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NONDESTRUCTIVE TESTING  
INFORMATION ANALYSIS CENTER

FY 1986 ANNUAL REPORT

Southwest Research Institute  
San Antonio, Texas 78284

Contract No. DLA900-84-C-0910  
SwRI Project 17-7958

Prepared for

Office of the Undersecretary of Defense  
Research and Engineering  
Washington, D.C. 20301

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October 1986

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## EXECUTIVE SUMMARY

The Nondestructive Testing Information Analysis Center (NTIAC) is one of the technical Information Analysis Centers (IACs) chartered and sponsored by the Department of Defense (DoD). The objective of the Centers is to increase the productivity of scientists, engineers and technicians engaged in scientific and engineering programs for the DoD. The NTIAC is responsible for the collection, review, analysis, appraisal, and evaluation of available scientific and technical information and data on nondestructive testing, evaluation, and inspection technology. The resources and capabilities of NTIAC, a full-service IAC, are also available to the technical community at large through an extensive program of products and services.

This report on Contract No. DLA900-84-C-0910 covers the program activities for FY86 from 1 October 1985 to 30 September 1986. Operating statistics and contract status reports are provided for this period, as well as for the 4th Quarter of FY86, 1 July 1986 to 30 September 1986. During FY86, direct income from the sale of products and services was \$12,848; income from special tasks and related activity was \$1,245,691. This income may be compared with basic funding for FY86 of \$285,000 which represents a budget reduction of 29% from the contracted amount of \$400,000.

The NTIAC bibliographic data base now stands at 32,178 documents with 2,659 documents being added during FY86. A total of 12,389 records appeared on remote terminal displays of various user categories with 4,185 of these records ordered off-line from DTIC. During FY86, NTIAC responded to 114 technical and bibliographic inquiries and 46 general inquiries. Publications completed and disseminated during the reporting period include the Proceedings of the 15th NDE Symposium. Two State-of-the-Art Reports are in preparation on Neutron Radiography and Digital Signal Processing for NDE. Progress has been slowed on these reports because of the FY86 budget reduction. A total of 402 NTIAC publications were sold during FY86.

A new updated NTIAC User's Guide was prepared and distributed. The updated User's Guide provides general information on NTIAC and available products/services and includes NTIAC points of contact, descriptions of inquiry services and a list of publications. A TRIAC Conference, jointly organized by NTIAC in collaboration with MMCIAC and MCIC, on Nondestructive Testing and Evaluation of Advanced Materials and Composites was held at the Air Force Academy in Colorado Springs during August 1986. Approximately 220 persons attended 7 sessions in which 31 presentations were made on various topics including new NDE techniques, mechanical properties, failure mechanisms, and other NDE related areas. A Conference Proceedings will be published early in FY87. In April 1986, a presentation based on a Review and Analysis of Foreign NDT Technology was made at the Structures and Materials Intelligence Seminar in Charlottesville, VA. The presentation included a review of available literature and an evaluation of the relative NDE strengths and weaknesses in various countries.

Sixteen Special Tasks were initiated or expanded during FY86 and six Tasks were completed.

Future plans will depend on the final outcome of the FY87 budget. A budget reduction of 25-30% will require scale-back of NTIAC activities, including data base input, technical publications, and current awareness efforts. It is anticipated that the two State-of-the-Art Reports currently in preparation will be completed and published. At least one new SOAR will be initiated. The 16th NDE Symposium will be held in San Antonio in April and a proceedings published. It is anticipated that a broad Special Task program for various DoD agencies will continue to expand.

## I. INTRODUCTION

### A. Background

From its establishment in 1961, through 1975, the Nondestructive Testing Information Analysis Center (NTIAC) was operated by the U.S. Army Materials and Mechanics Research Center, Watertown, Massachusetts. In February 1974, the Department of Defense supplemented the capabilities of NTIAC through a contractor operated support function designated as the Nondestructive Testing Data Support Center (NTDSC). AMMRC continued, however, to bear responsibility as the officially designated DoD information analysis center in the field of nondestructive testing. Accordingly, AMMRC was charged to provide the interface with the NDT community for services of both NTIAC and NTDSC. During the period from February 1974 to January 1976, AMMRC worked closely with NTDSC to develop the latter's capability to function independently as a full-service information analysis center of technical excellence. On January 6, 1976, by amendment of contract DSA900-74-C-5268, the Department of Defense transferred to Southwest Research Institute full responsibility for operation of NTIAC and discontinued the Nondestructive Testing Data Support Center as a separate function. Although technical monitorship was initially provided by AMMRC to the fully contractor operated NTIAC, the contracting officer's technical representative responsible for technically monitoring NTIAC activities is now the Office of the Undersecretary of Defense, Research and Engineering.

### B. Objectives and Scope

The NTIAC is one of a family of technical information analysis centers sponsored by the DoD and administered and funded by the Defense Logistics Agency (DLA) and the Defense Technical Information Center (DTIC). As with other IACs, the broad mission of NTIAC is to increase the productivity of scientists, engineers and technicians engaged in scientific and engineering programs for the Department of Defense. The NTIAC also renders service to other U.S. Government agencies and their contractors, and to the extent practical, without impairment of services to the foregoing users, to the private sector (consistent with security and other limitations on NTIAC information). NTIAC functions to collect, review, analyze, appraise, summarize and disseminate pertinent and timely literature on the processes, techniques, and associated technologies within the scope of NTIAC's competence and concern. The objectives of NTIAC are achieved by:

1. Establishing and continuously maintaining a comprehensive, up-to-date, authoritative technical information base in the field of nondestructive testing.
2. Responding to inquiries for technical or bibliographic advice and assistance from government agencies, contractors, suppliers, and the public sector.
3. Publishing a current awareness periodical (the NTIAC Newsletter) covering nondestructive testing and evaluation technology on a variety of subjects.
4. Responding to the needs of the user community by preparing, publishing and marketing timely and authoritative state-of-the-art reports, critical reviews, technology assessments, databooks and handbooks.

5. Conducting special tasks and studies for DoD agencies and other departments of the Federal Government.

The technical scope of NTIAC is that of the entire field of nondestructive testing (NDT), nondestructive evaluation (NDE), and nondestructive inspection (NDI) - the full range of methods and techniques whereby a material, component or entire system can be so characterized as to reliably predict its performance under a prescribed service regime. NTIAC is also concerned with the economic aspects of the NDT/NDE/NDI industry, economic considerations with respect to selection of techniques and processes, and industry trends in applying current NDT/NDE/NDI technologies to research and development, production, maintenance, safety monitoring, and failure prevention of in-service material.

### C. Organization of NTIAC

NTIAC is formally assigned to the Division of Nondestructive Evaluation Science and Technology at Southwest Research Institute (SwRI) with inter-divisional effort closely coordinated through the Senior Vice President for Planning and Program Development. An organization chart for NTIAC is shown in Figure 1. Direct management of NTIAC is vested in an NTIAC Director who is responsible for operating NTIAC in accordance with the terms of the contract, for leading the development of NTIAC, for direct supervision of the NTIAC staff, for surveillance and review of the literature, for overall coordination of NTIAC products and services, and for interaction with the COTR, the Tri-Service Steering Committee, and the IAC program manager.

In addition to the NTIAC Director, other staff positions include:

- Manager of the Information Support System - responsible for indexing of literature; for input to, and maintenance of, the NTIAC bibliographic file at DTIC; for performing literature searches; for retrieval of bibliographic information; and for coordinating responses to technical and bibliographic inquiries by utilizing the extensive pool of SwRI professional staff available to the ISS for such inquiries.
- Administrative Coordinator - serves in an overall clerical capacity as well as assisting in the indexing of literature into the data base and preparing inquiry responses.
- Technical Publications Specialist - in charge of editing and producing the NTIAC Newsletter as well as providing technical editing expertise in publication of NTIAC products.
- Data Base Clerk - assists in acquiring literature and inputting information to the NTIAC bibliographic data base at DTIC.

As illustrated in Figure 1, the SwRI senior professional staff with expertise in NDE is available to supply assistance in all functions of NTIAC. Approximately 200 professional staff constitute the resource of knowledge and expertise which can directly support NTIAC in the preparation of technical publications, maintenance of the literature data base, and performance of special tasks.

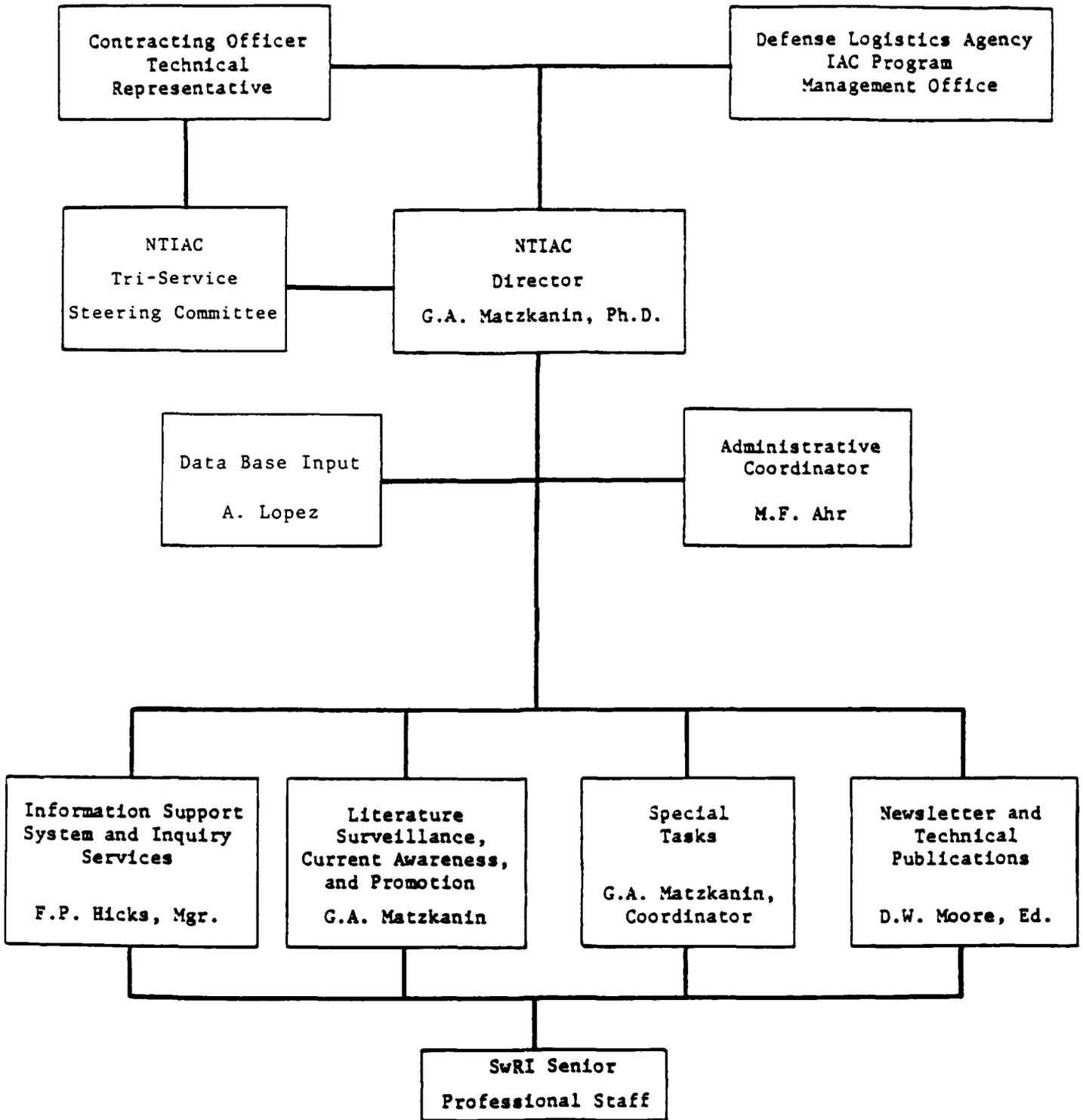


FIGURE 1. NTIAC ORGANIZATION

#### D. Report Format

This report summarizes NTIAC activities for fiscal year 1986 from 1 October 1985 through 30 September 1986. Operational and statistical tables also include information for the fourth quarter of FY86 (1 July 1986 - 30 September 1986).

