CHICAGO LEGAL CLINIC, INC.
Sharon A. Hwang , President · Adam Salzman, Executive Director

Downtown Office
211 W. Wacker Dr.
Suite 750
Chicago, IL 60606
Phone: 312-726-2938
Fax: 312-726-5206
TDD: 773-731-3477
Keith I. Harley
Greta M. Doumanian
Marta C. Bukata
Daryl Grable

May 22, 2020

City of Chicago, Department of Public Health
Attn: Environmental Permitting and Inspections
333 South State Street, Room 200
Chicago, IL 60604

Via email to: EnvComments@cityofchicago.org; Jennifer.Hesse@cityofchicago.org
Dave.Graham@cityofchicago.org

Re: May 12, 2020 Proposed Rules For Large Recycling Facilities

To Whom It May Concern:

Please be advised that I represent the Southeast Environmental Task Force ("SETF"). SETF is an environmental education and advocacy organization based on Chicago's southeast side.[1] SETF's members include individuals who live, work and recreate on the southeast side. SETF's mission is to ensure a healthy and safe environment for its residents, to preserve regional ecological resources and to achieve a sustainable economy that enhances local communities.

SETF's comments are supported by the Natural Resources Defense Council ("NRDC") and its thousands of members and activists in the City of Chicago, including those who reside on Chicago's southeast side.[2] These comments are also supported by the Chicago South East Side Coalition to Ban Petcoke[3], a community-based organization that is dedicated to the health, safety and welfare of the people who live, work and recreate in the Calumet region. Because of the short comment period, it wasn't possible for these aligned organizations to coordinate fully on a single set of comments. Consequently, additional comments that are also supported by SETF will also be submitted by these organizations focusing on other aspects of the proposed rules.

SETF's comments recommend changes to Section 3.9.21 ("Air Quality Impact Assessment") and Section 4.7.3 (Consequential Facility Air Monitoring Requirements). SETF also requests clarification and makes a recommendation for Section 4.4.1 (Storage Stockpiles).

By way of summary, metal shredders emit Volatile Organic Materials (VOM) which have both local and regional air quality impacts. For two Chicago metal shredders, U.S. EPA identified unpermitted VOM releases by employing an infrared cameras and mandatory information

[1] http://setaskforce.org/

[2] https://www.nrdc.org/

[3] https://www.facebook.com/SSCBP60617/

requests. CDPH should require Air Quality Impact Assessments for VOMs. CDPH should require monitoring of processing equipment for fugitive VOM releases using infrared monitoring. This type of monitor is a reliable means to detect VOM releases that are not detected by other facility protocols or required by state-issued permits.

Metal shredders – whether classified as large recycling facilities or consequential facilities - are significant sources of volatile organic materials (VOMs).[4] VOMs are photochemical oxidants associated with a number or detrimental health effects, which include birth defects and cancer, as well as environmental and ecological effects.[5] In the presence of sunlight, VOMs are influenced by a variety of meteorological conditions that have the ability to create photochemical smog, reacting with oxygen in the air to produce ground-level ozone.[6]

As evidenced by two recent U.S. EPA Region 5 enforcement actions against metal shredding facilities in Chicago, VOM emissions have been poorly characterized and controlled by facility operators. In the first case, In the Matter of Metal Management Midwest d/b/a Sims Metal Management 2500 South Paulina Street Chicago, Illinois, Docket No. CAA-05-2019-006, U.S. EPA concluded that the facility operators significantly underestimated the maximum theoretical emissions of VOM emissions.[7] Based on the evidence gathered using an EPA Forward Looking Infrared (FLIR) camera and a subsequent Section 114 Information Request, U.S. EPA concluded the hammermill shredder employed by the facility "…has a maximum theoretical emissions rate of more than 100 tons per calendar year of VOM." [8] Despite this, the facility had been mischaracterized as a minor VOM source (less than 25 tons per year). As part of a December 18, 2018 Consent Agreement and Final Order, the facility operator agreed to acquire a new operating permit with production and capacity limits in order to lower potential VOM emissions to below 25 tons per year.[9]

In the second case, In the Matter of General Iron Industries, Inc. Chicago, Illinois, Docket No. EPA-5-19-113(a)-IL-08, U.S. EPA again concluded that a metal shredder significantly underestimated its VOM emissions when it, in fact, had a potential to emit more than 100 tons of VOM per year.[10] Despite this, General Iron did not have any emission capture or control

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[4] In the Matter of General Iron Industries, Inc. Chicago, Illinois, Docket No. EPA-5-18-IL-14, U.S. EPA Region 5, July 18, 2018, at 6. Available at: https://www.epa.gov/sites/production/files/2018-07/documents/general_iron_industries_inc._nov-fov.pdf

[5] Id.

[6] Id.

[7] In the Matter of Metal Management Midwest d/b/a Sims Metal Management 2500 South Paulina Street Chicago, Illinois, Docket No. CAA-05-2019-006, U.S. EPA – Region 5, December 19, 2018, at 6. Available at: https://www.mitchellwilliamslaw.com/webfiles/CAFO%20Metal%20Management.pdf

[8] Id.

[9] Id.

[10] In the Matter of General Iron Industries, Inc. Chicago, Illinois, Docket No. EPA-5-18-IL-14, U.S. EPA Region 5, July 18, 2018, at 4. Available at: https://www.epa.gov/sites/production/files/2018-07/documents/general_iron_industries_inc._nov-fov.pdf

equipment to achieve an overall reduction of uncontrolled VOM emissions of at least 81 percent, nor did it have the appropriate operating permit that corresponded with its VOM emissions.[11] Again, U.S. EPA identified the magnitude of the VOM emissions through inspections using its FLIR camera and a Section 114 Information Request.[12] As part of an August 22, 2019 Administrative Consent Order, General Iron agreed to complete the installation of a regenerative thermal oxidizer with a minimum VOM destruction efficiency of 98%.[13]

The MMM and General Iron cases demonstrate that metal shredding facilities are significant sources of volatile organic materials and that, absent regulatory intervention, these VOM emissions are significantly underestimated and poorly controlled. Indeed, absent EPA's determination to employ FLIR cameras and Section 114 requests, these significant VOM emissions would remain undetected. Absent EPA's enforcement initiatives, the facilities would not be controlling their VOM emissions and would not be operating using the correct permitting protocols. As a practical matter, these significant but poorly controlled VOM emissions potentially impact local communities and regional air quality.

