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RESULTS OF THE DESC TEST FACILITY'S EFFORTS TO IMPROVE THE QUALITY OF ELECTRONIC REPLACEMENT PARTS

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ABSTRACT

Test data evaluated to date shows that the quality of Defense Electronics Supply Center (DESC) managed stocks has been increasing dramatically. Early in the DESC test program Non-Mil lot rejection rates were nearing 50 percent for discrete semiconductors tested in receiving inspection. The associated part reject rate was nearly 15 percent. Today, the part reject rate for all Federal Supply Classes (FSCs) being sampled is less than 1 percent. Plans are in place and being implemented to drive the defect rate toward 100 PPM.

This paper shows data indicating an increase in the quality of DESC sampled devices being supplied for the military services over the last few years. These improvements, in large part, can be credited to the efforts of the DESC Test Facility. Through continued testing and analysis we have built a data base that depicts the overall quality of the electronic parts DESC manages. DESC currently manages 93 Federal Supply Classes (FSCs) and the Test Facility performs incoming inspection on selected new buys, monitors and samples the material in storage, and performs support testing for DESC, DLA, and other Government agencies.

The DESC Test Facility is continuing to expand both the number and types of devices selected for testing. Our test results serve to identify and correct deficient material before it is placed in inventory and monitors the quality of older devices already in storage. Rejected lots are returned to the manufacturers, corrective actions required, and future purchases of these same and similar part types screened. Feedback to suppliers and corrective actions are key ingredients to continuously improving the quality of electronic parts being received by DESC.

Introduction

The crippling effect of nonconforming parts in the DoD Supply System has been painfully evident for a number of years. Historically, the source of these problems has been traced to many different general areas, i.e. the acquisition process, technical data package requirements, contractor compliance, in-plant Government surveillance, and depot operations. Initiatives have been undertaken in each area. The Government may now under Federal Acquisition Regulation (FAR) 15.605 award to other than the lowest bidder using quality, performance, or other value added

factors as the selection criteria. Considerations are obtained from contractors when nonconforming parts are accepted by the Government. These and many other initiatives have had some degree of success in their cognizant area. However, the multidimensional testing program initiated by the Defense Electronics Supply Center under the Directorate of Quality Assurance has the unique ability to provide input and corrections into almost all facets of the electronics DoD Supply System for the identification, evaluation, and correction of quality problems.

On 1 January 1962, the Defense Electronics Supply Center, located in Dayton, Ohio, was established as a Primary Field Level Activity (PFLA) of the Defense Logistics Agency (DLA) (see Figure 1). DESC supports DLA's mission by purchasing and providing electronic piece parts to the military services and certain civilian agencies such as NASA and the FAA. DESC now manages 93 Federal Supply Classes, close to 1 million electronic part types (National Stock Numbers) for over 83 Critical Weapons systems.⁽¹⁾

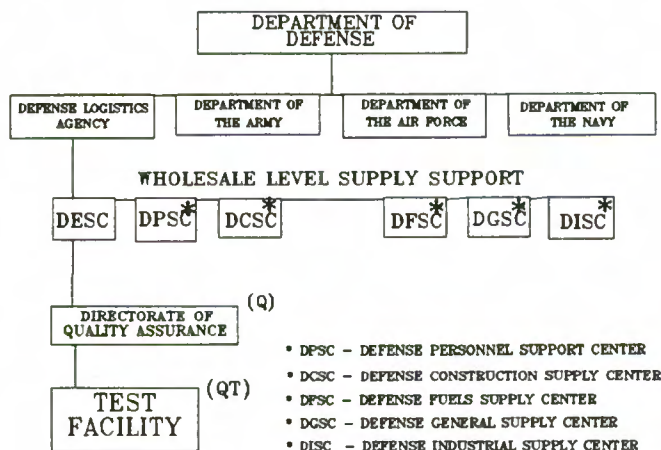


Figure 1

In January, 1977, DESC's Directorate of Engineering Standardization (DESC-E) performed a study to determine the quality level of military specification semiconductors procured by DESC. Based on results indicating significant counterfeit (8.2%) and quality problems (20% non-conformance), DESC Engineering was assigned the responsibility for continued product testing. By 1979, the incoming inspection testing for MIL-S-19500 discrete semiconductors was in full operation. In 1980 the program was expanded to include

commercial semiconductors (non-MIL-S-19500 products) and in 1985 the program was reassigned to the Directorate of Quality Assurance. By 1986, the testing program was expanded to test nine Federal Supply Classes (FSCs) and in 1986 the new test facility was opened. Currently we are routinely testing in 18 FSCs.⁽²⁾

