Library

J. B. McChesney, II 03/66

MLM-MR-80-64-0007

RECEIVED

JUL 01 1996

OSTI

QUALITY PROGRAM STATUS REPORT

JANUARY - MARCH, 1980

APRIL 18, 1980

**DONALD R. BOHL
PROCESS QUALITY
CONTROL MANAGER**

Monsanto

MOUND FACILITY

Miamisburg, Ohio 45342

operated by

MONSANTO RESEARCH CORPORATION

a subsidiary of Monsanto Company

for the

U. S. DEPARTMENT OF ENERGY

Contract No. DE-AC04-76-DP00053

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

D I S T R I B U T I O N

R. L. Allen
M. E. Babcock
B. E. Baughn
H. E. Bent
D. R. Bohl (6)
B. L. Bond
R. T. Braun
N. U. Breene
J. E. Caldwell
W. T. Cave
H. I. Charbeneau
G. Clarren
D. L. Coffey
R. J. DeSando
R. A. Fischbein
C. S. Friedman
D. J. Gorman
J. D. Hastings
D. R. Hill
D. W. Hohler
D. P. Kelly
F. D. Lonadier
D. F. Luthy
J. F. Madden
J. R. McClain
M. Mullins
W. J. Murphy
D. L. O'Brien
D. W. Organ
R. L. Parks
F. H. Scott (2)
R. D. Schaefer
C. H. Shearer
W. C. Sheidler
D. H. Stitzel, II
H. L. Turner
P. G. Vanderhoven
D. E. Wendeln
G. R. Wirth
H. A. Woltermann

External

H. N Hill, DOE (3)
D. D. Behne/R. W. Hurd, MRC at Unidynamics/
Phoenix

m ***Mound*** ***Symbol of Quality***

Quality Program Theme

The keystone of quality at Mound Facility is a cost effective, quality and process, and product design program. The Facility is equally committed to quality, safety and productivity in a manner which is not only cost effective, but which utilizes the skills of all of our employes as a vital ongoing resource for DOE.

A handwritten signature in cursive script that reads "John R. McClain". The signature is written in dark ink and is positioned above the printed name.

J. R. McClain

CONTENTS

	<u>PAGE</u>
INTRODUCTION	5
ABSTRACTS.	6
QUALITY COST PROGRAM	9
PRODUCT INSPECTION AND PERFORMANCE REPORTING PLAN	20
LONG TERM AGING STUDY OF MC3004 ACTUATORS.	31
QUALITY CONTROL ENGINEERING: DETONATORS AND PYROTECHNICS	40
QUALITY CONTROL ENGINEERING: TIMERS AND TRANSDUCERS.	48
MANUFACTURING DEVELOPMENT ENGINEERING PRACTICE GUIDELINES.	51
ANALYTICAL CHARACTERIZATION AND QUALIFICATION OF WR MATERIALS.	56
ANALYTICAL QUALITY ASSURANCE	61
PRODUCT ASSURANCE HIGHLIGHTS	65
QUALITY PROGRAM HIGHLIGHTS	70

INTRODUCTION

The purpose of this Quality Program Status Report is to provide MRC and DOE management with a periodic summary of the status of the Advanced Devices' Quality Program.

A primary objective of this report is to achieve visibility of the numerous activities and achievement highlights that are an important foundation to a successful Quality Program, but are not normally recognized by examining the major Quality indexes that are used to rate the Quality Program's status.

The information in this report indicates results and accomplishments of selected areas of the Advanced Devices' Quality Program during the period of January - March, 1980.

The status of specific projects to improve elements of the Quality Program is also published periodically in this report.

Requests for further information or details, as well as comments and suggestions about this report, may be addressed to Donald P. Kelly, Manager, Quality and Reliability, or Donald R. Bohl, Process Quality Control Manager.

ABSTRACTS

The following brief abstracts are included as an aid to surveying the content of this report.

QUALITY COST PROGRAM

Quality program costs for the first four months of FY-1981 have been reported. By way of illustrating the type of Quality Costs data and report formats that are being collected and reported, the following reports have been included in this report:

- Quality Costs by Program Type
- Relationship of Planned Quality Costs to Unplanned Quality Costs for WR Production Programs
- Quality Costs Summary for All Programs
- Breakdown of Quality Costs by Element for WR Production Programs
- Breakdown of B-Item Quality Costs by Element
- Comparison of Quality Costs to Direct Costs

PRODUCT INSPECTION AND PERFORMANCE REPORTING

The status of this new element of the Quality Program is reported. During this quarter, a reporting format has been designed for graphically reporting product yield rates based on production and final acceptance inspection data. The first Production Screen Summary Report was issued in March. Computer programs are being developed for computing a product quality index based on final inspection data. This last project is ahead of the action plan schedule reported last quarter.

LONG TERM AGING STUDY OF MC3004 ACTUATORS

The initial results of the engineering evaluation of the long-term monitoring of corrosion in Lot 02 of the MC3004 is reported. The amount of corrosion or corrosion product has generally increased with time, but does not seem to be affected by the thermal conditions of the test. The severity or depth of corrosion observed on the bridgewire is not significantly affected by time or temperature.

QUALITY CONTROL ENGINEERING STUDIES: DETONATORS
AND PYROTECHNICS PROGRAMS

Summaries of various process or product related quality engineering studies during this period are reported. A detailed statistical report of "Evaluation of 1E34 Detonator Resistance Measurement" Fixtures is included.

QUALITY CONTROL ENGINEERING STUDIES: TIMERS
AND TRANSDUCERS PROGRAMS

Summaries of various process or product related quality engineering studies during this period are reported. Studies on MC3106 Modified Cups, MC3347 Ceramic, MC3106 Ring Assembly, MC3359 Lot 5, MC3004 Lot 12, and MC2990 processes are reported.

MANUFACTURING DEVELOPMENT ENGINEERING
PRACTICE GUIDELINES

Additional Engineering Practice Guidelines for Manufacturing Development have been issued. These cover the following:

- Philosophy of Variation Engineering
- Technique Diagrams
- Material and Design Reviews
- Tolerance Layouts
- Process and Paper Flow Diagrams
- Labor and Material Standards
- Cost of Scrap
- Index of Productivity
- Engineering Unit Costs

By way of example, the "Material and Design Review" Guideline is included in entirety.

ANALYTICAL CHARACTERIZATION AND QUALIFICATION OF WR MATERIALS

Representative analytical development and testing in support of the WR Production Quality Program is reported. Brief status reports are included that describe work in the areas of plastics characterization and explosives and pyrotechnic materials characterization.

ANALYTICAL QUALITY ASSURANCE

The current results of the participation of Mound's Analytical capability for assay of plutonium and uranium in an inter-laboratory testing program are reported. Their participation in the Metals Exchange and SALE programs has demonstrated that Mound's controlled-potential coulometry technique is as good or better than any other participant's for the assay of plutonium in the samples exchanged.

PRODUCT ASSURANCE HIGHLIGHTS

Engineering development efforts in product performance testing by the Advanced Devices' Product Assurance Section are described. Projects reported on include:

- 1E35 Qualification Testing
- TF2000 Opto-Electronic Tester
- New 1E34 Resistance Fixture
- Investigation of MC3028 Low Voltage Outputs During Destructive Testing
- New Vibration Control System

QUALITY PROGRAM HIGHLIGHTS

Representative briefs and highlights related to achievements, plans, problem-solving, and other positive aspects of the Advanced Devices Quality Program are reported.

QUALITY COST PROGRAM
REPORTS

D. R. BOHL
D. W. ORGAN
P. G. VANDERHOVEN
D. E. FRIEDLINE

Quality Program Cost Reports

Quality Program Costs for FY-1980 are being reported to Mound Facility management. The following report summaries have initially been provided:

- Quality Costs by Program Type
- Relationship of Planned to Unplanned Quality Costs
- WR Program Quality Costs by Category
- Quality Costs Breakdown by Category for All Programs
- Quality Costs Breakdown by Category for WR Programs
- Quality Costs Breakdown by Category for B-Items
- Quality Costs Breakdown by Category for Nuclear Component Evaluation Programs
- Quality Costs Breakdown by Category for Energy Programs
- Quality Costs Compared to Direct Costs and Direct Labor

These reports are summaries of the type of information obtained via our Quality Program Cost Collection system. We initially plan to issue this Quality Program Cost Report on a frequency of every three-four months. The format in which the information has been presented is not fixed, but may evolve into other formats as necessary based on our future utilization of the information, as well as feedback we receive.

The graph of "WR Production Program Quality Costs by Category" shows that the weapons Quality Program is appraisal (inspection and test) intensive. This is not unexpected, considering the high reliability products that Mound manufactures.

