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MANUFACTURING METHODS AND TECHNOLOGY FOR PIEZOELECTRIC TRANSFOR--ETC(U)

SEP 78 W B HARRISON

DAAB07-76-C-0008

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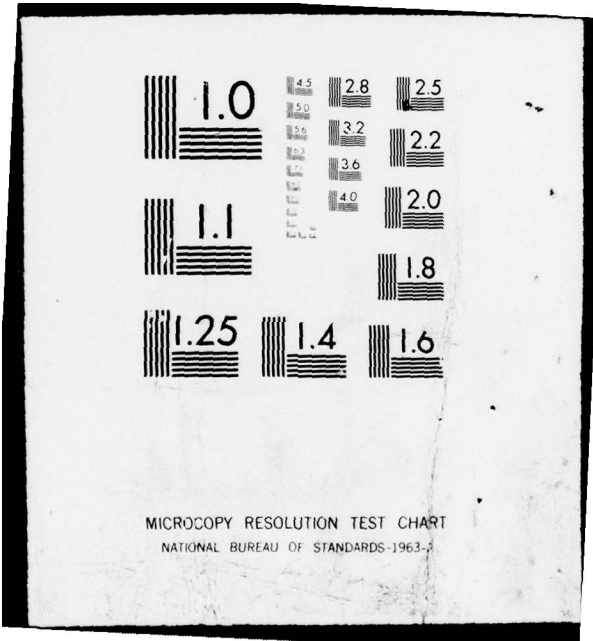
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QUARTERLY PROGRESS REPORT  
PRODUCTION ENGINEERING MEASURE (PEM)

MANUFACTURING METHODS AND TECHNOLOGY  
FOR PIEZOELECTRIC TRANSFORMERS

CONTRACT DAAB07-76-C-0008  
January 14, 1978 to June 14, 1978

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)		
This is the final quarterly report on Contract DAAB07-76-C-0008 which describes the progress and status of this program to establish a cost-effective production capability for piezoelectric, ceramic transformer operating 18 mm night vision image intensifier tubes. The conformational samples were accepted and a pilot production run of 150 18 mm PET's was initiated. All parts for the pilot run have been produced and the final assembly of these is in progress. These are due to be delivered August 7, 1978.		

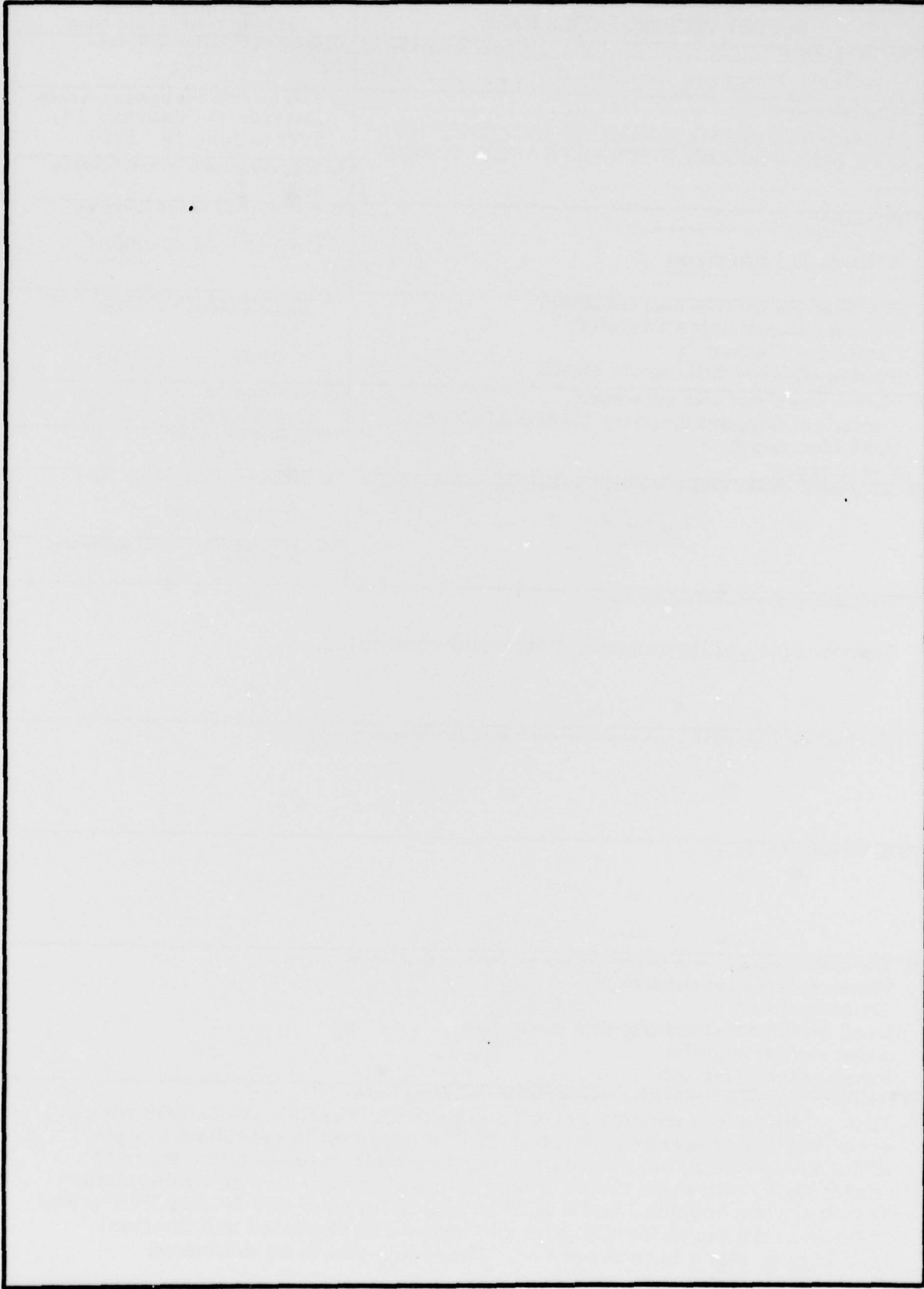
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ELEVENTH  
QUARTERLY REPORT

