

AVAILABILITY OF TRAINING IN VISUAL INSPECTION FOR THE AIR TRANSPORT INDUSTRY

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INTRODUCTION

Traditionally nondestructive testing (NDT) has focused on the NDT areas of penetrants, magnetic particle, eddy current, ultrasound, radiographic, and other related areas of NDT. These areas are all well developed with much training available and also full levels of inspector certification⁽¹⁾.

It has only been within recent years that the area of Visual Inspection (VI) has received attention and consideration in the nature of training and certification. Common practice has been that VI training has not been a separate entity, but that it was taught within other subjects or simply left to on-the-job (OJT) training.

It should be noted here that VI (Visual Inspection) is the recognized designation for this activity by the aircraft industry. Traditionally, the American Society of Nondestructive Testing (ASNT) refers to all of their areas of application as testing, i.e., Eddy Current Testing (ET) and continues this pattern into the area of Visual Testing (VT). Except for clarification when dealing with the use of ASNT publications, visual inspection in this aviation related article will use the acronym VI.

As the field of NDT has grown and matured, there has been a growing interest in formalizing the area of VI. It is interesting to note that in aviation it is documented⁽²⁻⁵⁾ that NDT is 80-90% VI and that it is responsible for identifying the greatest number of potential malfunction discrepancies.

A major consideration of VI is that it has been deemed that in the final analysis, the training and experience must be product specific and process specific. Industries involving such areas as pressure vessels and welding have well established training and inspection programs. Within these programs much time and detail is spent on the specifics of pressure vessels and welds and their characteristic flaws and discrepancies. Since product and process specificity is so essential to the visual inspection process, this study revolved around seeking sources of VI training which could be relevant to the air transport industry.

In an effort to establish a data base for the availability of training in the area of VI, specifically for the air transport industry, the FAA undertook an in depth study of establishments providing relevant training. This study was conducted by staff at the Center for Aviation Systems Reliability (CASR) - Center for Nondestructive Evaluation (CNDE), Iowa State University, Ames. Sources of study included colleges and universities, airframe and powerplant (A&P) training schools and various other commercial, industrial, and military schools listing NDE training which included VI.

PROCEDURE

General

The scope of the work undertaken in this study was to identify, survey, and evaluate training sources in visual inspection existent in the United States. The intent was to compile a list containing the widest possible variety of sources, and then to evaluate more specifically the sources on the list. While it is recognized that the purpose of the study was to identify training sources in VI appropriate to airlines, airframe and engine manufacturers, and to the FAA, the initial breadth of the study was not limited to aircraft applications. The aviation area may benefit from some VI training which is generic with respect to vision, light, etc., and from some VI training techniques from other product and process specialties. The methodologies of other specialties in preparing VI courses of instruction were examined for utility in the air transport area. During the study an attempt was made to identify some sources of VI training as more appropriate to FAA and air transport industry needs than others. It is understood that FAA Inspectors need training in how visual testing is performed by aircraft and engine maintenance inspectors, and that the technicians who do visual testing need training in how to do it well. The scope of this study was to find sources of instruction on the methods for doing visual inspection. The most relevant sources identified in the study are listed.

The procedural outline was as follows:

1. Seek out directory sources of potential deliverers of VI training.
2. Delineate the lists in terms of relevance to the air transport needs.
3. Conduct a telephone survey of potential deliverers.
4. Compile both quantitative and subjective results of the survey.
5. Identify the most relevant deliverers.
6. Write the report.

IDENTIFYING SOURCES OF INSTRUCTION IN VI

Two lists of potential VI training sources were identified. These were:

- (1.) the ASNT master list⁽⁴⁾ of facilities offering NDT training of all kinds, and
- (2.) the Federal list of A&P schools⁽⁵⁾.

The A&P schools are known because of their charter⁽⁶⁾ to offer training in VI. These lists were also augmented with names found through networking.

The ASNT list is updated annually by means of a questionnaire method in which all institutions are invited to submit information about their NDT education and training programs.

The lists produced the following categories of institutions:

- (1.) Universities and four-year colleges,
- (2.) Junior colleges,
- (3.) Technical/Vocational schools, general
- (4.) Airframe and Powerplant schools,
- (5.) Industrial and Corporate,

(6.) Military organizations.

With the exception of the A&P schools, these categories appear in the ASNT list.

Educational Institutions

As a first step, all the institutions listing VI were selected for further study. Institutions noted as teaching one or more NDT methods, but not VI, were dropped from the lists. It was assumed that VI training would have been listed along with the others if available. Third, all institutions which were ambiguous (i.e., saying they offered NDT training but not supplying a list such as UT, ET, RT, etc.) were queried by a single-purpose telephone call to ascertain whether VI training was available. If "yes", they were kept on the list. (In the ASNT list, the notation VT is used instead of VI.)