In the near future, the ratio of failure costs to appraisal costs is expected to increase to some extent for the following reason: In some cases, labor for reinspection or inspection of rework is being reported as an appraisal cost instead of a failure cost. As this situation is corrected during the next several months, the failure costs are expected to become a larger proportion of the total Quality Program Costs. This will achieve a more realistic reporting of actual failure costs.

Quality Costs alone provides insufficient information to properly evaluate their trends and magnitude as a business expense. Normally they must be related to some other measurement bases that reflect different viewpoints of the business. Total Direct Cost, Direct Labor and Number of Units Produced are being investigated for bases to which WR Program Quality Costs may be compared.

Product Quality Cost reports similar to the formats enclosed are planned for selected product lines. The principal audience for the Product Quality Cost Reports will be first level supervisors and engineers that have technical responsibility for the specific products.

For the purpose of illustrating the type of Quality Cost information and report format that is being used some of the Quality Cost Reports for the first four months of FY-1980 are attached.

QUALITY COSTS BY PROGRAM TYPE

<u>MONTH</u>	<u>WR PRODUCTION</u>	<u>B-ITEMS</u>	<u>ENERGY (NON- WEAPONS) PROGRAMS</u>	<u>NUCLEAR COMPONENT EVALUATION</u>	<u>TOTALS</u>
October	497,722	24,028	50,879	95,339	667,968
November	604,654	21,893	22,971	52,381	701,899
December	621,784	16,286	21,078	53,288	712,436
January	653,991	7,774	19,707	57,706	739,178
	<u>2,378,151</u>	<u>69,981</u>	<u>114,635</u>	<u>258,714</u>	<u>2,821,481</u>
% of Total	84.29%	2.48%	4.06%	9.17%	100.00%

RELATIONSHIP OF PLANNED QUALITY COSTS TO
UNPLANNED QUALITY COSTS: WR PRODUCTION PROGRAMS

<u>MONTH</u>	<u>PLANNED^a QUALITY COSTS</u>	<u>UNPLANNED^b QUALITY COSTS</u>	<u>UNPLANNED PLANNED</u> , %
October	\$ 451,226	\$ 46,496	10.30
November	513,122	91,532	17.84
December	544,691	77,093	14.15
January	<u>583,114</u>	<u>70,877</u>	<u>12.15</u>
	\$2,092,153	\$285,998	13.67

^aPrevention + Appraisal Quality Costs

^bFailure Quality Costs

QUALITY COSTS SUMMARY FOR ALL PROGRAMS, FY-1980
BREAKDOWN OF QUALITY COSTS BY ELEMENT CODE

PREVENTION

Quality Element Code	MONTH				TOTAL	PERCENT OF TOTAL
	OCTOBER	NOVEMBER	DECEMBER	JANUARY		
1.1	40,775	39,984	45,606	49,558	175,923	6.24
1.2	28,136	21,198	15,930	18,109	83,373	2.96
1.3	16,881	16,963	13,499	16,240	63,583	2.25
1.4	443	502	1,639		2,584	.09
Sub- totals	86,235	78,647	76,674	83,907	325,463	11.54

APPRAISAL

Quality Element Code	MONTH				TOTAL	PERCENT OF TOTAL
	OCTOBER	NOVEMBER	DECEMBER	JANUARY		
2.1	335,242	360,542	341,034	343,506	1,380,324	48.94
2.2	68,355	31,672	73,853	72,986	246,866	8.75
2.3	92,461	95,774	98,071	120,281	406,587	14.41
2.4	8,495	12,692	11,372	13,273	45,832	1.62
2.5	30,684	31,040	34,339	33,621	129,684	4.60
Sub- totals	535,237	531,720	558,669	583,667	2,209,293	78.32

QUALITY COSTS SUMMARY FOR ALL PROGRAMS, FY-1980
BREAKDOWN OF QUALITY COSTS BY ELEMENT CODE

FAILURE

Quality Element Code	MONTH				TOTAL	PERCENT OF TOTAL
	OCTOBER	NOVEMBER	DECEMBER	JANUARY		
3.1	360	601	392	628	1,981	.07
3.2	105				105	.00
3.3	9,162	9,905	12,765	12,765	44,676	1.58
Manf. \$ ^a Loss (Scrap)	31,120	74,597	60,296	53,221	219,234	7.78
Rework ^b Direct Labor	5,749	6,429	3,640	4,326	20,144	.71
Sub- totals	46,496	91,532	77,093	71,019	286,140	10.14
Grand Totals	667,968	701,899	712,436	738,593	2,820,896	100.00

^aFrom Industrial Engineering Report: "Product Loss and Rework Report - Manufacturing \$ Loss Product History", 2/25/80, T. Z. Jones.

^bFrom Product Labor Analysis Reports Issued by Industrial Engineering.

BREAKDOWN OF QUALITY COSTS BY ELEMENT CODE
WR PRODUCTION PROGRAMS, FY-1980

PREVENTION

Quality Element Code	MONTH				YTD TOTAL	PERCENT OF TOTAL
	OCTOBER	NOVEMBER	DECEMBER	JANUARY		
1.1	22,353	36,391	45,448	41,616	145,808	6.13
1.2	10,487	13,875	9,646	10,211	44,219	1.86
1.3	13,054	15,167	10,494	13,968	52,683	2.22
1.4	443	502	1,639		2,584	.11
Sub- total	46,337	65,935	67,227	65,795	245,294	10.32

APPRAISAL

Quality Element Code	MONTH				YTD TOTAL	PERCENT OF TOTAL
	OCTOBER	NOVEMBER	DECEMBER	JANUARY		
2.1	286,428	325,159	305,332	324,647	1,241,566	52.21
2.2	45,203	16,655	65,290	68,769	195,907	8.24
2.3	51,803	77,296	81,264	94,956	305,319	12.84
2.4	8,265	7,739	6,620	10,044	32,668	1.37
2.5	13,190	20,338	18,968	18,903	71,399	3.00
Sub- total	404,889	447,187	477,464	517,319	1,846,859	77.66

BREAKDOWN OF QUALITY COSTS BY ELEMENT CODE
WR PRODUCTION PROGRAMS, FY-1980

FAILURE

Quality Element Code	MONTH				TOTAL	PERCENT OF TOTAL
	OCTOBER	NOVEMBER	DECEMBER	JANUARY		
3.1	360	601	392	628	1,981	.08
3.2	105				105	.00
3.3	9,162	9,905	12,765	12,702	44,534	1.87
Manuf. \$ Loss (Scrap)	31,120	74,597	60,296	53,221	219,234	9.22
Rework Direct Labor	5,749	6,429	3,640	4,326	20,144	.85
Sub- totals	46,496	91,532	77,093	70,877	285,998	12.02
Grand Totals	497,722	604,654	621,784	653,991	2,378,151	100.00

B-ITEM QUALITY COSTS FY-1980

PREVENTION

Quality Element Code	MONTH				YTD TOTAL	PERCENT OF TOTAL
	<u>OCTOBER</u>	<u>NOVEMBER</u>	<u>DECEMBER</u>	<u>JANUARY</u>		
1.1	6,838				6,838	9.77
1.2						
1.3						
1.4						
Sub- totals	<u>6,838</u>	<u></u>	<u></u>	<u></u>	<u>6,838</u>	<u>9.77</u>

APPRAISAL

Quality Element Code	MONTH				YTD TOTAL	PERCENT OF TOTAL
	<u>OCTOBER</u>	<u>NOVEMBER</u>	<u>DECEMBER</u>	<u>JANUARY</u>		
2.1	1,564	6,108	3,116	1,851	12,639	18.06
2.2	15,482	10,553	8,418	1,894	36,347	51.95
2.3	144	0	0	585	729	1.04
2.4	0	4,953	4,752	3,229	12,934	18.48
2.5		279		73	352	.50
Sub- totals	<u>17,190</u>	<u>21,893</u>	<u>16,286</u>	<u>7,632</u>	<u>63,001</u>	<u>90.03</u>

B-ITEM QUALITY COSTS FY-1980

FAILURE

Quality Element Code	MONTH				YTD TOTAL	PERCENT OF TOTAL
	<u>OCTOBER</u>	<u>NOVEMBER</u>	<u>DECEMBER</u>	<u>JANUARY</u>		
3.1						
3.2						
3.3				142	142	.20
Sub-						
totals	-0-	-0-	-0-	142	142	.20
Grand Totals	24,028	21,893	16,286	7,774	69,981	100.00

QUALITY PROGRAM PLAN

PRODUCT
INSPECTION AND PERFORMANCE
REPORTING

PRINCIPAL RESPONSIBILITY

D. R. BOHL
M. E. BABCOCK
H. E. BENT

As reported in a prior "Quality Program Status Report" dated January 18, 1980, a new Quality Program Plan Element has been initiated to provide "Quality Information" about product and materials submitted to, and processed by, Mound Inspection and Test operations. The objective is to achieve greater quality program utilization and visibility of inspection and performance testing data. It is intended to provide a tool for the Advanced Devices' Quality Program to indicate the level of quality achieved by each product lot so that trends will be apparent. Equally important, it should provide visibility for excellent quality levels, as well as revealing what products are achieving quality levels that need improvement.

