A1.1 Preface

This Quality Assurance Project Plan (QAPP) is submitted in partial fulfillment of the Comprehensive Flare Study Project contract issued by the Texas Commission on Environmental Quality (TCEQ) to The University of Texas at Austin, Center for Energy and Environmental Resources under Grant Activities No. 582-8-862-45-FY09-04, Tracking No. 2008-81. It has been prepared in accordance with the Environmental Protection Agency QA-R5 document format for National Air Monitoring Stations/State and Local Air Monitoring Stations (NAMS/SLAMS) and Photochemical Assessment Monitoring Stations (PAMS). In this regard, the most current versions (at the time of initial preparation) of the TCEQ NAMS/SLAMS/PAMS QAPPs for air monitoring in Texas have been used as the basis for this document. It is expected that during the life of this project, the requirements of this QAPP will always meet or exceed the TCEQ NAMS/SLAMS/PAMS QAPPs for air monitoring in Texas.

Contact:

Edward L. Michel
Flare Tests Coordinator
Comprehensive Flare Study

E-mail Address: terrafood1@mail.utexas.edu

The University of Texas at Austin
Center for Energy & Environmental Resources (R7100)
10100 Burnet Road, EME (Bldg 133)
Austin, TX 78758

A1.2 Approval Page

Project Manager Air Quality Division Texas Commission on Environmental Quality	Danielle Nesvacil	Date
Project Manager Air Quality Division Texas Commission on Environmental Quality	Russ Nettles	Date
Project Manager Air Quality Division Texas Commission on Environmental Quality	Kevin Cauble	Date
Project Quality Assurance Manager Air Quality Division Texas Commission on Environmental Quality	Bryan Foster	Date

A1.2 Approval Page (Continued)

TCEQ Technical Review Committee Comprehensive Flare Study Project	Peter Gogolek, Ph.D.	Date
TCEQ Technical Review Committee Comprehensive Flare Study Project	John Pohl, Sc.D.	Date
TCEQ Technical Review Committee Comprehensive Flare Study Project	Eben Thoma, Ph.D.	Date

A1.2 Approval Page (Continued)

Principal Investigator Comprehensive Flare Study Project The University of Texas at Austin Austin, Texas	_____ David T. Allen, Ph.D.	_____ Date
Project Manager Comprehensive Flare Study Project The University of Texas at Austin Austin, Texas	_____ Vincent M. Torres, MSE, PE	_____ Date
Project Quality Assurance Manager Comprehensive Flare Study Project The University of Texas at Austin Austin, Texas	_____ Dave Sullivan, Ph.D	_____ Date
Flare Tests Coordinator Comprehensive Flare Study Project The University of Texas at Austin Austin, Texas	_____ Edward L. Michel	_____ Date

A1.2 Approval Page (Continued)

Project Representative/ Project Director Aerodyne Research, Inc. Billerica, Massachusetts	Scott Herndon, Ph.D.	Date
Project Quality Assurance Officer Aerodyne Research, Inc. Billerica, Massachusetts	Charles E. Kolb, Ph.D.	Date

A1.2 Approval Page (Continued)

Project Representative/ Project Director Industrial Monitor and Control Corporation Round Rock, Texas	Robert L. Spellicy, Ph.D.	Date
Project Quality Assurance Officer Industrial Monitor and Control Corporation Round Rock, Texas	Curt Laush, Ph.D.	Date

A1.2 Approval Page (Continued)

Project Representative/ Project Director
John Zink Company, Inc.
Tulsa, Oklahoma

_____ _____
Robert Schwartz Date

Project Quality Assurance Officer
John Zink Company, Inc.
Tulsa, Oklahoma

_____ _____
Wes Bussman, Ph.D. Date

Project Operations Director
John Zink Company, Inc.
Tulsa, Oklahoma

_____ _____
Zachary Kodesh Date

A1.2 Approval Page (Continued)

Project Representative/ Project Director
Leak Surveys, Inc.
Early, Texas

Bud McCorkle

Date

Project Quality Assurance Officer
Leak Surveys, Inc.
Early, Texas

Joshua Furry

Date

A1.2 Approval Page (Continued)

Project Representative/ Project Director
Telops
Quebec City, Quebec
Canada

Vincent Farley

Date

Project Quality Assurance Officer
Telops
Quebec City, Quebec
Canada

Jean Giroux

Date

A1.2 Approval Page (Continued)

Project Representative/ Project Director TRC Austin, Texas	Jim Barufaldi	Date
Project Quality Assurance Officer TRC Austin, Texas	Clayton Elliot	Date

A1.2 Approval Page (Continued)

Project Representative/ Project Director Zephyr Environmental Consulting Austin, Texas	Karen Olsen	Date
Project Quality Assurance Officer Zephyr Environmental Consulting Austin, Texas	Maria Gou	Date

TABLE OF CONTENTS

Section	Title	Pages	Revision	Date
	PROJECT MANAGEMENT			
A1	Title and Approval Sheets	11	0	8/10
	A1.1 Preface			
	A1.2 Approval Page			
A2	Table of Contents	8	0	8/10
	A2.1 List of Figures			
	A2.2 List of Tables			
	A2.3 List of Appendices			
A3	Distribution List	1	0	8/10
A4	Project/Task Organization	13	0	8/10
	A4.1 Project Sponsor			
	A4.2 TCEQ Technical Review Panel			
	A4.3 Principal Investigator and Project Manager			
	A4.4 UT Austin and TCEQ Project Quality Assurance (QA) Officers			
	A4.5 UT Austin Flare Tests Coordinator			
	A4.6 Flare Test Facility			
	A4.7 Direct Flare Stack & Flue Gases Measurements			
	A4.8 Direct Flare Flue Gas Measurements			
	A4.9 Flare Flue Gas Remote Sensing Measurements			
	A4.10 Infrared and Visible Wavelength Video Camera Recordings of Flare Flue Gas			
	A4.11 Flare Test Data Collection, Coordination, Management and Validation			
	A4.12 Statistical Support			
	A4.13 Subcontractors			
A5	Problem Definition/Background	3	0	8/10
	A5.1 Background			

TABLE OF CONTENTS

Section	Title	Pages	Revision	Date
	A5.2 Conclusions to be Made			
	A5.3 Uses of Data			
	A5.4 Decision Makers			
	A5.5 Principal Customers for the Results			
A6	Project/Task Description	2	0	8/10
	A6.1 Project Overview			
	A6.2 Sampling Measurement Activities			
	A6.3 Standards and Screening Levels			
	A6.4 Assessment Tools			
	A6.4.1 Performance Evaluations			
	A6.5 Project Reports			
A7	Data Quality Objectives (DQO) for Measurement Data	2	0	8/10
	A7.1 General Project Objective			
	A7.2 Measurement Quality Objectives			
	A7.2.1 Detection Limits			
	A7.2.2 System Contribution to the Measurement			
	A7.2.3 Precision			
	A7.2.4 Accuracy			
	A7.2.5 Completeness			
	A7.2.6 Representativeness			
	A7.2.7 Comparability			
A8	Special Training Requirements/Certification	1	0	8/10
A9	Documentation and Records	2	0	8/10
	A9.1 Mechanisms for Documentation of Procedures and Objectives			
	A9.2 Mechanisms for Record Keeping			

TABLE OF CONTENTS

Section	Title	Pages	Revision	Date
	A9.3 Data Reporting Turnaround Time			
	A9.4 Data Storage			
	MEASUREMENT/DATA ACQUISITION			
B1	Sampling Process Design (Experimental Design)	2	0	8/10
	B1.1 Study Site Design			
	B1.2 Study Site Design Rationale			
	B1.3 Measurement Validation			
B2	Sampling Methods Requirements	5	0	8/10
	B2.1 Continuous Methods			
	B2.1.1 John Zink Company, Inc.			
	B2.1.2 Aerodyne Research, Inc.			
	B2.1.3 Telops			
	B2.1.4 Industrial Monitor and Control Corporation			
	B2.1.5 Leak Surveys, Inc.			
	B2.2 Non-continuous Methods			
	B2.2.1 TRC			
	B2.3 Corrective Actions			
B3	Sample Handling and Custody	1	0	8/10
B4	Analytical Methods Requirements	1	0	8/10
	B4.1 Analytical Procedures			
	B4.1.1 Aerodyne Research, Inc.			
	B4.2 Corrective Actions			
B5	Quality Control (QC)	2	0	8/10
	B5.1 John Zink Company LLC			
	B5.2 TRC			
	B5.3 Aerodyne Research, Inc.			
	B5.4 Telops			
	B5.5 Industrial Monitor and Control Corporation			
	B5.6 Leak Surveys, Inc.			
B6	Instrument/Equipment Testing, Inspection, and Maintenance Requirements	2	0	8/10
	B6.1 Instrument Testing/Inspection			
	B6.2 Preventive Maintenance Procedures			
	B6.2.1 John Zink Company LLC			
	B6.2.2 TRC			
	B6.2.3 Aerodyne Research, Inc.			
	B6.2.4 Telops			
	B6.2.5 Industrial Monitor and Control Corporation			
	B6.2.6 Leak Surveys, Inc.			
	B6.3 Corrective Maintenance Procedures			
	B6.3.1 John Zink Company LLC			
	B6.3.2 TRC			
	B6.3.3 Aerodyne Research, Inc.			

TABLE OF CONTENTS

Section	Title	Pages	Revision	Date
	B6.3.4 Telops			
	B6.3.5 Industrial Monitor and Control Corporation			
	B6.3.6 Leak Surveys, Inc.			
	B6.4 Availability of Spare Parts			
B7	Instrument/Equipment Calibration and Frequency	2	0	8/10
	B7.1 Calibration			
	B7.1.1 John Zink Company LLC			
	B7.1.2 TRC			
	B7.l.3 Aerodyne Research, Inc.			
	B7.1.4 Telops			
	B7.1.5 Industrial Monitor and Control Corporation			
	B7.1.6 Leak Surveys, Inc.			
	B7.2 Traceability			
	B7.2.1 John Zink Company LLC			
	B7.2.2 TRC			
	B7.2.3 Aerodyne Research, Inc.			
	B7.2.4 Telops			
	B7.2.5 Industrial Monitor and Control Corporation			
	B7.2.6 Leak Surveys, Inc.			
	B7.3 Documentation			
B8	Inspection/Acceptance Requirements for Supplies and Consumables	1	0	8/10
	B8.1 Sampling Supplies			
	B8.2 Standards			
	B8.3 Spare Parts			
B9	Data Acquisition Requirements (Non-Direct Measurements)	1	0	8/10
B10	Data Management	2	0	8/10
	B10.1 John Zink Company LLC			
	B10.2 TRC			
	B10.3 Aerodyne Research, Inc.			
	B10.4 Telops			
	B10.5 Industrial Monitor and Control Corporation			
	B10.6 Leak Surveys, Inc.			
	B10.7 Acceptability of the Hardware/Software Configuration			
	B10.8 Data to Users			
	ASSESSMENT/OVERSIGHT			
C1	Assessments and Response Actions	3	0	8/10
	C1.1 Technical Systems Audit			
	C1.1.1 Field Technical Systems Audit			
	C1.1.2 Field Inspections			
	C1.2 Performance Evaluations			

TABLE OF CONTENTS

Section	Title	Pages	Revision	Date
	C1.2.1 Field Assessment			
	C1.3 Assessment of Data Quality Indicators			
	C1.3.1 Specific Procedures to Assess Data Quality			
	C1.3.1.1 Data Precision Assessment			
	C1.3.1.2 Data Accuracy Assessment			
	C1.3.1.3 Data Completeness Assessment			
	C1.4 Audits of Data Quality			
	C1.5 Corrective Actions			
C2	Reports to Management	1	0	8/10
	C2.1 Quality Assurance (QA) Audit Reports			
	C2.2 Annual Project QA Report			
	C2.3 Data Reports			
	C2.3.1 Field Activity Reports			
	C2.3.2 Quality Assurance Reports			
	C2.4 Reporting Schedule			
	DATA VALIDATION AND VERIFICATION			
D1	Data Review, Validation, and Verification	3	0	8/10
	D1.1 Data Validation			
	D1.1.1 John Zink Company LLC			
	D1.1.2 TRC			
	D1.1.3 Aerodyne Research, Inc.			
	D1.1.4 Telops			
	D1.1.5 Industrial Monitor and Control Corporation			
	D1.1.6 Leak Surveys, Inc.			
	D1.2 Data Custody			
	D1.2.1 John Zink Company LLC			

TABLE OF CONTENTS

Section	Title	Pages	Revision	Date
	D1.2.2 TRC			
	D1.2.3 Aerodyne Research, Inc.			
	D1.2.4 Telops			
	D1.2.5 Industrial Monitor and Control Corporation			
	D1.2.6 Leak Surveys, Inc.			
D2	Validation and Verification Methods	2	0	8/10
	D2.1 John Zink Company LLC			
	D2.2 TRC			
	D2.3 Aerodyne Research, Inc.			
	D2.4 Telops			
	D2.5 Industrial Monitor and Control Corporation			
	D2.6 Leak Surveys, Inc.			
	D2.7 Data Review			
D3	Reconciliation with User Requirements	3	0	8/10
	D3.1 Detection Limits			
	D3.2 Precision			
	D3.2.1 John Zink Company LLC			
	D3.2.2 TRC			
	D3.2.3 Aerodyne Research, Inc.			
	D3.2.4 Telops			
	D3.2.5 Industrial Monitor and Control Corporation			
	D3.2.6 Leak Surveys, Inc.			
	D3.3 Accuracy			
	D3.3.1 John Zink Company LLC			
	D3.3.2 TRC			
	D3.3.3 Aerodyne Research, Inc.			
	D3.3.4 Telops			
	D3.3.5 Industrial Monitor and Control Corporation			
	D3.3.6 Leak Surveys, Inc.			