### II. OPERATIONAL REPORT

#### A. Goals and Objectives

As indicated previously in Section I.B., the primary objective of NTIAC is to collect, review, analyze, appraise, summarize and disseminate timely and useful information on the processes, techniques and technologies associated with NDT/NDE/NDI in order to increase the productivity of scientists, engineers and technicians engaged in scientific and engineering programs, in particular, those of the Department of Defense. Specific goals include the following:

1. Maintain continuous surveillance of the NDT literature in the form of books, journals, magazines and other publications. In addition, assimilate NDT information through attendance at relevant meetings and conferences and personal contact with the NDT community.
2. Maintain and continuously expand the NDT bibliographic literature base.
3. Maintain and continuously update a mailing list of the NDT user community to serve as the basis for distribution of current awareness periodicals and other technical publications.
4. Prepare, publish and distribute a periodic current awareness newsletter providing recent, relevant and useful information on NDT activities.
5. Prepare, publish and distribute technical publications, in particular, including two state-of-the-art reports, critical reviews or technology assessments per year and one handbook, supplement or revision per year. Publish and distribute other publications such as special bibliographies and conference proceedings as manageable within the scope of available funding.
6. Provide a technical and bibliographic inquiry service to the NDT user community utilizing the resources of the bibliographic data base and SwRI.
7. Propose and perform special tasks and studies for the various DoD agencies in response to specific NDT related needs of the agencies involved.

Progress toward these goals during FY86 will be described in the following sections.

## B. Summary Activities

Significant activities and accomplishments by NTIAC during FY86 are summarized in the executive summary appearing in the front of this report.

## C. Acquisition and Input of Information

The Information Support System (ISS) continues the surveillance, indexing, and input of NDE literature. During FY86, 2,850 documents were reviewed with 2,659 being added to the data base which now totals 32,178. The file status is summarized in Table 1.

Other DTIC users continue to call for assistance in searching the NTIAC file and significant utilization of the NTIAC data base continues. A summary of this usage for the reporting period is presented in Table 2.

Enhancements or changes to the system during FY86 are as follows:

- a. Effective 22 November 1985, the Search Tech Report command automatically defaults to the most recent 10 years of data. This is the latest 10 years of AD-number ranges, not report date. This also applies when searching for an NT-number. In order to search the entire file, (ALL) has to be inserted in one of the search levels.
- b. DTIC is developing a Program Planning Data Base. Extensive test time is required and, consequently, some reallocation of computer and personal resources. Two alternatives were presented for user's consideration:

Alternative 1 was to delay DROLS activation from 0800 to 0900.

Alternative 2 was to maintain present hours of operation, thus delaying system improvement.

NTIAC prefers Alternative 1, and DTIC was notified of this preference.

- c. Six new retrieval commands were implemented in March. These commands combine the search and recall questions.
- d. Due to a software problem, NTIAC could not input any data to the DTIC computer between May 20 and July 3. No data were taken from NTIAC's storage between those dates. As the program operated, flags were removed but no data were transferred. DTIC programmers were informed of the problem and it was suspected that the problem occurred as a result of changing NTIAC's site ID. On July 3 the problem was corrected and it was reported that the cause of the problem was a code at DTIC incorrectly showing NTIAC as a dial-up site. Since NTIAC is a dedicated site, constraints imposed by the code for dial-up sites prevented removal of NTIAC's data.

TABLE 1  
FY86 SUMMARY OF ADDITIONS TO NTIAC DATA BASE

	<u>Records Unique to NTIAC</u>	<u>Records Shared with DTIC</u>	<u>Total</u>
1st Quarter	364	85	449
2nd Quarter	527	66	593
3rd Quarter	668	55	723
4th Quarter	<u>833</u>	<u>61</u>	<u>894</u>
<b>FY86 Totals</b>	2,392	267	2,659
<b>Cumulative Totals</b>	27,399	4,779	32,178

TABLE 2  
 FY86 SUMMARY OF NTIAC FILE USAGE BY OTHERS

User Category	1st Quarter		2nd Quarter		3rd Quarter		*4th Quarter		FY86 Totals	
	<u>D</u> <sup>(a)</sup>	<u>O</u> <sup>(b)</sup>	<u>D</u>	<u>O</u>	<u>D</u>	<u>O</u>	<u>D</u>	<u>O</u>	<u>D</u>	<u>O</u>
Army	533	27	542	217	613	29	305	24	1,993	297
Navy	163	19	312	63	426	40	320	56	1,221	178
Air Force	88	12	293	19	358	40	148	22	887	93
Other Gov't.	61	83	148	10	116	345	53	87	378	525
Contractors	858	898	1,166	566	1,368	635	1,014	322	4,406	2,421
DTIC	466	15	584	21	1,049	42	524	0	2,623	78
Other IACs	<u>189</u>	<u>237</u>	<u>388</u>	<u>105</u>	<u>236</u>	<u>65</u>	<u>68</u>	<u>186</u>	<u>881</u>	<u>593</u>
<b>FY86 TOTALS</b>	2,358	1,291	3,433	1,001	4,166	1,196	2,432	697	12,389	4,185

\*This report is for August and September. The report for July was not received from DTIC.

(a) Displays - any records displayed on a remote terminal

(b) Orders - records appearing on a bibliography ordered off-line from DTIC

- e. New computer terminal equipment for access to the DTIC system was provided by DTIC and installed at the NTIAC location on July 22, 1986. This is a TEMPEST-configured Sperry Personal Computer system with a Model 0425 printer. Included was Sperry Terminal Emulation Package (STEP) software along with installation procedures. Also provided was a DTIC User's Terminal Emulation Package for connecting to DROLS. After initial installation, no problems have been experienced with this new equipment.
- f. Posting to the Master File is still taking much time, with as long as 4 weeks between TAB closings and Master File loadings. For years DTIC had a schedule of closing the TAB on alternate Thursdays with the Master File being loaded on the following Wednesday. DTIC's present practice of delaying posting of NTIAC's input to the Master File is causing problems for NTIAC, particularly when literature searches are performed for customers, and often as much as 4 weeks data is unsearchable. DTIC has been informed of the problems caused by this present practice, and it is anticipated that DTIC will remedy this situation in the near future.

#### D. Inquiry Activities

During FY86, NTIAC responded to a total of 160 inquiries with the breakdown as indicated in Table 3. Of the inquiries responded to, 10 resulted in service charges while the remaining were answered without charge. The responses provided without charge were either of a general nature or represented minimal effort (less than an hour) of response time. Ninety-five of the total number of inquiries were from registered DTIC users while thirteen foreign inquiries were handled. A listing of NTIAC inquiry services during the 4th quarter of FY86 is provided in Appendix A.

#### E. Technical Publications

Two state-of-the-art reports (SOARs) are in preparation. One is on Neutron Radiography and the other is on Digital Signal Processing and Pattern Recognition for NDE (outlines are provided in Appendix B). Since Digital Signal Processing is a relatively new field for most NDT people, as much tutorial material as possible is being included in this SOAR; each chapter is being structured to stand alone. The final chapter will emphasize the three areas where this technology is primarily being utilized, namely, ultrasonics, electromagnetic systems, and acoustic emission. Drafts have been completed of several chapters of each of these two SOARs. Progress has been slowed due to the FY86 budget reduction and the delay in receiving FY87 funds; however, it is anticipated that these two SOARs will be completed in FY87.

Publication of the 15th NDE Symposium Proceedings was completed and distribution is in progress. Copies of the Proceedings title page and Table of Contents are included in Appendix B.

A total of 402 publications were sold during FY86 including 29 foreign orders. A tabulation of publication sales is provided in Table 4.

TABLE 3  
 FY86 SUMMARY OF INQUIRY SERVICES

	<u>Technical Inquiries</u>	<u>Bibliographic Inquiries</u>	<u>General</u>	<u>Total</u>	<u>No. Charged</u>	<u>DTIC Users</u>	<u>Foreign</u>
1st Quarter	8	22	22	52	4	28	7
2nd Quarter	19	11	10	40	--	25	3
3rd Quarter	21	13	8	42	4	27	1
4th Quarter	<u>10</u>	<u>10</u>	<u>6</u>	<u>26</u>	<u>2</u>	<u>15</u>	<u>2</u>
<b>FY86 TOTALS</b>	58	56	46	160	10	95	13

TABLE 4

## FY86 PUBLICATION SALES

## DOMESTIC SALES

Publication Number	Title	Number Sold				FY86 Total
		First Quarter	Second Quarter	Third Quarter	Fourth Quarter	
NTIAC-76-1	Electromagnetic Acoustic Transducers	2	2	2	--	6
NTIAC-76-2	Proceedings of a Workshop on NDE of Residual Stress	--	--	1	--	1
NTIAC-77-1	Advanced Ultrasonic Testing Systems	13	22	19	--	54
NTIAC-78-1	Automated Radiography	4	2	1	--	7
NTIAC-78-2	Liquid Crystals for NDE	--	1	2	1	4
NTIAC-79-1	NTIAC Handbook	--	2	--	--	2
NTIAC-79-2	The Barkhausen Effect and Its Application to NDE	--	--	2	--	2
NTIAC-80-1	NDE Applications of Magnetic Leakage Field Methods	21	2	14	--	37
NTIAC-80-2	Technology Assessment of Optical Methods for NDE, Part I	--	11	14	--	25
NTIAC-80-3	Economics of NDE, A Bibliography	--	--	--	--	0
NTIAC-81-1	Technology Assessment of Optical Methods for NDE, Part II	--	--	3	1	4
NTIAC-81-2	Life Predictions/Failure Prob. Utilizing NDE & Fracture Mech.	--	--	--	--	0
NTIAC-82-1	NDE of Fiber Reinforced Composites, Vol. I	5	2	3	--	10
NTIAC-82-2	Acoustic Emission, A Bibliography	1	--	--	--	1
NTIAC-82-3	Handbook Revision/Supp. No. 1	1	1	--	--	2
NTIAC-83-1	Electromagnetic-Acoustic Transducers, A Bibliography	1	2	2	--	5
NTIAC-84-1	Ultrasonic Transducers	5	4	5	2	16
NTIAC-84-2	Automated Radiography, 2nd Ed.	20	7	2	4	33
NTIAC-85-1	Depot Maintenance Handbook	8	2	1	2	13
NTIAC-85-2	ACE/AACE Inspection and Analysis Handbook	8	2	1	2	13
	15th Symposium on NDE, Proceedings	--	--	113	6	119
	14th Symposium on NDE, Proceedings	3	2	5	1	11
	13th Symposium on NDE, Proceedings	1	--	3	--	4
	2-12th Symposia on NDE, Proceedings	--	--	3	1	4
<b>FY86 TOTAL DOMESTIC SALES</b>		<b>93</b>	<b>64</b>	<b>196</b>	<b>20</b>	<b>373</b>