The following primary sources of data and information were identified.

- I. Receiving Inspection
- II. Production Inspection
- III. Production Screen Data
- IV. Final Inspection
- V. Inline Quality Control Inspection
- VI. Performance Testing

Additional inspection reporting formats are being considered for implementation. These are listed in Table I.

The following provides status reports of work on this Quality Program Plan Element.

SOURCE: PRODUCTION AND FINAL INSPECTION

To assist management in monitoring product and process trends, a monthly report, by product and lot, will be issued graphically showing the reject rates encountered in Production and Final Inspection. By separating the Production and Final Inspection results, the overall reject rate can be monitored for the product, as well as the effectiveness of Production in identifying and removing all reject material from the lot. Each month's report will be composed of those products which had at least one lot completed through Final Inspection during the month.

Attached are examples of graphs representing the type of data that will be reported each month. These were designed and printed during this reporting period. Procedures have been established by Quality Control Engineering to collect and summarize the data by a Quality Control Technician each month. The first formal report to management of this quality information will occur in April for those products completed through Final Inspection in March, 1980. (F. H. Scott)

TABLE I: ADDITIONAL INSPECTION REPORTING FORMATS UNDER CONSIDERATION

SOURCE	INFORMATION TO BE REPORTED	PRINCIPAL INVESTIGATOR	REPORT FREQUENCY	PLANNED START DATE
Receiving Inspection	Variables data trends by piecepart or material.	H. E. Bent	Monthly	Not Established
Production Inspection	Product yield trends by lot.	D. R. Bohl	Monthly	2/80
Production Screen Results	Yield from production screens.	D. R. Bohl	Monthly	4/80
Final Inspection	Acceptance Inspection Index by product for lot completed each month.	D. R. Bohl M. E. Babcock	Monthly	11/80
Performance Testing	Destructive Testing Index	M. E. Babcock	Monthly	1981
In-process Verification Inspection	Inspection Index based on defects found	D. R. Bohl	Pilot Study	12/80

[illegible]

LOT NO.	DOE	ACCEPT DATE	STARTS	PROD. REJ.	FINAL REJ.	TOTAL REJ.
001	002	003	004	005		
5-78	5-79	5-79	6-79	12-79		
330	540	330	515	530		
24	48	15	36	25		
2	11	1	0	0		
26	59	16	36	25		

MC3319

(YIELD BASED ON PRODUCTION STARTS AT SERIAL NUMBER ENGRAVING)

LOT NO.	003	004	005	006	007												
DOE ACCEPT DATE	4/79	4/79	5/79	6/79	12/79												
STARTS	519	540	540	520	525												
PROD. REJ. ●	45	31	28	31	17												
FINAL REJ. □	1	0	14	20	0												
TOTAL REJ.	46	31	42	51	17												

SOURCE: PRODUCTION INSPECTION

The first Production Screen Summary Report was issued in March, 1980. It summarized Production screen inspection results for the period of January - February, 1980. A copy of the report is attached. This pilot study to determine the value of the report will continue through the next quarter. (D. R. Bohl)

MONSANTO RESEARCH CORPORATION

Inter-Office Correspondence

From : Process Quality Control

cc: File

Location : A-177G

Date : March 20, 1980

Subject : Production Screen
Summary Report

Reference:

TO : DISTRIBUTION

The attached quality information is being provided for your information and review.

When Inline Verification Inspection by Quality Control Inspectors finds a level of defects that exceeds the number allowed by the stipulated sampling plan, a complete reinspection by Production Inspectors is required. This request and its results are tabulated by Production and reported to Quality Control. The value of reporting the yield from production screens will be investigated.

A pilot study is being made to evaluate the usefulness of summarizing this information and reporting it to Engineering and management personnel. Its effectiveness will be judged primarily on the report's utility for leading to needed corrective action that improves product quality.

Since this is a pilot study, various formats of summarizing and reporting the data each month will be evaluated. If you have comments or suggestions about the report, or would like to see other information reported, please contact one of us.

Carl H. Shearer

Donald R. Bohl

CHS:DRB:cb

PRODUCTION SCREEN SUMMARY REPORT

JANUARY 1, 1980, THROUGH FEBRUARY 29, 1980

Product	Quantity		Units	Yield		Attribute
	Screened	Rejected		Percent		
MC2352	219	3	216	98.6		Thread depth
MC2352	124	124*	124*			Flash
MC3095	120	6	114	95.0		Well depth
MC3095	139	3	136	97.8		Thickness
MC3196	418	35	383	91.6		Chips
MC3319	178	2	176	98.9		Extension
MC3359	112	1	111	99.1		Foreign material
MC3359	85	2	83	97.6		Adhesive in well
Test Devices	50	2	48	96.0		No contact
1E34 (cup)	241	109	132	54.8		Pdr. height
1E34 (cable)	153	1	152	99.3		Dent and glue
1E34 (cup)	312	14	298	95.5		Glue
MC3366/MC3041	1014	65	949	93.6		Thickness
MC3106 Modified Cup	279	7	272	97.5		Damaged O.D.
MC3347 Ceramic Spacer	9	9*	9			Adhesive
1E33 Det.	128	1	127	99.2		Glue in well
1E34 Headers	148	7	141	95.3		Cracks

*Asterisked items were reworked and how many required rework is not known. In the future, Inline Inspection is going to request this information be supplied on the screen form.

(Continued on next sheet)

PRODUCTION SCREEN SUMMARY REPORT
JANUARY 1, 1980, THROUGH FEBRUARY 29, 1980 (continued)

- 2 -

CORRECTIVE ACTION

A "Rule of Thumb" in using this report could be that any screen yield less than 95% requires investigation and corrective action. Using this criteria, for the period of this report, the following products (attributes) should have received corrective action investigation as a result of the screen:

MC3095 (well depth)
MC3196 (chips)
1E34 Cup (Powder Height)

MC3366/MC3041 (Thickness)
1E34 (Cracks)
MC2352 (Flash)

MC3347 (Adhesive)

SOURCE: FINAL INSPECTION

Quality Control Engineering recently purchased a new floppy disk mass storage system for their Tektronix 4051 minicomputer. The system is called the 4907 File Manager by Tektronix and it employs single side, dual density, hard sector floppy discs with a storage capacity of over 600,000 bytes. With this vastly expanded capability, Quality Control will now be able to store, retrieve, and utilize significant amounts of data in ways not previously practical.

One such project made possible by this new capability involves the creation of a new system to monitor the quality of products sent to Final Inspection by Production. The mathematical and software support for this project is being provided by members of Mound's Experimental Design Group.

The data base will consist primarily of seven items entered for each lot of weapons components submitted to Final Inspection. These items will be:

1. Weapons Program
2. Lot Number
3. Date
4. Number of parts processed by Final Inspection
5. Dimensional rejects (attributes can be quantified)
6. Visual rejects (workmanship or qualitative attributes)
7. Number of reject attributes

In addition, each lot will be given a performance index based on the number of dimensional and visual rejects, the number of different reject attributes, and the yield of the lot. The equation used to produce the index is being modeled and evaluated.

With this information on hand, answers can be provided for many important questions. The software under development will deliver, in seconds and for any weapons program, information such as:

1. How many parts have been processed by Final Inspection?
2. How many dimensional rejects were there?
3. How many visual rejects were there?
4. What is the average index?

5. What is the reject percent?
6. What lots are involved?
7. What is the yield?

These and other questions will be answered by easy to read tables of information and fact packed graphic displays.

The status of the software program development is ahead of the schedule reported in the action plan in the January 18, 1980, Quality Program Status Report. All of the preliminary work has been completed and a substantial part of the actual program has been encoded. By early summer, the data base should be up, and running, and debugging will begin.
(R. W. Caldwell, P. D. Bantz)

LONG TERM AGING STUDY
OF MC3004 ACTUATORS

D. J. GORMAN

In 1976, a contract was placed by Sandia National Laboratories, Albuquerque (SNLA) to fabricate, age, test fire and post mortem MC3004 actuators. After delays in the production process due to a massive corrosion problem, an alternate plan was implemented.