The list was further reduced by removing all the universities and four-year colleges after a series of preliminary telephone calls. These calls revealed that VI training was invariably only a small segment of a full-semester course which covered a multiplicity of topics. It was ascertained that the small relevant segment would not be readily available to an influx of extra pupils from the FAA or from industry needing 1 week or 2 weeks of training. Utilization of the training would be feasible only after special arrangements

Among the universities, there are two special cases:

- (1.) Lewis University which has a 2 + 2 program with Moraine Valley Community College where the NDT is taught at the community college level.
- (2.) The University of Alaska-Anchorage which has a 2 + 2 program within the 4 year college setting.

These were included in the community college section of this study.

A&P Schools

There are approximately 180 FAA approved A&P schools ⁽⁷⁾ which must follow FAA regulations. Four large, well-known schools (Northrop, Embry-Riddle, Spartan, and Parks) were selected arbitrarily along with a statistical sampling of 11 other schools from Reference 7.

Commercial

The commercial sources are divided into two categories, namely consultants and firms manufacturing and selling equipment. The teaching consultants are of immediate interest for VI training while the others may be of longer-term interest for their expertise; they are maintained on the list.

Most equipment manufacturers surveyed, generally teach only the operation and use of their own products to their own customers; as a rule, their training is not typically available to the public. An example of such products would be vision enhancement devices such as fiber optic probes. Exceptions to this general rule can occur, such as Olympus which ran the Second International Symposium on Remote Visual Inspection of Aircraft in conjunction with the 1992 ATA meeting. Such special deviations by manufacturers could be of particular value in the VI training field. The manufacturers were retained on the list in the event that their expertise in the technical aspects of their work could be of value. The two manufacturers that fit this category in addition to Olympus are Welch-Allyn and Zetec.

Commercial training is highly product-oriented. The types of VI available are specialized toward definite products such as pipes and definite fabrication techniques such as welds. VI in industry is heavily slanted toward weld inspection. It was the opinion of some trainers that VI must be specialized to a material/process/product. (See the discussion in the Results section.)

Military Training

The military NDT sources contacted share characteristics with the colleges and the equipment manufacturers. These characteristics are the inclusion of several methods of NDT in one course and the

general unavailability to the public at large. At present, these courses contain very limited VI, but that could change as needs arise. The military training is completely product-oriented in the sense that a student is being trained to maintain a particular weapons system.

Most students are military personnel, but DOD civilians and civilian contractors on weapons systems may be trained on a “need-to-know” basis. Generally the training of civilians by the Air Force is called out in procurement contracts. Training for the general public has not been provided or requested to date. The military expertise would be valuable if it could be accessed by special intra-governmental arrangements.

Telephone Questionnaire

It was decided that the most reliable way to obtain information from the institutions on the lists was through a telephone questionnaire. A formal set of questions to be asked of the NDT training officer in each institution was prepared. The telephone respondent was asked as a last item to send published information about the training to FAA-CASR. The telephone interview method provided direct contact with the “resident experts” on VI training in the institutions contacted. This method provided in-depth insight into the approaches the various institutions took toward training. Comments by the “resident experts” were treated as qualitative data points with validity comparable to the quantitative data points on training availability, class hours, etc. The telephone interview method applied to “resident experts” elicited the most up-to-date information on the “state of the industry” in VI training. Under Results, the comments made by the “resident experts” are summarized into short statements on various topics. These are presented along with the firm information from the questionnaire and from other literature.

RESULTS

Tabulated Data

Following the telephone survey, an effort was made to determine which institutions delivered the most relevant information in terms of meeting the FAA air transport needs. A listing of answers for the institutions offering relevant training was tabulated for further study.

Qualitative Statements

Trends have been noted in the data from several types of institutions. These trends are listed here by source type.

1. Universities and Four-Year Colleges

As noted above, any VI material is part of semester courses on a variety of subjects. The VI portion is unavailable to “walk-ins”. Special arrangements would be necessary in order for the public to access portions of a course.

2. Technical Schools and Community Colleges

- Currently there are no short courses in VI, specifically focused on the commercial aircraft fleet.
- Most programs are geared for specifics such as welding, piping or general aviation.
- VI training in these schools varies from 26 to more than 50 hours.
- Several of the schools are set up so that a specific course can be developed and delivered on site.
- Most curriculums are based on the ASNT SNT-TC-1A recommended practice⁽⁸⁾.
- Most NDT students have not had prior exposure to NDT--those that have prior training received their training from the military or OJT.

Lecture vs. laboratory (hands-on) training varied widely, from 25% lecture/75% lab to 100% lab.

3. A&P Schools

There is a large system of A&P training in the United States. Currently, the Department of Transportation, Directory of FAA Certified Aviation Maintenance Schools, lists 180 such programs⁽⁹⁾. All of these programs are operating⁽¹⁰⁾ under Federal Aviation Regulations Part 147. From this listing, fifteen schools were selected for surveying. Results are as follows:

- All A&P schools address VI as a curriculum topic
- The majority of schools devote 1 to 25 hours to VI instruction
- There seems to be little, if any, theoretical introduction to VI and there is no instruction on physiological aspects of the VI process
- All A&P program training is aviation specific, but is geared to general aviation rather than to the commercial aircraft fleet.
- Lecture/laboratory instruction is varied from 25%/75% to 50%/50%
- Very few students have had prior NDT exposure and of those who have, most had military or OJT experience
- These programs are based on FAR part 147⁽¹¹⁾ standards and train for level I, II & III, part 147 standards (I = exposure, II = perform maintenance under supervision, III = return to service)
- Most of these are one year programs or 2 year Associate of Science Community College programs
- About half of the schools have extension programs in which they are equipped to deliver specific courses on site

4. Commercial and Military

In addition to schools, training in visual inspection is given by commercial (for-profit) institutions and military institutions. Many of the relevant ones appear on the ASNT list while some were found through other sources.