Section 3.9.21

For the foregoing reasons, SETF asserts that Section 3.9.21 ("Air Quality Impact Assessment") should include mandatory air quality impact assessment for volatile organic emissions as well as PM10 emissions. This is the only way to ensure that facilities are required to accurately assess VOM emissions and the impacts that arise from these accurate emission calculations. In turn, this will enable permit applicants, CDPH and public commentators to ensure there are adequate controls for VOM sources. Accurately assessing and appropriately controlling VOM emissions will benefit both local communities and regional air quality. This task cannot be offloaded to IL EPA, which failed to accurately assess VOM emissions for MMM and General Iron, failed to require appropriate permits and is ill-suited to address local public health impacts.

Section 4.7.3

SETF also asserts that Section 4.7.3 (Consequential Facility Air Monitoring Requirements) should include mandatory FLIR monitoring requirements for processing equipment. Permits must include monitoring using an infrared camera that is capable of detecting fugitive VOM releases. This protocol should be implemented and/or verified by qualified, independent third party vendors. This monitoring protocol should be incorporated into permit provisions that include appropriate recordkeeping, reporting and corrective action requirements. It appears CDPH already mandates using this or a similar technology for stockpiles (see 3.10.4.7). Section

[11] In the Matter of General Iron Industries, Inc. Chicago, Illinois, Docket No. EPA-5-18-IL-14, U.S. EPA Region 5, July 18, 2018, at 5. Available at: https://www.epa.gov/sites/production/files/2018-07/documents/general_iron_industries_inc._nov-fov.pdf

[12] In the Matter of General Iron Industries, Inc. Chicago, Illinois, Docket No. EPA-5-18-IL-14, U.S. EPA Region 5, July 18, 2018, at 4. ("35. During the May 24 & 25, 2018 inspection, EPA observed and recorded hydrocarbons exiting the hammermill shredder with a FLIR infrared camera."). Available at: https://www.epa.gov/sites/production/files/2018-07/documents/general_iron_industries_inc._nov-fov.pdf

[13] In the Matter of General Iron Industries, Inc. Chicago, Illinois, Docket No. EPA-5-19-133(a)-IL-08, U.S. EPA Region 5, August 22, 2019 at 7. Available at: https://www.epa.gov/sites/production/files/2019-08/documents/general_iron_industries_inc_aco.pdf

3.10.4.7 demonstrates the importance of this type of monitoring for purposes of fire prevention as well as detecting and responding to VOM releases.

In order to demonstrate the technical credibility of this technology – commonly referred to as FLIR (Forward Looking Infrared Radiation) monitoring – SETF is attaching an Environmental Technology Verification Report prepared by Batelle under a cooperative agreement with U.S. EPA. Generally speaking, FLIR cameras are a technology that uses infrared detectors to take pictures or videos. It works by having sensors take in infrared radiation (IR) and using differences in the wavelengths of radiation to create images. Variations in temperature cause the variations in IR wavelength that the detectors can register. This allows the detector to pick up objects or trends that are not necessarily visible to the naked eye, such as colorless gases, if they have a different temperature than their surrounding environment. IR also passes through some solid objects that visible light is not able to, allowing FLIR systems to effectively see through walls in some contexts.

The technology was originally developed in the late 50’s to early 60’s. It has historically been used mostly for police and military reconnaissance and surveillance due to its portability (such as being attached to aircraft and drones), its ability to see through walls, and it being harder to detect than other systems like radar. FLIR systems have only begun being used in a larger variety of uses in the past few decades due to decreasing production costs and improved software that increases resolution and sensitivity. More recently, the technology has seen wider applications in security, public safety, and manufacturing. In particular, FLIR technology has proven useful for detecting and monitoring gas leaks in industrial settings.

For gas leaks, the cameras rely on detecting minute differences in temperature between the gas and the surrounding environment. The software on the cameras can be calibrated to look for very specific, pre-defined temperature differences that are known to be associated with very specific gases. Studies have shown these cameras are very accurate and precise for the compounds they are programed to detect. There are multiple companies that produce FLIR cameras. However, the largest one is a company called FLIR Systems. FLIR Systems produces a camera that is specifically designed to detect VOMs and Methane, called the FLIR GF320. The camera was first released in 2005, and it is still available through the company directly as well as specialized dealers.

For these reasons, SETF asserts that Section 4.7.3 should mandate FLIR monitoring for processing equipment along with corresponding recordkeeping, reporting and corrective action requirements. This is the only credible way for facilities to detect and, in turn, respond to VOM releases that otherwise would pose an undetected, unaddressed danger to the local community.

<u>Section 4.4.1</u>
Section 4.4.1 requires:

> “Post-processed auto Shredder residue shall be stored inside a covered, fire-proof bunker that effectively protects the stored material from precipitation and potential ignition sources.”

However, the regulations do not describe the engineering features for a "bunker". SETF requests this clarification. Moreover, SETF requests this section be amended in the following manner:

> "Post-processed auto Shredder residue shall be stored inside a covered, fire-proof bunker that effectively protects the stored material from precipitation and potential ignition sources and that prevents this material from becoming windborne."

The reasons for preventing releases of ASR are described in earlier comments.

Thank you for your consideration of these comments. Please contact me if you have any questions or if I can provide additional information.

Sincerely,

Keith Harley

Keith Harley, Attorney for the Southeast Environmental Task Force
Chicago Legal Clinic, Inc.
211 W. Wacker, Suite 750
Chicago, IL 60606
(312) 726-2938
kharley@kentlaw.iit.edu

enc

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

In the Matter of:	)	**Docket No.** CAA-05-2019-0006
	)	
Metal Management Midwest, Inc.	)	**Proceeding to Assess a Civil Penalty**
d/b/a Sims Metal Management	)	**Under Section 113(d) of the Clean Air Act,**
2500 South Paulina Street	)	**42 U.S.C. § 7413(d)**
Chicago, Illinois	)	
	)	
Respondent.	)	
	)	

REGIONAL HEARING CLERK
RECEIVED
DEC 20 2018
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 5

Consent Agreement and Final Order

Preliminary Statement

1. This is an administrative action commenced and concluded under Section 113(d) of the Clean Air Act (CAA), 42 U.S.C. § 7413(d), and Sections 22.1(a)(2), 22.13(b) and 22.18(b)(2) and (3) of the Consolidated Rules of Practice Governing the Administrative Assessment of Civil Penalties and the Revocation/Termination or Suspension of Permits (Consolidated Rules), as codified at 40 C.F.R. Part 22.

2. Complainant is the Director of the Air and Radiation Division, U.S. Environmental Protection Agency (EPA), Region 5.

3. Respondent is Metal Management Midwest, Inc., d/b/a Sims Metal Management (MMMI), a corporation doing business in Illinois.

4. Where the parties agree to settle one or more causes of action before the filing of a complaint, the administrative action may be commenced and concluded simultaneously by the issuance of a consent agreement and final order (CAFO). 40 C.F.R. § 22.13(b).