CONTRACT NO. DAAB07-76-C-0008  
Manufacturing Methods and Technology  
for Piezoelectric Transformers

PERIOD COVERED: January 14, 1978 to June 14, 1978

PREPARED BY: W. Harrison

OBJECT OF STUDY:

The objective of this contract is to establish a production capability for piezoelectric ceramic transformers with all required manufacturing methods, test procedures and production tooling for high production rates. These transformers are to be used in conjunction with a power supply for operating 18 mm night vision image intensifier tubes.

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PURPOSE

This Production Engineering Measure (PEM) contract covers all of the tooling, test methods, package designs, mounting techniques, interconnection techniques and other manufacturing methods and techniques required for eventual production of 18 mm piezo-electric transformers. These units are to be used with a power supply to improve the performance and reduce cost for image intensifier tubes used in various 18 mm night vision devices.

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## SECTION I APPROACH

Our approach to the design of piezoelectric transformers, its advantages and the analytical method used to determine performance of these transformers were discussed in the first quarterly report<sup>(1)</sup>. During the engineering sample-build phase of this program it was shown that both of our 18 mm and 25 mm PET designs were feasible. However, during the confirmatory-build phase it was concluded that the assembly techniques for the 25 mm PET were too unreliable and therefore too costly. Thus work on the confirmatory samples was limited to the 18 mm PETs. The pilot production build phase was also limited to the 18 mm PET.

(1) First Quarterly Progress Report, Production Engineering Measures (PEM) Manufacturing Methods and Techniques for Piezoelectric Transformers, Contract Number DAAB07-76-C-0008, July 14, 1975 to October 14, 1975.

SECTION II  
PROCESS REVIEW

All processing steps used on this program up to this time have been documented previously<sup>(1-7)</sup>.