TABLE 4 (Cont'd)  
FY86 PUBLICATION SALES

FOREIGN SALES		Number Sold				
Publication Number	Title	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	FY86 Total
NTIAC-76-1	Electromagnetic Acoustic Transducers	1	--	1	--	2
NTIAC-76-2	Proceedings of a Workshop on NDE of Residual Stress	--	--	--	1	1
NTIAC-79-2	The Barkhausen Effect and Its Application to NDE	--	1	--	--	1
NTIAC-81-2	Life Predictions/Failure Prob. Utilizing NDE & Fracture Mech.	1	--	1	--	2
NTIAC-82-1	NDE of Fiber Reinforced Composites, Vol. I	--	1	--	--	1
NTIAC-82-2	Acoustic Emission, A Bibliography	--	1	--	--	1
NTIAC-83-1	Electromagnetic-Acoustic Transducers, A Bibliography	1	--	--	--	1
NTIAC-84-1	Ultrasonic Transducers	--	1	--	--	1
NTIAC-84-2	Automated Radiography, 2nd Ed.	--	1	1	1	3
	15th Symposium on NDE, Proceedings	--	--	10	2	12
	14th Symposium on NDE, Proceedings	1	1	--	--	2
	13th Symposium on NDE, Proceedings	--	1	--	--	1
	12th Symposium on NDE, Proceedings	--	1	--	--	1
<b>FY86 TOTAL FOREIGN SALES</b>		<b>4</b>	<b>8</b>	<b>13</b>	<b>4</b>	<b>29</b>

#### F. Current Awareness and Promotion

Because of the reduction in NTIAC FY86 budget and the unavailability of 4th Quarter FY86 funds, only two issues of the NTIAC Newsletter were published and distributed during FY86; when funding is restored in FY87, efforts will be made to increase the frequency of publication. The principal article topics are given below:

<u>Issue</u>	<u>Topic</u>
December 1985	Integrated Blade Inspection System Components Demonstrated at GE Plant
March 1986	Electric Current Perturbation Finds Flaws in Non-Magnetic Super Alloys

A new, updated NTIAC User's Guide was prepared during the past fiscal year. The updated User's Guide is an entirely different format from the previous version and provides general information on NTIAC and available products and services. Included are NTIAC points of contact (names and telephone numbers), objective and scope of NTIAC, descriptions of bibliographic and technical inquiry services, special services available, a complete price list of NTIAC publications, information on how to obtain NTIAC's products and services, and forms for ordering publications. The cover and Table of Contents of the User's Guide is included in Appendix C.

Considerable effort was expended during the past fiscal year in collaborating with MCIC and MMCIAC to organize the Conference on Nondestructive Testing and Evaluation of Advanced Materials and Composites which was held August 19-21, 1986 at the Air Force Academy in Colorado Springs. The Conference, which was attended by over 220 persons, included presentations by representatives from industry, academia, DoD, and other government agencies on topics including mechanical properties and behavior, material characterization, fracture mechanics and failure mechanisms, critical properties and defects, special applications, and new and emerging NDE methods. The Conference was opened with welcoming remarks by Lt. Gen. Winifield W. Scott, Jr., Superintendent of the Air Force Academy. In all, the technical program consisted of 31 presentations including a keynote address by Prof. R. Byron Pipes, a DoD overview by Mr. Jerome Persh, overviews by TTCP representatives from Australia and the United Kingdom, and a luncheon address by Dr. William Oran of NASA. A copy of the Conference program is included in Appendix C. Efforts are currently underway to complete collection of manuscripts so that a proceedings can be published early in FY87.

Current awareness, information, and promotion meetings and conferences at which NTIAC was represented during FY86 are listed in Table 5. The World Conference on NDT (WCNDT) is one of the major international conferences and exhibitions on NDT. Held every three years, the conference in Las Vegas was the first time in thirty years the WCNDT was held in the USA. Total registration for the WCNDT was about 2,900 including representatives from 35 countries. Included in the exhibition were 246 exhibits by about 150 different companies or organizations. NTIAC participated in a Southwest Research Institute exhibit and assisted in manning the booth. Responses were provided to a number of inquiries concerning NTIAC services, state-of-the-art reports and the Newsletter. Almost 200 updated NTIAC User's Guides and 65 IAC Directories were distributed at the exhibition. The technical program included over 350 papers presented either

TABLE 5  
FY86 CURRENT AWARENESS AND PROMOTIONAL MEETINGS

<u>Meeting</u>	<u>Date and Location</u>
World Conference on NDT	November 3-9, 1985 Las Vegas, NV
Testing Technology of Metal Matrix Composites	November 17-21, 1985 Nashville, TN
Sensors for Automated Material Processing	December 16-17, 1985 Santa Barbara, CA
ASTM E7 Committee on NDT	January 20-23, 1986 Ft. Lauderdale, FL
DoD Composite NDE Technology Enhancement Workshop	February 25-27, 1986 New Orleans, LA
ASNT Spring Conference	March 10-12, 1986 Tulsa, OK
Structures and Materials Intelligence Seminar	April 22, 1986 Charlottesville, VA
2nd International Symposium on the Nondestructive Characterization of Materials	July 21-23, 1986 Montreal, Canada
Review of Progress in Quantitative NDE	August 3-8, 1986 La Jolla, CA
Nondestructive Testing and Evaluation of Advanced Materials and Composites	August 19-21, 1986 Colorado Springs, CO
Air Transport Association NDT Forum	August 26-28, 1986 Denver, Co
ASNT Fall Conference and Exhibition	September 29-October 3, 1986 New Orleans, LA

orally or in poster sessions. NTIAC Director, Dr. George A. Matzkanin, gave a presentation on "Application of Spatially Localized NMR to Nondestructive Evaluation."

The Composite NDE Technology Enhancement Workshop had the objective of providing input for the development of a five year (1989-1994) DoD Composite NDE Program Plan. Featured were government/industry composite NDE state-of-the-art presentations and panel sessions/workshops covering a variety of composite NDE areas. NTIAC Director, Dr. George A. Matzkanin, participated in the Workshop and gave a presentation on "NDE of Composites Using Nuclear Magnetic Resonance."

NTIAC Director, Dr. George A. Matzkanin, presented a Review and Analysis of Foreign Nondestructive Testing Technology at the Structures and Materials intelligence Seminar in Charlottesville, Virginia on April 22, 1986. This presentation, made at the request of Mr. Jerome Persh, was intended to provide an overview to the intelligence community of foreign NDT technology and to summarize information resources on foreign technology available to them. The presentation provided general information on NDT, testing methods, and NTIAC. The focus of the presentation was an analysis of foreign NDT technology based on a review of available literature. Statistics were presented on the number of documents from various countries dealing with NDT, and bar charts were used to illustrate the NDE method and NDE application emphasis for various countries based on a review of the literature. An evaluation was presented of the relative NDE strengths and weaknesses for various countries and areas identified in which the U.S. is behind and ahead, respectively, of the rest of the world. The title page, outline, and summary of the presentation are included in Appendix C.

The 2nd International Symposium on the Nondestructive Characterization of Materials focused on the science and technology of nondestructive measurements applied to materials characterization and processing. The Symposium consisted of 114 technical presentations in various areas of material characterization and was attended by approximately 200 persons. NTIAC Director, Dr. George A. Matzkanin, gave a presentation on "Nondestructive Characterization of Kevlar Composites Using Pulsed NMR," and distributed copies of the program for the Colorado Springs Conference on NDE of Advanced Materials and Composites. Following the Symposium, Dr. Matzkanin participated in a tour of the Canadian Industrial Materials Research Institute with emphasis on current NDE activities which include thermography, optical sensors, ultrasonic characterization of metals and polymers, magnetic characterization of steels, and laser-ultrasonics.

NTIAC participated in the Southwest Research Institute exhibit at the 1986 ASNT Fall Conference and Exhibition in New Orleans. Responses were provided to a number of inquiries concerning NTIAC services and updated NTIAC User's Guides were distributed.

#### G. Contract Status Reports

Statistical summaries of NTIAC's activities are attached as Exhibits I, II and III for the 4th Quarter FY86, cumulative FY86 and the contract cumulative. Contract status highlights are as follows:

1. 4th Quarter FY86 - Total man-hours expended are 4,031; total costs incurred are \$393,460; and total income earned is \$938,232.

AREA TITLE	OUTPUT UNITS PRODUCED	MANHOURS EXPENDED			COSTS INCURRED			INCOME
		PRO FES SIONAL	NON PRO FES SIONAL	TOTAL	DI R E C T	IND I R E C T	TOTAL	
		NAME OF INFORMATION ANALYSIS CENTER		QUARTER ENDING		CUMULATIVE THROUGH		
<b>INFORMATION ANALYSIS CENTER CONTRACT STATUS REPORT</b>		Testing Information Analysis Center Nondestructive		30 September 1986		7/1/86-9/30/86		
1. ACQUISITION AND INPUT OF SOURCE INFORMATION		179	554	733	9,840	13,693	23,533	
a. DOCUMENTS ACQUIRED	950							
b. DOCUMENTS REVIEWED	950							
c. DOCUMENTS CATALOGED	894							
2. TECHNICAL INQUIRY RESPONSES PROVIDED	10	22	--	22	489	680	1,169	11
3. BIBLIOGRAPHIC INQUIRY RESPONSES PROVIDED (includes general information)	16	29	--	29	644	897	1,541	1,046
4. HANDBOOKS/ DATA BOOKS COMPLETED		--	--	--	--	--	--	--
a. NEW CHAPTERS/PAGES COMPLETED	--							
b. REVISED CHAPTERS/PAGES COMPLETED	--							
c. DATA SETS COMPILED	--							
5. STATE-OF-THE-ART STUDIES COMPLETED	.3	1	2	3	4,875	477	5,352	691
6. CRITICAL REVIEWS AND/OR TECHNOLOGY ASSESSMENTS COMPLETED (includes Conf. Proc.)	--	--	--	--	--	537	537	430
7. CURRENT AWARENESS AND PROMOTION EFFORTS		71	79	150	7,267	5,228	12,495	3,660
a. NUMBER NEWSLETTERS AND OR ANNOUNCEMENTS PUBLISHED	--							
b. NUMBER MEETINGS CONFERENCES ETC SUPPORTED	5							
8. OTHER (Special Studies/Tasks)	4	2,043	672	2,715	230,180	103,480	333,660	932,394
9. MANAGEMENT AND SUPPORT		106	273	379	6,627	8,546	15,173	
10. UNASSIGNABLE INDIRECT COSTS		--	--	--	--	--	--	
11. TOTAL		2,451	1,580	4,031	259,922	133,538	393,460	938,232



ASSESSMENTS COMPLETED (includes Conf. Proc.)	4	117	69	186	3,979	5,067	9,046	4,554
7. CURRENT AWARENESS AND PROMOTION EFFORTS		3,435	1,133	4,568	166,977	159,478	326,455	32,822
8. NUMBER NEWSLETTERS AND OR ANNOUNCEMENTS PUBLISHED	11							
9. NUMBER MEETINGS CONFERENCES ETC SUPPORTED	33							
10. OTHER (Special Studies/Tasks)	16	9,975	2,888	12,863	1,235,345	522,886	1,758,231	2,867,168
11. MANAGEMENT AND SUPPORT		3,099	2,249	5,348	116,503	154,682	271,185	
12. UNASSIGNABLE INDIRECT COSTS		--	--	--	--	--	--	
13. TOTAL		20,308	9,705	30,013	1,673,033	1,014,791	2,687,824	2,919,954

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- Total man-hours expended are 13,734; incurred are \$1,285,826; and total income is \$1,539.