TABLE OF CONTENTS

Section	Title	Pages	Revision	Date
D3.4	Completeness			

LIST OF FIGURES

Section		Title	Pages	Revision	Date
A4	Figure A4.A	Comprehensive Flare Study Project Organization	1	0	8/10
B2	Figure B2.A	LSI Camera Image	1	0	8/10
B5	Figure B5.A Appendix F	Aerodyne Mass Spectrometer	1	0	8/10

LIST OF TABLES

Section		Title	Pages	Revision	Date
A7	Appendix G	Reporting Units of Measurements	1	0	8/10
B2	Table B2A	Flare Plume Compounds Measured by Aerodyne	1	0	8/10
B2	Table B2.B	Flare Plume Compounds Measured by Telops	1	0	8/10
C1	Appendix I	Field Inspection Report	2	0	8/10
App. D	Draft Tests	Comprehensive Flare Study Draft ZINK Tests	1	0	8/10
App. L	Appendix L	Acronyms	2	0	8/10

LIST OF APPENDICES

Appendix	Title	Pages	Revision	Date
A	Overall Plan View of Flare Operation Facility Area	1	0	8/10
A1	Satellite Photo of Flare Operation Facility Area, Subcontractor Location	1	0	8/10
A2	Satellite Photo of Flare Operation Facility Area, Observer Room, Propylene Storage Location	1	0	8/10
B	TRC Modified EPA Method 3A, O_2 and CO_2	11	0	8/10
B1	TRC Modified EPA Method 18, GC Analysis	12	0	8/10
B2	TRC Modified EPA Method 19, Mass Emission Calculations	14	0	8/10
B3	Heating Value Calculations	1	0	8/10
B4	Aerodyne Methods	8	0	8/10
B5	John Zink Company LLC QC	4	0	8/10
B6	Zephyr Calculations	1	0	8/10
B7	John Zink Calculations	3	0	8/10
B8	Aerodyne DRE	4	0	8/10
B9	IMACC CE	1	0	8/10
B10	IMACC Procedures	8	0	8/10
B11	IMACC Calibrations	6	0	8/10
B12	Telops Methods	2	0	8/10
C1	Schematic of Flare Measurements; Wake Dominated Flare Flue Gas	1	0	8/10
C2	Schematic of Flare Measurements; Buoyancy-Dominated Flare Flue Gas	1	0	8/10
C3	Schematic of Flare Measurements; Remotely Sensing of Flare Flue Gas	1	0	8/10
D	Comprehensive Flare Study Proposed Flare Test Plan	10	0	8/10
E	Flare Test Plan Modification Process	1	0	8/10
F	Quality Assurance Steps for the Aerodyne Measurements	2	0	8/10
G	Measurement Data Quality Objectives	4	0	8/10
H	Measurement Data Quality Control Activities	5	0	8/10
I	Field Inspection Report	2	0	8/10

LIST OF APPENDICES

Appendix	Title	Pages	Revision	Date
J	Flare Flue Gas Sampling Device Diagram	1	0	8/10
J1	Flare Flue Gas Sampling Device Drawings, Vertical	1	0	8/10
J2	Flare Flue Gas Sampling Device Drawings, Horizonal	1	0	8/10
K	Comprehensive Flare Study Project Schedule of Major Activities for Field Measurements	2	0	8/10
L	Steam Flare Tip Drawing	1	0	8/10
L1	Air Flare Tip Drawing	1	0	8/10
M	ZINK Waste Gas and Steam Flow Diagram, 1	1	0	8/10
M1	ZINK Waste Gas and Steam Flow Diagram, 2	1	0	8/10
N	Flare Project Activity and Protocol Documents	25	0	8/10
O	Acronyms	3	0	8/10

A3 DISTRIBUTION LIST

Texas Commission on Environmental Quality

Danielle Nesvacil, Project Manager, Air Quality Division
Russ Nettles, Project Manager, Air Quality Division
Bryan Foster, Project Quality Assurance Officer, Air Quality Division

Texas Commission on Environmental Quality– Technical Review Panel

Peter E. G. Gogolek, Ph.D., CanmetENERGY
John Pohl, Sc.D., Virginia Polytechnic Institute and State University
Eben, Thoma, Ph.D., US Environmental Protection Agency

Flare Tests Subcontractors

Scott Herndon, Ph.D., Aerodyne Research, Inc.
Robert L. Spellicy, Ph.D., Industrial Monitor and Control Corporation
Bob Schwartz, John Zink Company, LLC
Bud McCorkle, Leak Surveys, Inc.
Vincent Farley, Telops
Jim Barufaldi, TRC
Karen Olsen, Zephyr Environmental Corporation

The University of Texas at Austin

David T. Allen, Ph. D., Principal Investigator
Vincent M. Torres, Project Manager
Edward L. Michel, Flare Tests Coordinator
Dave Sullivan, Ph. D., Project Quality Assurance Officer

A4 PROJECT/TASK ORGANIZATION

The Comprehensive Flare Study Project is performed by The University of Texas at Austin and its contractors. The overall project organization is shown in Figure A4.A. The project participants involved in the flare testing and their role and responsibilities are presented in Table A4.1. The interrelationships and responsibilities of the participants in this project are listed below.

A4.1 Project Sponsor

Ms. Danielle Nesvacil, Mr. Russ Nettles Texas Commission on Environmental Quality (TCEQ)

- Sets the study objectives for the project.
- Allocates adequate resources to ensure completion of the project in compliance with the stated objectives.
- Defines the project team and organization
- Reviews and approves the Quality Assurance Project Plan (QAPP) and any changes.
- Defines the overall project schedule and deliverables.
- Determines the ultimate use of the data set developed from the project activities.

A4.2 TCEQ Technical Review Panel

Dr. Peter Gogolek, Dr. John Pohl, and Dr. Eben Thoma

- Reviews and comments on the Draft QAPP.
- Reviews and comments on the Draft Preliminary Flare Measurements Report.
- Reviews and comments on the Draft Comprehensive Flare Study Report.

A4.3 UT Austin Principal Investigator, Project Manager

Dr. David Allen and Mr. Vincent M. Torres, The University of Texas at Austin

- Are the primary contact personnel for the project.
- Provide project planning, coordination of all project work and preparation of all reports to the Project Sponsor.
- Provide oversight of subcontractor work and approval of work products.
- Ensure that all subcontractors are qualified for the operations they will perform and/or the measurements they will be making.
- Prepare the QAPP for the project for review and approval by the TCEQ.
- Coordinate the QA activities for the project including QA activities with external agencies and non-agency groups.
- Coordinate data compilation, oversee and perform data analysis, prepare project draft preliminary flare measurements report and production of project final report.

A4.4 UT Austin and TCEQ Project Quality Assurance (QA) Officers

Dr. Dave Sullivan, The University of Texas at Austin and Mr. Bryan Foster, Texas Commission on Environmental Quality (TCEQ)

- Participate in the development, approval, implementation, and maintenance of the project's written quality assurance documents (e.g, QMPs, SOPs, QAPPs).
- Perform project and laboratory technical systems audits.
- Participate in the preparation of quality assurance reports.
- Determine conformance with project quality system requirements.
- Review and approve proposed corrective actions and verifications.
- Monitor the implementation of corrective actions.
- Report on the status of corrective action programs.
- Assess the effectiveness of the project's quality systems.
- Coordinate the identification, disposition, and reporting to project management of nonconforming items and activities.

A4.5 UT Austin Flare Tests Coordinator

Edward L. Michel, The University of Texas at Austin

- Participate in project planning, participate in coordination of project work and participate in the preparation of all reports to the Project Sponsor.
- Coordinate the subcontractor's work during the flare tests and review their work products.
- Coordinate the assurance that all subcontractors are qualified for the operations they will perform and/or the measurements they will be making.
- Participate in the preparation of the QAPP for the project for review and approval by the TCEQ.
- Participate in the coordination of the QA activities for the project including QA activities with external agencies and non-agency groups.
- Coordinate delivery of all subcontractors' preliminary report of flare measurements, final report of flare measurements, and delivery of quality assured data in prescribed formats.

A4.6 Flare Operations Facility

Mr. Robert E. Schwartz, Senior Technical Specialist, John Zink Company, LLC

- Provide the flare test facility with the capabilities specified in the flare test plan.
- Provide the qualified technical and test coordination support to operate the flare test facility during the flare tests.
- Review and certify that all flare test facility instrumentation, sampling equipment, and surveillance cameras meet or exceed the QAPP specifications.

- Perform quality control checks on all flare test facility instrumentation, sampling equipment and surveillance cameras before and during the flare tests and take corrective action when indicated.
- Perform scheduled preventive maintenance procedures for all flare test facility instrumentation, sampling equipment, meteorological equipment, and surveillance cameras
- Record data/information as required in appropriate flare and quality assurance test logs.
- Calibrate instrumentation.
- Perform calibration verification checks.
- Maintain calibration equipment.
- Participate in the development of updates and revisions to written quality assurance standards (e.g., QMPs, SOPs, QAPPs).

A4.7 Direct Flare Stack & Flue Gases Measurements

Mr. Jim Barufaldi, TRC Companies, Inc.

- Provide the stack gas instrumentation, sampling and analysis equipment to perform measurements of stack gases as specified in the flare test plan.
- Provide the qualified technical support to operate the stack gas instrumentation, sampling and analysis equipment before and as needed during the flare tests.
- Review and certify that all stack gas instrumentation, sampling and analysis equipment meet or exceed the QAPP specifications.
- Perform quality control checks on all stack gas instrumentation, sampling and analysis equipment before and during the flare tests and take corrective action when indicated.
- Perform scheduled preventive maintenance procedures for all stack gas instrumentation, sampling and analysis equipment.
- Record data/information as required in appropriate flare test and quality assurance logs.
- Calibrate instrumentation, sampling equipment and meteorological equipment.
- Perform calibration verification checks.
- Maintain calibration equipment.
- Participate in the development of updates and revisions to written quality assurance standards (e.g., QMPs, SOPs, QAPPs).

A4.8 Direct Flare Flue Gas Measurements

Dr. Scott Herndon, Aerodyne Research, Inc.

- Provide the Aerodyne mobile monitoring lab with all the instrumentation to perform measurements in the flare plume and associated analysis of samples as specified in the flare test plan.
- Provide the qualified technical support to operate the Aerodyne mobile monitoring lab in advance of, as required, and during the flare tests.
- Review and certify that all instrumentation, sampling equipment, and meteorological equipment meet or exceed the QAPP specifications.
- Perform quality control checks on all instrumentation, sampling equipment, and meteorological equipment before and during the flare tests and take corrective action when indicated.
- Perform scheduled preventive maintenance procedures for all instrumentation, sampling equipment, and meteorological equipment.
- Record data/information as required in appropriate flare test and quality assurance logs.
- Calibrate instrumentation, sampling equipment and meteorological equipment.
- Perform calibration verification checks.
- Maintain calibration equipment.
- Participate in the development of updates and revisions to written quality assurance standards (e.g., QMPs, SOPs, QAPPs).

A4.9 Flare Flue Gas Remote Sensing Measurements

Dr. Robert L. Spellicy, Industrial Monitor and Control Corporation

- Provide the passive Fourier transform infrared spectrometer with the capabilities specified in the flare test plan.
- Provide the qualified technical support to operate passive Fourier transform infrared spectrometer before, as required, and during the flare tests.
- Review and certify that passive Fourier transform infrared spectrometer meets or exceeds the QAPP specifications.
- Perform quality control checks on passive Fourier transform infrared spectrometer before and during the flare tests and take corrective action when indicated.
- Perform scheduled preventive maintenance procedures for the passive Fourier transform infrared spectrometer.
- Record data/information as required in appropriate flare test and quality assurance logs.
- Calibrate the passive Fourier transform infrared spectrometer as required.
- Perform calibration verification checks.
- Maintain calibration equipment.
- Participate in the development of updates and revisions to written quality assurance standards (e.g., QMPs, SOPs, QAPPs).

Mr. Vincent Farley, Telops, Inc

- Provide an infrared hyper-spectral imaging instrument with the capabilities specified in the flare test plan.
- Provide the qualified technical support to operate the infrared hyper-spectral imaging instrument before, as required, and during the flare tests.
- Review and certify that the infrared hyper-spectral imaging instrument meets or exceeds the QAPP specifications.
- Perform quality control checks on passive the infrared hyper-spectral imaging instrument before and during the flare tests and take corrective action when indicated.
- Perform scheduled preventive maintenance procedures for the infrared hyper-spectral imaging instrument.
- Record data/information as required in appropriate flare test and quality assurance logs.
- Calibrate the passive infrared hyper-spectral imaging instrument as required.
- Perform calibration verification checks.
- Maintain calibration equipment.
- Participate in the development of updates and revisions to written quality assurance standards (e.g., QMPs, SOPs, QAPPs).

A4.10 Infrared and Visible Wavelength Video Camera Recordings of Flare Flue Gas

Mr. Bud McCorkle, Leak Surveys, Inc.

- Provide infrared and visible wavelength cameras with the capabilities specified in the flare test plan.
- Provide videography (60 frames per second) of the flare flue gas during both the steam and air flare tests.
- Provide the qualified technical support to operate the infrared and visible wavelength cameras before, as required, and during the flare tests.
- Review and certify that the infrared and visible wavelength cameras meet or exceed the QAPP specifications.
- Perform quality control checks on the infrared and visible wavelength cameras before and during the flare tests and take corrective action when indicated.
- Perform scheduled preventive maintenance procedures for the infrared and visible wavelength cameras.
- Record images from all LSI cameras, data/information as required in appropriate flare test and quality assurance logs.
- Calibrate the infrared and visible wavelength cameras as required.
- Perform calibration verification checks.
- Maintain calibration equipment.