5. The parties agree that settling this action without the filing of a complaint or the adjudication of any issue of fact or law is in their interest and in the public interest.

6. Respondent consents to the assessment of the civil penalty specified in this CAFO and to the terms of this CAFO.

Jurisdiction and Waiver of Right to Hearing

7. Respondent admits the jurisdictional allegations in this CAFO and neither admits nor denies the factual allegations and violations alleged in this CAFO. Neither this CAFO nor anything herein constitutes or shall be construed as an admission of liability on the part of MMMI.

8. Respondent waives its right to request a hearing as provided at 40 C.F.R. § 22.15(c), any right to contest the allegations in this CAFO and its right to appeal this CAFO.

Statutory and Regulatory Background

9. Section 110 of the CAA, 42 U.S.C. § 7410, requires each state to adopt and submit to EPA for approval a State Implementation Plan (SIP) that provides for the implementation, maintenance, and enforcement of the National Ambient Air Quality Standards (NAAQS).

10. The administrator of the EPA approved Illinois' plan for the attainment and maintenance of the NAAQS under Section 110 of the CAA. See 40 C.F.R. § 52.722 and 55 Fed. Reg. 40661 (October 4, 1990).

11. On May 31, 1972, EPA approved Part 201.122 of Title 35 of the Illinois Administrative Code (IAC) as part of the federally enforceable Illinois SIP. 37 Fed. Reg. 10862.

12. 35 IAC § 201.122 states that evidence that specified air contaminant emissions, as calculated on the basis of standard emission factors or other factors generally accepted as true by those persons engaged in the field of air pollution control, exceed the limitations prescribed under 35 IAC, Chapter 1, shall constitute adequate proof of a violation, in the absence of a showing that actual emissions are in compliance.

13. On September 9, 1994, and through subsequent SIP amendment approvals, EPA approved Part 211 of the IAC as part of the federally enforceable Illinois SIP. 59 Fed. Reg. 46567.

14. 35 IAC § 211.3690 defines "maximum theoretical emissions" as the quantity of volatile organic material (VOM) emissions that theoretically could be emitted by a stationary source before add-on controls based on the design capacity or maximum production capacity of the source and 8760 hours per year.

15. 35 IAC § 211.4970 defines "potential to emit" as the maximum capacity of a stationary source to emit any air pollutant under its physical and operational design.

16. On February 21, 1980, EPA approved Part 212 of the IAC as part of the federally enforceable Illinois SIP. 45 Fed. Reg. 11493.

17. 35 IAC § 212.301 states that no person shall cause or allow the emission of fugitive particulate matter from any process, including any material handling or storage activity, that is visible by an observer looking generally toward the zenith at a point beyond the property line of the emission source.

18. On March 12, 1997, EPA approved 35 IAC § 218.980, as part of the federally enforceable SIP. 62 Fed. Reg. 11327.

19. 35 IAC § 218.980(a)(1) states that a source is subject to 35 IAC Part 218, Subpart TT, if it contains process emission units not regulated by the Subparts identified in 35 IAC § 218.980(a)(1), which as a group both have maximum theoretical emissions of 100 tons or more per calendar year of VOM and are not limited to less than 100 ton of VOM emissions per calendar year in the absence of air pollution control equipment through production or capacity limitations contained in a federally enforceable permit or SIP revision.

20. 35 IAC § 218.980(b)(1) states, in pertinent part, that a source is subject to 35 IAC Part 218, Subpart TT, if it has the potential to emit 25 tons or more of VOM per year, in aggregate, from emission units, that are not regulated by the Subparts identified in 35 IAC § 218.980(b)(1)(A) and not included in the categories listed in 35 IAC § 218.980(b)(1)(B).

21. On October 21, 1996, EPA approved 35 IAC §§ 218.986 and 987, as part of the federally enforceable SIP. 61 Fed. Reg. 54556.

22. 35 IAC § 218.986 states that every owner or operator of an emission unit subject to 35 IAC Part 218, Subpart TT shall comply with the requirements of 35 IAC § 218.986.

23. 35 IAC § 218.987 requires every owner or operator of an emissions unit which is subject to 35 IAC Part 218, Subpart TT to comply with the requirements of 35 IAC Part 218, Subpart TT, on and after March 25, 1995.

Federal Enforcement

24. The Administrator of EPA (the Administrator) may assess a civil penalty of up to $37,500 per day of violation up to a total of $295,000 for CAA violations that occurred after January 12, 2009, through December 6, 2013; $37,500 per day of violation up to a total of $320,000 for CAA violations that occurred after December 6, 2013, through November 2, 2015; and $45,268 per day of violation up to a total of $362,141 for violations that occurred after November 2, 2015, under Section 113(d)(1) of the CAA, 42 U.S.C. § 7413(d)(1), and 40 C.F.R. Part 19.

25. Section 113(d)(1) limits the Administrator's authority to matters where the first alleged date of violation occurred no more than 12 months prior to initiation of the administrative action, except where the Administrator and the Attorney General of the United

States jointly determine that a matter involving a longer period of violation is appropriate for an administrative penalty action.

26. The Administrator and the Attorney General of the United States, each through their respective delegates, have determined jointly that an administrative penalty action is appropriate for the period of violations alleged in this CAFO.

Factual Allegations and Alleged Violations

Factual Allegations

27. MMMI owns and operates a metal shredding and recycling facility at 2500 South Paulina Street, Chicago, Illinois (Paulina Street Facility).

28. MMMI receives, handles, stockpiles and/or otherwise stores, processes, otherwise recycles, and ships ferrous and non-ferrous recyclable metallic materials such as end-of-life vehicles (ELVs), major appliances and other post-consumer sheet metal and metal clips received directly from manufacturers, and/or the specification-grade recyclable metals resulting from such processing and recycling, at the Paulina Street Facility.

29. ELVs and other recyclable metallic materials are processed in a hammermill shredder at the Paulina Street Facility.

30. During an EPA off site surveillance of the Paulina Street Facility conducted on September 7, 2016, EPA observed fugitive particulate matter emitted from the hammermill shredder crossing the property line.

31. On or about December 2, 2016, EPA conducted an onsite inspection at the Paulina Street Facility.

32. During the December 2, 2016 inspection, EPA observed and recorded hydrocarbons exiting the hammermill shredder with a FLIR infrared camera.

33. On or about December 2, 2016, EPA again observed fugitive particulate matter emitted from the hammermill shredder crossing the property line of the Paulina Street Facility.

34. On or about February 24, 2017, EPA issued a Section 114 Information Request (2017 Information Request) to MMMI regarding the Paulina Street Facility.