WR Lot 02 was initially found to be extensively corroded so it was retained for evaluation. Some preliminary data suggested that further corrosion proceeds at a much lesser rate or may even stop. Therefore, this lot of actuators was chosen to determine the extent that corrosion proceeds after the initial corrosion reaction.

The aging study started in October, 1978, with five actuators being post mortemed and ten actuators test fired for baseline data, prior to any environmental conditions. Data were already seven months old since MC3004, Lot 02, actuators were fabricated in February-March, 1978.

Below is the test matrix.

Sampling Interval from Baseline Months	Number of Units per Environment			
	Ambient	60°C	90°C	Cycling
1	0	5	5	5
3	5	5	5	5
6	5	5	5	5
12	5	5	5	5
18	5	5	5	5
24	5	5	5	5
36	5	5	5	5
Extra	5	5	5	5

*Cycling is 30°C for seven days and
60°C for seven days.

Following the environmental conditioning, the actuators are electrically tested and dissected or test fired.

The following are results from Electrothermal Response (ETR) and test fire.

ELECTRICAL AND FUNCTIONAL TESTING

		<u>*BASELINE</u>	<u>1 MONTH</u>	<u>3 MONTHS</u>	<u>6 MONTHS</u>	<u>12 MONTHS</u>
AMBIENT	AB	0.815		0.814	0.830	0.844
	BC	3.073		3.20	3.12	3.16
	BF	15.51		14.78	16.58	17.35
	BJ	501		501	510	524
+60°C	AB		0.877	0.963	0.968	0.938
	BC		2.63	2.40	2.40	2.69
	BF		14.50	13.95	16.70	16.92
	BJ		487	478	509	516
+90°C	AB		0.990	0.968	0.998	1.024
	BC		2.37	2.43	2.24	2.65
	BF		13.97	14.51	16.45	16.62
	BJ		475	496	513	520
CYCLING +60° - -30°C	AB		0.996	1.035	1.022	1.020
	BC		2.17	2.31	2.15	2.45
	BF		14.80	14.58	16.17	16.16
	BJ		496	498	504	508

AB - Resistance before firing ohms

BC - Function time milliseconds

BF - Peak Force - Bio Kilo Newtons

BJ - Total Impulse Millinewton-seconds

*Baseline - No temperature correlation.

As seen on the previous page of data, after one month and six months in an environment, nearly all data changed from the baseline, but not drastically. With such a small sample, a conclusion is difficult to confirm. However, it can be seen from these data that the functioning went well considering the harsh environment the actuators have been through.

In addition to three actuators being checked for resistance, electrothermal response, and test fired, there are also two actuators dissected. After dissection, the two are analyzed by the following methods: (1) photomicroscopy of the Kapton/powder interface, bridgewire/powder/pin/glass interface; (2) Scanning Electron Microscopy (SEM) analysis of bridgewire and pins for any corrosion products; (3) if additional data are needed, an extraction replica of the bridgewire and pins are pulled for Transmission Electron Microscopy (TEM) and x-ray diffraction to determine chemical composition; (4) SEM analysis of pyro powder for powder morphology where contact is made on surface A; (5) free chloride analysis of pin areas as well as bulk area further into the charge holder away from the pin/bridgewire area. Figure 1 illustrates the location of these various areas of the actuator.

During the initial examination of the Lot 02 samples, isolated areas of corrosion deposits were found on the pin and bridgewire surface. (Note: Some corroded areas of the bridgewire penetrated approximately 20-30% of the bridgewire diameter.)

Samples exposed at room temperature for longer periods of time, up to seven months exposure for the "baseline" sampling, showed an increasing number of corroded areas on the pin and bridgewire surface, but the apparent depth or severity of corrosion did not seem to be increased. From baseline to one year exposure (including temperature conditions), the corrosion deposit has become more evident over the pin surfaces and more numerous across the bridgewire. That observation is a general statement of the examination to date and there are isolated exceptions within the population of samples examined; i.e., two bridgewires at one year found to be free of corrosion. (Note: This case is believed to be the only bridgewire not corroded in Lot 02.)

The amount of corrosion or corrosion product has generally increased with time, but does not seem to be affected by the thermal conditions of the test. As stated before, the severity or depth of corrosion observed on the bridgewire is not significantly greater with time or temperature.

Based upon the results of the first year sample, the eighteen months sample has been cancelled and the test matrix will be extended to include an additional twelve months (i.e., 2 years, 3 years, 4 years).

FIGURE 1

MC3004

1

2

- 37 -

3

4

MC3004 LOT 02
S/N 1898 - BASELINE

S/N 1819 - AMBIENT 12 Mos.

MC3004 LOT 02

3

1

4

2

1

2

- 39 -

3

4

MC3004 LOT 02

S/N 1894 - 90°C 12 Mos.

QUALITY CONTROL ENGINEERING:
DETONATORS AND PYROTECHNICS

D. L. O'BRIEN

QUALITY CONTROL ENGINEERING STUDIES

Quality Engineering studies were performed by the Detonators and Pyrotechnics Quality Control Engineering Group on several different programs to provide information on pieceparts, processes, and inspection equipment.

The following are very brief descriptions of the studies along with the principal conclusions.

1E34 Detonator Resistance Study Between Operators (1/16/80)

Three days of resistance readings against two different operators demonstrated no difference existed within the days, but a difference does exist between the operators.

1E35 Spacer Development Studies (1/22/80)

Two molding methods are being considered for this application. Analyses are continuing and are providing guidance to the mold designers as to the performance level of dimensional features against different plastic batches, and molding methods.

MC3095, PPI Lot 2 Study Developing Resistance Limits (1/29/80)

Product Specifications did not provide limits for resistance limits. Production needed limits for evaluation of future lots to be manufactured. The variation analysis of the process provided these limits.

MC2320, Lot 72, Header X-Ray Evaluation (2/14/80)

The x-ray film showed different plastic texture on 50% of the units produced which did not meet acceptance requirements. Investigation of this problem resulted in identifying inclusions as calcium silicate, a common filler material, not a metallic material.

Evaluation of torque values, Scanning Electron Microscope-X-Ray Fluorescence (SEM-XRF) results, statistical analysis, and x-ray film density provided the data to correct the root of the problem. The film density was changed for a better film reader definition of metallic materials.

MC2990 Lot 007 Contact Pin Evaluation (2/18/80)

During x-ray, it was observed that excess material existed between the contact pin and contact wire. Investigation with SEM-XRF identified the material which was caused by internal heating. This was not normally observed. A data summary was conducted of the lot records. These units were found to be welded with a borrowed power source which operated at acceptable limits. Sampled units were pull tested, and the units exceeded minimum limits. The result of this activity saved many production units.

Evaluation of 1E34 Detonator Resistance Measurements Fixtures (Brian T. Leahy)

The attached detailed report is representative of many of the Quality Control Engineering studies conducted during this period. Experimental design concepts and Analysis of Variance statistical tests were used to evaluate the fixtures.

1E34 detonator resistance measurements are reported and studied for new and old fixtures that are used to measure the resistance. The purpose of the following discussion is to identify the differences between the new and old test fixtures. The data were transformed prior to analysis by multiplying the data by 10,000X. The corrected detonator resistances comparisons eliminate the day-to-day temperature variable that is a source of variation.

Tables I-IV are the analyses of variance tables for operators one and two. The label A in each of the tables is the between samples variability and the error term is the within sample variability. The between sample variability measures the variability of the level means about the overall mean (grand mean). The within sample variability measures the variability of an observation about its sample mean. The F value is the ratio of the between samples mean square and the within samples mean square. The significance level is the probability of observing an F value greater than the one calculated. For example, in Table I, the probability of $F > F_{obs} = .00014$, a rare event. In Table II, the probability of observing an $F > F_{obs} = .00000$. This value is from a table having five significant digits. The probability here should be interpreted as less than .00001. All the analyses of variance tables indicate that the respective mean resistance measures are significantly different from the mean resistance measures of other days.

Table V is a record of the resistance measures mean ($\bar{X}$) and standard deviation (S). The table identifies the operator, the type of resistance, and the fixture. Levels (days) one, two, and three are the old fixture. Levels (days) four, five, and six are the new fixture.

The graphs following the tables give visual display to the data. The graphs are the means (marked with an "X") for the levels (days) and the corresponding 95% confidence interval about the means. Each graph indicates the type of resistance measure and the operator taking those measurements.

Summarizing the results, it can be concluded that the new 1E34 detonator fixture provided higher mean resistance measurements, higher mean corrected resistance measurements, and lower variances for the detonator and corrected resistances.