- Participate in the development of updates and revisions to written quality assurance standards (e.g., QMPs, SOPs, QAPPs).

A4.11 Flare Test Data Collection, Coordination, Management and Validation

Mr. Edward L. Michel, The University of Texas at Austin

- Coordinate the participation and data collection of all subcontractors during the flare tests.
- Review validation of all flare test data.
- Provide technical support on data management issues that may arise.
- Document all data management activities.
- Coordinate delivery of all subcontractors' preliminary report of flare measurements, final report of flare measurements, and delivery of quality assured data in prescribed formats.

Mr. Robert E. Schwartz, Senior Technical Specialist, John Zink Company, LLC

- Validate all John Zink Company, LLC, flare test data.
- Provide technical support on data management issues that may arise.
- Document all data management activities.
- Deliver data per schedule in Section C2.4.
- Submit draft and final John Zink reports to UT Austin flare project manager.

Mr. Jim Barufaldi, TRC Companies, Inc.

- Validate all TRC Companies, Inc. stack test data.
- Provide technical support on data management issues that may arise.
- Document all data management activities.
- Deliver data per schedule in Section C2.4.
- Submit draft and final TRC reports to UT Austin flare project manager.

Dr. Scott Herndon, Aerodyne Research, Inc.

- Validate all Aerodyne Research, Inc. flare plume test data.
- Provide technical support on data management issues that may arise.
- Document all data management activities.
- Deliver data per schedule in Section C2.4.
- Submit draft and final Aerodyne reports to UT Austin flare project manager.

Dr. Robert L. Spellicy, Industrial Monitor and Control Corporation

- Validate all Industrial Monitor and Control Corporation flare plume test data.

- Provide technical support on data management issues that may arise.
- Document all data management activities.
- Deliver data per schedule in Section C2.4.
- Submit draft and final Industrial Monitor and Control Corporation reports to UT Austin flare project manager.

Mr. Vincent Farley, Telops, Inc.

- Validate all Telops, Inc. flare plume test data.
- Provide technical support on data management issues that may arise.
- Document all data management activities.
- Deliver data per schedule in Section C2.4.
- Submit draft and final Telops reports to UT Austin flare project manager.

Ms. Karen Olsen, Zephyr Environmental Corporation

- Validate all flare plume test data.
- Provide technical support on data management issues that may arise.
- Document all data management activities.
- Submit draft and final Zephyr reports to UT Austin flare project manager.

Mr. Bud McCorkle, Leak Surveys, Inc.

- Validate all Leak Surveys, Inc. flare plume tests images and associated date/time data.
- Provide technical support on data management issues that may arise.
- Document all data management activities.
- Deliver data per schedule in Section C2.4.
- Submit draft and final Leak Surveys, Inc. reports to UT Austin flare project manager.

A4.12 Statistical Support

Mr. Robert E. Schwartz, Senior Technical Specialist, John Zink Company, LLC

- Provide statistical evaluation of John Zink Company, LLC, flare test data to assist in achieving the study objectives.
- Provide assurance as to data quality.

Mr. Jim Barufaldi, TRC Companies, Inc.

- Provide statistical evaluation of all TRC Companies, Inc. stack test data to assist in achieving the study objectives.
- Provide statistical evaluation of these data to quality assure data.

Dr. Scott Herndon, Aerodyne Research, Inc.

- Provide statistical evaluation of Aerodyne Research, Inc. flare plume test data to assist in achieving the study objectives.
- Provide statistical evaluation of these data to quality assure data.

Dr. Robert L. Spellicy, Industrial Monitor and Control Corporation

- Provide statistical evaluation of Industrial Monitor and Control Corporation flare plume test data to assist in achieving the study objectives.
- Provide statistical evaluation of these data to quality assure data.

Mr. Vincent Farley, Telops, Inc.

- Provide statistical evaluation of Telops, Inc. flare plume test data to assist in achieving the study objectives.
- Provide statistical evaluation of these data to quality assure data.

Ms. Karen Olsen, Zephyr Environmental Corporation

- Provide statistical evaluation of all flare plume test data to assist in achieving the study objectives.
- Provide statistical evaluation of these data to quality assure data.

Mr. Bud McCorkle, Leak Surveys, Inc.

- Provide statistical evaluation of Leak Surveys, Inc. flare plume test data to assist in achieving the study objectives.
- Provide statistical evaluation of these data to quality assure data.

A4.13 Subcontractors

Mr. Robert Schwartz, Project Representative
John Zink Company, LLC
11920 East Apache
Tulsa, Oklahoma 74116-1300

Mr. Jim Barufaldi, Project Representative
TRC
9225 US Highway 183 South
Austin, Texas 78747

Dr. Scott Herndon, Project Representative
Aerodyne, Research, Inc.
45 Manning Road
Billerica, Massachusetts 01821-3976

Dr. Robert L. Spellicy, Project Representative
Industrial Monitor and Control Corp.
800 Paloma, Suite 100
Round Rock, Texas 78664

Mr. Bud McCorkle, Project Representative
Leak Surveys, Inc.
1102 Early Blvd.
Early, Texas 76803

Mr. Vincent Farley, Project Representative
TELOPS
10-2600 St-Jean-Baptiste Avenue
Quebec City, Quebec
Canada
G2E 6J5

Ms. Karen Olsen, Project Representative
Zephyr Environmental
2600 Via Fortuna, Suite 450
Austin, Texas 78746

According to terms of the contract, responsibilities include but are not limited to:

- Provide and operate test, instrumentation and/or sampling equipment according to this approved QAPP.
- Perform quality control checks on test, instrumentation, and/or sampling equipment as specified in this approved QAPP.
- Calibrate and maintain all equipment as required for use during the flare tests period.
- Perform data validation.

According to terms of the contract, contractor's communications responsibilities include, but are not limited to:

- Maintain an open line of communication between The University of Texas Project Representatives, TCEQ Personnel, and other subcontractors.
- Attend and/or provide information for, if requested, any meetings that may be requested by The University of Texas Project Representatives and TCEQ Personnel.

The types and frequency of communications may include:

- Cell phone, land-line, and e-mail exchanges several times per week among The University of Texas Project Representatives, TCEQ Personnel, and subcontractors.
- Daily on-site meetings at the John Zink flare test facility in Tulsa, Oklahoma between the subcontractors, TCEQ Personnel and The University of Texas Project Representatives.
- Intermittent meetings among The University of Texas Project Representatives, TCEQ Personnel, and subcontractors.
- Written and electronic versions of reports of test data in the format specified by the The University of Texas Project Manager per the contract deliverables schedule. Section C2.4.

The University of Texas Project Manager and Project Quality Assurance Officers monitor the subcontractors through these communications.

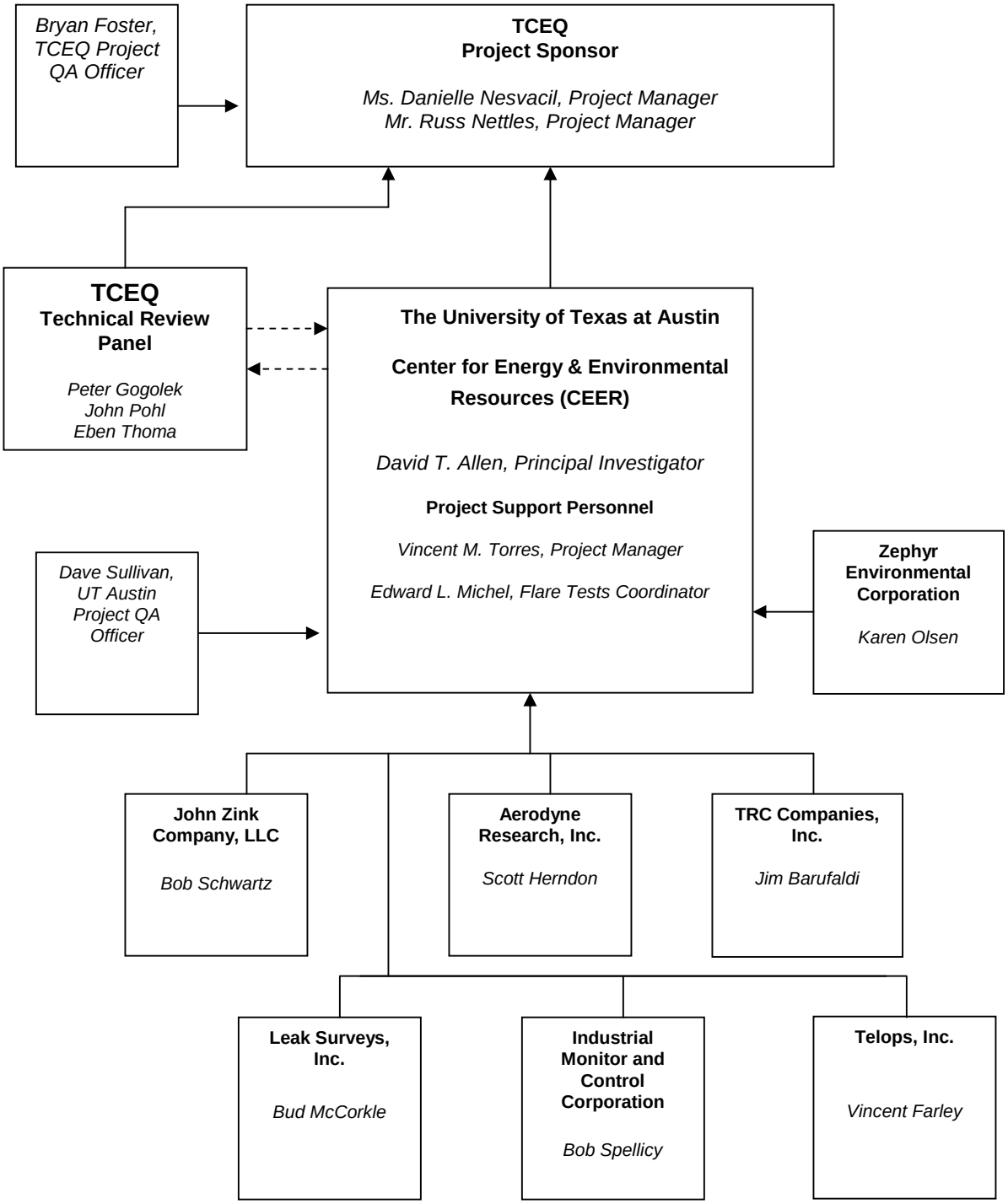

Figure A4.A Comprehensive Flare Study Project Organization

Table A4.1
Responsibilities of Project Participants During Flare Tests

Company/Entity and Role	Primary Responsibility/Measurement to be Performed During Flare Tests	What and Frequency
Texas Commission on Environmental Quality (TCEQ)	Be on site and ensure flare tests are addressing project objectives and rule on any changes proposed to the test plan.	Be On-site – Continuously each day. Rule on Proposed Test Plan Changes – As needed.
TCEQ Technical Review Panel (TRP)	Witness tests, offer comments on technical implementation of test procedures and provide advice on any proposed changes to the test plan to TCEQ	Witness Tests and Offer Comments and Advice - At daily briefings.
The University of Texas at Austin (UT Austin) – Principal Investigator, Project Manager and Flare Tests Coordinator	Ensure all flare test equipment and direct and remote sensing measurement instrumentation is ready before the tests begin each day and ensure/oversee that subcontractors pretest QC checks are performed. Conduct daily briefings with all project participants to review tests to be run that day. During the tests, direct the John Zink personnel when to begin flare tests and what operational conditions are to be run during each test. Also communicate and coordinate with all project participants during each test to ensure that each knows what test is being conducted, when it begins, when it ends and when measurements should be made of test points in between. Coordinate with ARI to ensure proper placement of the plume sampling device. Conduct post test briefings with all project participants to learn of and address problems encountered during the day. Propose changes to the test plan.	Instrumentation Readiness & Briefing - At the beginning of the day and as needed at other times. Flare Tests Activities – Continuously during each test. Post test briefing – At the end of days briefing. Consider changes to test plan – As needed.
John Zink Company, LLC (Zink) – Flare Operations Facility	Allow personnel on site and ensure utility infrastructure support is operating properly. Operate flare equipment during each test at parameters specified by UT Austin, measure and record operating parameters, and ensure flare is operating as expected. Direct crane operator to position plume sampling device at location specified by UT Austin and ARI.	Utility Infrastructure Support – Continuously. Operate Flare Test Equipment – As needed.
Aerodyne Research Inc. (ARI) – Direct Flare Flue Gas Measurements	Ensure that all instrumentation is ready to conduct direct measurement of flue gas constituents before each flare test begins. During each test, specify to UT where the plume sampling device should be positioned, and make, record, and send to control room display direct measurements of flue gas per Appendix G.	Instrumentation Readiness – Beginning of the day. Direct Measurements of Flue Gas – Continuously during each test.