35. On or about March 31, 2017, MMMI provided a response to the 2017 Information Request.

36. Based on the March 31, 2017 response provided by MMMI, the hammermill shredder at the Paulina Street Facility has a maximum theoretical emissions rate of more than 100 tons per calendar year of VOM.

37. Based on the March 31, 2017 response provided by MMMI, the hammermill shredder alone has the potential to emit 25 tons or more of VOM per year.

38. On or about August 10, 2017, EPA issued a Notice of Violation (NOV) to MMMI alleging that it violated provisions of the Illinois SIP.

39. MMMI will submit an application for a federally enforceable state operating permit for the metal shredder at the Paulina Street Facility which will: (a) limit the quantity of ELVs and other recyclable metallic material it will feed into and process in the metal shredder at the Paulina Street Facility to 344,000 net tons per year, (b) limit the potential to emit VOM at the Paulina Street Facility to below 25 tons per year, and (c) incorporate an updated Fugitive Dust Plan for the Paulina Street Facility.

Alleged Violations

40. The preceding paragraphs are incorporated by reference.

41. MMMI allowed fugitive particulate matter from the hammermill shredder that was visible by an observer looking generally toward the zenith to cross the property line of the

Paulina Street Facility on at least September 7, 2016 and December 2, 2016, in violation of 35 IAC § 212.301.

42. Respondent's violation of 35 IAC § 212.301 subjects Respondent to the issuance of an Administrative Complaint assessing a civil penalty under Section 113(d) of the CAA, for each day of violation.

43. To date, MMMI has not complied with 35 IAC § 218.986.

44. Respondent's violation of 35 IAC § 218.986 subjects Respondent to the issuance of an Administrative Complaint assessing a civil penalty under Section 113(d) of the CAA, for each day of violation.

Civil Penalty

45. Based on analysis of the factors specified in Section 113(e) of the CAA, 42 U.S.C. § 7413(e), the facts of this case and Respondent's agreement to enter into an Administrative Consent Order under Section 113(a) and 114(a) to bring the facility into compliance with the CAA, Complainant has determined that an appropriate civil penalty to settle this action is $225,000.00.

46. Within 30 days after the effective date of this CAFO, Respondent must pay a $225,000.00 civil penalty by electronic funds transfer, payable to "Treasurer, United States of America," and sent to:

> Federal Reserve Bank of New York
> ABA No. 021030004
> Account No. 68010727
> 33 Liberty Street
> New York, New York 10045
> *Field Tag 4200 of the Fedwire message should read:*
> *"D68010727 Environmental Protection Agency"*

In the comment or description field of the electronic funds transfer, state Respondent's name and the docket number of this CAFO.

47. Respondent must send a notice of payment that states Respondent's name and the docket number of this CAFO to EPA at the following addresses when it pays the penalty:

Attn: Compliance Tracker (AE-18J)
Air Enforcement and Compliance Assurance Branch
Air and Radiation Division
U.S. Environmental Protection Agency, Region 5
77 W. Jackson Boulevard
Chicago, Illinois 60604

Nidhi O'Meara (C-14J)
Office of Regional Counsel
U.S. Environmental Protection Agency, Region 5
77 W. Jackson Boulevard
Chicago, Illinois 60604

Regional Hearing Clerk (E-19J)
U.S. Environmental Protection Agency, Region 5
77 W. Jackson Boulevard
Chicago, Illinois 60604

48. This civil penalty is not deductible for federal tax purposes.

49. If Respondent does not pay timely the civil penalty, EPA may request the Attorney General of the United States to bring an action to collect any unpaid portion of the penalty with interest, nonpayment penalties and the United States enforcement expenses for the collection action under Section 113(d)(5) of the CAA, 42 U.S.C. § 7413(d)(5). The validity, amount and appropriateness of the civil penalty are not reviewable in a collection action.

50. Respondent must pay the following on any amount overdue under this CAFO. Interest will accrue on any overdue amount from the date payment was due at a rate established by the Secretary of the Treasury pursuant to 26 U.S.C. § 6621(a)(2). Respondent must pay the United States enforcement expenses, including but not limited to attorneys' fees and costs incurred by the United States for collection proceedings. In addition, Respondent must pay a quarterly nonpayment penalty each quarter during which the assessed penalty is overdue. This

nonpayment penalty will be 10 percent of the aggregate amount of the outstanding penalties and nonpayment penalties accrued from the beginning of the quarter. 42 U.S.C. § 7413(d)(5).

General Provisions

51. Consistent with the Standing Order Authorizing E-Mail Service of Orders and Other Documents Issued by the Regional Administrator or Regional Judicial Officer under the Consolidated Rules, dated March 27, 2015, the parties consent to service of this CAFO by e-mail at the following e-mail addresses: omeara.nidhi@epa.gov (for Complainant), and mlarose@laroseboscolaw.com (for Respondent). The parties waive their right to service by the methods specified in 40 C.F.R. § 22.6.

52. This CAFO resolves only Respondent's liability for federal civil penalties for the violations alleged in this CAFO and the related Notice of Violation.

53. The CAFO does not affect the rights of EPA or the United States to pursue appropriate injunctive or other equitable relief or criminal sanctions for any violations of the law.

54. This CAFO does not affect Respondent's responsibility to comply with the CAA and other applicable federal, state and local laws. Except as provided in paragraph 52, above, compliance with this CAFO will not be a defense to any actions subsequently commenced pursuant to federal laws administered by EPA.

55. Except as otherwise provided for herein, Respondent certifies based upon information and belief formed after reasonable inquiry that it is complying at the Paulina Street Facility with the CAA.

56. With respect to the subject matter hereof, this CAFO constitutes an "enforcement response" as that term is used in EPA's Clean Air Act Stationary Civil Penalty Policy to

determine Respondent's "full compliance history" under Section 113(e) of the CAA, 42 U.S.C. § 7413(e).

57. The terms of this CAFO bind Respondent, its successors and assigns.

58. Each person signing this consent agreement certifies that he or she has the authority to sign for the party whom he or she represents and to bind that party to its terms.

59. Each party agrees to bear its own costs and attorneys' fees in this action.

60. This CAFO constitutes the entire agreement between the parties.

Metal Management Midwest, Inc. d/b/a Sims Metal Management, Respondent

12/7/2018
Date

Peter Bird
President, Metal Management Midwest, Inc.

United States Environmental Protection Agency, Complainant

12/18/18	Edward Nam
Date	Edward Nam Director Air and Radiation Division U.S. Environmental Protection Agency, Region 5

Consent Agreement and Final Order
In the Matter of: Metal Management Midwest, Inc., d/b/a Sims Metal Management
Docket No. CAA-05-2019-0006

Final Order

This Consent Agreement and Final Order, as agreed to by the parties, shall become effective immediately upon filing with the Regional Hearing Clerk. This Final Order concludes this proceeding pursuant to 40 C.F.R. §§ 22.18 and 22.31. IT IS SO ORDERED.