Five - Total man-hours expended are 13,734; costs incurred are \$2,687,824; and total income is \$2,919,954.

funding, operating expenditures and income for the 7, and 8 respectively. NTIAC was informed by the 27, 1986, that due to DoD budget cuts, no fourth quarter for basic operation of the IACs and that further funding for the fourth quarter was unlikely. Thus, for FY86, NTIAC received a grant of \$400,000 (71%) for basic center operations. In July 1986 to the Contracting Officer, it was indicated that operations would continue through the fourth quarter FY86 utilizing existing funds. Some NTIAC activities would operate at a reduced level to conserve remaining funds as much as possible. In late measures, existing funds enabled basic center operations through September 30, 1986, there is an urgent need to continue NTIAC operations.

Costs were \$1,285,826 including Special Task expenditures and indirect expenditures of \$332,817.

No. DLA900-84-C-0910 was amended on August 7, 1986 with a "window" available for Special Tasks and Studies. The "window" for the basic 3-year period was increased to \$5,455,862 and the "window" for the fourth quarter was increased to \$4,175,708. The estimated total year option period was increased to \$6,265,875, and the "window" for the fourth quarter was increased to \$5,365,878. As a result of the "window" pending Special tasks were funded resulting in the fourth quarter of \$932,394 and total Special Task expenditures of \$1,245,691. Income from sales of NTIAC services was \$12,848 resulting in total income for FY86 of \$1,258,539.

NTIAC continues to be good with payments generally received within 30 days after submission of invoices. Detailed invoices and supporting expenditures by Contract Line Item Number were sent monthly to document NTIAC costs. A summary of invoices received during FY86 is presented in Table 9.

#### Studies

13 Special Tasks were initiated or expanded resulting in 10 Special Tasks completed, while proposals for 13 Special Tasks totaling \$291,867 have been submitted and are pending and completed Special Tasks are listed in Table 10. Brief summaries of funded and completed Special Tasks are presented in Appendix D.

TABLE 6  
FY86 SUMMARY OF BASIC FUNDING

<u>Mod. No.</u>	<u>Date</u>	<u>Period Funded</u>	<u>Amount</u>
33	11-18-85	1 Oct 85-31 Mar 86	\$200,000
47	05-13-86	1 Apr 86 - 17 Jun 86	<u>85,000</u>
		<b>FY86 TOTAL</b>	\$285,000
		<b>CUMULATIVE CONTRACT TOTAL</b>	\$935,000

TABLE 7  
FY86 OPERATING EXPENDITURES

<u>Period</u>	<u>NTIAC Operations (\$)</u>	<u>Special Tasks (\$)</u>	<u>Totals (\$)</u>
1st Quarter	87,757	114,361	202,118
2nd Quarter	92,111	238,543	330,654
3rd Quarter	93,149	266,445	359,594
4th Quarter	<u>59,800</u>	<u>333,660</u>	<u>393,460</u>
<b>FY86 TOTAL</b>	332,817	953,009	1,285,826

TABLE 8

## FY86 INCOME SUMMARY

Period	State-of-the Art Reports (\$)	Crit. Rev., Tech. Assess. (\$)	Handbooks, Databooks (\$)	Inquiry Services (\$)	Conference Proceedings (\$)	Total Sales (\$)	Special Tasks (\$)	Total Income (\$)
1st Quarter	970	244	--	1,096	465	2,775	130,642	133,417
2nd Quarter	1,156	245	60	35	392	1,888	112,000	113,888
3rd Quarter	1,073	636	60	40	538	2,347	70,655	73,002
4th Quarter	<u>691</u>	<u>430</u>	<u>--</u>	<u>1,057</u>	<u>3,660</u>	<u>5,838</u>	<u>932,394</u>	<u>938,232</u>
<b>FY86 TOTAL</b>	<b>3,890</b>	<b>1,555</b>	<b>120</b>	<b>2,228</b>	<b>5,055</b>	<b>12,848</b>	<b>1,245,691</b>	<b>1,258,539</b>

TABLE 9  
FY86 SUMMARY OF INVOICE PAYMENTS

Invoices		Payments	
<u>Date</u>	<u>Amount</u>	<u>Date</u>	<u>Amount</u>
10-08-85	\$ 52,193.79	10-02-85	\$ 55,679.41
11-14-85	59,907.59	10-28-85	48,515.00
12-11-85	59,498.95	11-04-85	3,678.79
		12-03-85	57,649.73
		12-13-85	2,257.86
01-09-86	73,560.38	01-03-86	57,278.91
01-24-86	61,642.40	02-17-86	135,202.78
02-25-86	62,550.62		
03-26-86	176,972.80		
04-24-86	109,096.16	03-31-86	62,550.62
05-27-86	79,462.47	04-29-86	166,709.97
06-20-86	117,280.89	06-16-86	195,331.71
		06-27-86	3,489.75
07-22-86	112,056.82	07-10-86	117,280.89
08-08-86	83,535.14	08-21-86	112,056.82
09-22-86	132,332.41	09-25-86	83,535.14
<b>FY86</b>			
<b>TOTALS</b>	\$1,180,090.42		\$1,101,217.38

Table 10

## SPECIAL TASKS FUNDED DURING FY86

<u>Mod. No.</u>	<u>Date</u>	<u>CLIN</u>	<u>Description</u>	<u>Agency</u>	<u>Amount</u>	<u>Status</u>
32	10-22-85	AV	Review and Evaluation of Army Aviation Depot NDI and Reliability Centered Maintenance	AVSCOM	\$ 80,642	Active
35	12-06-85	AR	Evaluation of Depot Maintenance Handbook	AVSCOM	50,000	Complete
37	01-14-86	AS	Nondestructive ESS for Army Aircraft Systems and Components	AVSCOM	63,000	Active
38	02-03-86	AW	Development of a Diagnostic/NDI Oriented Maintainability Prediction Standard	NAC	24,000	Complete
39	02-07-86	AV	Review and Evaluation of Army Aviation Depot NDI and Reliability Centered Maintenance (Add'l funds)	AVSCOM	25,000	Active
43	03-28-86	AX	Laser Induced Fluorescence Inspection of Urethane and Related Materials	Belvoir R&D Ctr.	49,954	Active
49	06-20-86	AP	Nondestructive Investigation of WALLEYE Pressure Probe Failures	PMTC	20,701	Active
51	07-10-86	AY	Dielectric Properties Sensor Evaluation	RADC	60,000	Active
52	07-11-86	AZ	Nondestructive Evaluation of Moisture Intrusion in Missile Components	PMTC	67,036	Active
54	08-19-86	AV	Review and Evaluation of Army Aviation Depot NDI and Reliability Centered Maintenance (Add'l funds)	AVSCOM	369,358	Active
56	09-11-86	AE	Evaluation of Space Plasma Data for Material Degradation (Add'l funds)	AFGL	51,000	Active
57	09-11-86	AV	Review and Evaluation of Army Aviation Depot NDI and Reliability Centered Maintenance (Add'l funds)	AVSCOM	25,000	Active

Table 10 (Cont'd)

## SPECIAL TASKS FUNDED DURING FY86

<u>Mod. No.</u>	<u>Date</u>	<u>CLIN</u>	<u>Description</u>	<u>Agency</u>	<u>Amount</u>	<u>Status</u>
58	09-17-86	AS	Nondestructive ESS for Army Aircraft Systems and Components - Phase II, Part 2	AVSCOM	\$ 160,000	Active
58	09-17-86	BA	Nondestructive Qualification of UH-1 Replacement Parts for Competition Enhancement	AVSCOM	100,000	Active
59	09-26-86	BB	Eddy Current Probe Performance Requirements	SAALC	60,000	Active
59	09-26-86	BC	Through-Transmission/Pulse-Echo Ultrasonic Equipment Evaluation	SAALC	40,000	Active
<b>TOTAL</b>					<u>\$1,245,691</u>	

TABLE 11  
 PENDING SPECIAL TASKS AT THE END OF FY86

<u>Submitted</u>	<u>Proposal Number</u>	<u>Description</u>	<u>Agency</u>	<u>Amount</u>
03-11-86 (Resubmittal)	02-3268A	Application of NDE to Prediction of Diesel Fuel Storage Stability	DTNSRDC	\$100,706
05-19-86	06-4121	Nondestructive Analysis of HARPOON Missile Container, Mark 607, Upper Shell Assembly	PMTc	26,578
09-02-86	06-4720	Nondestructive Evaluation (NDE) of Solid Propellant Rocket Motor Casings, Phase II	NWC	64,583
09-18-86	06-4880	Nondestructive Qualification of UH-1 Replacement Parts for Competition Enhancement - Expansion of Tasks	AVSCOM	100,000
				<hr/>
			<b>FY86 TOTAL</b>	<b>\$291,867</b>

TABLE 12  
SPECIAL TASKS COMPLETED DURING FY86

<u>CLIN</u>	<u>Description</u>	<u>Agency</u>	<u>Amount</u>
AC	Optimize HARPOON NDT and NDI Procedures, Phases IV and V	PMTC	\$179,475
AQ	NDE of Black Hawk Helicopter Rotary Wing-Head Spindle Threads Using Electric Current Perturbation	AVSCOM	15,537
AR	Evaluation of Depot Maintenance Handbook	AVSCOM	74,000
AT	Development of NDT Procedure Data Base for Evaluating Thermally Stressed Surfaces	BRL	42,300
AV	Eddy Current Probe Characterization	SA-ALC	20,000
AW	Development of a Diagnostic/NDI Oriented Maintainability Prediction Standard	NAC	24,000
			<hr/>
		<b>FY86 TOTAL</b>	<b>\$355,312</b>

#### J. Management and Support

On October 15-16, 1985, NTIAC Director, Dr. George A. Matzkanin, attended the IAC Business Meeting at the Johns Hopkins Applied Physics Lab. The meeting was well attended by IAC directors as well as DTIC and DoD representatives. Much of the discussion centered around export control of technical information and acquisition of foreign technical information. Additional topics discussed included SDI applications, IAC sponsored conferences, scientific and technical intelligence, and developments at DTIC.

In October 1985, NTIAC Information Analyst, Ms. Fran Hicks, attended the annual DTIC User's Conference in Alexandria, VA.

In December 1985, NTIAC added a new full-time person to its staff, Ms. Alice Lopez, who assists in acquisition of information, input to the data base, and general office activities.

NTIAC Director, Dr. Matzkanin, visited MMCIAC at Kaman Tempo in Santa Barbara, CA in December 1985 and MCIC at Battelle in Columbus, OH in August 1986. At both centers, operations were reviewed with the respective Directors and mutual problems discussed.

In April 1986, NTIAC was visited by Ms. Sarah Williams and Ms. Shirley Robbins, Contracting Officers for NTIAC from DESC in Dayton, OH. Meetings took place with the Contracting Officers from SwRI and the status of the NTIAC contract was discussed. Several approaches were explored to expedite contractual modifications and matters of mutual interest were discussed. Ms. Williams and Robbins were provided a tour of the NDT facilities at SwRI.