Table A4.1 (Continued)
Responsibilities of Project Participants During Flare Tests

Company/Entity	Primary Responsibility/Measurement to be Performed During Flare Tests	What and Frequency
TRC – Direct Flare Stack & Flue Gases Measurements	Ensure that all instrumentation is ready to conduct direct measurement of stack and flue gas constituents before each flare test begins. During each test, make, record, and send to control room display direct measurements of flare emissions per Appendix G.	Instrumentation Readiness – Beginning of the day. Direct Measurements of Stack and Flue Gases – Continuously during each test.
Leak Surveys, Inc. (LSI) – IR & Visible Wavelength Video Camera Recordings of Flare Flue Gas	Ensure that all instrumentation is ready to make IR, visible frequency spectrum video camera images and videography of flue gas constituents before each flare test begins. During each test, make, record, and send to control room display IR, visible frequency spectrum digital and camera images of flare emissions per Appendix G.	Instrumentation Readiness – Beginning of the day. IR, visible frequency spectrum and digital camera images of Flare Emissions – Continuously during each test.
Industrial Monitor and Control Corporation (IMACC) – Flare Flue Gas Remote Sensing Measurements	Ensure that all instrumentation is ready to conduct remote sensing measurement of flue gas constituents using active and passive FTIR spectroscopy before each flare test begins. During each test, make and record active and passive FTIR spectroscopy measurements of flare emissions per Appendix G.	Instrumentation Readiness – Beginning of the day. Active and Passive FTIR Measurements of Flare Emissions – Continuously during each test.
Telops – Flare Flue Gas Remote Sensing Measurements	Ensure that all instrumentation is ready to conduct direct measurement of stack and flue gas constituents before each flare test begins. During each test, make and record measurements of flare emissions per Appendix G.	Instrumentation Readiness – Beginning of the day. Infrared Hyper-Spectral Imaging Measurements of Flare Emissions – Continuously during each test.

A5 PROBLEM DEFINITION/BACKGROUND

A5.1 Background

The TCEQ contracted National Physical Laboratory (NPL), based in the United Kingdom, to perform differential absorption lidar (DIAL) measurements on industrial emissions sources located in a refinery and a storage terminal near Houston during 2007.

Measurements focused on those industrial sources that are difficult to measure using conventional sampling techniques. Specifically, the study involved:

1. Identifying potentially under-reported industrial emissions sources,
2. Conducting remote sensing measurements of these sources,
3. Collecting process and operational data from these sources, and
4. Comparing emissions determined using conventional EPA-approved determination methods to the remote sensing measurements.

TCEQ 2007 Remote Sensing Study Results

NPL submitted a final report to EPA in 2008. An independent third party is currently comparing remote sensing measurements to conventionally determined emissions. Although these results are still being analyzed, based upon the preliminary total volatile organic compounds (VOC) measurements, flare emissions may potentially be under-reported when emissions are determined using EPA or TCEQ material balance calculation methods. Additionally, preliminary results indicate flare destruction and removal efficiency (DRE) may be reduced during certain operating conditions, such as combusting small volumes of waste gas, and during flare air- or steam-assist operations. These preliminary results indicate the need to conduct a study that determines the relationship between flare design, operation, and DRE.

Purpose

The purpose of this study is to measure flare flue gas and collect required process and operational data in a semi-controlled environment to determine the relationship between flare design, operation, and DRE. The ambient air conditions, i.e., temperature, humidity, wind speed and wind direction will not be controlled. Direct measurement techniques of flare emissions as well as remote sensing measurement techniques, will be employed in the semi-controlled environment. Analysis of collected process and operational data will permit comparisons between traditional flare material balance emissions determinations, process stream and air measurements, and the emissions rates and concentrations measured by the direct and remote sensing technologies.

The TCEQ anticipates that the results of the controlled tests will be broadly applicable and provide insight to operational conditions that may impact flare VOC, DRE and flare combustion efficiency (CE), such as steam- and air-assist rates or waste gas volumetric flow rates. For this project, the following definitions will be used. (1) Destruction Removal Efficiency (DRE) is the percent of the

waste gas molecules that are removed or destroyed, relative to the number of the waste gas molecules that enter the flare. (EPA web site) (2) Combustion Efficiency (CE) is the percent of the waste gas molecules converted to carbon dioxide and water.(John Zink Handbook) (3) Visible emissions are the populations of smoke particles that can be seen with the naked eye. (4) Waste gas flow rate turndown is the ratio of the maximum flow rating over the minimum flow occurring during the measurement collection time. (5) A flame is the visible part of a fire. (6) Blow off means to come off due to a strong force. (7) Flash back is when the flame goes into the tip. (8) Ignition is the process of setting the vent gas on fire. (9) A stable flame is when the flame velocity (rate of burning) is matched by the velocity of the material fed. If it is not possible to match the rate of burning and the imposed velocity at some position, the flame will either blow off or flash back. Therefore, a stable flame is one that has been heated to the temperature where the heat generation is balanced by the heat loss (ignition), and the rate of consumption is balanced by the imposed velocity. All calculations for this project are contained in Appendix B.

Study Objectives

Primary study objectives in order of importance include:

1. Assessing the potential impact of waste gas flow rate turndown on flare DRE and CE.
2. Assessing the potential impact of steam- and air-assist on flare DRE and CE at various operating conditions, focusing exclusively on low flow rate conditions.
3. Assessing whether flares operating over the range of requirements stated in 40 Code of Federal Regulations (CFR) § 60.18 achieve the assumed hydrocarbon DRE of 98 percent at varying flow rate turndown and assist ratios as well as variable waste gas heat content.
4. Identifying and quantifying the hydrocarbon species in flare flue gas currently visualized with passive infrared technology.

A5.2 Conclusions to be made

1. The impact on flare CE and VOC DRE of low waste gas volumetric flow rates.
2. The impact on flare CE and VOC DRE of excess use of steam-assist and air-assist at low waste gas volumetric flow rates.
3. The applicability of remote sensing technologies for measurement of flare flue gases.

A5.3 Uses of Data

The potential uses of the data are listed below:

- To compare flare flue gas rates and concentrations determined using conventional EPA-approved determination methods and remote sensing methods to direct measurements using material balance methods for low waste gas flow rates.
- To better understand the use of steam- and air-assist at low waste gas flow rates in controlling flare emission rates and VOC DRE.
- To determine if flare emissions are underreported using current conventional reporting practices.
- To determine if additional air pollution control strategies are required.

- To assess the use of the remote sensing technologies included in this study for measurement of flare flue gases.

A5.4 Decision Makers

- Ms. Danielle Nesvacil, Project Manager, Air Quality Division, Texas Commission on Environmental Quality.
- Mr. Russ Nettles, Project Manager, Air Quality Division, Texas Commission on Environmental Quality.
- Dr. David Allen, Principal Investigator, the University of Texas at Austin.

A5.5 Principal Customers for the Results

- Texas Commission on Environmental Quality.
- Environmental Protection Agency.
- Chemical and Petrochemical Industry.
- The University of Texas at Austin.
- Local city and county health departments.
- Texas citizens.

A6 PROJECT/TASK DESCRIPTION

This section provides a description of the work to be performed, an overall view of the project objectives, activities, assessments, and outputs of the project, identification of potentially applicable ambient air quality regulations and standards, and an implementation schedule for the project. The measurements to be made during the project are identified in Appendix G.

The data for this project will be produced during controlled flare tests over approximately a 2 to 3 week period in the late-summer of 2010. The project will be completed by March 2011.

A6.1 Project Overview

The University of Texas at Austin has developed and will oversee a prescribed series of flare tests (Appendix D), all of which will be conducted at the John Zink Company LLC flare test facility in Tulsa, Oklahoma. Appendix D has been developed to provide data that will fulfill as many of the Study Objectives as possible within the budgetary constraints of the Project. The study objectives are contained in Section A5.1. During each series, there will be direct measurement of the flare flue gas for many parameters. Remote sensing measurements of flare flue gas will also be made using remote sensing technologies specified by the TCEQ. All direct and remote sensing technology measurements that will be made during the flare test series are described in Appendix G and tabulated. The detailed schedule for conducting the flare tests, including pretest activities, is found in Appendix K.

The test plan includes flare operating conditions that attain the incipient smoke point. The definition of the incipient smoke point is included in Appendix N. In addition, two flare flame conditions, stable flame and wind-influenced flame, will potentially be observed during the operation of the flare. For this project, a stable flame will be defined as a visible, orange to white in color, area in the flue gas that does not go out of view for the observer while operating the flare at the test point. For this project, also defined, a wind-influenced flame will be defined as intermittently visible, orange to white in color area in the flue gas that goes out of view for the observer while operating the flare at the test point.

In the event that it is determined that a modification to the flare operation plan should be considered, a Test Series Modification Process will be followed. The Test Series Modification Process is detailed in Appendix E. After the test series is completed, the resulting data will be used to improve the understanding of flare operations and the impact of steam- and air-assist and waste stream turn down rate on DRE and CE.

After completion of the flare operation plan, The University of Texas at Austin will compile all data from the flare series, analyze the data and produce a final project report by March, 2011.

A6.2 Sampling and Measurement Activities

Sampling activities will include remote and direct measurements of the flare flue gas. These activities will be performed to measure concentrations and visible emissions of hydrocarbons, carbon monoxide, particulates, flared gas heat content and flared gas exit velocity to help understand DRE and CE on a typical steam-and air-assisted flare tip rated at 937,000 and 144,000 pounds per hour respectively, but operated nominally at 0.25 and 0.1 % of rated design.

In addition, a combustion zone heating value (CZHV) will be calculated for each test. For the study it will be referred to as the Flare Combustion Zone Net Heating Value and will be defined as follows:

$$NHV_{FCZG} = \frac{[(VG)(NHV_{VG})(385.23 / MW_{VG})] + [(PG)(NHV_{PG})(385.23}{[(VG)(385.23 / MW_{VG}) + (PG)(385.23 / MW_{PG}) + (S)(385.23 / 18)]}$$

Parameter	Description (Unit)	Source
NHV_{FCZG} =	Flare Combustion Zone net heating value (BTU/sft^3)	Result
VG =	Vent Gas mass flow rate (lb/hr)	From pressure transmitters
NHV_{VG} =	Vent Gas Net Heating Value (BTU/sft^3)	Calculated from GC analysis
MW_{VG} =	Vent Gas molecular weight (lb/lb-mole)	Calculated from GC analysis
PG =	Pilot Gas mass flow rate (lb/hr)	As measured by flow meters
NHV_{PG} =	Pilot gas net heating value (BTU/sft^3)	Calculated from GC analysis
MW_{PG}=	Pilot Gas molecular weight (lb/lb-mole)	Calculated from GC analysis
S =	Actual total steam mass flow rate (lb/hr)	From ultrasonic steam flow meter
385.23 =	Constant (sft^3/lb-mole @ 68°F and 1 atm)	Ideal Gas Law

This calculation is being used at the direction of this projects sponsor. This is the same definition that was used by the Marathon Petroleum Company, LCC during the flare testing program in Texas City, Texas that was conducted September 15 – 24, 2009.

A6.3 Standards and Screening Levels

This section references some federal statutes for which data generated by this project may be compared.

40 CFR, Part 60.18 Determination of tip velocity, heating value, pilot flame requirements for flares

40 CFR, Part 63.11(b) Determination of Flare exit velocity, visible emissions, pilot flame presence, minimum heating value

A6.4 Assessment Tools

Assessment tools that will be used are described in this section.

A6.4.1 Performance Evaluations

Performance evaluations will not be able to be performed by the respective project participants on the instruments and sampling systems provided by each project participant due to the fact that this is a first of its kind research project, therefore not lending itself to commercially available performance standards.

A6.5 Project Reports

The following reports will be produced. See Section C2.4 for more detailed information.

- Daily Field Activity Reports will be provided by each project participant.
- Comprehensive Flare Study Draft and Final Report.
- Daily Quality Assurance Reports will be provided by each project participant.
- Final Project Report.
- Final Quality Assurance Report will be provided by each project participant.

A7 DATA QUALITY OBJECTIVES (DQO) FOR MEASUREMENT DATA

This section presents the data quality objectives for the project.

The results of the DQO process include:

1. specifying the intended use of the data;
2. defining the type of data needed to support the decision;
3. identifying the conditions under which the data should be collected; and
4. Specifying tolerable limits on the probability of making a decision error due to uncertainty in the data.

The quality control indicators of each measurement technique for this project are presented in Appendix G.

A7.1 General Project Objectives

- Provide direct and remote sensing measurements of flare flue gas to be used in calculating CE and DRE for low waste gas flow rates and typical steam- and air-assist operating conditions.
- Provide data and information on flare flue gas to guide in the minimization of flare flue gas during periods of low waste gas flow rates.
- Guide in the use of remote sensing technologies and design of future flare test work.

A7.2 Measurement Quality Objectives

The approaches used to assess data uncertainty and the measurement quality objectives for each type of measurement are addressed in this section. Total Measurement Error is the combination of the published instrument error and the potential error from installation and application of the equipment to this project. Appendix G presents the measurement quality objectives for each measurement that will be employed.

A7.2.1 Detection Limits

Detection limits are expressed in units of concentration and reflect the smallest concentration of a compound that can be measured with a defined degree of certainty. The detection limits for each parameter measured during the project are provided in Appendix G.

A7.2.2 System Contribution to the Measurement

A blank or “zero air” level is part of each calibration and span check for each measurement that is reported in units of ppm, ppb or ppt. The units for each project measurement are contained in Appendix G. As part of the calibration, the zero level is used along with the upscale (span) concentrations to establish the monitor’s calibration curve. As

part of the span check, this upscale level is used as a quality control check for a monitor's zero drift.

A7.2.3 Precision

Precision is a measure of the repeatability of the results. Estimates of precision are assessed in different ways for different measurement technologies. Each project participant's precision criteria are presented in Appendix G.

A7.2.4 Accuracy

Accuracy is the closeness of a measurement to a reference value, and reflects elements of both bias and precision. Each project participant's accuracy criteria are presented in Appendix G.

A7.2.5 Completeness

Data completeness for all measurements is calculated on the basis of the number of valid measurements made out of the total possible number of measurements. Data completeness is calculated as follows:

$$\% \text{ Completeness} = \frac{\text{Number of valid measurements}}{\text{Total possible measurements}} \times 100$$

Each contractor will provide an assesment of data completeness in the draft and final reports provided to the UT Austin Project Manager.