- (1) First Quarterly Progress Report, p. 1.
- (2) Second Quarterly Progress Report, Production Engineering Measure (PEM) Manufacturing Methods and Techniques for Piezoelectric Transformers, Contract Number DAAB07-76-C-0008, October 14, 1975, to January 14, 1976.
- (3) Third Quarterly Progress Report, Production Engineering Measure (PEM) Manufacturing Methods and Techniques for Piezoelectric Transformers, Contract Number DAAB07-76-C-0008, January 14, 1976, to April 14, 1976.
- (4) Fourth Quarterly Progress Report, Production Engineering Measure (PEM) Manufacturing Methods and Techniques for Piezoelectric Transformers, Contract Number DAAB07-76-C-0008, April 14, 1976, to July 14, 1976.
- (5) Fifth Quarterly Progress Report, Production Engineering Measure (PEM) Manufacturing Methods and Techniques for Piezoelectric Transformers, Contract Number DAAB07-76-C-0008, July 14, 1976, to October 14, 1976.
- (6) Sixth Quarterly Progress Report, Production Engineering Measure (PEM) Manufacturing Methods and Techniques for Piezoelectric Transformers, Contract Number DAAB07-76-C-0008, October 14, 1976 to January 14, 1977.
- (7) Seventh, Eighth, Ninth and Tenth Quarterly Progress Report, Production Engineering Measure (PEM) Manufacturing Methods and Techniques for Piezoelectric Transformers, Contract Number DAAB07-76-C-0008, January 14, 1977 to January 14, 1978.

SECTION III  
STATUS AND FUTURE WORK

This section describes the status of work against the various tasks outlined in Figure 1. Since this is the last quarterly report, it covers those tasks which were active during the period between January 15, 1978 and June 15, 1978.

TASKS 1-19

Work completed previously.

TASK 20 - TEST CONFIRMATORY SAMPLES

Work on the second submittal group of 18 mm PETs was completed on January 26, 1978 with the final evaluation of the life test units. The 500 hour results obtained are reported in Table I with the previous life test data. All units met the required specifications. This was verified by Howard Kessler of Fort Belvoir on February 13, 1978 and by Sol Bremmer of Fort Belvoir on March 7, 1978.