TABLE I

OPERATOR 1

UNCORRECTED DETONATOR RESISTANCE MEASUREMENTS
(NEW VS OLD FIXTURE)

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F-TEST	SIG LEVEL
TOTAL	59	88.1698			
A	5	32.0788	6.4158	6.1766	0.00014
ERROR	54	56.0910	1.0387		

TABLE II

OPERATOR 1

CORRECTED RESISTANCE (NEW VS OLD FIXTURE)

LEVEL 1-3 OLD FIXTURE; LEVEL 4-6 NEW FIXTURE

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F-TEST	SIG LEVEL
TOTAL	58	94.5563			
A	5	42.5663	8.5133	8.6786	0.00000
ERROR	53	51.9900	0.9809		

TABLE III

OPERATOR 2

UNCORRECTED DETONATOR RESISTANCE MEASUREMENTS

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F-TEST	SIG LEVEL
TOTAL	59	301.0740			
A	5	187.8080	37.5616	17.9076	0.00000
ERROR	54	113.2668	2.0975		

TABLE IV

OPERATOR 2

CORRECTED RESISTANCE MEASUREMENTS
(OLD VS NEW FIXTURE)

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F-TEST	SIG LEVEL
TOTAL	59	321.0900			
A	5	242.6840	48.5368	33.4282	0.00000
ERROR	54	78.4060	1.4520		

TABLE V

RESISTANCE MEANS AND STANDARD DEVIATIONS FOR NEW AND OLD FIXTURES

DAYS LEVEL (FIXTURE)	MEAN AND STANDARD DEVIATION	DETONATOR RESISTANCE AS MEASURED		RESISTANCE CORRECTED TO 20°C	
		OPERATOR 1	OPERATOR 2	OPERATOR 1	OPERATOR 2
1 (Old)	$\bar{X}$	120.3	118.84	119.09	117.63
	S	0.8857	3.349	0.8925	3.319

2 (Old)	$\bar{X}$	120.72	117.84	119.07	116.24
	S	1.119	0.7412	1.0750	0.7412

3 (Old)	$\bar{X}$	120.41	119.37	118.86	117.85
	S	1.972	0.8667	1.9334	0.8423
=====					
4 (New)	$\bar{X}$	122.25	121.91	121.25	120.71
	S	0.5401	0.05676	0.5401	0.05676

5 (New)	$\bar{X}$	121.85	122.04	120.65	120.74
	S	0.1080	0.0516	0.1080	0.05164

6 (New)	$\bar{X}$	121.38	122.34	120.08	121.04
	S	.06325	0.2503	0.06324	0.2503

QUALITY CONTROL ENGINEERING:
TIMERS AND TRANSDUCERS

F. H. SCOTT

QUALITY CONTROL ENGINEERING STUDIES

Statistical and evaluation studies were performed by the Timers and Transducers Quality Control Engineering Group on several different products to provide information on pieceparts, processes, and equipment. The studies ranged from relatively simple one-time studies to more complex studies, which are being repeated periodically to measure progress being made.

The addition of a statistician to the Quality Control Engineering staff has provided increased strength in the area of planning, conducting and analyzing statistical studies.

Some of the following studies reflect this increased capability as will many of the studies, currently in process, that will be summarized in future Progress Reports.

MC3106 Modified Cup Study (10/12/79)

Five cups were anodized and then inspected to determine if anodizing would alter the dimensions of the cup significantly. Results were inconclusive; a second study was recommended.

MC3347 Ceramic Visual Inspection Specification and Technique Evaluation (12/4/79)

The compatibility of the visual inspection equipment and techniques used by the vendor, Mound Receiving Inspection, and Mound Production was assessed, along with the consistency of visual criteria interpretation. The specification's evaluation resulted in the specifications being clarified and the techniques made more compatible.

MC3106 Ring Assembly Resistance Study (12/5/79)

Circuit resistances of completed units were evaluated for compliance to specification limits and distribution of the data. The distributions were relatively tight, but some resistances fell below the specification limits.

MC3106 Modified Ring Study (12/20/79)

The slot width and slot location in the modified rings were evaluated. Slot width was found to be in conformance to specification requirements, but the slot location was not being adequately controlled.

MC3106 Modified Rings and Discs Study (12/20/79)

An analysis of four rings and four discs found that these parts are still having significant noncompliance-to-specification problems which could affect Mound's assembly operations.

MC3359 Lot 005 Yield and Process Data Analysis (1/8/80)

Lot yield was 95%, control charts and distribution studies indicated good process control.

MC3004 Lot 012 Disassembly Data Analysis (1/11/80)

An analysis of the disassembly units displaying contamination, corrosion precursor and corrosion that initially placed Lot 012 on hold was made to statistically determine how many units in Lot 012 could be expected to display this condition. It was found that at 95% confidence, a minimum of 28 units and a maximum of 100 units in Lot 012 could be expected to contain the condition.

MC2990 Header Plastic to Housing Flushness Inspection Study (2/26/80)

Thirteen headers were measured three times to evaluate the consistency of the inspection technique. Each set of data was found to be significantly different from the other two, indicating the inspection technique is not statistically consistent.

1E34 Detonator Resistance Fixture Evaluation (2/26/80)

The new 1E34 detonator resistance fixture was evaluated by having two operators remeasure the same part ten times on three different days. Statistically, significant differences were found between operators and between days.

MANUFACTURING DEVELOPMENT
ENGINEERING PRACTICE GUIDELINES

PRINCIPAL RESPONSIBILITY

D. E. WENDELN

Manufacturing Development Engineering Practice Guidelines

Several additional Manufacturing Development Engineering Practice Guidelines have been issued this quarter. These guidelines have been developed by Advanced Devices' Manufacturing Development to provide standards for the Manufacturing Development Engineering staff. The guidelines are not intended to provide strict procedures, rather they are meant to define the principles of operation within Manufacturing Development - a basis from which technical and managerial judgment can be applied.

The guidelines are in the process of evolution. Additional guidelines are planned as well as appropriate modifications of the existing ones.

Guidelines issued thus far are as follows:

- Operation Sheets
- Philosophy of Variation Engineering
- Technique Diagrams
- Material and Design Reviews
- Tolerance Layouts
- Process and Paper Flow Diagrams
- Labor and Material Standards
- Cost of Scrap
- Index of Productivity
- Engineering Unit Costs

By way of example, the "Material and Design Review" Guideline is reproduced in this report.

MATERIAL AND DESIGN REVIEW¹

One planning technique used by process engineering is preproduction design review. The review is required to determine dimensional parameters, applicable specifications, tooling and gaging, operational sequence, processes, and manufacturing facilities necessary for the production of a quality product at proper costs. The preproduction analysis of the design of a part or assembly is essentially a search for problem areas in producibility. Because product design is created offsite by an outside design agency, the requirements must be ascertained and thoroughly analyzed. This unique situation presents an obstacle to communication and cooperation between the process or manufacturing engineer and the product design engineer. The design is essentially finalized before the review is initiated.

As a consequence, the preproduction analysis procedure to be followed is as follows:

1. Assemble all applicable available information regarding the product.
2. Analyze and study product definition for producibility and practicability.
3. Determine and define all problem areas.
4. Consult and resolve problem areas with the design engineer.

In the first phase, the responsible process engineer obtains copies of all part and assembly drawings including mating assemblies. From the information on the drawings, all applicable specifications are determined and copies are procured. These include not only specific specifications, i.e., a material or process document, but also general specifications such as Sandia's 9900000 General Requirements and Drawing Interpretation. It is the responsibility of the process engineer to maintain an orderly file of the assembled material and documentation for ready reference.

In the second phase, all dimensions, specifications, and related standards are analyzed and studied for impact on producibility and practicability of the product. Obviously, this requires a team approach. The delegated, responsible engineer, after preliminary study, assembles a panel having the various types of expertise and experience required for the particular product being studied. All available resources must be utilized.

The team studies the product definition, specifications, and related standards with regard to the following points:

- Clarity
- Design intent
- Functional impact
- Interchangeability
- Durability
- Reliability
- Quality
- Appearance
- Cost

Concurrently the product materials, tolerances, critical parameters, quantities, and schedules are studied for impact on plant resources, the need for new technology, and additional plant facilities.

Throughout this phase, it is the responsibility of the process engineer in charge to coordinate the work and monitor the team's progress. These operations are expedited through frequent team meetings and reports. The frequency of meetings is a function of the project time constraints and the rate of progress. The success of the analysis depends upon securing good cooperation and collaboration among the various engineering groups, purchasing, accounting, and manufacturing functions.