A7.2.6 Representativeness

Representativeness is the extent to which a set of measurements reflects actual conditions for a specific application. The representativeness objective for the data is not stated numerically as a quality assurance objective because quantitation is generally not possible. The measurement results from each test will represent the actual flare flue gas under low flow conditions.

A7.2.7 Comparability

Comparability is achieved when the results are reported in standard units to facilitate comparisons between the data. In order to accomplish this objective, the reporting units for all measurements of this project are contained in Appendix G. Comparison of many measurements will be reported by UT Austin in the draft report documents, which will then be incorporated into the final report.

A8 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

Specialized training/certification required to operate any instruments will be the responsibility of each subcontractor.

A9 DOCUMENTATION AND RECORDS

All subcontractor personnel working on this project are expected to maintain records for three years from date of termination of the subcontractors contract, that include sufficient information to reconstruct each final reported measurement from the test data originally gathered during the flare tests conducted at the John Zink Company LLC test facility for a period of no less than three (3) years. These records include but are not limited to information (raw data, electronic files, and/or hard copy printouts) related to media preparation, sampler calibration, sample collection, sample handling (Chain-of-Custody and processing activities), measurement instrument calibration, quality control checks of sampling or measurement equipment, "as collected" measurement values, an audit trail for any modifications made to the "as collected" measurement values, and traceability documentation for reference standards.

Difficulties encountered during data collection, sampling or analysis need to be documented and must clearly indicate the affected measurements. All electronic versions of data sets should reflect the limitations associated with individual measurement values.

A9.1 Mechanisms for Documentation of Procedures and Objectives

- *Comprehensive Flare Study Project Quality Assurance Project Plan.*
- Published guidance (*Code of Federal Regulations*, U.S. Environmental Protection Agency [EPA] documents, and EPA *Quality Assurance Handbooks*).
- Method-specific Standard Operating Procedures (SOP's)

A9.2 Mechanisms for Record Keeping

The following electronic or hard copy documents are maintained by the analysts (e.g., Chain-of-Custody forms in the laboratory with final data), field operators (e.g., activity logs), or data managers (e.g., electronic logs). All hard copy documentation is recorded in non-erasable ink, with any changes denoted by a single line through the entry, the initials of the person making the change, and the date.

- Sampling information and Chain-of-Custody forms;
- Instrument calibration data forms;
- Electronic run logs;
- Electronic and manual daily activity logs;
- Electronic and manual data processing and validation logs;
- Electronic and manual data management activity logs;
- Records of assessment, such as performance evaluation records; and
- Exception reports.

A9.3 Data Reporting Turnaround Time

After the end of the flare test, all measurements made as specified in the contract shall be provided in a preliminary form 15 days after the flare tests are completed. The final report of measurements will be due 30 days after the flare tests are completed.

A9.4 Data Storage

All data shall be stored by the contractor for no less than three years from termination of the contractor's contract with UT. Electronic copies of all measurements shall be provided with the project final report in MS Excel and MS Word 2003 or newer. The format for all video images shall be MS Movie (.wmv), Apple QuickTime (.mp4 or newer) or other format approved in advance of collection of any data by the UT Project Manager.

B1 SAMPLING PROCESS DESIGN (EXPERIMENTAL DESIGN)

B1.1 Study Site Design

The laboratory that has been selected to conduct the field tests is the John Zink Company, LCC flare test facility in Tulsa, Oklahoma. The John Zink Company, LCC has a long history of testing combustion equipment. Built in 1991 and the subject of several major expansions, the current John Zink Company, LCC test facility provides rare capabilities. The facility includes multiple furnaces for the testing of process burners, boiler burners, and duct burners. It also includes an area for thermal oxidizer technology testing as well as a flare testing area. The flare testing area is a comprehensive, industrial-scale research and development test center with state-of-the-art equipment that can accommodate steam-assisted flares, air-assisted flares, enclosed flares, and high pressure flare arrays. The flare testing capabilities include large and small flow rates, a variety of fuels and fuel mixes, and a data acquisition system which records everything from flows, pressures, and temperatures, to radiation and noise. This facility is capable of characterizing the performance and operation of flares over a wide range of operating conditions and also has the flexibility and its personnel have the expertise to design and conduct flare tests safely at conditions never used before, i.e., low waste gas flow rates with extensive instrumentation of the waste gas flow and the steam flow rates, while at the same time accommodating the remote sensing technologies concurrently during the flare tests. This flexibility and expertise will be critical to the success of this project. The following URL has more details about the ZINK facility. http://www.johnzink.com/tech/rd_ctr/html/t_rd_ctr.htm

The flare test equipment utilized in the Comprehensive Flare Study Project consists of a fuel supply system, fuel metering system, steam supply system, steam metering system, steam assisted flare, air supply and measuring system, air assisted flare, and a data acquisition system. The study site is designed so that an unobstructed view of the project's test flare's flue gas may be seen from all directions within an arc of at least 180° about the centerline of the flare burner. The challenge is to allow for in situ sampling of the flare flue gas during each test that will not block the view required by the remote sensing technologies. See Appendix A for the study site diagram and satellite aerial photo. All measurements taken are classified as critical to meet project objectives. All steam-assisted and air-assisted flare tests proposed comply with 40CFR, Part 60.18 requirements for BTU and exit velocity for the flare flue gas emissions and presence of a pilot flame on each flare tip. (refer to Appendix D).

At the sponsor's direction, a 36" diameter flare burner with tip exit 13 feet above the ground will be used for the steam-assisted flare and a 24" diameter flare burner with tip exit 33 feet above the ground will be used for the air-assisted flare tip. These flare burners are designed for maximum capacities of 937,000 and 144,000 pounds per hour, respectively. At these heights, both direct and remote sensing technology measurements are possible. The steam-assisted flare tip is a ZINK model QSC. This tip design has an upper ring for injecting steam around the perimeter of the tip. It also has a center steam injection nozzle for injecting steam inside the body of the tip. This tip is equipped with three natural gas pilots. The air-assisted flare tip is a ZINK model LHTS. This tip design receives the fuel gas through a central riser. The assist air is delivered in an annulus around the fuel gas riser. This tip is equipped with three natural gas

pilots. Drawings of the steam- and air-assisted flare tips are included in Appendix L and L1. In Appendix A are the diagrams and aerial photos of the ZINK facility showing the site layout and locations of the project participants making direct and remote sensing measurements of the flare flue gas during each test.

The control room that is marked in the photo of Appendix A will be where the flare system operator will monitor steam, air and waste gas flow to each flare. Only one flare burner will be operated during any test. Operation of the equipment consists of manually adjusting the fuel control valves until the desired flow rate is achieved. Steam flow is also manually controlled by adjusting the steam control valves. Manual control is used on both the fuel and the steam in order to achieve fine control of flows. Air flow to the air assisted flare is manually controlled by the operator. The operator will command between 10 to 100% rotation via the computer.

Waste gas flow control will be monitored through the use of calibrated orifice plates and transmitters. Mixing of the waste gas components (Tulsa Natural Gas, propylene and nitrogen) is accomplished by injecting the components into a mixing manifold which contains a mixing device. The flow of each component is carefully monitored to achieve the desired lower heating value (LHV) for each test. Temperature of the steam will be monitored through the use of calibrated thermocouples and steam pressure will be monitored using calibrated pressure transmitters.

The flare flue gas will be characterized by direct, real-time measurements and by remote sensing technologies. The flare flue gas for this study is defined as the exhaust gas that exits from the flare tip. Direct measurements will be conducted by continuously extracting samples of the flue gas using the plume sampling device shown in Appendix's J and J1. The device consists of, an inlet cone, a sample preparation section, a sample extraction section, and eductor. The inlet face of the cone is 20" diameter tapered to a 12" outlet. The 12" outlet is connected to a 90 degree elbow which in turn is connected to the inlet of the sample preparation section. There are three exposed junction temperature elements located equidistant around the perimeter of the inlet to the 20" diameter cone to measure the temperature of the flue gas as it enters the cone.

Attached to the elbow is the sample preparation section, which consists of a 12" diameter Vortab insertion type flow mixer to homogenize the sample. This mixer is 3 feet into the inlet of the 9.5' long sample preparation section which consists of a 12" diameter stainless steel straight pipe. The sample preparation section will mix the gases to obtain a uniform composition. At the exit of the sample preparation section is the extractive sampling section. The sampling section is 1.5 feet long and consists of a pitot tube for measurement of the flue gas velocity in the apparatus, an exposed junction temperature element, and two flue gas sampling probes. The flare flue gas sample that will be analyzed for emissions composition will be obtained from this location.

Downstream of the sampling section 7.5 feet is the end of the flare flue gas sampling device where the eductor is attached. The eductor utilizes compressed air to induce a flow through the apparatus. By varying the pressure of the compressed air at the eductor, the flue gas eduction rate can be varied.

Pipe clamps are used to lift the apparatus with a crane. Rotation of the pipe in the clamps allows orientation of the cone inlet so the inlet plane can be positioned either horizontal to the ground to collect flue gas exiting vertically from the flare, perpendicular to the ground to collect flue gas exiting and traveling horizontally from the flare due to strong cross winds, or at any angle in-between.

During the flare operation, the sampling device cone inlet will be positioned outside the visible flame and downwind of the end of the visible flame approximately one flame length. The position of the inlet to the cone will be adjusted so that the average temperature readings of the three inlet temperature thermocouples is no more than 500°F or the temperature determined to be the point where all the combustion has ceased by O_2 concentration measured in the sampling device using a O_2 monitor and CO_2 concentration measured in the sampling device using a CO_2 monitor. It is expected that the oxygen content of the homogenized gases will be between 18.0% and 20.5%. Lower oxygen levels could indicate that the sampling is being conducted in an area where combustion reactions may still be occurring.

The carbon dioxide concentration will also be monitored to help position the entrance to the cone of the sampling device. A low O_2 concentration and a high CO_2 concentration will be an additional indication that the sampling device is located at a point in the flare flue gas where no further combustion or oxidation will occur. Analysis of the flue gas samples collected at this location by Aerodyne and TRC will be used to establish the true DRE and CE of each test condition. The correct positioning of the sampling apparatus will be determined by UT Austin and Aerodyne after careful review of the sample probe inlet temperature readings, CO_2 and O_2 concentrations, and the concentration of the other products of combustion determined by the carbon fraction analysis method as described in Appendix B8. If it is determined through this analysis that samples from multiple points in the flare flue gas are needed, then multiple samples will be collected and the analysis from the multiple samples integrated to calculate a DRE for the test condition.

The remote sensing technologies will be located with clear line-of-sight to the flare tip at various (as needed by each vendor) distances away from the flare test apparatus. The remote sensing technologies will be allowed maximum flexibility to relocate instruments to account for wind direction or other physical attributes of the flare test setup so as to maximize performance of their instruments.

LSI will be collecting digital IR, and visible frequency ranges of images of the flare flue gas constantly during each air and steam flare test. These images will be posted in the control room and observers' conference room live during each test. One set of cameras consisting of digital IR, and visible frequency range camera will be aimed perpendicular to the flare flue gas exit from the tip. A second set of digital IR and visible frequency range cameras will be mobile around the flare testing pad and used primarily to view the flare flue gas from and angle perpendicular to the first set of cameras. The lenses for the digital IR cameras will be determined on a case by case basis. Selection of the lens depends on many factors that can influence the quality of the image desired.

B1.2 Study Site Design Rationale

The study site design was developed to conduct tests on an air-assisted and steam-assisted flare tips at low waste gas flow rates that will provide data to answer as many of the study objectives as possible. This site design will also allow up to 6 types of remote air quality sensing (monitoring) devices the ability to collect data at the same time without interfering with each other as well as the continuous direct measurements of the flare flue gas.

B1.3 Measurement Validation

Appendix B references the measurement methods used to obtain data in this project. Standard methodology has been followed whenever possible. Sampling and validation efforts are described in Sections B2 and Appendix B. All data will be reviewed by the respective subcontractor's quality assurance officer for acceptable data quality and compliance with project objectives before inclusion in the final project report. The meteorological (met) data used for this project will be that measured using Aerodyne Research instrumentation. Aerodyne will use the adjacent John Zink Company LCC and Tulsa airport met data as a data validation tool. If there is a difference in the Aerodyne, ZINK, Tulsa airport meteorological data, the Aerodyne validated met data will be used as the valid data set for this project. UT Austin will conduct an on-site audit of all the Aerodyne meteorological equipment prior to beginning testing and after the testing ends. Project data may be invalidated due meteorological data on a case by case basis. Meteorological data will not be used to disqualify flare emissions data. When the acceptance criteria for a measurement are not achieved, the corrective action criteria will be followed by each project participant as noted in Appendix H.

B2 SAMPLING METHODS REQUIREMENTS

This section addresses the sampling methods for the equipment and their operating procedures. It should be recognized that some of the procedures might change over the course of the project if logistical, technical or quality related difficulties are encountered. A tabulation of all measurements that will be made during this project, the instrument that will be used to make the measurement, manufacturer of the instrument, model number and measurement location, and subcontractor who will be making the measurement, is contained in Appendices G and H. A schematic showing the location where these measurements will be made is included in Appendix C1, C2, C3.

B2.1 Continuous Methods

B2.1.1 John Zink Company LLC

The following flare operational parameters will be monitored and reported to the project members by the John Zink Company LLC., to verify that the flare system is producing the predetermined flare conditions during every operational plan series. Individual measurement of each waste gas component flow, total steam flow rate (upper plus center steam), flue gas temperature (three measurements at entrance of sampling device) and air flow rate for air-assisted flare will be measured by the flare operation facility. The flare waste gas average tip exit velocity (FV), lower heating value of waste gas mix, combustion zone heating value and pilot gas flow rate will be calculated by the flare operation facility**.** The quality control assessment methods of the instruments necessary for proper operation of the flare facility are contained in Appendix B5.

