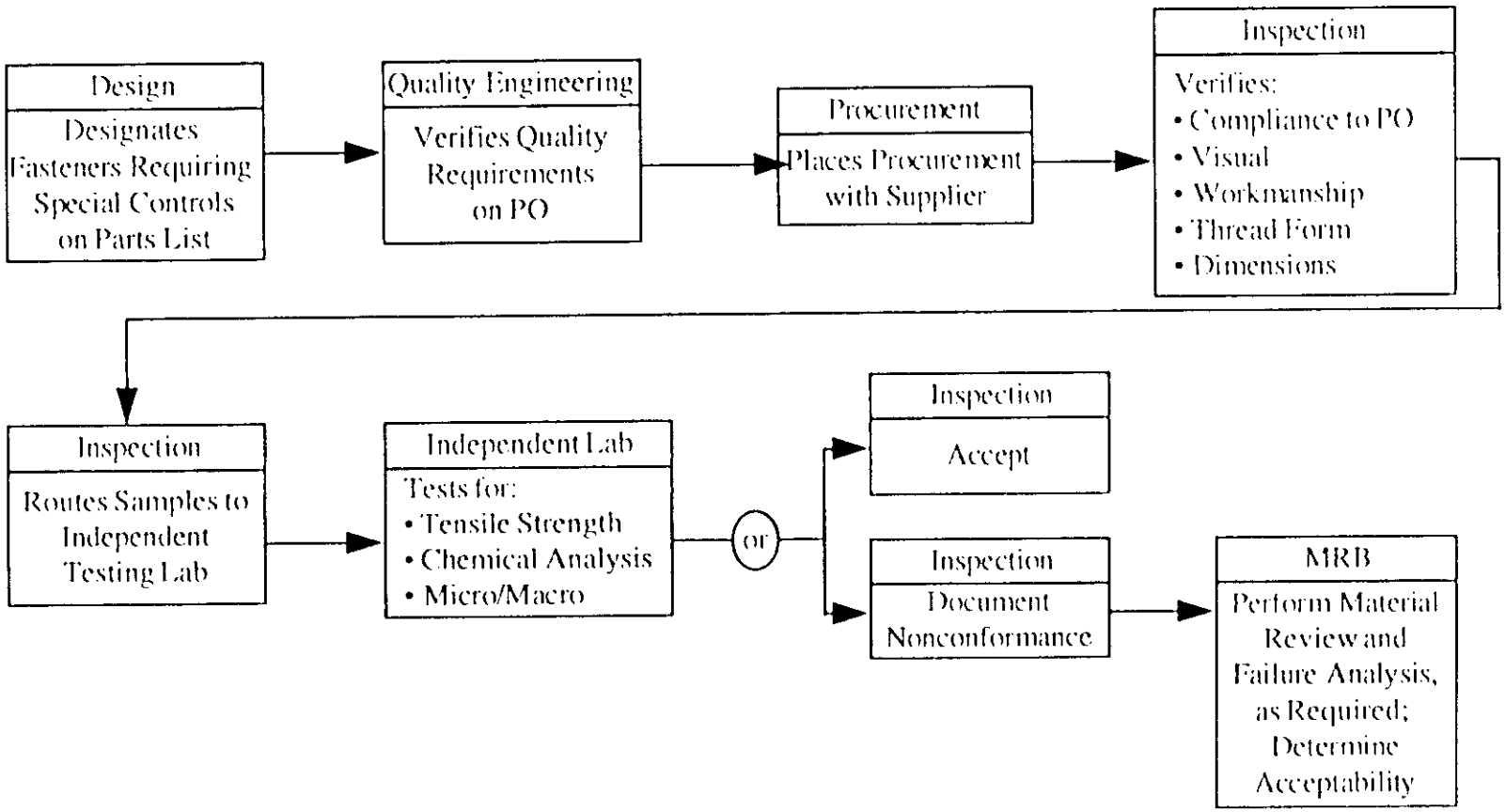




- **Introduction**
- **MDA-HSV Stock Purged - 1988**
- **Implemented Additional Procurement and Receiving Inspection Controls - 1988**

Fastener Technical Interchange Meeting

MDA-HSV Special Fastener Control Process



Fastener Technical Interchange Meeting

MDA-HSV Special Fastener Control

- Procurement Policy
  - Approved Manufacturers
  - Copy of Manufacturer's Test Data
  - Lot Traceability
- Receiving Inspection
  - Physical = Identification & Head Marking, Visual, Workmanship, Thread Form, Dimensional
  - Independent Testing = Tensile Strength, Chemical Analysis, Micro/Macro Evaluation
- Traceability = Each High Strength Fastener received by MDA-HSV which is subject to special controls is identified and is traceable to all documentation and testing.