TASKS 22-23

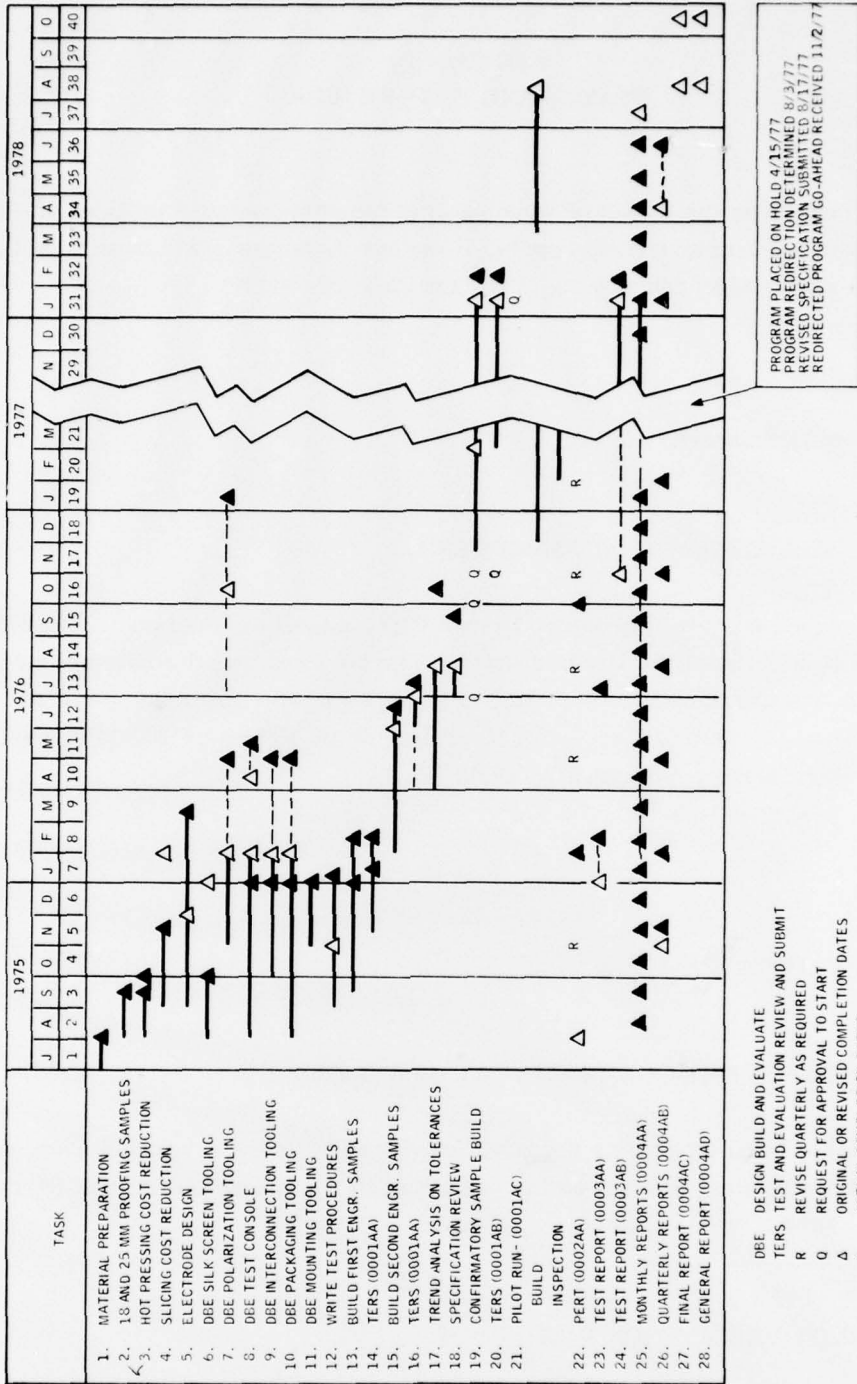
Work completed previously

TASK 24 - TEST REPORT CONFIRMATORY SAMPLES

The data in Table I and other data reported previously<sup>(7)</sup> were submitted February 8, 1978 along with a request to start on the pilot production run of 150 18 mm PETs on February 20, 1978.

TASK 21 - PILOT PRODUCTION RUN

Approval of the confirmatory samples and approval to start the pilot production run of 150 - 18 mm PETs was received March 22, 1978. The status of each operation as of June 14, 1978 is given in Table II.



PROGRAM PLACED ON HOLD 4/15/77  
 PROGRAM REDIRECTION OF TERMINED 8/3/77  
 REVISED SPECIFICATION SUBMITTED 8/17/77  
 REDIRECTED PROGRAM GO-AHEAD RECEIVED 11/2/77

Figure 1. Program Status Against Schedule

Table I. 18 mm Piezoelectric Transformer, Confirmatory Samples, Second Submittal Data

C. Group III Life Test												
	S/N	Resonant Frequency	Efficiency %	Step-Up V <sub>12</sub>	Step-Up V <sub>3</sub>	Capacitance			Dissipation			
						Input (nf)	V <sub>12</sub> <sup>2</sup> (pf)	V <sub>3</sub> (pf)	Input %	V <sub>12</sub> %	V <sub>3</sub> %	
Post Thermal Shock 1/4/78	42	31.771	38.2	92.0	136.0	14.510	6.0	5.5	1.46	-	-	
	44	32.108	42.0	90.8	138.0	13.242	6.0	5.4	.83	-	-	
	48	32.011	42.7	100.4	160.8	14.070	6.4	5.5	1.13	-	-	
	49	32.277	46.0	100.8	159.2	13.022	5.7	5.0	.78	-	-	
	50(1)	32.424	48.1	112.0	174.8	13.445	6.4	5.6	.62	-	-	
	54(1)	32.232	44.9	107.6	167.6	13.856	6.0	5.8	.75	-	-	
	56(1)	32.174	45.3	95.2	141.6	13.358	6.0	5.5	.80	-	-	
	57(1)	32.308	48.1	102.8	153.6	12.667	7.0	5.8	.75	-	-	
	74	32.352	38.9	91.6	144.4	13.997	5.3	5.1	.81	-	-	
	$\bar{X}$	32.184	43.8	99.2	152.8	13.574	6.1	5.5	.88	-	-	
	During Life (96 Hours) 1/7/78	42	31.717	49.0	89.6	132.0						
		44	32.076	40.0	88.0	133.6						
		48	31.949	39.6	94.4	150.8						
		49	32.279	45.2	100.0	156.8						
50		32.390	45.7	106.0	164.0							
54		32.130	40.3	96.0	150.0							
56		31.981	40.1	84.8	130.1							
57		32.272	45.4	97.6	145.6							
74		32.085	37.7	86.8	131.2							
$\bar{X}$		32.098	42.6	93.7	143.8							
During Life (240 Hours) 1/16/78		42	31.715	36.0	88.0	130.4						
		44	32.120	40.0	90.0	136.0						
		48	32.033	40.3	97.2	154.8						
		49	32.289	43.4	98.8	154.4						
	50	32.198	42.1	97.2	150.8							
	54	32.265	42.4	104.4	161.2							
	56	32.129	41.9	90.0	132.0							
	57	32.313	44.3	98.0	145.2							
	74	32.204	36.7	88.0	138.0							
	$\bar{X}$	32.141	40.8	94.6	144.7							
	Post Life (500 Hours) 1/26/78	42	31.869	39.6	94.8	138.8	14.307	6.0	5.5	1.22	-	-
		44	32.140	43.0	93.2	142.0	13.189	6.0	6.0	.77	-	-
		48	32.034	48.1	103.2	164.0	13.857	6.0	5.5	.97	-	-
		49	32.268	46.7	102.0	159.2	12.893	5.7	5.7	.65	-	-
50		32.446	48.9	113.2	175.6	13.397	5.5	6.0	.58	-	-	
54		32.312	47.2	111.2	172.0	13.694	5.3	6.0	.69	-	-	
56		32.218	45.5	95.2	140.8	13.747	6.0	6.0	.73	-	-	
57		32.351	48.8	103.6	154.8	12.655	5.8	6.0	.67	-	-	
74		32.221	40.9	91.6	144.8	14.143	5.5	5.0	.84	-	-	
$\bar{X}$		32.206	44.3	99.6	152.5	13.486	5.8	5.7	.79	-	-	