The second phase leads logically into the third phase. Here the problem areas are determined and defined. This encompasses all aspects of the product whether internal or external to Mound Facility. All engineering problems should be broken down into the following steps:

1. Problem recognition
2. Definition
3. Analysis
4. Possible solutions
5. Evaluation and/or Recommendation
6. Communication

The first four steps are self-explanatory; however, the remaining two steps deserve particular attention and thought. In actuality, they not only belong to the third phase for internal purposes, but also constitute the all important fourth phase. Because of the unique relationship between the product designer and the Mound process engineer, these two steps must be handled with care and tact.

The evaluation step is a critical study of each alternate solution in light of the defined problem. This is difficult when viewed only from Mound's perspective. Recommendations involving design changes are best handled by a joint review and conference discussion by the people involved and concerned. Good communications are the key to maintaining the interface and inter-relationship between Mound and the design agency. Communication must be thoroughly documented. The use of all types and means of written and visual communication is

mandatory. It is incumbent upon the process engineer to inform, consult, and resolve problem areas with the design agency and/or engineer in a spirit of teamwork. This is the culmination of the preproduction process.

Reference

1. D. E. Wendeln, "Manufacturing Development Guidelines for Engineering Practice", Section F, Issued 3/3/80.

ANALYTICAL CHARACTERIZATION
AND QUALIFICATION OF
WR MATERIALS

H. A. WOLTERMANN
ANALYTICAL MANAGER

PLASTICS CHARACTERIZATION

A method developed by the FMC Corporation for the generation and data reduction of cure exotherms has been adapted to the DSC1-B/PDP12A system to perform plastics analysis by differential scanning calorimetry (DSC). Analytical parameters, including sample preparation and computer software, have been established and a study initiated to determine the statistical boundaries of the method.

Study results indicated within day variability of +3% and day to day variability of +10% when comparing the ΔH_f values on the same batch of plastics. Other values generated in the analysis of the cure exotherm such as skewness, kurtosis, etc., were scattered, lending difficulty in determining precision values. Since there are no reference standards to compare the various mathematical moments of the cure exotherms, these values will be utilized in forming a historical data base which will be assembled upon the completion of approximately 36 reference samples now awaiting DSC analysis. To complete the initial study, two series of analysis are planned to more thoroughly define the day to day variability of the ΔH_f values. (N. R. Bonekowski)

EXPLOSIVE AND PYROTECHNIC MATERIALS CHARACTERIZATION

Work during the past month has been centered on evolving possible mechanisms for the decomposition of CP, both thermally and in solution, and on developing tests to determine the validity of the proposed mechanisms. As a consequence of this work, methods of analysis for the proposed decomposition products are also being developed. Briefly, the proposed mechanism for conversion of 2-CP, in DMSO solution, to the amidine complex is as follows: the first step of the conversion is loss of cyanogen $[(CN)_2]$ from the cyano tetrazole ring leaving the azido pentaamminecobalt (III) perchlorate. Cyanogen, which remains in solution, then reacts with the azide group to give a tetrazole ring. The net result of these two steps is that the tetrazole ring is now attached to the cobalt through the 1-nitrogen, not the 2-nitrogen, yielding what is designated as 1-CP. Water present in the DMSO hydrolyzes the 1-CP to the 1-amide, which is then easily converted to the amidine by the subsequent loss of water. Tests of this mechanism indicate that the azide can be converted by CP type materials by bubbling cyanogen gas through a DMSO solution of the azide. Purification of the crude product by means of ion exchange

chromatography yields several bands. One of these bands has been identified (by powder pattern) as 2-CP. Analytical methods are being developed to analyze CP for the azide, amide and amidine. At this time, the thermal decomposition mechanism is less well defined. It appears, however, that loss of cyanogen is the first step here as well as in solution. Spot tests have been developed to test for cyanogen and for cyanide ion. It appears that at a temperature of 140°C CN^- and NH_3 are given off by CP. The CN^- could be from cyanogen reacting with water adsorbed by the CP. A sample of CP was mixed with P_2O_5 to trap H_2O and heated to 80°C. A positive cyanogen test was obtained in less than 100 minutes. A sample of CP without P_2O_5 , heated to ~45°C for 120 hours gave a positive cyanide test. Work will be continuing in both areas. (K. E. Bullock, D. M. Coleman)

Initial ^{13}C spectra of cyanotetrazolatopentaamine cobalt (III) perchlorate (CP) have been obtained with the Varian FT-80A NMR spectrometer. Samples of isolated impurities have been requested from Unidynamics. These include the 5-amidino-tetrazolatopentaamine cobalt (III) perchlorate and carboxyamidotetrazolatopentaamine cobalt (III) perchlorate. Upon receipt of these impurities, work will be initiated to quantify the impurities in CP and also to follow degradation of the CP using NMR. (B. D. Craft, A. Attalla)

Dr. Mort Lieberman from SLA Sandia Laboratories/Albuquerque visited Mound March 5, 6, 1980, to discuss progress on the DDT Project. Once again Mort was impressed with the work accomplished by the Analytical Section. He complimented all involved with the work and encourages us to continue in this manner. (K. E. Bullock)

The experimental study of the effectiveness of drying $\text{TiH}_{0.65}/\text{KClO}_4$ pellets at 65°C, 100°C and 150°C for various time intervals in a vacuum has been completed. This study was formally requested by Tom Massis of Sandia Laboratories/Albuquerque, for specifying new drying conditions in detonator component manufacture. Similar studies have been previously carried out with $\text{TiH}_{0.15}/\text{KClO}_4$ (MLM 2596). $\text{TiH}_{0.65}/\text{KClO}_4$ pellets were dried at 150°C and 10^{-8} torr vacuum for eight days to establish a background "moisture" level. The determination of moisture by NMR is based on the conversion of the concentration of slow decaying hydrogen to its water equivalent. This background "moisture" is subtracted from the values obtained for analytical samples to arrive at the "true" moisture content, that is, the moisture that is volatile under the specified drying conditions. Very slight differences in moisture content were detected for $\text{TiH}_{0.65}/\text{KClO}_4$ pellets dried at 65°C, 107°C and 150°C for 1-13 days. The moisture results varied from 0 to 0.04 wt. % samples exposed to the ambient laboratory atmosphere (22°C and 60% R.H.) for 11 days exhibited a

moisture content of 0.04 wt. %. This was reduced to the background level in 8 days by drying at 65°C and 5 torr vacuum and in 5 days by drying at 107°C and 5 torr vacuum. Based on the results of this study, it is recommended that the $\text{TiH}_{0.65}/\text{KClO}_4$ pellets be dried for 8 days at 65°C and 5 torr vacuum to ensure complete removal of moisture from this highly compressed material. (A. Attalla)

A study of the effectiveness of reducing moisture adsorption in $\text{TiH}_{0.65}$ and $\text{TiH}_{0.15}$ pyrotechnic powders by carbon monoxide and heat treatments was also initiated. $\text{TiH}_{0.65}$ powder was treated with carbon monoxide and $\text{TiH}_{0.15}$ powder was heat treated to reduce the active moisture adsorbing sites on the surfaces of these materials. The CO treated $\text{TiH}_{0.65}$ exhibited no significant change (less than the experimental error of 0.01 wt. %) in moisture content after drying at 107°C and 5 torr vacuum for 72 hours. In fact, the "moisture" level (0.05 wt. %) in the CO-treated material was below background (0.07 wt. % H_2O) for untreated $\text{TiH}_{0.65}$. Heat treated $\text{TiH}_{0.15}$ showed a slight decrease (0.57 to 0.46 wt. %) in moisture content after drying at 107°C and 5 torr vacuum for 72 hours; whereas, the untreated $\text{TiH}_{0.15}$ moisture content decreased from 0.82 to 0.54 wt. % under the same conditions. The moisture levels in all samples were determined after exposure to the ambient atmosphere (22°C and 60% R.H.) for 5 days, prior to drying. The results indicate that the CO and heat treatments are effective in modifying the active moisture adsorbing sites on the surfaces of $\text{TiH}_{0.65}$ and $\text{TiH}_{0.15}$ powders. (A. Attalla)

A pulsed NMR study has begun to determine the effect of fluid energy milling on crystal defect formation in HMX for Advanced Devices' process development. The proton spin-lattice (T_1) and spin-spin (T_2) nuclear magnetic resonance relaxation times are being measured as a function of temperature and correlated with the mechanical treatment of HMX. It is theorized that the increased randomness of the HMX molecules will alter the relaxation times which are dependent on the relative orientations of the molecules. T_1 is a measure of the time required for the hydrogen nuclei (protons) to lose rf energy to its surroundings (the lattice). T_1 depends on the translational, vibrational, and rotational mobility of the molecules. T_2 is a measure of the time for the NMR signal to decay to zero amplitude. T_2 depends on the dipole-dipole magnetic coupling between the protons and all other nuclei, even of the same species. The dipole-dipole coupling depends upon the relative orientations of the dipoles. T_2 is also a measure of the broadness or linewidth of an NMR spectrum. A comparison of T_1 , T_2 and line shapes of milled and non-milled HMX crystal deformation. T_1 , T_2 and line-shape data are now being obtained at room temperature. (A. Attalla)

A study was conducted to determine the precision and accuracy of chloride determinations conducted on pyrotechnic powders employing the specific ion electrode. Based on current methodology utilizing a 5 milligram per millileter concentration of oxidizer (KClO_4) in solution, the accuracy was +8% (relative) with a precision of +2% (relative) in the 50 to 100 ppm range. In the 10 to 50 ppm range, the accuracy was +20% (relative) with a precision of +16% (relative). The minimum detectable limit was established at 10 ppm. It was suggested that if current or future programs require greater sensitivity, precision and accuracy, the method now in use may be modified to satisfy requirements.