These data will be recorded by the data acquisition system (DAS) located in the flare operation facility control room. Reporting of these data will be through e-mail and compact disk (CD)/flash drive media as directed by UT Austin project manager and as part of the John Zink Company LLC final report.

The John Zink Company LLC will make video recordings of the flare flame during each test series. These videos will be used as visual examples of flare conditions during each operational plan series. Additionally, the direct and remote sensing technology companies will use these videos during analysis of their data. Refer to Appendix L for the Steam Tip Diagram, Appendix L1 for the Air Tip Diagram, and Appendix M for the ZINK Facility Waste Gas and Steam Flow Diagram.

B2.1.2 Aerodyne Research, Inc.

Aerodyne Research Inc. (ARI) will use one-second detection methods (continuous) in conjunction with GC methods to determine the flare flue gas constituents in real time through direct extractive sampling of the flue gas. The continuous measurements will allow immediate review of the data to determine if the sample is representative of the flue gas or a portion of the flue gas. The indicators that determine if the location of the sample collector is representative of

either the whole flue gas or a portion of the flue gas is described in Section B1. The methods to make these measurements are contained in Appendix B4.

The direct measurement of VOC will help close the carbon mass balance and produce VOC/CO, VOC/CO_2 ratios in real time through the use of the in-the-flue gas extraction device. The device was designed by UT, UT's flare consultant, Aerodyne, and Zink. A diagram of the completed sample extraction device is included in Appendixes J and J1.

A summary of the chemical compounds, if present, in the flare flue gas that will be measured by Aerodyne and the instrument to be used for each is summarized below in Table B2.A.

Table B2.A

Instrument	Species	Time-response	Detection limit (Based on manufacturers literature)
QC-TILDAS	CO, NO_2 HCHO, HCOOH, CH_3CHO, HC_2H CH_4, C_2H_4, C_3H_6, HC_2H TNMHC	1 sec	~400 ppt
ThermoElectron 42i NOx analyzer	NO	1 sec	500 ppt
LI-COR CO_2 analyzer	CO_2	1 sec	2 ppm
Thermoelectron	SO_2	1-10 s	< 1 ppbv
2B Tech 205	O_3	2 sec	4 ppbv
PTR-MS	Acrolein,Benzene,Toluene,C2-Benzenes, C3-Benzenes,Acetaldehyde,Acetone,1,3 butadiene	1-15 s	~0.1-1 ppb
Auto-GC	EPA TO-14 analysis list	30 min	1 ppb
Aerosol Mass Spectrometer	size-resolved chemical composition and mass loadings of PM1	5 sec – 10 sec	
MAAP	black carbon	2 sec	
SMPS	PM size distribution	2 min	
CPC	Particle number (D_p>7 nm)	2 sec	
Dustrak	Particle mass (80 nm < D_p < 2.5 µm)	2 sec	

QC-TILDAS: pulsed quantum cascade tunable infrared laser differential absorption spectrometer
MAAP: Multi-angle absorption photometer
SMPS: Scanning mobility particle sizer
CPC: Condensation Particle Counter

Dp: Particle Diameter

B2.1.3 Telops

Telops will be making remote measurements of the flare flue gas with their FIRST, Field-portable Imaging Radiometric Spectrometer Technology, instrument. This instrument uses a Fourier transform, infrared electronics, onboard data processing system and a visible bore sight camera for detection of hydrocarbon concentrations in flare flue gas. The methods and QC protocols that will be employed by Telops are included in Appendix B12.

A summary of the chemical compounds, if present, in the flare plume that will be measured by Telops is shown below in Table B2B.

Table B2.B

Chemical species	Chemical Formula
Butane	C_4H_{10}
Formaldehyde	HCHO
Formic Acid	HCOOH
Carbon Dioxide	CO_2
Water	H_20
Ozone	O_3
Sulfur Dioxide	SO_2
Ethylene (Ethene)	C_2H_4
Propylene (1-Propene)	C_3H_6

B2.1.4 Industrial Monitor And Control Corporation

Industrial Monitor And Control Corporation (IMACC) will be using Passive Fourier Transform Infrared (PFTIR) and Active Fourier Transform Infrared (AFTIR) spectroscopy to remotely detect hydrocarbon concentration in the flare flue gas. The PFTIR operates by receiving the infrared radiation emitted by hot gases and producing an infrared spectrum from this radiation. The AFTIR operates by retro reflecting a source infrared radiation and receiving the infrared radiation emitted by hot gases and producing an infrared spectrum from this radiation. These spectrums then allow for evaluation of species that are present and their concentration in part per million volume (ppmV). The methods for this technology are contained in Appendix B9, B10 and B11.

Prior to deploying the PFTIR and AFTIR instruments, IMACC will calibrate the instrument to known concentrations of the analytes of interest in the ranges of concentrations expected to be encountered during the flare operation series. In addition, IMACC will evaluate, in a laboratory setting, the maximum Combustion Efficiency (CE) that can be calculated using the PFTIR and AFTIR technologies at various gas temperatures to be prepared for the exact flare operation conditions during the field campaign.

B2.1.5 Leak Surveys, Inc.

Leak Surveys, Inc, (LSI). will provide real-time visualization of the flare flue gas hydrocarbons recorded in standard digital video formats. Using two sets of Forward Looking Infrared (FLIR) technology along with digital videography a video record of the flare operation series will be made for future analysis. One set will be perpendicular to the flare flue gas emission point form each flare tip and the second set will be mobile to allow for collecting visual information on a "waffling" flare flue gas and understand background sky conditions on all images being collected. Gas imaging will be performed from approximately 100 feet from the target at 12 ms time resolution per frame, lens size (25mm, 50mm, 100mm) will be determined during each test series. A high speed (30 frames per second) digital camera will be collecting images of the flare flue gas for each steam and air assisted test.

Figure B2.A shows typical black and white images that are produced using the IR technology.

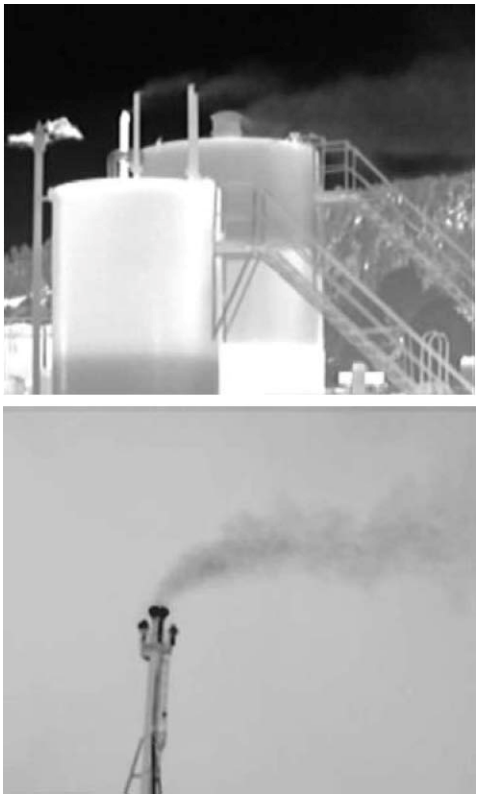

Figure B2.A

B2.2 Non-Continuous Methods

B2.2.1 TRC

Concentrations of methane, ethane and propylene in the waste gas fed to each flare and in the flare flue gas will be reported every 10 minutes through the use of a Gas Chromatograph (GC) equipped with a flame ionization detector (FID) and an electronic integrator. Appendix B1 contains this analysis method. A National Institute of Standards and Technology (NIST) traceable standard containing a known concentration of methane, ethane and propylene will be used to calibrate the GC. The samples will be collected from the mixed fuel supply piping, prior to combustion and the flare flue gas using a heated transfer line to transport the sample to the GC inside the TRC trailer. Reporting of these data will be through e-mail and compact disk (CD)/flash drive media to the project participants and UT Austin project representative.

Mass emission rates will be calculated using a modified EPA Method 19 that is contained in Appendix B2. This reference is written to calculate sulfur compound concentrations emitted from flares and applied to methane, ethane and propylene for this project. Preliminary calculations will be available immediately after each flare operation series.

The method for determining the oxygen and carbon dioxide concentrations of the flare flue gas are contained in Appendix B.

There will be three sample lines used in this test. The plume sampler will draw and mix a large volume of air and two of the sample points will draw sample from this mixed flow. As the test matrix proceeds, a third probe, which does not 'premix' portions of the plume may be sampled in order to address the scale of combustion dynamics.

Sample Locations
Sample probe after mixing, *non dilution tip*
Sample probe after mixing, *dilution tip*
Sample probe before mixing, *dilution tip*

The non-dilution probe tip refers to whole sample being drawn through a temperature-controlled manifold to the instrument packages. The temperature will be kept high to prevent combustion water or added steam from condensing.

The dilution tip probes add nitrogen within 1 mm of the sample entrainment in the probe. The dilution ratio will be adjusted to keep the sum of the measured CO and CO_2 less than 2000 ppm by volume. Based on the anticipated C:H ratio in the fuel stocks for this test, this will keep the level of H_2O below the condensation point for the anticipated ambient temperatures. *The level of dilution by nitrogen will not affect the calculated DRE based on carbon mass balance*. The dilution ratio will be measured by the difference between the total flow (in-line venturi flow meter) and the added nitrogen. The dilution level estimates will be corroborated by flow

calculated dilution factor to the effect of dilution on stable atmospheric species such as CO_2 and CH_4.

Past experience with the dilution system suggests it is an effective way to arrest trace combustion and preserve the hydrocarbon speciation (particularly oxygenated compounds such as formaldehyde) through the sample lines.

B2.3 Corrective Actions

During the field testing, each subcontractor is responsible for operating their respective equipment and initiating minor corrective actions on equipment when required. Equipment problems are generally detected through a failed sample run or through performing routine quality control (QC) checks. The QC checks that are performed on the sampling equipment are identified in Section B5.

When a major equipment problem is encountered, the company operating the equipment has the responsibility to follow up on restoring the equipment to its proper operating status. The University of Texas at Austin Project Manager shall also be informed of major problems and the corrective action employed to solve the problem and documented in the daily field inspection report. Appendix I has an example of a daily field inspection report.

Any equipment problems that can result in the loss of data are addressed as high priority. All situations requiring corrective action will be documented in the site activity logs. Section B4.2 contains additional information on documentation of corrective action.

B2.4 Equipment Failure

In the event that one of Aerodyne's measurement instruments fail or LSI's, Zink's, TRC's, Telops' or IMACC's equipment fail, the UT project manager will consult with the project sponsor to determine whether to continue flare operation series, postpone, or cancel the testing until a correction is implemented. This project is not being conducted to compare remote measurements with the in situ measurements, so if a remote technology fails, testing will continue. Flare testing will not be terminated if a remote sensing technology is unable to continue making measurements.

B3 SAMPLE HANDLING AND CUSTODY

There are no discrete samples handled by individuals for the methods in this project with one exception. There may be a need for Aerodyne to collect Summa® polished evacuated canister samples.

If there is a need to collect Summa® polished evacuated canister samples for this project, Aerodyne will "T" off the main flare flue gas sampling line to collect a 6 liter sample. The canister will be shipped over night for analysis at the UT Austin, NELAC accredited, laboratory in Austin, Texas. In addition, if there is a need for an ambient air sample collected in a Summa® polished evacuated canister, Aerodyne will collect a "grab" sample and ship it over night to the UT Austin, NELAC accredited laboratory in Austin, Texas. All analysis results will be reported to the project manager for inclusion into the final project report.

B4 ANALYTICAL METHODS

B4.1 Analytical Procedures

B4.1.1 Aerodyne Research, Inc.

The analysis of any Summa® polished evacuated canister samples will be accomplished through the use of the EPA TO-14 method.

B4.2 Corrective Actions

Documentation of the problem will be through using the site activity logs. Generally the subcontractor is responsible for or arranging for the repair of all equipment. The subcontractor shall notify the UT Austin Project Manager of all corrective action.

B5 QUALITY CONTROL (QC)

The QC protocol for the project is discussed in this section. An attempt has been made to provide adequate information from which to estimate the uncertainty and potential limitations of measurements generated by the instruments. In an ambient air regulatory network the minimum expectation is that the QC protocol should address:

- Matrix effects on the measurements;
- Sampling system contribution to the measurements;
- Measurement system contribution to the measurements; and
- Qualitative performance of the method.

Since this project is a research program, many of the methods that will be utilized are being developed for this project. In some cases, limitations of project resources restrict the ability of UT Austin to make certain quality assessment measurements. The specific QC procedures and acceptance criteria for each company referenced are contained in Appendix H.

B5.1 John Zink Company, LCC

The flow rate of each waste gas component (propylene, Tulsa Natural Gas or nitrogen) will be measured by in-line metering systems. The flare flue gas sample temperature will be measured by a Type “K” thermocouple located at the entrance to the flare flue gas sampling device. The exact quality control parameters for the measurement techniques contained in the flare flue gas sampling device are included in Appendix H.

A Fluke Model 743 will be used to calibrate the pressure sensor/transmitter (PT) or differential pressure sensor/ transmitter (DPT) used in flare operation system.

A calibrated thermal mass flow meter will be used to measure the amount of air assist provided to the air assist flare burner. Data quality control parameters for this technology are contained in Appendix G. A proposed plan to assess the ZINK facility is contained in Appendix K. ZINK will use the instantaneous data feed from all the flow devices to determine that the specified test condition has been achieved to within ± 5% of the requested test conditions. A test condition is not considered stable until the flow measurement devices are within ± 5% of target.