The commercial organizations have been denoted "industrial and corporate" in this report. This category includes vendor companies of NDT equipment who give training to purchasers of their systems.

As explained above under Telephone Questionnaire, the telephone interview method elicited comments from the commercial and military sector which are treated as valid data points in this qualitative field of training expertise. Comments and data from "resident experts" in these organizations are summarized in five topical areas as follows:

a. Product Expertise and Experience

- A visual inspector must be a product expert, not someone possessing general knowledge about a part or component subsystem.
- Visual Inspection should be the first step in inspection. The inspector must know the product to be aware of any obvious problems. An inspector must know what he/she is looking for during inspection. This comes with experience.

- Visual Inspection primarily is intended to enhance inspection and make a job easier for inspectors, not replace other inspections.
 - Visual Inspection was the original inspection. As technology became more specialized, there was a movement away from general VI. Technology is applied to the investigation process to reduce uncertainty and risk of failure. General VI is almost impossible to teach across industries due to the specialization of both the product and the NDI methodology.
- b. Transferable Techniques
- Although VI training is not specifically aimed at the aircraft industry, it may be relevant through knowledge transfer.
 - Visual Inspection courses for welding are taught in a general form, but are very specific both as to methodologies such as PT for enhancement and as to product such as piping. Portions of training for visual inspection of welds could be applicable to specific aircraft structures.
 - Little training is available for auditing and surveillance.
- c. Demand for VI
- VI courses have not been offered or developed due to low industry demand, although there seems to be a recent increase in demand for VI.
 - Courses in VI would be offered if the market were to demand VI. Visual Inspection could be offered through extension of other NDI training program(s).
- d. Visual Testing, Level III in NDI
- Only the nuclear industry (EPRI) and the American Welding Society (AWS) offer visual training through Level III that may be applicable for knowledge transfer to the aircraft industry.
 - The nuclear industry covers VT through three means; (1.) component surface, (2.) leakage, and (3.) structural support. Portions of these VT courses may be applicable to aircraft inspection.
 - Visual Testing at AWS is taught, through Level III, in three stages, (1.) before the weld, (2.) during the welding process, and (3.) after the weld is finished, using the AWS guidelines only (not ASNT guidelines).
- e. Visual Inspection Provided as Aftermarket Service or Marketing Technique.
- Visual Inspection could be offered as an extension of other NDI courses; i.e., eddy current courses specifically aimed at the aircraft industry. Training on one brand of equipment, along with possible VI, is offered only after purchase of equipment from the manufacturing company.
 - Consulting services related to NDI and VI often do not provide training.
 - Visual training combined with videoborecopying is offered with specific application to the airline industry, engines and airframe structures. This training is offered only after purchasing that equipment. The general rule is that clients must purchase the product to receive training in NDI and VI. Marketing is enhanced by offering the training to the customer.

Table 1 Summary of Sources with Highest Availability and Relevance

Institution	City, State
American Welding Society (AWS)	Miami, Florida
Electric Power Research Inst. (EPRI)-NDE Center	Charlotte, North Carolina
Hellier Associates Inc.	Niantic, Connecticut
Hutchinson Area Vocational-Technical Inst.	Hutchinson, Minnesota
Moraine Valley Community College	Palos Hills, Illinois
MQS Inspection Inc.-NDE Training Center	Elk Grove Village, Illinois
USAir-Inspection Department	Pittsburgh, Pennsylvania

MOST RELEVANT SOURCES

Several community colleges, technical/vocational schools, A&P schools, and commercial/industrial organizations offer relevant VI training in the form of short courses either on-site or at their facilities. The most relevant of these are listed in Table 1.

CONCLUSION

This study shows that the availability of instruction (training) in VI is limited as is the training in the audit and surveillance area. The available training is highly product-oriented and/or process-oriented. Examples are specialties in pressure vessels and pipes (products) and emphasis on welding (process). Another class of instruction is oriented toward the use of particular commercial optical instruments. The latter visual training is generally given to customers of the instrument manufacturers and sometimes to special groups (not to be classed as public).

Considering aircraft as a "product" to be tested, it was found that very little aircraft-specific training in VI is available. The knowledge from other fields such as VI of welds can be partially transferred to aircraft. An acceptable VI training course for use with the commercial air fleet is needed.

Considerations such as availability, curriculum, and reputation, led to a select list that includes USAir, MQS, Hellier, EPRI, and AWS from industrial sources and among the schools, Hutchinson and Moraine Valley. These seven organizations represent the strongest programs currently available. These are summarized in Table 1.

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