Fastener Technical Interchange Meeting

Procurement Clause Summary

- NASA/MSFC Approved Fastener Manufacturers
- Acceptance Test Reports
- Manufacturer's Certificate of Conformance
- Single Manufacturer's Lot
- Manufacturing Lot Date Codes No Older Than 2 Years
- Receiving Inspection Contingent On Sample Testing
- Fracture Critical Parts (When Applicable)
- Assemblies Containing High Strength Fasteners

Fastener Technical Interchange Meeting

NASA/MSFC Programs
SUMMARY OF RESULTS - 1/93 to Present

•Total Fasteners Procured =			2185
•Total Samples Tested =			134
•Total Rejections =			981
•Visual =		8	
•Marking/Identification =		14	
•Thread Form =		0	
•Dimensional =		2	
•Testing =		959	
•Cracks =	147		
•Grain Size =	19		
•Tensile Strength =	13		
•Grain Flow =	767		
•Thread Laps =	13		

Fastener Technical Interchange Meeting

What Happened To The Rejected Fasteners?

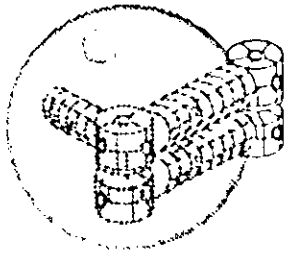
- MSFC Lab (M&P) Analyzed Parts - No Defect = 946
- Scrapped Duplicate Serial Numbers = 2
- Returned To Supplier - (12 Cracks, 12 Marking, 8 Visual) = 32
- Accept As Is = 1

Total Confirmed Physical Rejections = 23
Total Confirmed Testing Rejections = 12
1.6% of the total fasteners received during this period.

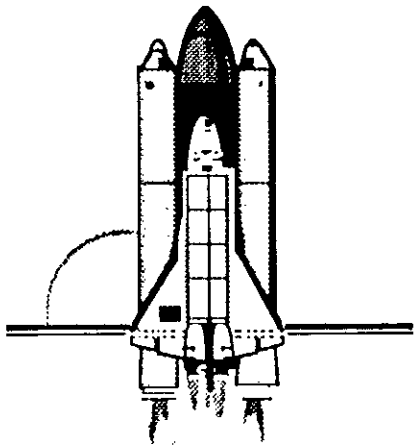
Fastener Technical Interchange Meeting

- Based on costs for procurement, materials (samples), testing, rejection, investigations, and scrapped hardware - the cost added to **each** useable fastener is estimated at ***$25.65***.
- We may want to re-consider whether the benefits gained justify this additional cost.

NASA-wide Fastener Technical Interchange Meeting



Teledyne Brown Engineering
Fastener Controls



Charlie Blass

November 16, 1994

TELEDYNE
BROWN ENGINEERING
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CFB 11/10/94

Fastener Control Topics

- Definitions
- External/Internal Threads
- Procurement of Fasteners
- Receiving Inspection
- Verification Testing

CFB 11/10/94

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Externally-Threaded FASTENERS

	STANDARD: NAS, MS, AN Standard Fasteners (Non-Structural Applications)	SPECIAL: NAS, ≥ .190"∅, A-286, ≥ 140 ksi (Structural Applications)

PROCUREMENT	• Approved Suppliers
	• QA Review
	• Electronic ALERT Screening
	• Quality Terms on PO
	• QA Approval
		• Approved Suppliers
		  • Product Audits
		  • Manufacturer or Authorized Distributor (Drop Ship)
		• QA Review + ALERT Screen
		• Quality Terms on PO
		• Require ALL Test Data
		• QA Approval