December 19, 2018
Date

Ann L. Coyle
Ann L. Coyle
Regional Judicial Officer
U.S. Environmental Protection Agency
Region 5

Consent Agreement and Final Order
In the matter of: Metal Management Midwest, Inc. d/b/a Sims Metal Management
Docket Number: CAA-05-2019-0006

CERTIFICATE OF SERVICE

I certify that I served a true and correct copy of the foregoing **Consent Agreement and Final Order**, docket number CAA052019 0006, which was filed on 12/20/2018, in the following manner to the following addressees:

Copy by E-mail to Attorney for Complainant: Nidhi O'Meara
omeara.nidhi@epa.gov

Copy by E-mail to Attorney for Respondent: Mark A. LaRose
mlarose@laroseboscolaw.com

Copy by E-mail to Regional Judicial Officer: Ann Coyle
coyle.ann@epa.gov

Dated: 12/20/2018

LaDawn Whitehead
LaDawn Whitehead
Regional Hearing Clerk
U.S. Environmental Protection Agency, Region 5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

JUL 18 2018

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

REPLY TO THE ATTENTION OF:

Mr. Adam Labkon
General Iron Industries, Inc.
1909 N. Clifton Ave.
Chicago, Illinois 60614

Re: Notice and Finding of Violation
General Iron Industries, Inc.
Chicago, Illinois

Dear Mr. Labkon:

The U.S. Environmental Protection Agency (EPA) is issuing the enclosed Notice and Finding of Violation (NOV/FOV) to General Iron Industries, Inc. (you) under Sections 113(a)(1) and 113(a)(3) of the Clean Air Act (CAA), 42 U.S.C. §§ 7413(a)(1) and 7413(a)(3). We find that you are violating and have violated the Illinois State Implementation Plan, Title V of the CAA, 42 U.S.C. §§ 7661a-7661f, and Section 114 of the CAA, 42 U.S.C. § 7414, at your facility in Chicago, Illinois.

Section 113 of the CAA gives the EPA several enforcement options. These options include issuing an administrative compliance order, issuing an administrative penalty order and bringing a judicial civil or criminal action.

While we have been in discussions with you for some time regarding conditions at your facility, the emissions tests you have performed, and possible options for pollution controls, this letter provides formal notice of the violations, and offers you an opportunity to confer with us about those violations as alleged in the NOV/FOV. The conference will give you an opportunity to present information on the specific findings of violation, any efforts you have taken to comply and the steps you will take to prevent future violations. In addition, in order to make the conference more productive, we encourage you to submit to us information responsive to the NOV/FOV prior to the conference date.

Please plan for your facility's technical and management personnel to attend the conference to discuss compliance measures and commitments. You may have an attorney represent you at this conference.

The EPA contact in this matter is Mr. Scott Connolly. You may call or email him at (312) 886-1493 or connolly.scott@epa.gov to request a conference. You may also have your attorney contact Erik Olson at (312) 886-6829 or olson.erik@epa.gov. You should make the request within 10 calendar days following receipt of this letter. We should hold any conference within 30 calendar days following receipt of this letter.

Sincerely,

Edward Nam
Director
Air and Radiation Division

Enclosure

cc: Julie Armitage, Chief, Bureau of Air

Ann Zwick
Freeborn and Peters LLP
311 South Wacker Drive
Suite 3000
Chicago, IL 60606

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

IN THE MATTER OF:	)	
	)	
General Iron Industries, Inc.	)	**NOTICE AND FINDING**
	)	**OF VIOLATION**
Chicago, Illinois	)	
	)	**EPA-5-18-IL-14**
Proceedings Pursuant to	)	
Section 113(a)(1) of the	)	
Clean Air Act, 42 U.S.C.	)	
§ 7413(a)(1)	)	

NOTICE AND FINDING OF VIOLATION

The U.S. Environmental Protection Agency (EPA) is issuing this Notice and Finding of Violation (NOV/FOV) under Sections 113(a)(1) and 113(a)(3) of the Clean Air Act (CAA), 42 U.S.C. §§ 7413(a)(1) and 7413(a)(2). EPA finds that General Iron Industries, Inc. (General Iron) is violating Section 114(a)(1) of the CAA, 42 U.S.C. §7414, Title V of the CAA, 42 U.S.C. §§ 7661a-7661f, and the Illinois State Implementation Plan (SIP), as follows:

Statutory and Regulatory Background

1. The Administrator of EPA may require any person who owns or operates an emission source who is subject to any requirement of the CAA to provide information required by the Administrator under Section 114(a)(1) of the CAA, 42 U.S.C. § 7414(a)(1). The Administrator has delegated this authority to the Director of the Air and Radiation Division.

2. Title V of the CAA, 42 U.S.C. §§ 7661a-7661f, establishes an operating permit program for certain sources, including "major sources" and "major stationary sources."

3. Section 502(a) of the CAA, 42 U.S.C. § 7661a(a), and 40 C.F.R. § 70.7(b) provide that, after the effective date of any permit program approved or promulgated under Title V of the CAA, no source subject to Title V may operate except in compliance with a Title V permit.

4. 40 C.F.R. § 70.1(b) provides that all sources subject to the Part 70 regulations shall have a permit to operate that assures compliance by the source with all applicable requirements, as defined in 40 C.F.R. § 70.2.

5. Section 503(c) of the CAA, 42 U.S.C. § 7661b(c), and 40 C.F.R. § 70.5(a) provide that any person required to have a permit under Title V must timely submit an application for a permit.

6. U.S. EPA granted full approval to the Illinois Title V operating permit program (CAAPP) on December 4, 2001, set forth at 415 Illinois Compiled Statutes (ILCS) Section 5/39.5. The program became effective on November 30, 2001. 66 Fed. Reg. 62946.

7. Section 39.5(6)(b) of the Illinois Environmental Protection Act states that no person shall operate a CAAPP source without a CAAPP permit unless a CAAPP permit or renewal application has been timely submitted. 415 ILCS § 5/39.5(6)(b).

8. Section 502 of the CAA, 42 U.S.C. § 7661a, applies to all major stationary sources, defined at Section 501 of the CAA, 42 U.S.C. § 7602.

9. Section 39.5 of the Illinois Environmental Protection Act applies to any source defined as a major source or major stationary source. 415 ILCS § 5/39.5(2)(a)(ii).

10. The definition of "major stationary source" includes any stationary source located in a "marginal" or "moderate" ozone non-attainment area that emits or has the potential to emit 100 tons per year or more of volatile organic compounds. 415 ILCS § 5/39.5(2)(c)(iii).