B5.2 TRC

The gas chromatorgraph’s (GC) response will be checked and adjusted in the field prior to the collection of data using a multi-point calibration error test. The linearity of the GC instrument will be checked by first adjusting the zero and span responses to zero (nitrogen) and an upscale calibration gas of propane in the range of the expected concentrations. The GC’s response can then be challenged with other calibration gases of known concentration and accepted as being linear if the response of the calibration gases agrees to within ± 2% of range of the predicted value if funding allows for this type of check.

Before and after each test run, the analyzers will be checked for zero and span drift (calibration drift checks). This check allows each test run to be bracketed by calibrations and documents the precision of the data just collected. Anytime an adjustment is made to an

analyzer, a calibration error test will be performed. Measurement data quality objectives for this technology are contained in Appendix G.

B5.3 Aerodyne Research, Inc.

Please refer to Appendix F for the Aerodyne quality assurance step for their analytical methods. Measurement data quality objective for this technology are contained in Appendix G.

B5.4 Telops

The QC checks will be performed using a black body on the flare stack. Measurement data quality control objectives for this technology are contained in Appendix H.

B5.5 Industrial Monitor and Control Corporation

A log will be kept with the beginning and ending times of activities. Sample, background and calibration measurement times will be recorded. Start time, time of stable IR signal and test end time will be recorded for each test condition for time averaging of the data.

Before the unit is shipped to John Zink, a laboratory calibration of the unit will occur to allow comparison to the field calibration so that any instrument adjustment that may be necessary will take place.

On a daily basis temperature calibration of the IR will conducted using a black body source at known temperatures.

Before and during each test series, a sky background spectrum will be collected to enable correction of the IR signal to the background signal.

During all tests measurements, the data will be manually checked for completeness and accuracy to insure that the IR system is operating in a quality manner. Measurement data quality control objectives for this technology are contained in Appendix H.

B5.6 Leak Surveys, Inc.

Daily, the camera systems will be allowed to condition for 30 minutes before actual video footage will be recorded. If during this conditioning time it is discovered that the images are not clear and concise by operator review, adjustment to the systems will be accomplished to achieve a quality image determined by the operator. Before each test, a propane cylinder will be opened and the camera will be aimed at the cylinder so that the camera can prove it is detecting hydrocarbons.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

This section describes the procedures to ensure and maintain the readiness of the field equipment throughout all phases of the project.

B6.1 Instrument Testing/Inspection

Each contractor that is providing an instrument to assess the flare flue gas will test and inspect their monitors in accordance with company standards.

B6.2 Preventive Maintenance Procedures

This section describes the routine preventive maintenance procedures performed on equipment used to assess the flare flue gas. This project will be conducted over a two week period, due to the short operation of the equipment, preventive maintenance may not be necessary for all instruments during the testing period.

B6.2.1 John Zink Company LLC

Flow metering system maintenance will be conducted, as necessary, in accordance with the manufactures requirements.

B6.2.2 TRC

Routine preventative maintenance procedures and schedules for the Gas Chromatograph (GC) are described in the instrument service manuals. The TRC Standard Operating Procedures for monitoring using a GC are contained in Appendix B.

B6.2.3 Aerodyne Research, Inc.

If preventative maintenance is required, it will be in accordance with recommendations from the manufacturer of the analysis and meteorological equipment.

B6.2.4 Telops

Routine preventive maintenance procedures are not available since this is an experimental technology.

B6.2.5 Industrial Monitor And Control Corporation

Routine preventive maintenance procedures are not available since this is an experimental technology.

B6.2.6 Leak Surveys, Inc.

If routine preventive maintenance procedures are required, they will be in accordance with the instrument manual direction.

B6.3 Corrective Maintenance Procedures

This section describes the corrective maintenance procedures performed on the technologies participating in this flare project.

B6.3.1 John Zink Company LLC

Corrective maintenance procedures for the flow monitors follow the Manufacturer’s recommendations in the device service manuals.

B6.3.2 TRC

Corrective maintenance procedures for the gas chromatograph monitor follow the manufacturer's recommendations in the instrument service manuals.

B6.3.3 Aerodyne Research, Inc.

Corrective maintenance procedures for the mobile lab follow the manufacturer's recommendations in the service manuals.

B6.3.4 Telops

Corrective maintenance procedures for the spectral imaging equipment follow the manufacturer's recommendations in the instrument service manuals.

B6.3.5 Industrial Monitor And Control Corporation

Corrective maintenance procedures for the infra red camera follow the manufacturer's recommendations in the service manual.

B6.3.6 Leak Surveys, Inc.

Corrective maintenance procedures for the infra red camera will follow the manufacturer's recommendations in the service manual.

B6.4 Availability of Spare Parts

A minimum stock level shall be maintained by the subcontractors and stored in the area designated by each subcontractor.

B7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

This section identifies the instruments, tools, and standards whose quality must be controlled, the methods and frequency of calibration, the calibration and performance standards, and the traceability of the standards. It is the responsibility of each participant to maintain documentation regarding the traceability of the standard materials used as references for calibration purposes via logbooks or electronic logs.

B7.1 Calibration

B7.1.1 John Zink Company LLC

Second source standards are used by ZINK for this project. Calibration frequency is contained in Appendix H.

B7.1.2 TRC

The methane, ethane and propylene calibration gases will be derived from secondary standard span gas bottles that have been certified by the vendor. The primary cylinders are traceable to a National Institute of Standards and Technology (NIST) Standard Reference Materials (SRMs). Calibration frequency is contained in Appendix H.

B7.1.3 Aerodyne Research, Inc.

The calibration of the formaldehyde measurement is performed using a calibrated permeation source diluted into zero air. NIST traceable sources of Carbon Monoxide, Carbon Dioxide, Nitrogen Oxide and Sulfur Dioxide are used as standards. An effusive source of naphthalene, mounted inside the ionization region of the mass spectrometer provides a low concentration constant background signal which is used to provide a mass calibration marker at 128 amu. The PTR-MS (Ionicon Analytic GMBH) is a chemical ionization based mass spectrometry method that utilizes H_3O^+ as a reagent ion. These H_3O^+ reagent ions are pulled through the air sample by an electric field where they can react via proton transfer reactions. The reagent ions and the resulting proton transfer reaction products are mass selected and detected using the mass spectrometer. Calibration frequency is contained in Appendix H.

B7.1.4 Telops

The gas signatures are from a library of spectral data. Calibration frequency is contained in Appendix H.

B7.1.5 Industrial Monitor And Control Corporation

Before the unit is shipped to John Zink Company, Inc., a laboratory calibration of the unit will occur to allow comparison to the field calibration so that any instrument adjustment that may be necessary will take place.

On a daily basis, temperature calibration of the IR will conducted using a black body source at known temperatures.

Before and during each test series, a sky background spectrum will be collected to enable correction of the IR signal to the background signal. Calibration frequency is contained in Appendix H.

B7.1.6 Leak Surveys, Inc.

There are no standards used by the Leak Surveys company for this project.

B7.2 Traceability

Each contractor will provide documentation as requested of the traceability of their standards.

B7.2.1 John Zink Company LLC

There are no standards used by the John Zink Company LLC for this project.

B7.2.2 TRC

The primary cylinders are traceable to National Institute of Standards and Technology (NIST) Standard Reference Materials (SRMs).

B7.2.3 Aerodyne Research, Inc.

NIST-traceable certified sources of Carbon Monoxide, Carbon Dioxide, Nitrogen Oxide and Sulfur Dioxide are used as standards. An effusive source of naphthalene, mounted inside the ionization region of the mass spectrometer, provides a low concentration constant background signal which is used to provide a mass calibration marker at 128 amu. The PTR-MS (Ionicon Analytic GMBH) is a chemical ionization based mass spectrometry method that utilizes H_3O^+ as a reagent ion.

B7.2.4 Telops

The gas signatures are from a library of spectral data.

B7.2.5 Industrial Monitor And Control Corporation

The gas signatures are from a library of spectral data.

B7.2.6 Leak Surveys, Inc.

There are no standards used by the Leak Surveys, Inc. for this project.

B7.3 Documentation

It is the responsibility of each subcontractor to maintain documentation regarding the traceability of the standard materials used as references for calibration purposes. Site logbooks, electronic logs, and data are maintained by each company's operators.

B8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

This section identifies the quality objectives for supplies and consumables to ensure high, valid data return.

B8.1 Sampling Supplies

Each subcontractor is required to order/obtain, prepare, and store all required sampling materials and supplies for operating analyzers and samplers.

B8.2 Standards

Standards for the analytical calibrations shall be ordered by the subcontractor on an as needed basis either from EPA or from commercial suppliers who provide standards meeting applicable EPA requirements. Standards are either traceable to National Institute of Standards and Technology (NIST) or are certified by the vendor and certification of traceability is kept on file by each laboratory.

B8.3 Spare Parts

Each subcontractor shall procure, store and maintain an inventory of spare parts for all equipment based on equipment manufacturer's recommendations, experience, and project history.

B9 DATA ACQUISITION REQUIREMENTS (NON-DIRECT MEASUREMENTS)

All data for this project are expected to be direct measurements.

B10 DATA MANAGEMENT

Continuously sampled data are managed by each subcontractor within their own data management system. Subcontractor data will be handled in flat file format in Excel 2003 or newer spreadsheets. The UT Quality Assurance officer will compile all data collected under this QAPP so that the data may provide for analysis of DRE and CE.

B10.1 Zink

Data collected by ZINK will be stored at the ZINK facility for up to three years. The data will be reported to UT in Excel 2003 or newer spreadsheets, after the subcontractor validates the data. In addition, the subcontractor's data validators keep individual notebooks of corrections to data files.

B10.2 TRC

Data will be collected on the TRC data acquisition system and reported to UT in Excel 2003 or newer spreadsheets after the subcontractor validates the data. In addition, the subcontractor's data validators keep individual notebooks of corrections to data files. After the validated data have been archived, project personnel continue to review the data for higher levels of data validation. If there is clear evidence that a problem exists that was not detected by earlier stages of data validation, then the Project Quality Assurance Officer may choose to invalidate the data.

B10.3 Aerodyne

Data will be collected on the Aerodyne mobile lab data acquisition system and reported to UT in Excel 2003 or newer spreadsheets, after the subcontractor validates the data. In addition, the subcontractor's data validators keep individual notebooks of corrections to data files. After the validated data have been archived, project personnel continue to review the data for higher levels of data validation. If there is clear evidence that a problem exists that was not detected by earlier stages of data validation, then the Project Quality Assurance Officer may choose to invalidate the data.

B10.4 Telops

Data will be collected on the Telops data acquisition system and reported to UT in Excel 2003 or newer spreadsheets after the subcontractor validates the data. In addition, the subcontractor's data validators keep individual notebooks of corrections to data files. After the validated data have been archived, project personnel continue to review the data for higher levels of data validation. If there is clear evidence that a problem exists that was not detected by earlier stages of data validation, then the Project Quality Assurance Officer may choose to invalidate the data.

B10.5 IMACC

Data will be collected on the IMACC mobile lab data acquisition system and reported to UT in Excel 2003 or newer spreadsheets after the subcontractor validates the data. In addition, the

subcontractor's data validators keep individual notebooks of corrections to data files. After the validated data have been archived, project personnel continue to review the data for higher levels of data validation. If there is clear evidence that a problem exists that was not detected by earlier stages of data validation, then the Project Quality Assurance Officer may choose to invalidate the data.

PLAN to Ensure Data Processing Without Multiple Algorithms

Purpose: To insure the raw spectral data collected during each test are post-processed with 1) the normal industrial process data usually provided, i.e., gas flow and gas composition, as if these tests were conducted at an industrial facility 2) that a copy of the algorithm used by each remote sensing technology is provided to the UT project manager prior to the field campaign so that an independent post processing of test data may occur.

Method: The UT flares test coordinator will follow up to be sure each remote sensing technology provides the post processing algorithm prior to the first day of testing. The flares test coordinator will monitor the communication between the test facility personnel, direct measurement personnel and remote sensing measurement personnel before, during and after each test sequence.

Status Checks: During the field inspection data acquisition each morning, a visual review of the remote sensing measurement stations will be made to verify that there are no cell phone or walkie talkie devices to allow for communication with anyone who could relay test condition information to the remote measurements teams. If these types of devices are discovered, the flares test coordinator will have these devices removed by the measurements company. Periodically during the day, the field tests coordinator will have the remote measurements companies download recently generated data to a removable drive for later comparison to the data presented in the company's preliminary report. If the comparison proves that the preliminary post processed data does not match the independent post processing of the data, then this company's data will be deleted from the project final report with a footnote replacing the data stating post processed data were not acceptable.

B10.6 Leak Surveys

Data will be collected on the Leak Surveys data acquisition system and reported to UT in a video format after the subcontractor validates the data. In addition, the subcontractor's data validators keep individual notebooks of corrections to data files. After the validated data have been archived, project personnel continue to review the data for higher levels of data validation.

B10.7Acceptability of the Hardware/Software Configuration

Each project participant will determine the process and equipment they require to produce quality data.

B10.8 Data to Users

Data will be provided to users through the issuance of the final project report within 30 days after the last test.

C1 ASSESSMENTS AND RESPONSE ACTIONS

Review of process performance is done on a continuous basis. This section addresses the assessment and response actions for this project.

C1.1 Technical Systems Audit

Due to limitations in the project funds, technical systems audits are not scheduled to be performed. If funds become available, technical systems audits may be performed by UT Austin or a subcontractor to UT Austin during the project field campaign.