(N. R. Bonekowski)

ANALYTICAL QUALITY
ASSURANCE

R. J. SEILER

ANALYTICAL QUALITY ASSURANCE

Controlled-Potential Coulometry (CPC) has been used at Mound as a method for plutonium and uranium assay of metal, oxide and solution samples. The method is capable of determining both plutonium and uranium in reactor fuels consisting of sintered mixed oxides (U, Pu)O₂ without detectable bias. No separation of the two elements is required. As with any CPC method, these determinations are based on the quantitative oxidation or reduction of the element under precisely controlled conditions and the subsequent measurement of the quantity of electricity necessary to do this.

The two controlled-potential coulometers currently in use are all solid-state instruments initially designed by J. E. Harrar and E. Behrin of Lawrence Livermore Laboratory, and supplied by M-T Electronics Company. These instruments can be connected to various titration cells for use in any laboratory.

Mound's participation in the Metals Exchange and SALE (Safeguards Analytical Laboratory Evaluation) programs has demonstrated that Mound's CPC technique is as good or better than any other participants for the assay of plutonium in these samples. Two plots which show the monthly means for plutonium concentration values reported in CY-1979 by SALE participants are included in this report to demonstrate Mound's capability. Mean assay values for PuO₂ samples are shown in Plot 31 and for mixed (Pu,U)O₂ samples in Plot 45.

The CPC titration coupled with a unique but simple total dissolution technique also has provided excellent support for NDA (nondestructive analysis) total plutonium determination experiments involving reactor grade PuO₂ here at Mound.

MONTHLY MEANS
(PU,U)O2 PELLET -PU-CONC
ALL METHODS

FEB 1979 JAN 1980

(EXPANDED SCALE FOLLOWS)

PLOT 45

MONTHLY MEANS
 PU02 - PU-CONC
 ALL METHODS

FEB 1979 - JAN 1980

(EXPANDED SCALE FOLLOWS)

PLOT 31

PRODUCT ASSURANCE
HIGHLIGHTS

M. E. BABCOCK

1E35 Qualification Testing (M. J. Stein)

Various changes were made in the 1E35 cable assembly Qualification testing. The LASL designed simulator fireset previously used to initiate the detonator cable assembly was replaced with two Sandia supplied High Energy Density (HED) firesets. Two HED units are used in tandem to test the same number of 1E35's tested with the simulator. This was necessary to maintain the present rate of testing.

The main concern with using two firesets in tandem was jitter in the function time of the firesets. If the jitter between firesets was too high, timing data would be lost. Fortunately, this problem has not occurred on the firesets tested to date, so only minor tester modifications were necessary to accommodate tandem fireset testing.

Design changes in the length of cable used on the 1E35 required modification to test barricades for the protection of the detonator cable assemblies and the HED firesets. Smaller test pads were implemented at the same time which made barricading less extensive.

The output waveform of the HED fireset continues to be a concern. The erratic waveform creates problems in obtaining a consistent transit time for the 1E35's. Various filtering and pulse forming techniques have been tried with little success. Tests performed using CVR's to monitor the output waveforms have been successful, but LASL has been reluctant to approve the use of CVR's.

LASL has requested that testing of the 1E35's be done on the new Opto-electronic tester, TF2000, by June, 1980.

TF2000 Opto-Electronic Tester (M. J. Stein)

The TF2000 was designed and fabricated at the request of LASL to support acceptance testing of the 1E34 cable assemblies. The advantages of using an Opto-electronic tester to monitor the transit time of detonator cable assemblies are less operating and data analysis time, less expensive test fixturing, as well as instantaneous data.

TF2000 utilizes a 10 channel time interval counter to record timing data for each detonator with backup recorded on an oscilloscope. The counter is triggered by the fireset output voltage and various counter channels are stopped by pulses from photodiode circuits which react to the light output from each detonator. The tester is an improvement over its Sandia Pantex counterpart in that an inexpensive

lens system protects the expensive fiber optic cables and an explosive test fire pad is not required.

The tester is now operational in B-test area. Manuals, forms and drawings are all complete and are being published or finalized. The tester has been designed to test detonators located either in the tank or with a portable boom box. The advantage of this is that large detonators such as 1E35's or development tests with crude fixtures may be fired in the tank without recabling. The boom box was designed to be versatile enough to accommodate new products requiring different optical fixtures. The fixtures are bolted in and may be removed easily. If modifications are still necessary, the bottom plate of the box can be removed and modified. TF2000 is tentatively planned to be operational for acceptance testing of the 1E34 in March, 1980, and the 1E35 in June, 1980.

New 1E34 Resistance Fixture (N. J. Seubert)

A quality concern on the 1E34 detonator is the possibility of BW diameters (therefore, resistance) varying within a given lot of product. Final Inspection has conducted an evaluation of a new resistance fixture per MD and LASL request. Studies indicate that the new fixture improves the consistency of the resistance measurement by approximately 75%. Results further indicate that a relatively clear distinction can be made between the resistance values of 1E34 detonators with known BW diameter differences of 0.00016 inch. Due to the positive results of this evaluation, this fixture was implemented effective with Lot 3412. The resistance on this lot was measured using both the old and new fixtures. The results are as follows:

Old Fixture---Standard deviation for 296 units of
Lot 3412 detonators was (0.000158).

New Fixture---Standard deviation for 296 units of
Lot 3412 detonators was (0.000097).

Utilizing the new fixture improved the standard deviation approximately 39%.

Samples from additional resistance studies of suspected varying BW diameters have been submitted for diameter verification.

Investigation of MC3028 Low Voltage
Outputs During Destructive Testing (J. L. Allison)

An investigation into the Class II failure of MC3028, Lot 007 (S/N 1367), is being conducted to determine the cause of low output voltages and currents. The product specification, which was changed prior to testing Lot 007, allows for one Class II failure in every sixty WR test units without affecting shipments. Two MC3028 units from Lot 006 failed in the same manner as this Lot 007, Class II failure. The Lot 006 units were deviated from the product specifications by a special engineering release.

An investigation committee, composed of SLA and Mound personnel, discussed the procedures to determine the cause of failure. The committee recommended the following steps be taken:

1. The integration of the current films to determine if the unit received the proper charge.
2. Changes in rate of rise in the voltage films.
3. Destructively test an MC3028 unit with a six millimeter gap between the buffer and stacks.
4. Build several units with different gaps which SLA would test on their system.
5. Change the point of oscilloscope triggering in the test system to enable the comparison of films between tests.
6. Add an additional two oscilloscopes to the test system for recording output voltage after the MC3028 switch.
7. Nondestructively test the fully assembled units with reflected sound or vibration in an attempt to detect a gap.

A number of current films with normal outputs from Lots 007, 006, and 002 were integrated to form a basis of comparison. The current films from tests with lower than normal outputs were then integrated to determine if the charge was similar to normal tests for that lot. From the results of the integrations, all indications are that the low output units delivered the proper amount of charge to the loads. However, the method of hand calculation used had about a 10% error factor.

The rate of rise in the voltage output was analyzed for those tests where charge was calculated. The results of this data analysis were that a part of the low output tests also had a slower rate of rise than the normal output tests. The reason for this slower rate of rise on part of the lower output test is not readily apparent. The special MC3028 unit with a six millimeter gap between the buffer and stacks was tested to simulate the Class II failure which occurred during testing of Lot 007. The test resulted in electrical data that were similar to the Class II failure. Additional investigation into different size gaps is continuing at Sandia with their test system. The MC3028 test has been modified to allow for the triggering of the oscilloscopes and fiducial generator from the output of the MA1015 fire-set. This change will make it easier to compare data points between tests by eliminating the jitter of two pulse generators. The other change to the test system is the addition of two oscilloscopes for recording output voltage after the internal switch of the MC3028. This change allows for a more accurate determination of charge since the time for which the charge is applied can be read directly from the two additional oscilloscopes.