11. Section 110 of the CAA, 42 U.S.C. § 7410, requires each state to adopt and submit to EPA for approval a SIP that provides for the implementation, maintenance, and enforcement of the National Ambient Air Quality Standards (NAAQS).

12. The Administrator of the EPA approved Illinois' plan for the attainment and maintenance of the NAAQS under Section 110 of the CAA. *See* 40 C.F.R. § 52.722 and 55 Fed. Reg. 40661 (October 4, 1990).

13. On May 31, 1972, EPA approved Section 201.122 of Title 35 of the Illinois Administrative Code (IAC) as part of the federally enforceable Illinois SIP. 37 Fed. Reg. 10862.

14. 35 IAC § 201.122 states that evidence that specified air contaminant emissions, as calculated on the basis of standard emission factors or other factors generally accepted as true by those persons engaged in the field of air pollution control, exceed the limitations prescribed under 35 IAC, Chapter 1, shall constitute adequate proof of a violation, in the absence of a showing that actual emissions are in compliance.

15. On September 9, 1994, EPA approved Part 211 of the IAC as part of the federally enforceable Illinois SIP. 59 Fed. Reg. 46567.

16. 35 IAC § 211.3690 defines "maximum theoretical emissions" as the quantity of volatile organic material emissions that theoretically could be emitted by a stationary source before add-on controls based on the design capacity or maximum production capacity of the source and 8760 hours per year.

17. 35 IAC § 211.4970 defines "potential to emit" as the maximum capacity of a stationary source to emit any air pollutant under its physical and operational design.

Any physical or operational limitation on the capacity of a source to emit an air pollutant, including air pollution control equipment and restriction on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design if the limitation is federally enforceable. *See also* 40 C.F.R. § 70.2; 415 ILCS § 5/39.5(1).

18. On February 21, 1980, EPA approved 35 IAC § 212.301 as part of the federally enforceable Illinois SIP. 45 Fed. Reg. 11493.

19. 35 IAC § 212.301 states that no person shall cause or allow the emission of fugitive particulate matter from any process, including any material handling or storage activity, that is visible by an observer looking generally toward the zenith at a point beyond the property line of the emission source.

20. On March 12, 1997, EPA approved 35 IAC § 218.980, as part of the federally enforceable SIP. 62 Fed. Reg. 11327.

21. 35 IAC § 218.980(a)(1) states that a source is subject to 35 IAC Part 218, Subpart TT, if it contains process emission units not regulated by the Subparts identified in 35 IAC § 218.980(a)(1), which as a group have a maximum theoretical emissions of 100 tons or more per calendar year of volatile organic matter (VOM) and are not limited to less than 100 ton of VOM emissions per calendar year in the absence of air pollution control equipment through production or capacity limitations contained in a federally enforceable permit or SIP revision.

22. 35 IAC § 218.980(b)(1) states, in pertinent part, that a source is subject to 35 IAC Part 218, Subpart TT, if it has the potential to emit 25 tons or more of VOM per year, in aggregate, from emission units, that are not regulated by the Subparts identified in 35 IAC § 218.980(b)(1)(A) and not included in the categories listed in 35 IAC § 218.980(b)(1)(B).

23. On October 21, 1996, EPA approved 35 IAC §§ 218.986 and 987, as part of the federally enforceable SIP. 61 Fed. Reg. 54556.

24. 35 IAC § 218.986 states that every owner or operator of an emission unit subject to 35 IAC Part 218, Subpart TT shall comply with 35 IAC § 218.986(a).

25. 35 IAC § 218.986(a) requires every owner or operator to operate emission capture and control equipment which achieves an overall reduction in uncontrolled VOM emissions of at least 81 percent from each emission unit.

26. 35 IAC §§ 218.987 and 218.106(c) require every owner or operator of an emission unit which is subject to 35 IAC Part 218, Subpart TT to comply with the requirements of 35 IAC Part 218, Subpart TT, by March 15, 1995.

Findings

27. General Iron owns and operates a metal shredding and recycling facility at 1909 North Clifton Ave, Chicago, Illinois (Facility), which is located in Cook County.

28. Cook County is part of the Chicago-Naperville, IL-IN-WI nonattainment area which is classified as "marginal" or "moderate."

29. General Iron stores, processes, and recycles ferrous and non-ferrous scrap metals from cars and post-consumer sheet metal at the Facility.

30. Scrap metal is shredded in a hammermill shredder at the Facility.

31. On or about June 13, 2017, May 24 & 25, 2018 and June 13, 2018, EPA conducted onsite inspections at the Facility, including inspections during emissions testing conducted by the Facility.

32. On or about November 11, 2017, EPA issued a Section 114 Information Request (2017 Information Request) to General Iron regarding the Facility. The 2017 Information Request, among other things, required General Iron to conduct emission testing at the facility and to provide the results of the emission testing to EPA. The required emissions testing included evaluations of VOM, particulate matter (PM) and metals emissions.

33. On December 13, 2017 and May 21, 2018, General Iron met with EPA to discuss the 2017 Information Request.

34. General Iron conducted testing as required by the 2017 Information Request on May 24, 2018, May 25, 2018, including testing for VOM, PM, and metals emissions, and on June 13, 2018 and June 14, 2018, including testing for PM and metals emissions.

35. During the May 24 & 25, 2018 inspection, EPA observed and recorded hydrocarbons exiting the hammermill shredder with a FLIR infrared camera.

36. During the June 13, 2018 inspection, EPA observed fugitive particulate matter emitted from the hammermill shredder crossing the property line.

37. On or about December 12, 2017 and June 27, 2018, General Iron provided responses to the 2017 Information Request, including the results of emissions testing for VOM conducted on May 24 and 25, 2018 and emissions testing for PM and metals conducted on June 13 and 14, 2018.

38. General Iron did not provide to EPA the results of the emissions testing for PM and metals conducted on May 24 and 25, 2018.

39. Based on the results of the emissions testing, the Facility emits or has the potential to emit more than 100 tons per calendar year of volatile organic compounds.

40. General Iron is a "major source" as defined at 42 U.S.C. § 7661(2) and 415 ILCS § 5/39.5(2)(c)(i).

41. By operating as a major source, General Iron is subject to the requirements of the CAA's Title V, 42 U.S.C. §§ 7661a-7661f, at the Facility.

42. To date, General Iron has not submitted a complete CAAPP permit application to Illinois EPA.

43. To date, General Iron has not received a CAAPP permit from Illinois EPA.

44. Based on the December 12, 2017 response and the results of the emissions testing, the hammermill shredder at the Facility has maximum theoretical emissions rate of more than 100 tons per calendar year of VOM.

45. Based on the December 12, 2017 response and the results of the emissions testing, the hammermill shredder alone emits 25 tons or more of VOM per year.