RECEIVING INSPECTION	• Markings Check • Physical Configuration • Workmanship • Plating / Treatment • Compliance to Quality Terms	• 100% Markings Check • 100% Damage Check • Workmanship • Plating / Treatment • Compliance to Quality Terms • Variable-Gaging - System 22 • 105, Level S-2, AQL 2.5 • Record Lot Numbers / Hold

VERIFICATION		• Audited and Approved Test Labs
		  • Independent Testing
		  • 3 Tensile Tests per Lot
		  • 2 Macros / Micros per Lot
		  • 1 Chemistry per Lot

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Definition

Special

- Structural Fastener Controls
  - Externally-Threaded
  - National Aerospace Standards (NAS)
  - Structural Applications
  - Material
    - A-286 CRES
    - ≥ 140 ksi
  - ≥ .190" ∅

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Internally Threaded Fasteners

(Mates to Externally-Threaded Fasteners for Structural Applications)

○ Current Procurement Procedure

- ≥ .190 Diameter Internal Threads
  - 3B Thread Form (Structural)
- Impose (again) the Requirements of MIL-S-8879C or MIL-S-7742D (as applicable) on the TBE Supplier

○ Near Term Plans

- Purchase System 22 Variable-Gaging Equipment for 3B Internal Threads

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TBE Procurement of Fasteners

(Structural Application - Externally-Threaded Fasteners)

Special

- **TBE Approved Fastener Suppliers**
  - Product Audits
    - QA and M&P Membership
    - Previously Purchased Fasteners
    - Examine Fastener "Build Paper"
      - Objective Evidence of Literal Compliance
    - Examine Macros/Micros
    - Verify Procedures And Implementation
    - Publish Report
  - QA Assures That The Supplier Is An Approved Source
    - Imposes Quality Terms On The Purchase Order
- **All Test Report Data To TBE**

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TBE Receiving Inspection

(Structural Application - Externally-Threaded Fasteners)

Special

- 100% Visual Inspection
  - Head Marking
  - Damage
- Variable-Gaging
  - System 22
  - MIL-STD 105, Level S-2, AQL 2.5 Sampling
- Record Manufacturer and Lot Number
- Hold For Verification Testing

CFB 11/10/94

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TBE Verification Testing

(Structural Application - Externally-Threaded Fasteners)

Special

- Approved Test Labs
  - Independent
  - QA and M&P Audits
- Lot Testing (regardless of lot size)
  - Must Meet Original Specification Requirements
    - 3 Tensile Tests Per Lot
    - 2 Macros / Micros Per Lot
    - 1 Chemistry Per Lot
- Upon Acceptance - Release to Stock
    - Maintain Lot Traceability

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TRW

TRW FASTENER CONTROLS

presented at

National Aeronautics and Space Administration
Marshall Space Flight Center

Second Fastener Technical Interchange Meeting

November 15 and 16, 1994

by

Donald Evans

TRW INVOLVEMENT IN THE PROBLEM OF COUNTERFEIT FASTENERS

- 1986 — Testimony to Congress by Industrial Fastener Association
- 1987 — GIDEP Alerts Promulgated
- 1988 — Article in Machine Design
  Aerospace Corp. Recommendations
  Many More GIDEP Alerts
  NASA Questions Regarding Fasteners Procurement for OMV And TDRS
- 1990-1992 — Air Force Peacekeeper Survey

TRW

GIDEP ALERTS

- Tests Certified But Not Performed
- Cracks
- Decarburization
- Wrong Finish
- No Manufacturer's Mark
- Poor Grain Flow
- Hydrogen Embrittlement
- Wrong Heat Treatment

TRW

NASA INQUIRY TO TRW RE: OMV

- MSFC LETTER 28 APRIL 1988
  - "Identify which of the recommended procurement requirements will not be met by TRW or subcontractors"
  - Procure only from original manufacturers (OM) that have been approved by a product audit or OM distributors that have been designated in writing
  - Require copies of all test results
  - Require traceability to lot number
  - Require record retention for ten years
  - Require witness of testing on first and future orders
  - Require manufacturer's certification that the items supplied were manufactured and tested in accordance with applicable specifications
  - Require manufacturer to state on certification that the items supplied were manufactured and tested in accordance with applicable specifications
  - Require manufacturer to prepare and implement a quality assurance plan that meets the intent of this policy