The impact of our testing is greatly multiplied by the other DESC organizations which interface with the Quality Assurance Directorate (see Figure 2) and the Test Facility. The Directorate of Engineering Standardization (E) has a program in place consisting of Specification Management, Standardization and Parts Control, and the Qualified Products List (QPL) with its attendant Audit Program. DESC-E engineers support the test facility with their expertise and contacts in manufacturing and the test facility provides data, part evaluation, part characterization, and testing for DESC-E. In a like manner, we also interface with the Directorate of Contracting and Production (P), providing data for their Quality Vendor Program, and with the Directorate of Technical Operations (S) performing testing for Value Engineering Reviews.

DESC'S INTEGRATED QUALITY PROGRAM

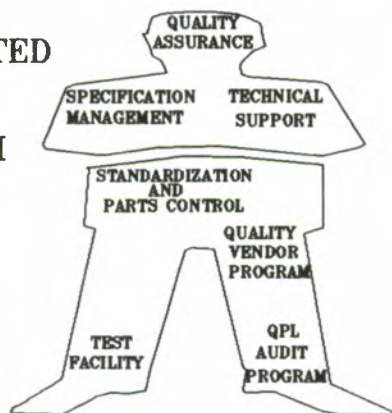


Figure 2

Testing Programs

The five basic testing programs of the test facility were added as needed to apply to specific demands. In addition, two more have been added and are still in the evaluation stage (see Figure 3).

TESTING PROGRAMS

RECEIVING INSPECTION
STOCK QUALITY ASSURANCE
SUPPORT TESTING
JAN CLASS S DPA
COMMERCIAL SUPPORT
DMS*
RETURNS*

* UNDER REVIEW

Figure 3

The purpose of the Receiving Inspection Program is to verify the conformance of new DESC purchases to contractual requirements. Devices are selected from newly awarded contracts for items within the 18 primary FSCs, with emphasis on causative action, i.e., a suspect contractor or National Stock Number (NSN) with a history of low quality. Upon arrival at the depot the selected parts are shipped to the Test Facility in Dayton, Ohio and tested. Conforming lots are accepted and nonconforming returned to the manufacturer for replacement or refund.

The Stock Quality Assurance Program monitors and screens the materiel currently stored at the DLA Depots. Selections are made at random with emphasis given to critical weapon system items, devices with Quality Deficiency Report (QDR) histories, Selective Management Category Codes (SMCC) which indicate high price/high volume, accessible test data, and current capability to test. All FSCs are subject to selection in this program. Conforming materiel is returned to the Depot. However, due to partial usage, missing identification or simply the age of the devices, many nonconforming lots cannot be returned to the manufacturer for a refund or replacement. These lots are destroyed and related Depot stock screened.

The objective of the Support Testing Program is to use the testing and analytical capabilities of the Test Facility to provide engineering evaluation and product verification for other DESC, DLA, and DoD organizations. Failure analysis, Destructive Physical Analysis (DPA), and environmental testing are included along with electrical testing in this program.

The JAN Class S is one of the newer programs used principally to perform destructive physical analysis (DPA) on JAN Class S Microcircuits. These devices are designed and manufactured for applications where quality and reliability are essential for the success of a mission. These tests are used to enable Original Equipment Manufacturers (OEMs), who build government systems, access to pretested parts. In this manner, they avoid the impact of required testing on their cost and delivery schedules.