During the Conference on NDT of Advanced Materials and Composites in Colorado Springs, meetings were held with the COTR, Mr. Jerome Persh, Tri-Service Steering Committee Chairman, Dr. Al Broz, and the Directors of MMCIAC and MCIC. Much of the discussion centered on the future budget picture for the IAC's, however, possible joint activities among IAC's, such as publication of the Proceedings of the NASA Ceramics Meeting in January 1987, were also discussed.

NTIAC Information Analyst, Ms. Fran Hicks, attended the RSAG (Resource Sharing Advisory Group) Meeting at Kirtland AFB in New Mexico in August 1986.

At the 1986 Fall ASNT Meeting in New Orleans, NTIAC Director, Dr. Matzkanin, was elected to a 3-year term on the ASNT National Board of Directors. In this capacity, Dr. Matzkanin will attend ASNT business meetings and participate in policy making decisions regarding the operation of the National Society of over 9,000 members.

Professional staff contributing to NTIAC's activities during FY86 are listed in Table 13.

#### K. Information from NTIAC Users

Several comments and letters of appreciation regarding NTIAC services were received during FY86; these are included in Appendix E.

TABLE 13

PROFESSIONAL STAFF CONTRIBUTING TO SUPPORT OF  
NTIAC ACTIVITIES DURING FY86

<u>Name</u>	<u>Activity</u>
G. Matzkanin	NTIAC Director
F. Hicks	Information Analyst
M. Ahr	Office Administration
A. Lopez	Data Base Input
D. Moore	Newsletter and Technical Publication Editor
H. Kwun	Literature Surveillance
F. Iddings	State-of-the-Art Report
H. Berger (Consultant)	State-of-the-Art Report
G. P. Singh (Consultant)	State-of-the-Art Report
D. Winningham	Special Task
D. Present	Special Task
H. Gryting	Special Task
G. Burkhardt	Special Task
C. Anderson	Special Task
S. Stewart	Special Task
T. Cruse	Special Task
D. Pomerening	Special Task
T. Jeter	Special Task
H. Burnside	Special Task
P. Cox	Special Task
R. Hill	Special Task
J. Cardinal	Special Task

### III. FUTURE PLANNING

NTIAC activities during the next fiscal year (FY87) will depend to a large extent on the final outcome of the FY87 budget. If a 30% budget reduction is experienced as was the case for FY86, then it will be necessary to reduce efforts across the board to accommodate the budget. Surveillance of the NDT literature will continue since this is one of the most important functions of an information analysis center; however, it may not be possible to maintain the input of documents to the bibliographic data base at a level of approximately 2,000 per year. Efforts will continue to acquire foreign technology documents by utilizing a variety of available information resources, such as, the CIRC II Data Base, Foreign Broadcast Information Service and DIA intelligence reports. Because of the cost involved, a budget reduction would impact the feasibility of obtaining foreign document translations.

It is anticipated that the two State-of-the-Art Reports currently in preparation, Neutron Radiography and Digital Signal Processing for NDE, will be completed and published during the next fiscal year. Depending on the final budget outcome, at least one additional SOAR will be initiated; a potential topic is residual stress measurement. The Proceedings of the Conference on NDT of Advanced Materials and Composites will be completed during the next fiscal year. Publication and printing of this Proceedings are being performed by MCIC and distribution will take place separately by MCIC, MMCIAC and NTIAC.

The 16th NDE Symposium, organized by NTIAC, will take place in San Antonio in April 1987. Arrangements for meeting space and lodging have been made and a Call for Papers has been issued. It is anticipated that the program will be finalized during the early part of 1987. As in the case of past symposia, the purpose of the 16th NDE Symposium is to bring together technical and managerial personnel engaged in, and concerned with, fundamental and applied aspects of NDE for the exchange of information including new ideas, methods, and research and development results.

NTIAC will continue to maintain an aggressive program of Special Tasks to respond to special needs of the DoD especially in areas that result in substantial cost savings to the DoD. Evaluations have been initiated for the Air Force of ultrasonic inspection equipment and eddy current probe performance. Results of this work will help the Air Force in developing specifications for nondestructive inspection equipment. Special Tasks are continuing for AVSCOM to review and evaluate Depot Maintenance Work Requirements based on application of NDI and reliability centered maintenance concepts. Information obtained during this review and evaluation should help eliminate unnecessary tasks during depot maintenance and inspection, thereby enabling more economical overhaul procedures. Other Special Tasks are continuing on the development of a nondestructive environmental stress screening program for Army aircraft systems and components. Information is being obtained on recommended nondestructive screens for prioritized critical aircraft components and on the effectiveness of these screens.

APPENDIX A  
NTIAC INQUIRIES

## APPENDIX A

NTIAC INQUIRIES  
4th Quarter FY86

<u>No.</u>	<u>Requestor</u>	<u>DTIC Regis. (X) or Foreign (F)</u>	<u>Type</u>	<u>Charge</u>	<u>Date</u>
1227	Y. Prater		Service Info	n/c	07/03/86
1228	A. Broz, AMTL	X	Bibliography	n/c	07/10/86
1229	Div. 06 (SwRI)	X	Bibliography	\$460	07/11/86
1230	Kelly AFB	X	Tech. Info	n/c	07/28/86
1231	Redstone Arsenal	X	Service Info	n/c	07/28/86
1232	AMTL	X	Bibliography	n/c	07/31/86
1233	N.Y. Port Authority		Tech. Info	n/c	07/31/86
1234	Div. 06 (SwRI)	X	Bibliography	\$100	07/29/86
1235	NTIAC	X	Bibliography	n/c	08/15/86
1236	Patrick AFB	X	Bibliography	n/c	08/01/86
1237	B. Timmerman		Tech. Info	n/c	08/04/86
1238	Worltech Reports		Tech. Info	n/c	08/18/86
1239	T. Gillis		Tech. Info	n/c	08/19/86
1240	Science Applications		Tech. Info	n/c	08/15/86
1241	Aerojet Strategic Propulsion	X	Tech. Info	n/c	08/25/86
1242	Pasha Publications		Service Info	n/c	09/02/86
1243	Kelly AFB	X	Bibliography	n/c	09/03/86
1244	Physical Acoustics		Service Info	n/c	09/05/86
1245	Kelly AFB	X	Bibliography	n/c	09/08/86
1246	Naval Weapons Support Center	X	Tech. Info	n/c	09/19/86
1247	Kelly AFB	X	Bibliography	n/c	09/19/86
1248	Patrick AFB	X	Tech. Info	n/c	09/23/86
1249	Stanford Res. Institute	X	Service Info	n/c	09/23/86
1250	Framatome - France	F	Tech. Info	n/c	09/25/86
1251	USSR Academy of Science	F	Service Info	n/c	09/25/86
1252	Div. 17 (SwRI)	X	Bibliography	n/c	09/25/86

APPENDIX B  
TECHNICAL PUBLICATIONS

## Digital Signal Processing and Pattern Recognition

## Applications in NDE

A State-of-the-Art Survey

## 1. Introduction

## 2. Background

- a. Define various NDT techniques. Emphasis will be on the physical process and the type of signal that one gets. (UT, AE, Electromagnetic)
- b. Typical characterization (defect, material, and process) scheme.
- c. Introduce signal processing, Pattern recognition and (AI/Expert-systems very briefly, details in appendix)

## 3. Signal Processing

- a. Introduction - tasks involved are such and such. Refer reader to appendix for basic definitions and terminology.
- b. Description of a typical signal processing scheme (with a block diagram).
- c. Principles of Data Acquisition (sampling, quantization, trade offs involved)
- d. Signal Enhancement (Filtering, Temporal Averaging, spatial averaging or beam forming, frequency agility, correlation detection, moving window, etc.)
- e. Modeling (Phenomenological vs. Empirical) (Parametric vs. Non-parametric)

## 4. Pattern Recognition

- a. Introduction - tasks involved in PR are such and such. Parametric vs. non-parametric
- b. Basic PR Techniques including Histogram, PDF, Scatter Plot and Bayes Theorem
- c. Fisher Linear Discriminant, ALN, Nearest Neighbor Rule, Cluster Analysis and Discriminant functions

## 5. Survey of NDT Signal Processing Literature

A. Ultrasonics

- a. Introduction
- b. Description of a few typical ultrasonic systems/instrumentation (pulse-echo, thru-transmissions, tandem, etc.)
- c. Signal conditioning (enhancement, restoration, improvement of S/N ratio) examples of 3d
- d. Inversion problem (defect characterization)
- e. Ultrasonic Imaging (A-Scan, F-Scan, ultrasonic microscopy, holography, tomography, SAFT, Phased arrays)
- f. Pattern Recognition
- g. Application Examples-- UDRPS, TREES, ARIS, BNWSAFT, HOLUSAFT
- h. Future Trends -- materials characterization, process control

B. Electromagnetic

- a. Introduction
- b. Description of a few typical electromagnetic system/instrumentation including eddy current, Pulsed eddy current and multi-frequency eddy current
- c. Signal conditioning
- d. Inversion problem/defect characterization/modeling techniques
- e. Eddy current imaging
- f. Pattern recognition
- g. Application examples - IBUS, RFC, Deriviter, Westinghouse, Belgium system
- h. Future trends - material characterization and process control

C. Acoustic Emission

- a. Introduction
- b. Description of a typical AE test system/  
instrumentation
- c. Signal Conditioning
- d. Data interpretation
- e. Pattern recognition
- f. Application examples
- g. Future trends - Process control, materials  
characterization

VI. Conclusions

References

- Appendix A: Literature search strategy
- Appendix B: Expert systems/AI
- Appendix C: Definitions and Terminology

Revised 1/14/86

NEUTRON RADIOGRAPHY  
(State-of-the-Art Report)

Neutron radiography is being increasingly utilized for NDE in aerospace, military, nuclear manufacturing and in in-service inspection. Since neutrons have penetrating abilities that are quite distinct from those of x-rays, neutron radiography is applicable to inspection problems for which x-ray radiography is unsuited. Plastics, for example, are readily visible in neutron radiographs, but aluminum almost vanishes. Containers of lead and stainless steel can be easily penetrated by neutrons to show internal structures. Specific neutron radiography applications that have been reported include the following:

- Corrosion detection in airframe components
- Honeycomb bonding defect and moisture inclusion detection
- Helicopter blade inspection
- Turbine blade inspection
- Explosive device inspection for explosives content
- Nuclear fuel inspection
- Computerized tomography
- High speed motion studies of pyrotecnic and fuel systems

New developments, particularly in transportable sources, are likely to make neutron radiography much more practical in the near future and broaden its applications in NDE.

An outline of the proposed Neutron Radiography SOAR is attached. The SOAR would be prepared jointly by Dr. Frank Iddings and Mr. Harold Berger. Dr. Iddings recently joined SwRI and the NTIAC staff after serving on the faculty of the Nuclear Science Center at Louisiana State University for 20 years, including two years as Assistant Director of the Center. Mr. Berger is President of Industrial Quality, Inc. and currently serves as a consultant to NTIAC. He has over 30 years experience in NDE, primarily in various areas of radiography including x-ray, gamma-ray, neutron, proton, and imaging systems. Both Mr. Berger and Dr. Iddings are recognized experts in neutron radiography and are among the co-authors of the Neutron Radiography Section in the recent Radiography and Radiation Testing Volume of the ASNT Nondestructive Testing Handbook series.