46. To date, General Iron does not have any emission capture or control equipment that achieves an overall reduction of uncontrolled VOM emissions of at least 81 percent at the hammermill shredder nor does it have in place a federally enforceable alternative control plan that achieves an overall reduction of uncontrolled VOM emissions of at least 81 percent at the hammermill shredder.

Violations

47. By failing to submit a timely and complete CAAPP permit application to Illinois EPA, General Iron has violated of Section 503 of the CAA, the regulations at 40 C.F.R. §§ 70.5(a) and 70.7(b), and the Illinois Environmental Protection Act at 415 ILCS § 5/39.5(4)(c).

48. By operating as a major stationary source without a Title V permit, General Iron has violated Section 502 of the CAA, the regulations at 40 C.F.R. §§ 70.1(b) and 70.7(b), and the Illinois Environmental Protection Act at 415 ILCS § 5/39.5(6)(b).

49. General Iron allowed fugitive particulate matter from the hammermill shredder that was visible by an observer looking generally toward the zenith to cross the property line of the Facility on at least June 13, 2018, in violation of 35 IAC § 212.301 and the SIP.

50. To date, General Iron has failed to install any emission capture or control equipment that achieves an overall reduction of uncontrolled VOM emissions of at least of 81 percent at the hammermill shredder or, alternatively, obtain a federally enforceable equivalent control plan at the hammermill shredder, in violation of 35 IAC § 218.986(a) and the SIP.

51. To date, General Iron has failed to provide the results of the May 24 and 25 PM and metals emissions testing as required by the 2017 Information Request, in violation of Section 114 of the CAA, 42 U.S.C. § 7414.

Environmental Impact of Violations

52. These violations can cause and have caused excess emissions of VOMs and particulate matter.

53. VOMs are photochemical oxidants associated with a number of detrimental health effects, which include birth defects and cancer, as well as environmental and ecological effects. In the presence of sunlight, VOMs are influenced by a variety of meteorological conditions and have the ability to create photochemical smog. VOMs react with oxygen in the air to produce ground-level ozone.

54. Breathing ozone contributes to a variety of health problems including chest pain, coughing, throat irritation, and congestion. It can worsen bronchitis, emphysema, and asthma. Ground-level ozone also can reduce lung function and inflame lung tissue. Repeated exposure may permanently scar lung tissue.

55. Particulate matter, especially fine particulates, contains microscopic solids or liquid droplets, which can get deep into the lungs and cause serious health problems. Particulate matter exposure contributes to:
    - irritation of the airways, coughing, and difficulty breathing;
    - decreased lung function;
    - aggravated asthma;
    - chronic bronchitis;
    - irregular heartbeat;
    - nonfatal heart attacks; and
    - premature death in people with heart or lung disease.

7/18/18
Date

Edward Nam
Director
Air and Radiation Division

CERTIFICATE OF MAILING

I certify that I sent a Notice of Violation, No. EPA-5-18-IL-14, by Certified Mail, Return Receipt Requested, to:

Adam Labkon
Vice President
General Iron Industries Inc.
1909 North Clifton Street
Chicago, IL 60608

I also certify that I sent copies of the Notice of Violation by email to:

Julie Armitage
Chief
Bureau of Air
Julie.armitage@Illinois.gov

Ann Zwick
azwick@freeborn.com

On the 19th day of July 2018.

Kathy Jones
Kathy Jones
Program Technician
AECAB, PAS

CERTIFIED MAIL RECEIPT NUMBER: 7017 1070 0000 1030 0102

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

AUG 2 2 2019

REPLY TO THE ATTENTION OF

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Adam Labkon
General Iron Industries, Inc.
1909 N. Clifton Ave.
Chicago, Illinois 60614

Re: Administrative Consent Order EPA-5-19-113(a)-IL-08

Dear Mr. Labkon:

Enclosed is an executed original of the Administrative Consent Order regarding the above captioned case. If you have any questions about the Order, please contact me at (312) 886-3850.

Sincerely,

Nathan A. Frank, Chief
Air Enforcement and Compliance Assurance Section (IL/IN)

Enclosure

cc: Susan Tennenbaum/C-14J

Kent Mohr, Illinois Environmental Protection Agency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

In the Matter of:	)	**EPA-5-19-113(a)-IL-08**
	)	
General Iron Industries, Inc.	)	**Proceeding Under Sections 113(a)(1) and**
Chicago, Illinois	)	**114(a)(1) of the Clean Air Act, 42 U.S.C.**
	)	**§§ 7413(a)(1) and 7414(a)(1)**
______________________________	)	

Administrative Consent Order

1. The Director of the Enforcement and Compliance Assurance Division, U.S. Environmental Protection Agency (EPA), Region 5, is issuing this Order to General Iron Industries, Inc. (General Iron) under Sections 113(a)(1) and 114(a)(1) of the Clean Air Act (CAA), 42 U.S.C. §§ 7413(a)(1) and 7414(a)(1).

Statutory and Regulatory Background

2. The Administrator of EPA may require any person who owns or operates an emission source who is subject to any requirement of the CAA to provide information required by the Administrator under Section 114(a)(1) of the CAA, 42 U.S.C. § 7414(a)(1). The Administrator has delegated this authority to the Director of the Enforcement and Compliance Assurance Division.

3. Title V of the CAA, 42 U.S.C. §§ 7661a-7661f, establishes an operating permit program for certain sources, including "major sources" and "major stationary sources."

4. Section 502(a) of the CAA, 42 U.S.C. § 7661a(a), and 40 C.F.R. § 70.7(b) provide that, after the effective date of any permit program approved or promulgated under Title V of the CAA, no source subject to Title V may operate except in compliance with a Title V permit.

5. 40 C.F.R. § 70.1(b) provides that all sources subject to the Part 70 regulations shall have a permit to operate that assures compliance by the source with all applicable requirements, as defined in 40 C.F.R. § 70.2

6. Section 503(c) of the CAA, 42 U.S.C. § 7661b(c), and 40 C.F.R. § 70.5(a) provide that any person required to have a permit under Title V must timely submit a complete application for a permit.

7. 40 C.F.R. § 70.5(a)(2) requires that, among other things, that a complete application include all emissions of regulated air pollutants and air pollutant emission rates.

8. U.S. EPA granted full approval to the Illinois Title V operating permit program (CAAPP) on December 4, 2001, set forth at 415 Illinois Compiled Statutes (ILCS) Section 5/39.5. The program became effective on November 30, 2001. 66 Fed. Reg. 62946.

9. Section 39.5(6)(b) of the Illinois Environmental Protection Act states that no person shall operate a CAAPP source without a CAAPP permit unless a CAAPP permit or renewal application has been timely submitted. 415 ILCS § 5/39.5(6)(b).