The last of the main programs is the Commercial Test Facilities Support Program. Commercial test laboratories are contracted to supplement DESC's testing functions. Over 140 test labs have been audited and certified for use in this program. Test projects may be transferred from any of the previously listed programs as the need arises and, in addition, selections are made from Depot stock with the same selection procedure as the Stock Quality Program plus the addition of a Targeted Test Design to make the most efficient use of government funds.

Two new areas still being evaluated are the Diminishing Manufacturing Sources (DMS), and Customer Returns Programs. Upon notice that a particular manufacturing line is to be discontinued the Government may find it to its advantage to make one last, sometimes rather large, buy. After completion of a study in this area. Recommendations were made

and are being implemented to improve the quality of DMS materiel. Customer Returns is the other program still under review. An earlier study found that there were inadequate quality controls on parts returned by customers. Recommendations have been made for changes in DESC policies of accepting and placing in inventory returns as well as testing those to be placed in inventory.

Sampling and Test Requirements

The sampling and test requirements used at the Test Facility are those specified in DESC-DLA solicitation and contractual requirements or appropriate military or commercial specifications and standards. Currently, most DESC testing includes only visual/mechanical and "Group A", or basic electronic performance testing. Environmental, DPA, failure analysis, and part characterization are only included on an as needed basis. We have 39 engineers and technicians with extensive expertise in electronic component testing. We are also continuing to develop new techniques to detect counterfeiting and overmarking.

Results

Because DESC's mission does not include research type testing our data cannot be matched with baseline studies. Numerous variables, known and unknown, have been introduced in testing. However, much of the history of the basic variables is known and with a little interpretation, some implications can be assumed.

The Test Facility has been collecting lot and part failure data for over 10 years. A lot of materiel may be rejected for either a visual/mechanical deficiency or an electrical failure. Part failure history, however, is based only on electrical testing deficiencies. In Figures 4 and 5, lot failures and part failures are depicted with their respective scales. From FY80 through FY87 discrete semiconductors (see Figure 4) were the majority of the part types tested in Receiving Inspection. By FY88 and FY89, however, discrete semiconductors represented only ~38% of the devices tested.

TEN YEAR TEST HISTORY ALL TESTING

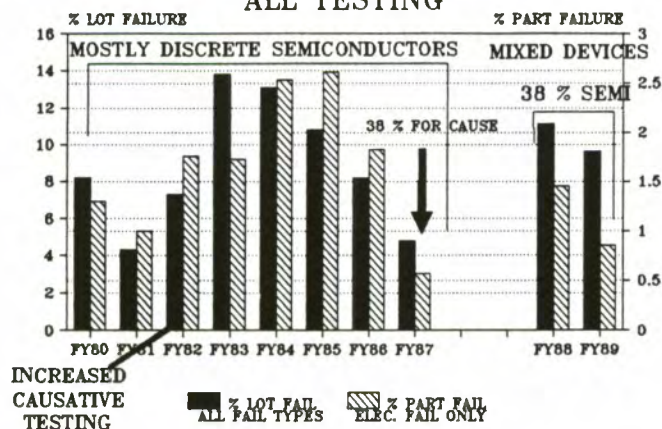


Figure 4

The sharp rise in both lot and part failure rates begins in FY82. Causative selections, those resulting from previous problems with a part of contractor, began increasing at this time and by FY87 almost 38% of all selections were made for cause. Please note that even with increased causative selections a decreasing failure rate occurs. We believe the correlation indicates the success of our testing efforts by continuously eliminating quality problems through identification and feedback.

In FY88 and FY89 we observed a sharp rise in both lot and part failure rates. This rise coincides with a large increase in testing parts other than discrete semiconductors, and in FY 89 selections favored Non-Mil and commercial devices. In previous years the ratio of Mil to Non-Mil was at least 5:1 if not greater. FY89 was the first year in which Non-Mil selections surpassed military. If our past experience applies here, we should continue to observe a decrease in failure rates as newly uncovered deficiencies are continuously corrected.