TRW

NASA INQUIRY TO TRW RE: TDRS

- GSFC RECOMMENDATION 29 FEBRUARY 1988
  - Existing Fasteners: Review Records
  - New Procurement: Recommended Tests and Documentation
- TRW RESPONSE IDC 18 MAY 1988
  - TDRS Critical Fastener Summary
  - TRW Fastener Procurement System
- GSFC FOLLOW-UP QUESTIONS 24 MAY 1988
  - Emphasis on Most Critical TDRS Fasteners
    -- Tests and Documentation of Tests
  - Details of Skip-Sampling of Lots

NASA INQUIRY TO TRW RE: TDRS (CONT.)

- RECOMMENDED PROCUREMENT PRACTICES
  - Single Point Failure Fasteners
    - -- 100% NDE
    - -- Tensile Test All Lots
  - Redundant Load Path Fasteners (High Strength)
    - -- Tensile Test All Lots
  - Redundant Load Path Fasteners (Low Strength)
    - -- Visual Inspection
  - Retain Lot Traceability Until Use
  - Require Documentation of Tests by Manufacturer

TRW

AEROSPACE CORP. ALERT ON FASTENERS

- APAB-8801 DATED 22 FEBRUARY 1988
  - To USAF/Space Division Contractors
- JUSTIFICATION
  - Widespread Potential Problems
  - Potential Impact on USAF/SD Programs
  - Possible Procurement and Use of Counterfeit and Substandard Mechanical Fasteners
- FASTENERS IN STOCK
  - Purge Parts from 2 Suppliers
  - Sample Test Parts from Other Suppliers
- FASTENERS INSTALLED ON HARDWARE
  - Replace Critical Fasteners in High Stress or High Temperature Applications

TRW

TRW METHODS FOR SELECTING AND CONTROLLING FASTENER SUPPLIERS

- SUPPLIER/SUBCONTRACTOR PRODUCT ASSURANCE
  - Surveys Suppliers and Distributors
  - Physical Quality Control and Document Control
  - Lists Approved Suppliers in QASD
- MANUFACTURERS EVALUATION AND CONTROL BOARD
  - Approves Suppliers for MECB List
- DISTRIBUTORS PERFORMANCE BOARD
  - TRW Random Checks
    -- Certification
    -- Traceability
  - 2 Distributors Terminated Since 1985
    -- Misrepresented Sources
- BLANKET PURCHASE ORDERS
  - 2 Current Distributors
  - Criteria from TRW Purchasing
  - Renewed Annually

TRW

TRW METHODS FOR PROCURING FASTENERS

TYPE	High Strength Fasteners with TRW Specs	High Strength Fasteners with Non-TRW Specs	Low Strength Fasteners with Non-TRW Specs
EXAMPLE	SP, CD	MS, NAS	AN, MS, NAS
SUPPLIER	Mostly Original Manufacturer or Modification Processor	Manufacturers and Blanket Distributors	Mostly TRW Contracted Blanket Distributor

TRW

TRW'S PRIOR EXPERIENCE WITH FASTENERS

- OVERWHELMINGLY SUCCESSFUL
- NO KNOWN MAJOR FAILURE IN TEST OR OPERATION ATTRIBUTED TO COUNTERFEIT OR NONCOMPLIANT FASTENERS
- ANECDOTAL EVIDENCE THAT ONE LOT OF FASTENERS FAILED DURING ASSEMBLY
  - Apparently Counterfeit
- TWO FASTENER SUPPLIERS DROPPED SINCE 1985
  - Falsified Certifications of Tests

TRW

AEROSPACE CORP. ALERT (CONT.)

