

800518055

CONTRACTOR: THE UNIVERSITY OF MICHIGAN

APPENDIX A

For the contract period January 1, 1980 through December 31, 1980.

Article A-I RESEARCH TO BE PERFORMED BY THE CONTRACTOR

(a) The unclassified scope of work under this contract entitled, "Improved Ultrasonic Nondestructive Testing of Pressure Vessels" is as follows:

Task I - Design, implement and evaluate a prototype of a real-time SAFT-UT imaging system for field implementation.

1. Analyze the scanning, processing and display segments carefully and identify the problem areas in each.
2. Compare each of the critical sections to determine the ones that are the most critical and need to be solved.
3. Write algorithms to verify that they are indeed the bottlenecks. For instance, to ascertain that processor and memory are not the real constraints, implement the algorithm on other processors and compare performance.
4. Implement the technique of partial apertures. Study its results and evaluate the use of this technique.
5. Write a report summarizing the findings and evaluate the results for future guidelines.

Task II - Design and implement methods for enhanced graphical display of flaws to provide better interpretability.

1. Study various techniques of continuous tone shading.
2. Implement a few that look promising and test them on images of real flaws as well as other images.
3. Based on the above results, select one and obtain results on actual flaw data.
4. Investigate techniques to implement progressive display of sequential planes.
5. Write a report on the above and evaluate the results for future directions.

Task III - Construct a mathematical model of the synthetic aperture processing system to enable characterization of flaws and improve the extraction of information in the signal.

1. Carry out the preliminary analysis using scalar wave theory and determine to what extent the Fourier optics analogies are justified.
2. Consider the effects of sampling and pulse width on the point spread function of the processing.
3. Investigate the possibility of constructing edge enhanced images by modifying the processing algorithms.
4. Write a report on the results of the analysis and its implications on future research.

Task IV - Develop methods for the imaging of weak reflectors near a front surface. Evaluate the relative merits of these methods on the basis of test results.

1. Develop and implement a spatial frequency technique.
2. Analyze more fully the requirements of a transient recorder for deconvolution techniques.
3. Write a report on the above.

Task V - Design, develop and implement methods for the automatic detection of flaw boundaries in an ultrasonic image which have less or no dependence on interpretation by an operator. Develop techniques for image interpolation to adjust for decreased scanning resolution in X and Y (compared to Z) directions.

1. Implement several two-dimensional edge operators.
2. Obtain results on several real flaw images and compare results.
3. Write a report on the findings and recommend one of the two-dimensional operators for actual use.

Task VI - Perform synthetic aperture imaging with shear waves.

1. Make modification to scanning, processing and display software to handle shear-wave imaging.
2. Test the algorithm on flat test pieces.
3. Write a report on the results and evaluate it.

Task VII - Improve and further develop the survey-mode detection system.

1. Develop software to perform various measurements on a pulse echo.
2. Develop a multidimensional data analysis program.
3. Write a report summarizing the results of feature collection.

Task VIII - Evaluate the spotlight mode scanning technique for possible field implementation.

1. Compare quantitatively the relative increase in sensitivity of spotlight mode scanning with that of other alternatives.
2. Determine whether or not the complex scanning is a true bottleneck to real-time imaging by considering its effect on the entire system.
3. If spotlight mode scanning still looks promising, propose a detailed design for a fast, efficient scanning mechanism which would be compatible with the entire imaging system and also with the geometry of a reactor pressure vessel region most likely to require spotlight mode scanning.
4. Write a report summarizing the results of this study and make recommendations for the use of spotlight mode scanning in the field.

Task IX - Analyze the needs for the project in terms of equipment and facilities. Modernize the laboratory by exploiting the trend in decreasing hardware costs of computer peripherals by equipping it with cost-effective equipment. This task to be in operation through the entire contract period.

Task X - Provide technical, analytical and other support to other organizations that may be involved in applying SAFT-UT for field inspections as may be required and requested by the NRC.

In addition to the reports outlined above, the following additional reports are required:

<u>Type of Report</u>	<u>Due</u>	<u>Copies</u>
Informal Monthly Letter Report	Monthly	1-copy to project office 1-copy to Contracting Officer
Semi-Annual Progress Report	Semi-Annually	Same as above reports
Annual Topical Report	Annually	1-camera ready copy to Branch

(b) The Principal Investigator expects to devote the following approximate amount(s) of time to the contract work:

60% of his time for nine (9) months, plus two (2) summer months.

Article A-II WAYS AND MEANS OF PERFORMANCE

(a) Items for which support will be provided as indicated in A-III, below:

- | | |
|---|--------------|
| 1. Salaries & Wages | \$104,315.00 |
| 2. Equipment to be purchased or fabricated by the Contractor: | \$ 750.00 |
| <u>Over \$1,000.</u> | |
| -0- | |
| <u>Under \$1,000.</u> | |
| Tube for Tektronix 4010 - \$750.00 | |
| 3. Travel: | |
| (i) Domestic | \$ 9,000.00 |
| (ii) Foreign | \$ -0- |
| 4. Other direct costs including fringe benefits. | |
| 5. Indirect costs based on a predetermined rate of 68.7% applicable to salaries, wages, and benefits. | |

- (b) Items, if any, significant to the performance of this contract, but excluded from computation of Support Cost and from consideration in proportioning costs:

None

- (c) Time or effort of Principal Investigator(s) including indirect costs and fringe benefits contributed by Contractor but excluded from computation of Support Cost and from consideration in proportioning costs:

None

Article A-III

The total estimated cost of items under A-II(a) above for the contract period stated in this Appendix A is \$231,250.00 ; the Commission will pay 100 percent of the actual costs of these items incurred during the contract period stated in this Appendix A, subject to the provisions of Article III and Article B-XXVIII. The estimated NRC Support Cost for the contract period stated in this Appendix A is \$231,250.00 .

The estimated NRC Support Cost is funded as follows:

- | | |
|---|----------------------|
| (a) Estimated unexpended balance from prior period(s) | \$ <u>-0-</u> |
| (b) New funds for the current period | \$ <u>231,250.00</u> |
| (c) The new funds being added in A-III(b) constitute the basis for advance payments provided under Article B-X. | |