Figure 5 displays the lot and part failure rates for discrete semiconductors over the past 10 years. Comparison of the relative changes in FY88 and FY89 tend to confirm our assumption that the introduction of new supply classes into the test program did have an effect because the relative increases in failure rates were not as great in FY88 and FY89. However, by FY87, selections for cause were up to almost 55% and Mil to Non-Mil ratios were only 2:1 in FY88 and 1:1 in FY89. Records are not available for causative selections at this time, but it is believed that "for cause" selections were increased both years.

TEN YEAR TEST HISTORY DISCRETE SEMICONDUCTORS

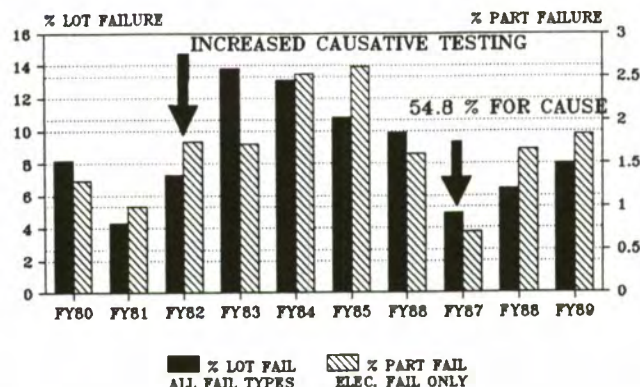


Figure 5

Figure 6 displays the part failure rates from testing discrete semiconductors over the last 5 years. Three things are evident from this illustration:

- Failure rates parallel the reliability levels of their respective specification.
- Military failure rates show good stability.
- Commercial failure rates are considerably higher than their military counterparts.

It should be noted that comparisons of Mil and Non-Mil failures rates are not completely fair. Military specification devices are usually tested to much more stringent testing requirements. There are usually many more tests (because Non-Mil data documents frequently present little data and sometimes none that's testable), the specification limits are usually tighter for comparable test parameters, and sampling and quality control requirements are almost always more restrictive.

DISCRETE SEMICONDUCTORS

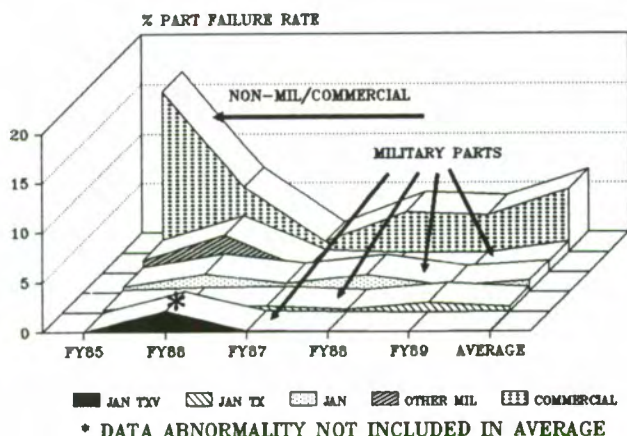


Figure 6

Many of the of quality problems uncovered at the test facility in FY89 are discrepancies that may have been induced after the manufacture of the devices was complete. The results show that 6.77 percent of the lot rejections were visual/mechanical deficiencies as compared with 2.87 percent of lot rejections due to electrical failures. When one considers the steps that precede the actual use of the device, (see Figure 7) there is little wonder that our overall lot reject rate approaches 10 percent. Unit packaging requirements, unusual transportation and detrimental environmental conditions are only a few of the hazards which await electronic replacement parts for military systems. The Test Facility has unusual insight into these field problems through a strong interface with the Quality Assurance Specialists (QASs) who resolve quality deficiency reports received from our customers.

There is a clearly visible deterrent effect resulting from the DESC Testing Program. Contractors are forced to think twice before knowingly or carelessly submitting deficient materiel to DESC. Often a processing problem identified by testing may affect more than one NSN, thereby multiplying the positive effect of our test program. Plans are being made to drive the quality levels even higher.

This paper has illustrated some of the impact which the test program at DESC is having on improving the quality of products being supplied to our customers. The Center is able to make informed decisions on quality

issues which arise and which require test data and evaluations to resolve. DESC continues to focus on 'QUALITY'.