- RECOMMENDATIONS FOR PROCUREMENT
  - Only from Original Manufacturer
  - Source Control Drawing
  - Manufacturer's Lot Traceability
  - Fastener Headmarkings
  - Testing by Manufacturer
    - -- Verify Chemistry
    - -- Penetrant NDI
    - -- Mechanical
    - -- Witness Tests Annually
  - Documentation Saved 5 Years
  - New Receiving Inspection
    - -- Chemistry
    - -- Tensile Tests
    - -- Hardness
    - -- Metallurgical Examination
    - -- Dimensions

TRW

TRW REQUIREMENT ON SUPPLIERS TO DEMONSTRATE QUALITY

CERTIFICATIONS REQUIRED FROM SUPPLIER	TRW HIGH STRENGTH	NON-TRW HIGH STRENGTH	LOW STRENGTH
Name and Address of Manufacturer	x	x	x
Statement of Compliance with Spec Requirements	x	x	x
Manufacturers Internal Lot Number -- If Required by Spec -- If Required by Project Material Control	x	x	
Manufacturers Test Data if Required by Spec	x		
Special Process Certification if Required by Spec	x		

TRW RECEIVING INSPECTION METHODS TO VERIFY FASTENER QUALITY

	TRW HIGH STRENGTH	NON-TRW HIGH STRENGTH	LOW STRENGTH
Check Documentation			
-- Manufacturer's Identity	x	x	x
-- Manufacturer and Distributor on TRW Approved Lists	x	x	x
Verify Packaging to Spec	x	x	x
Verify Marking and Part Identification	x	x	x
Visual Inspection at 1% AQL	x	x	x
For Parts with History of Problems:			
-- Visual Inspection All Parts	x	x	
-- Dimensional Inspection All Parts	x	x	
Skip Sampling of Lots			
-- Tensile Tests (3)	x	x	
-- Metallurgical Examination	x	x	
Verify Accomplishment of Special Process if Required by Spec	x		

COUNTERFEIT FASTENER STUDY TEAM

- Formed in 1987
- Headed by a Structures Engineer from the Materials Engineering Group (Dr. John Goodman)
- 13 Members
- Representatives from the Following Line Organizations: Supplier/Subcontractor, Product Assurance, Purchasing, Mechanical Design, Inventory Stores and Management, Materials and Processes, Components Engineering, Receiving Inspection, Materiel
- Made Recommendations to TRW Management in June 1988
- Primary finding was that the Fastener Procurement and Control System currently in place at TRW was adequate and comprehensive. However, several recommendations were made to improve it further.

TECHNICAL RECOMMENDATIONS TO ASSURE FASTENER QUALITY

- CONTINUE EXISTING PROCEDURES AND CONTROLS EXCEPT AS FOLLOWS:
  - Establish TRW SP or CD for All High Strength Fasteners
  - Revise Purchasing Procedures to Procure High Strength Fasteners Only as SP or CD
  - Revise/Prepare SP and CD to Require
    - -- Manufacturer's Internal Lot Number
    - -- Chemical Composition of Material Used by Manufacturer
  - Review/Update Criteria for Survey of Manufacturers and Distributors
  - Resurvey TRW Fastener Suppliers
  - Revise TRW Quality Documents for Tensile Tests and Metallurgical Examination
    - -- Eliminate Skip Lot Sampling for Tensile Tests and Metallurgical Examination
    - -- Require TRW Tensile Tests and Metallurgical Examination of All Inspection Lots of High Strength Fasteners

DISPOSITION OF COUNTERFEIT FASTENER TEAM RECOMMENDATIONS

1. TEAM RECOMMENDATION

   - Establish TRW SP or CD for all high strength fasteners. Include requirements for manufacturer's internal lot number and chemical composition. Revise purchasing procedures to procure high strength fasteners only as SP or CD.

   TRW MANAGEMENT DIRECTION

   - Rejected in its entirety as unnecessary. Team prepared a rationale for TRW customers (including NASA) explaining the current procurement and quality assurance procedures for fasteners, pointing out our successful experience, and asserting that additional measures are unnecessary.

2. TEAM RECOMMENDATION

   - Review and update the criteria for quality assurance surveys of fastener manufacturers and distributors.

   TRW MANAGEMENT DIRECTION

   - Accepted. Action Completed in August-September 1988.

TRW

DISPOSITION OF COUNTERFEIT FASTENER TEAM RECOMMENDATIONS (CONT.)

3. TEAM RECOMMENDATION

- Resurvey fastener suppliers.