## NEUTRON RADIOGRAPHY (OUTLINE)

## Introduction

Objective

Scope

Advantages

Complementary to X- and gamma radiography

Detection of hydrogen and hydrogen compounds in metal matrices

Distinguish between different metals with similar atomic number

Sensitive to certain isotopes vs. other isotopes of the same element

Radiography of radioactive specimen

Limitations

Radiation

Cost/availability of sources

Slowness of portable sources

Lack of experienced personnel

Development (historical)

## Theory

Neutron production principles

Neutron energies

Neutron interactions

Neutron detection

Image formation and geometry

Neutron shielding

## Neutron Sources and Collimation

Nuclear reactors

Accelerators

Isotopic Sources

Moderators

Collimators

Aperture

Parallel beam

L/D importance

## Neutron Imaging Techniques

Indirect or transfer

Direct

Real time

Tomography

Contrast agents

Image quality indicators

## Standards/Recommended Practices

System Performance

Personnel Qualification

Regulatory Control

## Applications

General

Aerospace

Electronic

Explosive devices

Motion and tomography

Nuclear

Miscellaneous

## Conclusions

## References

PROCEEDINGS OF THE  
FIFTEENTH SYMPOSIUM ON NONDESTRUCTIVE  
EVALUATION

APRIL 23-25, 1985

SAN ANTONIO, TEXAS

D. W. MOORE, G. A. MATZKANIN, PROCEEDINGS EDITORS

B. J. FORD, PUBLICATIONS ASSISTANT

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NONDESTRUCTIVE TESTING INFORMATION ANALYSIS CENTER  
AT SOUTHWEST RESEARCH INSTITUTE  
and  
SOUTH TEXAS SECTION, AMERICAN SOCIETY FOR  
NONDESTRUCTIVE TESTING, INC.

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# USER'S GUIDE

NONDESTRUCTIVE TESTING  
INFORMATION ANALYSIS CENTER



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TECHNICAL PROGRAM AND AGENDA

CONFERENCE ON NONDESTRUCTIVE TESTING AND EVALUATION  
OF ADVANCED MATERIALS AND COMPOSITES

Abstract  
Page

Monday, August 18, 1986

6:00 p.m. to 9:00 p.m. Registration, Comanche Room  
Colorado Springs Hilton

Tuesday, August 19, 1986

7:15 a.m. Buses Leave Hotels (approximate time;  
check bus schedule for details)

8:00 a.m. Continental Breakfast and Registration  
USAF Academy, Fairchild Hall

8:30 a.m. Opening Comments  
Welcoming Remarks

Lt. Gen. Winifield W. Scott, Jr.  
Superintendent, USAF Academy

8:45 a.m. **Keynote Address: Developments in Nondestructive  
Testing for Composite Materials**

Dr. R. Byron Pipes  
Dean of Engineering  
University of Delaware

9:30 a.m. Coffee Break

9:45 a.m. **Overview of DoD Advanced Materials and Composites  
Nondestructive Testing and Evaluation**

Mr. Jerome Persh  
Staff Specialist for Materials and Structures  
Office of the Undersecretary of Defense  
for Research and Engineering

**SESSION 1. OVERVIEWS OF NDT IN TTCP COUNTRIES**

10:15 a.m. **An Overview of Australian Research on  
Nondestructive Testing**

I. G. Scott and C. M. Scala  
Department of Defence  
Aeronautical Research Laboratories

- 10:45 a.m.      **NDT of Advanced Materials in the United Kingdom**      NA\*
- A. C. Lang  
Central Servicing Development Establishment  
Royal Air Force Swanton Morley
- 11:15 a.m.      Lunch (Bus transportation provided)  
USAF Academy, Officers' Club
- SESSION 2. MECHANICAL PROPERTIES AND BEHAVIOR**
- Chairman: Lou McCreight  
Aerospace Corporation
- 12:45 p.m.      **Measurement of Mechanical and Ultrasonic Properties**      2  
**of Al-SiC Metal-Matrix Composite**
- G. Mott and P. K. Liaw  
Materials Science Division  
Westinghouse R&D Center
- 1:15 p.m.      **Continuum Modeling of Ultrasonic Behavior of Fluid-**      3  
**Loaded, Fibrous Composite Media With Applications**  
**to Ceramics and Metal Matrix Composites**
- Adnan H. Nayfeh  
Department of Aerospace Engineering  
and Engineering Mechanics  
University of Cincinnati
- D. E. Chimenti  
USAF Materials Laboratory
- 1:45 p.m.      **High Sensitivity, High Spatial Resolution Strain**      4  
**Measurements in Alloys and Composites**
- B. N. Cox and W. L. Morris  
Rockwell International Science Center
- 2:15 p.m.      **Thermal Stability Properties of Graphite/**      NA  
**Glass Composites**
- Ramon A. Mayor  
Optics and Applied Technology Laboratory  
United Technologies Research Center
- 2:45 p.m.      Coffee Break

---

\* NA - Abstract not available.

**SESSION 3. NONDESTRUCTIVE MATERIAL  
CHARACTERIZATION**

Chairman: Al Broz  
Army Materials Technology Laboratory

- |                           |                                                                                                                                                                                                                                                                                                        |    |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 3:00 p.m.                 | <p><b>Ultrasonic-Velocity Studies in Metal-Matrix Composites: Measurements and Modeling</b></p> <p>S. K. Datta<br/>University of Colorado<br/>Department of Mechanical Engineering</p> <p>H. M. Ledbetter<br/>National Bureau of Standards<br/>Institute for Materials Science<br/>and Engineering</p> | 5  |
| 3:30 p.m.                 | <p><b>Elastic Representative Surfaces of Unidirectional Graphite-Magnesium</b></p> <p>R. D. Kriz and H. M. Ledbetter<br/>National Bureau of Standards</p>                                                                                                                                              | 6  |
| 4:00 p.m.                 | <p><b>Ultrasonic Characterization of Ceramics</b></p> <p>M. J. Slavin and J. J. Gruber<br/>Army Materials Technology Laboratory</p>                                                                                                                                                                    | 7  |
| 4:30 p.m.                 | <p><b>Interface Characterization in Composite Materials</b></p> <p>Roger Clough and Haydn Wadley<br/>National Bureau of Standards</p>                                                                                                                                                                  | NA |
| 5:00 p.m.                 | Buses Depart for Hotels                                                                                                                                                                                                                                                                                |    |
| 6:30 p.m. to<br>8:30 p.m. | No-Host Reception, Cheyenne/Arapahoe Room,<br>Colorado Springs Hilton                                                                                                                                                                                                                                  |    |

Wednesday, August 20, 1986

- |           |                                                                          |
|-----------|--------------------------------------------------------------------------|
| 7:30 a.m. | Buses Leave Hotels (approximate time;<br>check bus schedule for details) |
| 8:00 a.m. | Continental Breakfast<br>USAF Academy, Fairchild Hall                    |

#### SESSION 4. FRACTURE MECHANICS AND FAILURE MECHANISMS

Chairman: Yapa Rajapakse  
Office of Naval Research

- |            |                                                                                                                                                                                                                                                                 |    |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 8:30 a.m.  | <p><b>Mechanisms and Mechanics of Damage and Fracture in Advanced Composites</b></p> <p>S. S. Wang<br/>Departments of Theoretical and Applied Mechanics and of Aeronautical and Astronautical Engineering<br/>University of Illinois</p>                        | 8  |
| 9:00 a.m.  | <p><b>Quantitative AE and Fracture Mechanics</b></p> <p>Wolfgang Sachse and Kwang Yul Kim<br/>Department of Theoretical and Applied Mechanics<br/>Thurston Hall<br/>Cornell University</p>                                                                      | 9  |
| 9:30 a.m.  | <p><b>Detection of Failure Mechanisms in Metal-Matrix Composites During Low Cycle Fatigue Loading Through Acoustic Emission</b></p> <p>Jonathan Awerbuch and Madhu S. Madhukar<br/>Department of Mechanical Engineering and Mechanics<br/>Drexel University</p> | 10 |
| 10:00 a.m. | <p>Coffee Break</p>                                                                                                                                                                                                                                             |    |
| 10:15 a.m. | <p><b>Detection and Characterization of Damage in Thick Composites</b></p> <p>J. D. Achenbach and G. Kechter<br/>Northwestern University</p> <p>I. Daniel<br/>Illinois Institute of Technology</p>                                                              | 11 |
| 10:45 a.m. | <p><b>Evaluation of Failure Modes in Metal Matrix Composites</b></p> <p>Charles R. Saff<br/>McDonnell Aircraft Company<br/>McDonnell Douglas Corporation</p>                                                                                                    | 12 |

11:15 a.m. Conference Luncheon  
USAF Academy, Officers' Club

**Commercial Activity in Space**

Speaker: William Oran  
Commercial Development Division  
NASA Headquarters  
Washington, D.C. 20546

**SESSION 5. CRITICAL PROPERTIES AND DEFECTS**

Chairman: Cliff Anderson  
Naval Surface Weapons Center

1:00 p.m. **NDE of Ceramic Matrix Composites** 13

Robert F. Murphy, Richard Williams,  
and Robert W. Reed  
United Technologies Research Center

1:30 p.m. **Thermal and Mechanical Hysteresis in Metal  
Matrix Composites** 14

John M. Liu  
Naval Surface Weapons Center

2:00 p.m. **The Relationship of Nondestructive Indications  
to Microstructure and Properties of Carbon-  
Carbon Materials** 15

John Koenig  
Southern Research Institute

2:30 p.m. **Influence of Fiber Structure on  
Composite Properties** 16

Ronald N. Lee  
White Oak Laboratory  
Naval Surface Weapons Center

3:00 p.m. Coffee Break

**SESSION 6. NDT APPLICATIONS**

Chairman: Leonard Mordfin  
National Bureau of Standards

- 3:15 p.m.            **Future NDE Needs for High Performance Turbine Engine Components and Materials**            17
- William Koop  
Propulsion Laboratory/Turbine Engine Division  
Wright Aeronautical Laboratory
- 3:45 p.m.            **Scanning Laser Acoustic Microscope (SLAM) Analysis of Advanced Materials for Internal Defects and Discontinuities**            18
- L. W. Kessler and M. G. Oravec  
Sonoscan, Inc.
- 4:15 p.m.            **Laser Holographic NDT of Advanced Materials**            19
- John Newman  
Laser Technology, Inc.
- 4:45 p.m.            **Real-Time, On-Line Durability Measurements in Advanced Materials Using Surface Layer Activation**            20
- Charles C. Blatchley and Piran Sioshansi  
Wear Measurement Systems  
Spire Corporation
- 5:15 p.m.            Buses Depart for Hotels

Thursday, August 21, 1986

- 7:30 a.m.            Buses Leave Hotel (approximate time; check bus schedule for details)
- 8:00 a.m.            Continental Breakfast  
USAF Academy, Fairchild Hall
- SESSION 7. NEW AND EMERGING NDT AND E METHODS**
- Chairman: Joe Moyzis  
USAF Materials Laboratory  
Wright-Patterson AFB
- 8:30 a.m.            **Nondestructive Testing and Evaluation by Differential Infrared Emissions**            21
- Bela I. Sandor  
University of Wisconsin-Madison