Yield = 9/9

(1) First submittal samples resubmitted with no rework.

Table II. Pilot Production

No.	Operation Description	Yield (%)	Completion Date	Time Required (hours)
010	Press K-9 Slugs	100	3/28	3.0
020	Hot Press Slugs	100	4/5	3.0
030	Grind Slugs	100	4/6	5.0
040	Core Drill Slugs	100	4/7	8.5
050	Hone Slugs	75	4/12	11.0
060	OD Grind Slugs	100	4/15	4.5
070	Mount and Slice	83	5/3	13.0
080	Clean Elements	99	5/8	3.0
090	Insp. Elements	91	5/9	1.0
100	Silver Elements	99	5/11	11.0
110	Silver Fire	95	5/12	4.0
120	Polarize	92	5/24	24.2
130	Polarity Check	100	5/25	1.0
140A	Top Case Prep	100	6/19	25.0
140B	Base Case Prep	100	6/2	13.5
150	Top Case Assembly	To be completed		
160	Electrical Check			
170	Final Assembly			



SECTION IV  
CONCLUSIONS

Assembly of the 150 pilot production run 18mm PETs has progressed satisfactorily. We expect to complete the assembly in early July and complete testing and submission by August 7, 1978.

SECTION V  
RECOMMENDATIONS

We are continuing to construct the pilot lot of 18mm PETs and expect to submit these on August 7, 1978.

SECTION VI  
REPORTS

During this period an abstract for a paper on piezoelectric transformer design has been submitted to the American Ceramic Society for presentation at the Electronics Division Fall meeting in Dallas, Texas, September 17-20, 1978. This meeting is also being conducted in conjunction with the IEEE Committee on Ferroelectricity. The authors, title and abstract of this paper are given below.

**Title:** Relationship of Piezoelectric Properties to High Voltage Transformer Performance

**Authors:** W. B. Harrison and U. Bonne.

**Abstract:** The influence of various changes in piezoelectric material parameters on the high voltage step-up, efficiency and applied electrical load behavior of piezoelectric transformers is reviewed. This information is based on a well established math model which is described which can predict transformer performance.

SECTION VII  
IDENTIFICATION OF PERSONNEL

During this report period of this program, the following personnel worked the indicated hours in their area of responsibility. No new professional persons, whose backgrounds have not been given previously, <sup>(1)</sup> <sup>(2)</sup> were used.

Individual	Responsibility	Hours
W. B. Harrison*	Program Manager	10
W. H. Kammeyer*	Production Engineer	20
L. F. Hiltner*	Quality Engineer	24
M. P. Murphy	Ceramic Technician	78
M. R. Sandberg	Ceramic Technician	14.5
	Ceramic Manufacturing	238.6
R. Ripley	Insp. PET Testing	38

\* Backgrounds given in First and Second Quarterly Reports

(1) First Quarterly Progress Report, page 1

(2) Second Quarterly Progress Report, page 2

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