TRW MANAGEMENT DIRECTION

- Perform selective resurveys only if new survey criteria or information about individual suppliers establish a specific need and justification for each action.

4. TEAM RECOMMENDATION

- Eliminate skip lot sampling for tensile tests and metallurgical examination during TRW receiving inspection of high strength fasteners. That is, test samples from every lot of fasteners received.

TRW MANAGEMENT DIRECTION

- Consider every-lot tests for high strength fasteners and/or suppliers for which a specific justification can be shown. Gather data which may indicate the need to abandon or modify skip lot sampling. Initiate action to determine the cost of eliminating skip lot sampling for tests.

Fastener Information Management System (FIMS)
Splinter Group Minutes

Date: November 16, 1994

Location: Marshall Space Flight Center, 2nd NASA Fastener Technical Interchange Meeting

Attendees: Fred Mayer-JSC/Loral
Shane Walker-MSFC/DRD Tech
Joe Galey-MSFC/JA41
Mike Barthelmy-GSFC/Code 313
Wilson Harkins-HQ/Code QW
Ronald Quinn-MSFC/BIC
Michele McCullough-MSFC/BIC

Discussion:

User's Guides and Functional Requirements documents were distributed. Participants requested access to the system.

Mr. Barthelmy questioned why the manufacturer trend analysis function was covered during the system walk through presented the day before but absent from the Requirements Document. This question led to a discussion of the prior Fastener Integrity RTOP. Mr. Harkins explained that concerns had been raised regarding the lack of participation of intended users in the development process during the previous effort and in order to safeguard against the same situation reoccurring, it is imperative that a user's group be established and utilized.

Mr. Galey wanted clarification of the Preferred List--would it be by center? Could we have a NASA Approved List? Mr. Harkins agreed an agencywide approved list is something to strive fc. and again emphasized involvement in the development process for users to ensure both their requirements and their "wish list" functions were considered.

Mr. Mayer suggested that interested parties first "test drive" the system, then review the Functional Requirements document. Mr. Harkins suggested that the startup of a FIMS User Group be an agenda item on the December 1, 1994 Fastener Working Group telecon and include how to access the system and the identification of a MePIMS (Mechanical Parts Information Management System) /FIMS User Group point-of-contact for each NASA facility. Mr. Harkins further elaborated that each facility must be represented in the final approval process even though they may not have the manpower to be involved throughout the entire development process. Mr. Harkins suggested the functionality of the system could be voted upon on-line through the use of pick list on each screen where the options would be:

MANDATORY TO DO MY JOB
NICE TO HAVE
NO INTEREST

These would be accompanied by a place for comments and new suggestions. It was decided that during the December 1, 1994 Fastener Integrity telecon, potential members

would be identified to participate in an on-line walk through telecon tentatively slated for Thursday, December 15, 1994. Scripts and new User's Guides will be distributed. The revised User's Guides will include the voting options and a comment area to serve as a hard copy alternative for those unable to participate on-line.

Mr. Harkins stated that the new MePIMS/FIMS User Group should report their progress back to the Fastener Integrity Working Group. He also defined the acceptance test procedure for FIMS as "two-pronged" comprised of an ADSO (Assurance Data Systems Office) acceptance test to ensure their standards are met and a distributed, user's acceptance test where users at each center will logon and have scripts designed to test whether their requirements are met. He closed the meeting stating that the key is to cultivate interest and get it started with the December 1, 1994, Fastener Integrity telecon.

Action Items:

Fred Mayer	Ensure MePIMS/FIMS member list is a line item on the December 1, 1994 Fastener Integrity telecon.
Michele McCullough	Modify FIMS screens to include pick lists to vote on system requirements.
	Revise User's Guides to reflect pick lists.
	Write and distribute scripts for on-line walk through.
	Contact each participant to coordinate the logon procedure prior to the walk through.

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13. ABSTRACT *(Maximum 200 words)*

This document summarizes the minutes of the second NASA-Wide Fastener Technical Interchange Meeting (TIM) held November 15–16, 1994, and compiles the presentations at the TIM by NASA and contractor personnel. The information in this document may be of value to the NASA and contractor fastener engineering community in determining the fastener controls and initiatives that existed at the time of the TIM.

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