- 9:00 a.m.            **Computed Tomography: A Powerful NDE  
Method for Advanced Materials**            22
- James H. Stanley  
Advanced Research and Applications Corporation
- 9:30 a.m.            **Application of Medical X-Ray Computed  
Tomography to CVD Ceramic Components**            23
- W. A. Ellingson, M. W. Vannier, and E. Segal  
Materials Science and Technology Division  
Argonne National Laboratory
- D. P. Stinton  
Metals and Ceramics Division  
Oak Ridge National Laboratory
- 10:00 a.m.            **Coffee Break**
- 10:30 a.m.            **Engineering Tomography, A Quantitative  
NDE Approach for Composite Materials**            24
- William H. Pfeifer, Donna K. Archipley-Smith,  
and Richard L. Hack  
PDA Engineering
- 11:00 a.m.            **Ultrasonic Scattering and Nondestructive  
Evaluation of Defects**            25
- S. K. Datta  
Department of Mechanical Engineering  
University of Colorado
- 11:30 a.m.            **Conference Wrapup**
- 12:00 p.m.            **Adjournment  
Buses return to Colorado Springs**

**REVIEW AND ANALYSIS  
OF FOREIGN NONDESTRUCTIVE  
TESTING TECHNOLOGY**

**BY**

**DR. GEORGE A. MATZKANIN, DIRECTOR**

**NONDESTRUCTIVE TESTING  
INFORMATION ANALYSIS CENTER**

**SOUTHWEST RESEARCH INSTITUTE  
SAN ANTONIO, TEXAS**

**PRESENTED AT**

**STRUCTURES AND MATERIALS INTELLIGENCE SEMINAR  
CHARLOTTESVILLE, VA  
APRIL 22, 1986**

OUTLINE OF PRESENTATION

- I. INTRODUCTION
- II. INFORMATION SOURCES
- III. INFORMATION STATISTICS
- IV. TECHNOLOGY ASSESSMENT
- V. CONCLUSIONS

## SUMMARY

## U.S. Behind Rest of World:

- Broad System Implementation in Industry (& Defense)
- Process Control Applications
- Automated Real Time Inspection
- Characterization of Material Properties
- Mathematical Modeling

## U.S. Ahead of Rest of World:

- Use of Chip and Computer Technology in NDE
- Quantitative Detection, Classification and Sizing of Defects
- Sensor Technology
- Digital Signal Processing and Pattern Recognition
- Application of NDE to Advanced Materials (Composites)

APPENDIX D

SUMMARIES OF SPECIAL TASKS FUNDED  
OR COMPLETED DURING FY86

**SUMMARIES OF SPECIAL TASKS  
INITIATED OR EXPANDED DURING FY86**

**REVIEW AND EVALUATION OF ARMY AVIATION DEPOT  
NDI AND RELIABILITY CENTERED MAINTENANCE**

Agency: Army Aviation Systems Command

This Special Task is directed at reviewing and evaluating selected Depot Maintenance Work Requirements (DMWRs) based on application of nondestructive inspection and reliability centered maintenance concepts. The purpose of the review is to eliminate unnecessary tasks during depot maintenance and inspection, and to eliminate arbitrary remanufacture. The overhaul and nondestructive inspection criteria in each DMWR will be screened and guidelines prepared for revision. Information resulting from this Task will help eliminate non-essential and non-economic overhaul procedures and insure that the inherent design reliability and safety of the aircraft items reviewed are achieved with the least amount of maintenance and with efficient inspection.

**EVALUATION OF DEPOT MAINTENANCE HANDBOOK**

Agency: Army Aviation Systems Command

This work is an expansion of a Special Task being conducted to evaluate the adequacy of repair and inspection criteria and guidelines currently incorporated into the Depot Maintenance Handbook recently published by NTIAC. The additional work will be directed toward updating AVSCOM's Data Analysis, Reporting and Documentation System (DARDS) utilizing selected, pertinent and up-to-date information on depot maintenance and nondestructive inspection included in the Depot Maintenance Handbook. In addition, information on aircraft condition evaluation and NDI will be included in the DARDS.

**NONDESTRUCTIVE ENVIRONMENTAL STRESS SCREENING (ESS) FOR  
ARMY AIRCRAFT SYSTEMS AND COMPONENTS - PHASE II**

Agency: Army Aviation Systems Command

This work is an expansion and continuation of an NTIAC Special Task currently being conducted to gather information and define an optimum nondestructive environmental stress screening (ESS) program for selected Army aircraft systems and components. ESS is an important ingredient in the Army's overall NDI and Quality Assurance program. It is intended to be implemented during the manufacturing of new aircraft systems and components as well as during depot repair and overhaul of in-service aircraft. This NTIAC Special Task involves compiling and evaluating ESS bibliographic material and defining nondestructive ESS requirements for prioritized critical Army aircraft components. The results of this program are expected to maximize reliability while minimizing rework, repair and overhaul costs at Army Depots.

REVIEW AND EVALUATION OF ARMY AVIATION DEPOT  
NDI AND RELIABILITY CENTERED MAINTENANCE

Agency: Army Aviation Systems Command

This work is an expansion and modification of an NTIAC Special Task currently being conducted to review and evaluate selected Depot Maintenance Work Requirements (DMWRs) for Army aircraft systems and components based on application of nondestructive inspection (NDI) and reliability centered maintenance concepts. The effort includes screening the overhaul and NDI criteria in each DMWR to eliminate unnecessary tasks during depot maintenance and inspection. The additional work is to develop an economic-tradeoff analytical model to be used as a basis to derive and evaluate cost benefit data. The model will provide information on man-hour savings, man-hour cost savings, materiel cost savings and net cost savings resulting from the DMWR evaluation.

DEVELOPMENT OF A DIAGNOSTIC/NDI ORIENTED  
MAINTAINABILITY PREDICTION STANDARD

Agency: Naval Avionics Center

This Special Task is directed at preparing a diagnostic and NDI oriented maintainability prediction standard for use by the Naval Avionics Center. The effort will include a review of the latest maintainability prediction analysis, maintenance planning, and NDT inspection techniques, in particular, those applicable to systems incorporating ease of maintenance features. The standard will provide for the Navy clear, concise and effective guidelines and requirements for performing maintainability predictions, determining maintenance requirements and assessing the impact of diagnostic testing, nondestructive inspection and other methods on the total maintenance burden.

LASER INDUCED FLUORESCENCE INSPECTION OF URETHANE  
AND RELATED MATERIALS

Agency: U. S. Army Belvoir R&D Center

This work is directed at the problem of nondestructively evaluating the degradation of polyurethane storage tanks using laser induced fluorescence. These tanks, which are used to store various fluids, are subjected to a variety of aging environments. Laser induced fluorescence is currently finding widespread use for nondestructive inspection and preliminary indications are that it is capable of nondestructively determining degradation of elastomeric materials. This Special Task involves conducting a comprehensive literature survey on the analysis of elastomeric materials using laser excitation and obtaining information on laser induced fluorescence spectra from aged polyurethanes.

## NONDESTRUCTIVE INVESTIGATION OF WALLEYE PRESSURE PROBE FAILURES

Agency: Pacific Missile Test Center

This Special Task is directed at obtaining background information and data on WALLEYE pressure probe failures as a basis for developing appropriate nondestructive test procedures for inspecting pressure probes. An initial structural analysis model has been developed; however, additional effort is required in order to complete the analysis of WALLEYE pressure probe failures and to obtain information for the development of NDE approaches for preventing future probe failures.

NONDESTRUCTIVE EVALUATION OF MOISTURE INTRUSION  
IN MISSILE COMPONENTS

Agency: Pacific Missile Test Center

This work is directed toward obtaining information relevant to understanding the problem of moisture intrusion into the seeker compartment of the AIM-7 missile. Such moisture intrusion is conducive to damaging critical electronic components by corrosion thereby degrading the reliability of the missile. This Special Task involves nondestructive testing of the seeker section of the missile to evaluate conditions under which moisture intrusion takes place. The information obtained is expected to provide a basis for defining the nature of the problem and determining potential corrective action leading to improved reliability of the missile electronic components.

## DIELECTRIC PROPERTIES SENSOR EVALUATION

Agency: Rome Air Development Center

This work is directed toward evaluating an electrostatic nondestructive inspection technique based on capacitive sensing of the dielectric properties of a material. Information will be acquired on the effect of various electrostatic field sensor parameters on the depth of detection, spatial resolution, and scan rate. This information is needed in order to determine the requirements for an electrostatic field dielectric properties sensor suitable for use in a practical and reliable non-destructive inspection imaging system.

EVALUATION OF SPACE PLASMA DATA: EFFECTS UPON  
SPACECRAFT MATERIALS AND NDE IN THE SPACE ENVIRONMENT

Agency: Air Force Geophysics Lab

This work is a continuation and expansion of an NTIAC Special Task to analyze and evaluate space plasma data as input to a space environmental data base useful for predicting and/or avoiding damage and degradation of aerospace/satellite structural materials. Improved characterization of the space environment will provide guidance in the specification of applicable nondestructive testing techniques suitable for the space environment and will lead to improved design of communication, surveillance, and navigation satellites which must operate within this environment.

REVIEW AND EVALUATION OF ARMY AVIATION DEPOT  
NDI AND RELIABILITY CENTERED MAINTENANCE

Agency: Army Aviation Systems Command

This work is an expansion and continuation of an NTIAC Special Task currently being conducted to review and evaluate selected Depot Maintenance Work Requirements (DMWRs) for Army aircraft systems and components based on application of nondestructive inspection (NDI) and reliability centered maintenance (RCM) concepts. The additional work is to develop a detailed plan for expanding the RCM data base and program based on failure mode data and NDI/repair criteria from the current effort. The plan will provide complete functional descriptions and implementation timelines and will define staff and facility requirements and other resources necessary to support the expanded RCM/NDI program.

NONDESTRUCTIVE QUALIFICATION OF UH-1 REPLACEMENT  
PARTS FOR COMPETITION ENHANCEMENT

Agency: Army Aviation Systems Command

The objective of this work is to ensure that technical data and information regarding qualification of UH-1 helicopter replacement parts is complete, adequate and accurate for utilization by potential manufacturers other than the prime contractor in order to facilitate competitive procurement. Technical data will include nondestructive testing methodology for evaluation of critical structures and components to assure safety of flight under anticipated operating conditions and environments, and to establish location, size, and characteristics of critical effects from applied loads and duty cycles. NDT/NDI specifications and plans will be developed as part of the alternate source qualification program. The work will provide a basis for technical independence from prime contractors which is expected to result in significant cost savings to the U.S. Army.

EDDY CURRENT PROBE PERFORMANCE REQUIREMENTS

Agency: San Antonio Air Logistics Center

The objective of this work is to obtain information needed to improve eddy current nondestructive inspection reliability and to provide more uniform results of nondestructive inspections at field and depot levels. Commercially available eddy current surface probes will be evaluated to determine important probe measurement characteristics which may be used to predict probe performance. Information obtained will be utilized to develop a procurement specification document and a simple quality test procedure for field testing eddy current probes. Results of this Special Task are expected to lead to improved reliability in optimizing eddy current detection of material/component defects.

THROUGH-TRANSMISSION/PULSE-ECHO  
ULTRASONIC EQUIPMENT EVALUATION

Agency: San Antonio Air Logistics Center

The objective of this work is to identify and evaluate nondestructive bond testing equipment presently existing to obtain more reliable detection of disbonds and delaminations in aircraft structures. Commercially available equipment will be identified through a literature search and phone-contact with manufacturers. Evaluations and analysis will be conducted to determine overall performance (accuracy, sensitivity, repeatability), reliability and maintainability, required surface preparation and operator skill level, and cost. Information obtained in this Special Task is expected to help the Air Force in identifying an improved system for nondestructive testing of composite aircraft structures capable of accurately and repeatably locating bond defects.