Five MC3028 units, which Sandia had nondestructively tested in Final Inspection, were sent to Test Fire for testing. These units were suspected as possible low output candidates. The C-tank open test setup was used to destructively test these units; however, all five units produced normal outputs.

New Vibration Control System (M. J. Holt)

On February 13, 1980, the Development and Environmental Testing Group accepted delivery of a Hewlett-Packard Model 5427 vibration control system. This system was a replacement for an MB system which was over thirteen years old, and a maintenance and operations problem.

The Hewlett-Packard system utilizes a minicomputer with related support equipment to generate vibration signals which when transmitted to a shaker amplifier and table, controls the shaker output. In controlling the shaker, a response spectrum is produced matching the user specified reference spectrum. The software supplied with the system enables an operator through keyboard entry to initiate or recall from disk memory any required test response. Setup time has been greatly reduced and test repeatability has been improved. Test results are automatically stored on a disk and can be recalled and plotted for permanent record as desired. The system software makes it possible to perform sinusoidal and random vibration as well as transient shock tests.

QUALITY PROGRAM
HIGHLIGHTS

D. R. BOHL

VENDOR QUALIFICATION

Vendor surveys were conducted of Cerametic Corporation, City of Industry, California, and Northeast Electronics, Milford, Connecticut. After correction of a few minor deficiencies, Cerametic will be a qualified WR supplier. Northeast Electronics has considerable corrective action to take in order to become qualified. These vendors are potential suppliers of sealed glass-to-metal or ceramic-to-metal components such as the MC3004 header. (B. Bond)

DETONATOR RESISTANCE MEASUREMENT CAPABILITY

A 1E34 resistance measurement study encompassing corrected resistance, detonator resistance, for the new fixture, and standard resistor measurements was done focusing upon the day and operator as variables of interest. Generally, significant differences were found between the days of the measurements, the operator taking the measurements, as well as an interaction affect between day and operator for the detonator resistance, corrected resistance measurements for the new fixture, and for the standard resistors. Comparisons between the new and old 1E34 fixtures corrected and uncorrected detonator resistance measurements revealed lower variances and higher means for the new fixture for both the corrected and uncorrected detonator resistance measures. (B. T. Leahy)

RELIABILITY PROGRAM QUALITY COSTS REDUCED

Due to the high reliability and quality of the cone driver type timers, Sandia has agreed to reduce the total number of destructive test units from 48 units to 12 units per lot. The long term sample size, which is currently 20 units per lot, has also been terminated for the MC2453, MC3050, MC3155, and MC3359. All the long term samples currently in storage will also be reviewed and reduced to 20 timers per program. Over the next three years, this is a projected cost savings of approximately \$500,000. (C. J. Kaye)

MC2990, Lot 003 Evaluation Continues

To aid in explanation of MC2990, Lot 003, failures, several studies, focusing on Lots 3, 4, and 5 conditions, and possible differences in these conditions, within a lot and among lots, have recently been completed. Plots of current (I_b) vs effective time (t_e); current vs resistance (R); and effective time vs resistance; by their respective lot, overlaid, showed no systematic behavior; hence, the lots appear to be similar. Plots of current vs effective time; current vs resistance; and effective time vs resistance; by condition level, overlaid, showed no systematic behavior of the data. Analysis of variance for $t_e = R$,

$I_b = R$, classifying the condition was completed and no significant features were found. Analysis of variance was completed for $t_e = R$, $I_b = R$, classifying the condition and lots. Again, no significant features were found in these studies. Examination of lots and the environmental conditions under which the lots were tested, as well as each lot examined under their environmental conditions alone, did not reveal any new information as to what may have contributed to the failures encountered in Lot 3. The next area for examination is the review of the simulated failures as described in the isolated investigations. (B. T. Leahy)

CORRECTIVE ACTION TAKEN ON MC3348 FAILURE

On October 31, 1979, during the functional testing of MC3348, PPI Lot 001, a unit (S/N 366-H79) failed to produce the necessary pressure pulse for monitoring the total time of the unit. After an intensive review of the study Mound had done since the failure occurred, the following changes have been inaugurated. A teflon film will be inserted between the cover and the holder to offset any shearing of the MDF which may develop as the cover becomes separated from the holder during detonation. An MDF winding tool, a tool to cut the teflon film, and a tool to hold the MDF in the groove during the first cure, will also be utilized. There were also several process changes introduced, including the wearing of finger cots when handling the MDF or holder until the MDF is bonded to the holder. (C. J. Kaye)

QC ENGINEERING PROCESS EVALUATION LEADS TO SPECIFICATION CHANGE

The 1E34, Lot 3408, had an SXR written and approved by LASL for calculated density being slightly below the lower specification. Statistics were run on some data of the density, and Mound was able to convince LASL to change the specification. The old specification was $1.75 \text{ G/cm}^3 \pm 0.05$; the new specification is $1.71 \text{ G/cm}^3 \pm 0.03$. The old method for calculated density was to wait until the trays of loaded cups were assigned to a lot. Now the density is calculated as the cups are loaded. This will permit more timely issuance of the lot density data once the determination has been made as to which cups will be used in which lot. (W. S. Masque)

SA2799 CERAMIC INSPECTION PROBLEM RESOLVED

The reject rate using the clarified visual criteria for the inspection of SA2799 ceramics from Gulton Industries has been as follows:

<u>Original Criteria</u>	<u>Starts/Rejects</u>	<u>% Reject</u>
Receiving Inspection	487/171	35.1%
Production	224/136	60.7%
 <u>Clarified Criteria</u>	 <u>Starts/Rejects</u>	 <u>% Reject</u>
Receiving Inspection	171/10	5.8%
Receiving Inspection	136/6	4.4%

The results indicate that the yield of ceramics has increased by over 40% when inspected to the clarified inspection criteria. The clarified criteria for visual inspection is essentially the same criteria as used by Mound's Source Inspector during field acceptance of the lot. (J. S. Sukola, III)

QUALITY AUDITS CORRECTIVE ACTION

Investigation of the seriousness of unauthorized materials used in MC2046 and MC2987 (B-items at ICI and Unidynamics, respectively) has been completed. Laboratory tests combined with design review concluded no serious problem exists in either case. Both of these deviations were detected by MRC Internal Quality Audits conducted at the supplier's site. (B. L. Bond)

REJECT ANALYSIS: MC3347 AND MC3352

The inert process data are subdivided into two areas: ceramic/spacer bond, indicated on the histogram as CSB, and the ceramic/spacer/contact, indicated as CSC. The ceramic/spacer bond reject rate of only 1% in the MC3347 and only 5% in the MC3352 the month of January and February, 1980, show a tremendous yield improvement trend. As noted on previous reject analysis reports, a reject rate reduction from 55% to only 5% had previously been achieved.

The histogram for ceramic/spacer/contact indicates an excellent trend in reject reduction with only two rejects out of 147 starts on the MC3347, and only two rejects out of seventy-five starts on the MC3352 program.

Congratulations on this excellent yield accomplishment have been communicated to Production supervision.
(J. S. Sukola, III)

Quality Audits/B-Items

During this quarter, two QAS 2.0 Quality Audits by the ALO-DOE Quality Assurance organization were conducted on B-item programs.

Programs audited included the MC3133 Reefing Line Cutter and MC2987 Torch which Mound Facility procures from Unidynamics/Phoenix, Inc. A rating of Satisfactory was assigned to the audit. The audit team noted that the quality history of the MC2987 has been very good. The TMS lot had a yield of 96%, and the first WR production lot had a yield of 95%.

The other program audited was the MC2046 Match at ICI Americas, Inc. It was assigned a rating of Satisfactory, with no serious quality deficiencies being found. Although much remains to be done, this provided concrete evidence that much has been accomplished since Mound's takeover of the MC2046 from GEND in October, 1979. The results of the survey at Unidynamics also provide evidence that Mound's efforts to strengthen the B-item Quality Program are having an impact. (D. R. Bohl)

COST IMPROVEMENT

Reduced Sample Size - MC2352 Mold

A statistical study was performed on mold qualification of MC2352 Mold C which had an established history. The results was that inspections were reduced, saving \$1876 annually, while maintaining the necessary mold qualification requirements. (G. J. Hoey, B. T. Leahy)