LIFE OF A TYPICAL MILITARY SPECIFICATION DEVICE

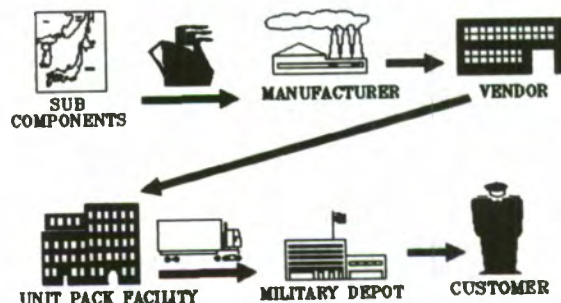


Figure 7

References

1. Fact Book, DLA, Defense Electronics Supply Center, Dayton, OH, RCS: C(Q)1), 4th QDR/Annual, FY 1989.
2. Directorate of Quality Assurance Fiscal Year 1989, Test and Evaluation Report, DLA, Defense Electronics Supply Center, Dayton, OH, 1989.

Biography

Glenda Robinson is currently an electronics engineer at DESC. She is responsible for data evaluation and coordination of the Commercial Test Facilities Support Program of the Test Facility of the Electronics Supply Center in Dayton, Ohio. She was previously employed for seven years in the Materials Department of Battelle Northwest in Richland, Washington. At Battelle she worked as a scientist/engineer coordinating certification studies for the Materials Characterization Center and performing durability studies on nuclear waste forms. She received a BSE Nuclear degree from the University of Washington and is currently working toward an MSA at Central Michigan University.

Mr. McNicholl received a BS degree in Electrical Engineering from Michigan Technological University and a Masters Degree in Logistics Management from Central Michigan University. Since starting his career, he has been a specification writer in the Materials and Parts area; a Standardization Program Manager in the Assignee Activity Branch; Chief of the Passive Devices Qualification Branch; and is presently Chief of the Test Division in the Directorate of Quality Assurance at the Defense Electronics Supply Center, Dayton, OH. Mr. McNicholl has received ASQC Certification as both a Quality Engineer and Reliability Engineer.

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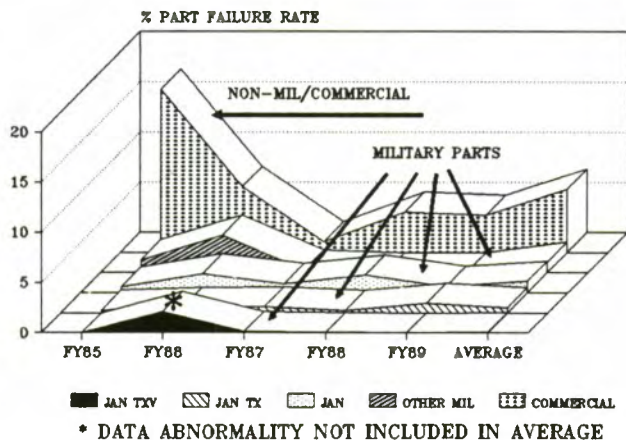


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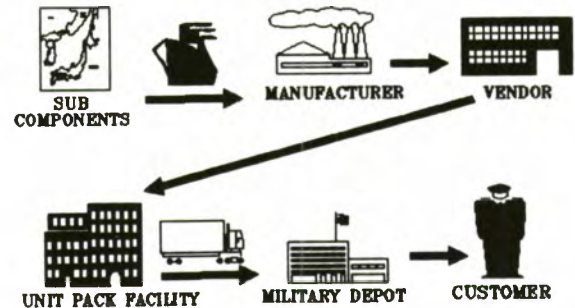


Figure 7

References

1. Fact Book, DLA, Defense Electronics Supply Center, Dayton, OH, RCS: C(Q)1), 4th QDR/Annual, FY 1989.
2. Directorate of Quality Assurance Fiscal Year 1989, Test and Evaluation Report, DLA, Defense Electronics Supply Center, Dayton, OH, 1989.