**SUMMARIES OF SPECIAL TASKS  
COMPLETED DURING FY86**

**OPTIMIZE HARPOON NDT AND NDI PROCEDURES,  
PHASES IV AND V**

Agency: Pacific Missile Test Center

This Special Task effort has involved review and evaluation of data in order to provide guidance to the Navy in optimizing NDT and NDI procedures for the HARPOON weapon system. Phase IV involved review of detailed data pertaining to NDT equipment items and utilization in order to develop low level flow charts as prerequisites to the final simulation model. In Phase V, statistical data collection and evaluation was performed of key parameters such as fleet return (missile) occurrences, missile and section failure rates and maintenance task time and priorities. The final outcome has been the development of a computer based model of the maintenance process for the HARPOON missile system. The model was developed as an aid to the Navy in assessing its ground support equipment needs, especially during the coming years as the size of the HARPOON fleet increases. Simulation models for each of the weapon stations, Concord and Yorktown, have been written in GPSS, and during execution, these programs send output to a program which performs statistical evaluation and prepares an output file. The user accesses these programs through a special interface program. The simulation model will be used by the Navy as a tool in delineating NDT and NDI equipment and procedures at two Naval weapon stations.

**NDE OF BLACK HAWK HELICOPTER ROTARY WING-HEAD  
SPINDLE THREADS USING ELECTRIC CURRENT PERTURBATION**

Agency: Army Aviation Systems Command

Six Black Hawk helicopter rotary wing-head spindles were inspected for flaws in the thread roots using the electric current perturbation (ECP) method. Both new spindles and spindles which had been removed from service were examined. The ECP method was shown to provide much higher sensitivity for detection of surface and slightly subsurface flaws than the presently-used ultrasonic method. In addition, ECP is not influenced by the presence of a tie rod in the spindle bore. A laboratory demonstration of the flaw detection capability of ECP was held for representatives of USAAVSCOM and Sikorsky Aircraft.

## EVALUATION OF DEPOT MAINTENANCE HANDBOOK

Agency: Army Aviation Systems Command

The Depot Maintenance Handbook, which was prepared under an earlier NTIAC Special Task, provides information on standardized methods for the repair and acceptance of minor structural discrepancies and/or variations in parts and materials used in Army aircraft systems and components. This Handbook defines common discrepant conditions, with limits as to where and to what extent repairs can be made, and it provides applicable repair instructions, with inspection criteria indicating application of nondestructive testing to assure the design integrity and quality of the reconditioned items. The Handbook was evaluated relative to the Corpus Christi Army Depot's modernization plans and particularly facility and resource requirements to support the new workload for overhauling, maintaining and inspecting the UH-60, the AH-64, the CH-47D, and OH-58D aircraft. The objective of the investigation was to judge the adequacy of criteria and guidelines currently incorporated into the handbook based on review of the new workload and to provide additional criteria and standardized repair guidelines, as necessary. In addition, the AVSCOM Data Analysis, Reporting and Documentation System (DARDS) was updated and an evaluation performed of its operating procedures and NDI/ACE output products. DARDS is used for the analysis, reporting, and documentation of the ACE profile data in order to support AVSCOM depot engineering requirements and internal management services.

DEVELOPMENT OF AN NDT PROCEDURE DATA BASE FOR  
EVALUATING THERMALLY STRESSED SURFACES

Agency: Ballistics Research Laboratory

This work was directed at obtaining data base information for guidance in developing nondestructive testing procedures for evaluating thermally stressed surfaces following blasts. This information is needed to assist in the design of hardened weapons systems and evaluation of current foreign and domestic military targets. The feasibility was determined of preparing and using a pyrotechnic hang-up thermal source for nondestructive evaluation of military targets subjected to thermal plus blast loadings in large shock tubes. Results of the study indicate that such thermal sources are feasible and they can be tailored to produce required thermal characteristics. Information obtained in this Task is expected to help reduce costs associated with full scale tests in which targets are destroyed.

## EDDY CURRENT PROBE CHARACTERIZATION

Agency: San Antonio Air Logistics Center

In this Special Task, measurements were made to: (1) determine the degree of variability in eddy current probes presently in use by the Air Force for inspection of aircraft structures; (2) provide data which would be useful for determining the percentage of probes which would be rejected if performance specifications were set at a desired limit; and (3) provide a data base which could be used in future work to study the relationship between probe physical characteristics and performance.

Thirty non-shielded and thirty shielded probes were tested. These probes were obtained from many different Air Force bases and should be representative of probes typically in routine use. The probes were scanned over four slots (1 in. long with depths ranging from 0.005 in. to 0.050 in.) and over a 0.050 in. long X approximately 0.012 in. deep fatigue crack in aluminum and were also subjected to a fixed change in liftoff. The impedance characteristics of the probes were measured during the scans by an impedance analyzer which provides an absolute measurement of the resistive and reactive impedance characteristics.

The flaw responses from the shielded probes were generally greater than from the non-shielded probes. The responses within each of these groups varied by a factor of six to seven for all of the flaws. For each group of probes, this variation could be reduced to a factor of two by rejecting approximately one-third of the probes. For all probes, the response to the 0.050 in. long fatigue crack was approximated by the response to the 0.010 in. deep slot. The absolute probe impedance varied by a factor of up to 10. A reasonable first step toward establishing consistent probe performance could be to set probe acceptance limits based on (1) the response to slots in an Air Force standard and (2) absolute probe impedance.

DEVELOPMENT OF A DIAGNOSTIC/NDI ORIENTED  
MAINTAINABILITY PREDICTION STANDARD

Agency: Naval Avionics Center

This Special Task was directed at preparing a diagnostic and NDI oriented maintainability prediction standard for use by the Naval Avionics Center. The effort included a review of the latest maintainability prediction analysis, maintenance planning, and NDT inspection techniques, in particular, those applicable to systems incorporating ease of maintenance features. The standard provides for the Navy clear, concise and effective guidelines and requirements for performing maintainability predictions, determining maintenance requirements and assessing the impact of diagnostic testing, nondestructive inspection and other methods on the total maintenance burden.

APPENDIX E  
INFORMATION FROM NTIAC USERS

Iowa State University *of Science and Technology* Ames, Iowa 50011



Department of Engineering Science  
and Mechanics  
~~314 Engineering Research Institute~~  
Telephone 515-294-6240  
2019 ME/ESM Building

October 21, 1985

Mr. Don Moore  
Publications Specialist  
Southwest Research Institute  
6220 Culebra Road  
San Antonio, TX 78284

Dear Don:

Thank you for agreeing to accept the enclosed paper which we presented at the 15th Symposium on NDE in April. We apologize for being late and appreciate your patience.

Please give my regards to George Matzkanin. the Symposium was very well organized and composed. We enjoyed our time in San Antonio very much indeed.

Sincerely,

Handwritten signature of Christian P. Burger.

Christian P. Burger  
Professor

CPB:deb  
enclosure



May we Have your Comments, Please?

In each of its responses to a technical or bibliographic inquiry, NTIAC strives to meet the goal of technical excellence. After you have examined the response provided to your inquiry, please take a few moments to complete this brief form and return it to us. Your response will help us in evaluating and improving our service. Of course, we will treat your response confidentially. Thank you.

G.A. Matzkanin, Director  
NTIAC

Inquiry No. INQ-1022

\_\_\_\_\_ Bib  Tech

Scope \_\_\_\_\_

Prepared for: S. Vinay  
Westinghouse

Title: Ultrasonic Testing of Thin Plate Welds

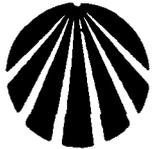
How do you rate NTIAC's response on the following points?

Relevance to your requirement	<input checked="" type="checkbox"/> Good	_____ Fair	_____ Poor
Timeliness of response	<input checked="" type="checkbox"/> Good	_____ Fair	_____ Poor
Utility of the response	<input checked="" type="checkbox"/> Good	_____ Fair	_____ Poor

Did the response meet your expectations?  Yes \_\_\_\_\_ No

Further comments Great work!

Signature S. Vinay  
Date 12/4/85



Aerojet Strategic Propulsion Company

6 May 1986

Fran Hicks  
Information Analysis  
NTIAC  
Southwest Research Institute  
P.O. Drawer 28510  
San Antonio, TX 78284

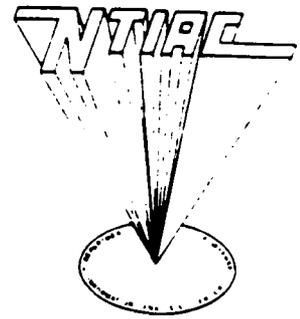
Please send your **A User's Guide** explaining NTIAC products and services to:

Phyllis Benson, Librarian  
AEROJET STRATEGIC  
Bldg. 2019 - Dept. 2018  
P.O. Box 15699C  
Sacramento, CA 95813

Your **Newsletter** is great and we're getting good comments from our managers and engineers. Thanks for adding us to your mailing list.

Kindest regards,

Phyllis Benson  
Librarian  
Advanced Technology



May we Have your Comments, Please?

In each of its responses to a technical or bibliographic inquiry, NTIAC strives to meet the goal of technical excellence. After you have examined the response provided to your inquiry, please take a few moments to complete this brief form and return it to us. Your response will help us in evaluating and improving our service. Of course, we will treat your response confidentially. Thank you.

G.A. Matzkanin, Director  
NTIAC

Inquiry No. ING-1200

Bib

Tech

Scope VISUAL INSPECTION

Prepared for: \_\_\_\_\_

**MARK H. WEINBERG, P.E.**  
Chief, Instrumentation Engineering Branch  
Artillery Systems Division  
Product Assurance Directorate  
U. S. Army AMCCOM  
AMSMC-QAR-1, Bldg. 62  
Dover, NJ 07801-5001

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\_\_\_\_\_  
\_\_\_\_\_

Title: \_\_\_\_\_

AUTOVON 880-2550  
(201) 724-2550

How do you rate NTIAC's response on the following points?

Relevance to your requirement

Good  Fair  Poor

Timeliness of response

Good  Fair  Poor

Utility of the response

Good  Fair  Poor

Did the response meet your expectations?

Yes  No

Further comments Judging by the abstracts, about 20% of the references appear to be very pertinent. The balance relate to my requirements but less directly. All in all a worthwhile effort & product. Many thanks to Francis Hicks.

Signature [Handwritten Signature]  
Date 6/18/86



**Central Servicing Development Establishment**  
Royal Air Force Swanton Morley, Dereham Norfolk NR20 4LJ  
Telephone Swanton Morley (036-283)291 Ext 282  
GPTN 894

Doctor George Matzkanim  
MITAC  
South West Research Institute  
PO Drawer 28150  
San Antonio  
Texas 70284

Please reply to  
The Officer Commanding  
Our reference  
CSDE/ACL/Folder  
Date

15 September 1986

*Dear Dr Matzkanim*

NDT CONFERENCE AT COLORADO SPRINGS

I am pleased I was able to attend your conference on Non-Destructive Testing and Evaluation of Advanced Materials and Composites. I found it a useful experience and a good insight into the amount of effort you are putting into new techniques and materials in the United States. I also feel that the technical cooperation programme is a worthwhile venture for all the countries, certainly the United Kingdom, and hope that we maintain this useful and close cooperation in the future.

I congratulate you on assembling so many people to the conference at Colorado Springs and for putting together such a worthwhile package.

*Sincerely*  
*AC Lang*