C1.1.1 Field Technical Systems Audit

Due to limitations in the project funds, field technical systems audits are not scheduled to be performed. If funds become available, field technical systems audits may be performed by UT Austin or a subcontractor to UT Austin during the project field campaign.

C1.1.2 Field Inspections

UT Austin will work with each contractor to develop a company specific field inspection checklist. See Appendix I for an example of a field inspection check list.

C1.2 Performance Evaluations

Due to limitations in the project funds, performance evaluations are not scheduled to be performed. If funds become available, performance evaluations may be performed by UT Austin or a subcontractor to UT Austin during the project field campaign.

C1.2.1 Field Assessment

Due to limitations in the project funds, field assessments are not scheduled to be performed. If funds become available, field assessments may be performed by UT Austin or a subcontractor to UT Austin during the project field campaign.

C1.3 Assessment of Data Quality Indicators

Assessment of data quality indicators consists of (1) performance evaluations to establish data accuracy; (2) repeatability checks and collocated samplers to establish data precision; and (3) valid data return calculations to determine data completeness.

C1.3.1 Specific Procedures for Assessment of Data Quality Indicators

C1.3.1.1 Data Precision Assessment

Precision is a measure of agreement among two or more determinations of the same parameter under similar conditions. The precision acceptance criteria for each parameter measured are presented in Appendix G.

C1.3.1.2 Data Accuracy Assessment

Accuracy is the closeness of a measurement to a reference value, and reflects elements of both bias and precision. The accuracy acceptance criteria for each parameter measured are presented in Appendix G.

C1.3.1.3 Data Completeness Assessment

For this project per cent completeness is calculated on the basis of the number of valid data runs divided by the total number of expected data runs for a given period of time.

Data completeness is calculated as follows:

$$\% \text{ Completeness} = \frac{\text{Number of valid measurements}}{\text{Total number of scheduled measurements}} \times 100$$

C1.4 Audits of Data Quality

The audit of data quality (ADQ) is an examination of data after they have been collected and verified by project personnel. The ADQ documents and evaluates the methods by which decisions were made during the treatment of the data. The project Quality Assurance Manager will perform post field campaign data quality assessments. Zephyr Environmental will perform data analysis that will include audits of data quality.

C1.5 Corrective Actions

Corrective action is an essential part of any quality system and involves those procedures and actions taken to correct situations causing data quality to fall below established expectations. The need for corrective actions will be minimized by the implementation of the *Comprehensive Flare Project Quality Assurance Project Plan*, project standard operating procedures (SOPs), and the application of statistical quality control to establish appropriate data quality limits for measurement activities. Refer to Appendix H for the list of corrective action documentation for each parameter measured during this project. Corrective action can be initiated by any project participant by contacting the UT project manager.

The UT project manager will make a determination on how to proceed to implement the corrective action on a case by case basis.

C2 REPORTS TO MANAGEMENT

C2.1 Quality Assurance (QA) Audit Reports

Due to funding limitations, performance evaluations and technical systems audits are not planned.

C2.2 Annual Project QA Report

This type of report will not be required by this project.

C2.3 Data Reports

Each of the subcontractors is responsible for preparing a preliminary and final data report to the Project Manager daily and 15 days after completion of the field campaign.

C2.3.1 Field Activity Reports

Daily field reports for technologies that generate 10 minute averages will consist of all 10 minute averages of each parameter collected during the field campaign.

Daily field reports for technologies that generate continuous data will consist of all data points collected for each parameter measured during the field campaign.

C2.3.2 Quality Assurance Reports

Daily instrument quality assurance reports will be provided by the project participants.

Final instrument quality assurance reports will be provided by the project participants.

C2.4 Reporting Schedule

Each subcontractor will be required to report their data on an as needed basis during each test, at the end of each test before the daily debriefing and within 15 days after completion of the field campaign to the UT Austin Project Manager.

D1 DATA REVIEW, VALIDATION, AND VERIFICATION

D1.1 Data Validation

Data validation is an integral part of quality management. All data and the conditions under which they were recorded shall be reviewed closely by the subcontractor's data validators to determine the validity of the data and whether individual measurements can be included for statistical analysis. The criteria for validity of each measurement made during the project will be a combination of the Measurement Quality Control objectives contained in Appendix G and the Data Quality Activities contained in Appendix H.

When a subcontractor determines that data are invalid, these data will not be reported to the project. If one subcontractor's data set is integral to another subcontractors set of data, neither set of data will be reported to the project.

D1.1.1 John Zink Company LLC

Initial data review and validation is performed by the test system control operator. If a problem is noticed, according to the measurement quality control objectives contained in Appendix G or the data quality objectives contained in Appendix H, the operator contacts the UT Austin project manager to discuss the next step. If determined, corrective action will be implemented by ZINK before any more tests begin.

D1.1.2 TRC

Initial data review and validation are performed by the test measurement equipment operator. If a problem is noticed, according to the measurement quality control objectives contained in Appendix G or the data quality objectives contained in Appendix H, the operator contacts the UT Austin project manager to discuss the next step. If determined, corrective action will be implemented by TRC before any more tests begin.

D1.1.3 Aerodyne Research, Inc.

Initial data review and validation are performed by the test measurement equipment operator. If a problem is noticed, according to the measurement quality control objectives contained in Appendix G or the data quality objectives contained in Appendix H, the operator contacts the UT Austin project manager lead to discuss the next step. If determined, corrective action will be implemented by Aerodyne before any more test begin.

D1.1.4 Telops

Initial data review and validation are performed by the test measurement equipment operator. If a problem is noticed, according to the Measurement Quality Control Objectives contained in Appendix G or the Data Quality Objectives contained in Appendix H, the operator contacts the UT Austin project manager to discuss the next step. If determined, corrective action will be implemented by Telops before any more tests begin.

D1.1.5 Industrial Monitor And Control Corporation

Initial data review and validation are performed by the test measurement equipment operator. If a problem is noticed, according to the Measurement Quality Control Objectives contained in Appendix G or the Data Quality Objectives contained in Appendix H, the operator contacts the UT Austin project manager to discuss the next step. If determined, corrective action will be implemented by IMACC before any more tests begin.

D1.1.6 Leak Surveys, Inc.

Initial data review and validation are performed by the test measurement equipment operator. If a problem is noticed, according to the Measurement Quality Control Objectives contained in Appendix G or the data quality objectives contained in Appendix H, the operator contacts the UT Austin project manager to discuss the next step. If determined, corrective action will be implemented by LSI before any more tests begin.

D1.2 Data Custody

Custody of data is maintained by each subcontractor. All data submitted to the project manager will be archived at UT for at least 3 years after the project terminates.

D1.2.1 John Zink Company LLC

Data custody of all measurement data generated by the John Zink Company, Inc. is maintained and managed by the John Zink Company LLC for at least 3 years after completion of testing. After all the John Zink Company LLC data have been reported to UT, UT will archive the data for at least 3 years after termination of the project.

D1.2.2 TRC

Data custody of all measurement data generated by TRC is maintained and managed by TRC. After all the TRC data have been reported to UT, UT will archive the data for at least 3 years after termination of the project.

D1.2.3 Aerodyne Research, Inc.

Data custody of all measurement data generated by Aerodyne Research, Inc. is maintained and managed by Aerodyne Research, Inc.. Once all the Aerodyne Research, Inc. data have been reported to UT, UT will archive the data for at least 3 years after termination of the project.

D1.2.4 Telops

Data custody of all measurement data generated by Telops is maintained and managed by Telops. After all the Telops data have been reported to UT, UT will archive the data for at least 3 years after termination of the project.

D1.2.5 Industrial Monitor And Control Corporation

Data custody of all measurement data generated by Industrial Monitor And Control Corporation is maintained and managed by Industrial Monitor And Control Corporation. After all the Industrial Monitor and Control Corporation. data have been reported to UT, UT will archive the data for at least 3 years after termination of the project.

D1.2.6 Leak Surveys, Inc.

Data custody of all measurement data generated by Leak Surveys, Inc. is maintained and managed by Leak Surveys, Inc. After all the Leak Surveys, Inc. data have been reported to UT, UT will archive the data for at least 3 years after termination of the project.

D2 VALIDATION AND VERIFICATION METHODS

The objective of the data processing and validation effort is to obtain quality assured databases containing the monitoring data in a consistent format. The procedures that will be implemented for data processing and validation will ensure that reported data are valid and comparable to those collected by other programs contributing data to this effort.

After the validated data have been archived, data analysts continue to review the data for higher levels of data validation. If there is clear evidence that a problem exists that was not detected by earlier stages of data validation, then the Quality Assurance Officer may choose to invalidate the data.

D2.1 John Zink Company LLC

The acceptance criteria for the measurement methods conducted by the John Zink Company, Inc. are presented in Appendix H. The John Zink Company LLC will provide validated data to UT in an Excel spread sheet in their final report 15 days after the end of the field campaign.

D2.2 TRC

The acceptance criteria for the measurement methods conducted by TRC are presented in Appendix H. TRC will provide validated data to UT in an Excel spread sheet in their final report 15 days after the end of the field campaign.

D2.3 Aerodyne Research, Inc.

The acceptance criteria for the measurement methods conducted by Aerodyne Research, Inc. are presented in Appendix H. Aerodyne Research, Inc. will provide validated data to UT in an Excel spread sheet in their final report 15 days after the end of the field campaign.

D2.4 Telops

The acceptance criteria for the measurement methods conducted by Telops are presented in Appendix H. Telops will provide validated data to UT in an Excel spread sheet in their final report 15 days after the end of the field campaign.

.

D2.5 Industrial Monitor And Control Corporation

The acceptance criteria for the measurement methods conducted by Industrial Monitor And Control Corporation are presented in Appendix H. Industrial Monitor And Control Corporation will provide validated data to UT in an Excel spread sheet in their final report 15 days after the end of the field campaign.

.

D2.6 Leak Surveys, Inc.

The acceptance criteria for the measurement methods conducted by Leak Surveys, Inc. are presented in Appendix H. Leak Surveys, Inc. will be provided validated data to UT in a PDF format in their final report 15 days after the end of the field campaign.

D2.7 Data Review

If any contractor's equipment operator notes any unusual or nonstandard conditions during the collection of the data, the operator enters the information in the contractor site activity log, which may be reviewed by the contractor's data validator during the data validation process. If during the data validation process the contractor's data validator determines that these conditions impact the data in a negative manner, and then the contractor's data validator may reject the data based on entries in the contractor site activity log on a case-by-case basis. If, during a review of the test data, the data validator discovers abnormal concentrations as compared to expected values based on knowledge of past data, meteorology, and other conditions, the data validator checks logs, and quality control records to determine if there is a reason to invalidate the data in question.

The Project Quality Assurance Officer (or their designee) reviews all data for anomalies and asks contractor's staff to investigate the value for an assignable cause. Any findings are documented as to the reason for invalidation and limitations on use of the data, if appropriate.

D3 RECONCILIATION WITH USER REQUIREMENTS

Problems with potential limitations of the data are handled at two different levels: (1) by the contractors' data validators communicating with the monitoring technician by telephone, e-mail; and (2) by users of data, who may question or want to verify the data quality objectives with a contractor data validator at a later date after data are processed. Issues are reconciled at the lowest level and earliest time possible. The mechanisms for communication between the producers and users of data are the telephone, the contractor site activity log, and electronic systems.

The QA officers, validators, analysts, and data managers are empowered to review and question any part of the measurement process and may initiate data reviews and corrective actions to bring the process back into compliance.

D3.1 Detection Limits

Instrument method detection limits for each measurement are provided by each contractor. They are presented in Appendix G. The methods contained in this project are experimental; method detection limits have not been developed.

D3.2 Precision

Precision for each instrument method will be determined using the procedures developed by each study participant. If precision is reported, it is presented in Appendix G. Precision between in situ instruments measurements will be presented in the project final report. Precision between remote sensing technologies will not be possible since these experimental measurements do not have a precision metric reported in any literature.

D3.2.1 John Zink Company LLC

Precision for all device measurements made by the John Zink Company LLC is presented in Appendix G.

D3.2.2 TRC

Precision for all instrument measurements made by TRC are presented in Appendix G.

D3.2.3 Aerodyne Research, Inc.

The Precision for all instrument measurements made by Aerodyne Research, Inc. is presented in Appendix G.

D3.2.4 Telops

Precision for all instrument measurements made by Telops is presented in Appendix G.

D3.2.5 Industrial Monitor And Control Corporation

Precision is not a metric reported by Industrial Monitor And Control Corporation since their measurement is made with an experimental instrument.

D3.2.6 Leak Surveys, Inc.

Precision is not a metric reported by Leak Surveys, Inc. since their measurement is made with a video instrument.

.

D3.3 Accuracy

Accuracy is the closeness of a measurement to a reference value, and reflects elements of both bias and precision.

D3.3.1 John Zink Company LLC

Accuracy for all device measurements made by the John Zink Company LLC is presented in Appendix G.

D3.3.2 TRC

Accuracy for all instrument measurements for all measurements made by TRC is presented in Appendix G.

D3.3.3 Aerodyne Research, Inc.

Accuracy for all instrument measurements made by Aerodyne Research, Inc., is presented in Appendix G.

D3.3.4 Telops

Accuracy for all instrument measurements made by Telops is presented in Appendix G.

D3.3.5 Industrial Monitor And Control Corporation

Accuracy is not a metric reported by Industrial Monitor And Control Corporation since their measurement is made with an experimental instrument.

D3.3.6 Leak Surveys, Inc.

Accuracy is not a metric reported by Leak Surveys, Inc. since their measurement is made with a video instrument.

D3.4 Completeness

For all data completeness calculations, see Sections A7.2.5 and C1.3.1.3.