Appendix A
Glossary of Terms

During the analysis of the NDE techniques in terms of flaw detection several new terms were introduced. This Appendix defines these new terms.

Real Flaw: An indication which was detected by at least 7 out of the 9 inspectors. A flaw was considered "detected" by a given inspector by first calculating the mean angular position of the flaw: if and only if the inspector's recorded position fell within a predefined angular range of this mean angle was it considered detected. For the preliminary analysis this range was calculated at ±20° for the first analysis and ±30° for the second.

Called Real Flaw: A Real Flaw detected by a given inspector.

Missed Real Flaw: A Real Flaw that was not detected by a given inspector. Also referred to as a False Negative.

False Positive: A flaw indicated by the inspector that was found by 3 or less out of the 9 inspectors.

False Negative: A flaw which was found by at least 7 out of the 9 inspectors, but not found by the current inspector. Also referred to as a Missed Real Flaw.

False Calls: Either a missed real flaw (false negative) or a detected nonexistent flaw (false positive).

False Call Index (FCI): The sum of the inspection's false negatives and false positives: the lower the number the better the inspection. Has a minimum value of 0 (found all real flaws, didn't have any false positives) to a maximum value equal to the sum of real flaws and false calls (missed all real flaws, had all the false positives), which was given as 190 and 172 for the ±20° and the ±30° analyses respectively. Leads to the Reliability Index.

Reliability Index (RI): False Call Index normalized to 100. Provides for easier comparison across analysis techniques. Best possible RI is 0; worst possible is 100: given 100 inspections, an inspector can be expected to make a number of false calls equal to his or her RI. Also referred to as the Normalized Index.

VT: Visual Testing. In the chart, refers to the averages across skill levels for the visual testing technique (i.e. independent of skill level).

ET: Eddy Current Testing. In the chart, refers to the averages across skill levels for the eddy current testing technique (i.e. independent of skill level).

UT: Ultrasonic Testing. In the chart, refers to the averages across skill levels for the ultrasonic testing technique (i.e. independent of skill level).

X: Expert skill level, either a system vendor or a practitioner with years of experience, e.g. 'VTX' is an expert in the visual testing of aluminum gas cylinders. In the chart, refers to the averages across inspection technique for the expert skill level (i.e. independent of NDE technique).

S: NDE Specialist skill level, an inspector familiar with NDE in general or the technique in general use but not experienced with the specific application to aluminum gas cylinders, e.g. 'ETS' is an inspector familiar with eddy current testing but new to eddy current testing of aluminum gas cylinders. In the chart, refers to the averages across inspection technique for the specialist skill level (i.e. independent of NDE technique).

T: Technician skill level, an inspector familiar with general testing procedures but not familiar with NDE or the inspection of aluminum gas cylinders, e.g. 'UTT' is an inspector with little to no prior experience with UT or its application to aluminum gas cylinders. In the chart, refers to the averages across inspection technique for the technician skill level (i.e. independent of NDE technique).

VET: Based on the preliminary data, the most promising inspection technique appears to be a combination procedure of using VT and ET. VE data are determined by taking the best results of VT and ET and combining them in a single inspection: it is thus assumed that in using ET and VT in combination an inspector gets the benefits of both and the drawbacks of neither. In the chart, refers to the averages across skill levels for the combination of visual and eddy current testing technique (i.e. independent of skill level).

Appendix B
Bryant-Lee Associates Data Report on EDM and Measurement of Cracks on Aluminum Cylinder Samples

The Statement of Work (SOW) for this project indicated that upon its completion NTIAC was to deliver several items to the RSPA. This Appendix outlines these items, as well as explaining some of the additional material delivered to the RSPA but not specifically stated as a deliverable in the SOW.

Gas Cylinders

These cylinders, serial numbers P4205 and T94863, were inspected as part of the project's initial investigation into NDE techniques. These bottles were chosen as representatives of the 51 bottles used during the study, and are detailed hereafter. The bottles were shipped intact to RSPA to allow for their own inspection studies with the NDE equipment: the flaws listed below are those reported by all inspectors and are not categorized as real or false.

Bottle Number	Mean Flaw Positions [Degrees from Reference Point]	Mean Flaw Size [Thread Count]
P4205 (SCUBA)	150 200	5 8
T94863 (SCBA)	70 90 200 285	6 5 8 5

Reference and Calibration Blocks

These cylinder heads were on loan from the RSPA during the project. They were used primarily to design the testing and data recording procedures and to calibrate the ultrasonic measurements. The eddy current test equipment comes with its own calibration references.

Visual Eddy Test System

This was the eddy current inspection system used to inspect the gas cylinders. Included are the calibration standards used during the initial setup of the system, 3 probes (two SCBA one SCUBA), and accompanying documentation. Note that Flare Technology normally requires that an inspector be certified prior to using the Visual Eddy System.

Flaw Samples

These samples were made during the destructive analysis phase of the project, and are detailed in the Destructive Analysis section of this report.

Data Sheets

These data sheets are duplicates of the original data sheets recorded by the NDE inspectors, the originals being stored in NTIAC's facilities. They are organized according to inspector and inspection technique.

Data Recording Sheets

These are the original data recording sheets used by the test coordinator to record the data from each inspection. The method involves placing the transparency over the neck of the

cylinder, aligning the 0° mark with the reference mark on the bottle, and then recording the actual flaw positions on the data sheet recorded by the inspector.

Destructive Analysis Report

A summary of the efforts by Bryant-Lee Associates in the destructive analysis of the flaws is presented in the main report submitted by NTIAC, but in the interests of full disclosure the fully report filed by Bryant-Lee is submitted as well.

Guide to Visual Inspection

A document prepared by Luxfer that details the recommended procedure for the visual inspection

Appendix C
Data Sheets