10. Sections 39.5(1.1)(a) and (b) of the Illinois Environmental Protection Act states that an owner or operator of a source may seek exclusion from the CAAPP prior to the date the CAAPP application for the source is due by submitting a permit application, consistent with the State permit program, requesting exclusion through the imposition of federally enforceable conditions limiting the potential to emit to below major source thresholds.

11. Section 502 of the CAA, 42 U.S.C. § 7661a, applies to all major stationary sources, defined at Section 501 of the CAA, 42 U.S.C. § 7602.

12. Section 39.5 of the Illinois Environmental Protection Act applies to any source defined as a major source or major stationary source. 415 ILCS § 5/39.5(2)(a)(ii).

13. The definition of "major stationary source" includes any stationary source located in a "marginal" or "moderate" ozone non-attainment area that emits or has the potential to emit 100 tons per year or more of volatile organic compounds. 415 ILCS § 5/39.5(2)(c)(iii).

14. Each state must submit to the Administrator of EPA a plan for attaining and maintaining the National Ambient Air Quality Standards under Section 110 of the CAA, 42 U.S.C. § 7410.

15. The Administrator of the EPA approved Illinois' plan for the attainment and maintenance of the NAAQS under Section 110 of the CAA (Illinois SIP). *See* 40 C.F.R. § 52.722 and 55 Fed. Reg. 40661 (October 4, 1990).

16. On September 9, 1994, EPA approved Part 211 of the IAC as part of the federally enforceable Illinois SIP. 59 Fed. Reg. 46567.

17. 35 IAC § 211.3690 defines "maximum theoretical emissions" as the quantity of volatile organic material emissions that theoretically could be emitted by a stationary source before add-on controls based on the design capacity or maximum production capacity of the source and 8760 hours per year.

18. 35 IAC § 211.4970 defines "potential to emit" as the maximum capacity of a stationary source to emit any air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of a source to emit an air pollutant, including air pollution control equipment and restriction on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design if the limitation is federally enforceable. *See also* 40 C.F.R. § 70.2; 415 ILCS § 5/39.5(1).

19. On March 12, 1997, EPA approved 35 IAC § 218.980, as part of the federally enforceable SIP. 62 Fed. Reg. 11327.

20. 35 IAC § 218.980(a)(1) states that a source is subject to 35 IAC Part 218, Subpart TT, if it contains process emission units not regulated by the Subparts identified in 35 IAC § 218.980(a)(1) which as a group have a maximum theoretical emissions of 100 tons or more per calendar year of volatile organic matter (VOM) and are not limited to less than 100 ton of VOM emissions per calendar year in the absence of air pollution control equipment through production or capacity limitations contained in a federally enforceable permit or SIP revision.

21. 35 IAC § 218.980(b)(1) states, in pertinent part, that a source is subject to 35 IAC Part 218, Subpart TT, if it has the potential to emit 25 tons or more of VOM per year, in aggregate, from emission units, that are not regulated by the Subparts identified in 35 IAC § 218.980(b)(1)(A) and not included in the categories listed in 35 IAC § 218.980(b)(1)(B).

22. On October 21, 1996, EPA approved 35 IAC §§ 218.986 and 218.987 as part of the federally enforceable SIP. 61 Fed. Reg. 54556.

23. 35 IAC § 218.986 states that every owner or operator of an emission unit subject to 35 IAC Part 218, Subpart TT shall comply with 35 IAC § 218.986(a).

24. 35 IAC § 218.986(a) requires every owner or operator to operate emission capture and control equipment which achieves an overall reduction in uncontrolled VOM emissions of at least 81 percent from each emission unit.

25. 35 IAC §§ 218.987 and 218.106(c) require every owner or operator of an emission unit which is subject to 35 IAC Part 218, Subpart TT to comply with the requirements of 35 IAC Part 218, Subpart TT, by March 15, 1995 or upon startup.

26. Under Section 113(a)(1) and (a)(3) of the CAA, 42 U.S.C. § 7413 (a)(1) and (a)(3), the Administrator of EPA may issue an order requiring compliance to any person who has violated or is violating a SIP and Title V of the CAA. The Administrator has delegated this authority to the Director of the Enforcement and Compliance Assurance Division.

Findings

27. General Iron owns and operates a metal shredding and recycling facility at 1909 North Clifton Ave, Chicago, Illinois (Facility), which is located in Cook County.

28. General Iron receives, processes, and recycles ferrous and non-ferrous scrap metals from cars and post-consumer scrap metal at the Facility.

29. Scrap metal is shredded in a hammermill shredder at the Facility that is equipped with a "Pedcon UHF High-Efficiency Roll Filter System" consisting of a capture hood, cyclone and roll-media filter system.

30. On or about June 13, 2017, May 24 and 25, 2018 and June 13, 2018, EPA conducted onsite inspections at the Facility, including inspections during emissions testing conducted by the Facility.

31. On or about November 11, 2017, EPA issued an Information Request pursuant to Section 114 of the CAA (2017 Information Request) to General Iron regarding the Facility. The 2017 Information Request, among other things, required General Iron to conduct emission testing of the hammermill shredder at the Facility and to provide the results of the emission testing to EPA. The required emissions testing included VOM, particulate matter (PM) and metals emissions rates.

32. On December 13, 2017 and May 21, 2018, General Iron met with EPA to discuss the 2017 Information Request.

33. General Iron conducted testing as required by the 2017 Information Request on May 24, 2018, and May 25, 2018, including testing for VOM, PM, and metals emissions, and on June 13, 2018 and June 14, 2018, including testing for PM and metals emissions.

34. On or about January 12, 2018 and June 25, 2018, General Iron submitted to EPA responses to the 2017 Information Request, including the results of emissions testing for VOM conducted on May 25, 2018 and emissions testing for PM and metals conducted on June 13 and 14, 2018, and an impact assessment for metals emissions.

35. On July 18, 2018, EPA issued General Iron a Notice and Finding of Violation (NOV/FOV) for violations of the Clean Air Act and the Illinois SIP.

36. General Iron provided to EPA the results of the emissions testing for PM and metals conducted on May 24, 2018 in submittals on July 23, 2018 and August 21, 2018.

37. General Iron submitted a written response to the NOV/FOV on August 23, 2018.

38. General Iron met with EPA to discuss the NOV/FOV on July 24, 2018 and September 14, 2018.

39. Based on the results of the emissions testing, the Facility is below the permitted hammermill shredder emission limits for PM and the Facility emits or has the potential to emit more than 100 tons per calendar year of volatile organic compounds.

40. General Iron is a "major stationary source" as defined at 42 U.S.C. § 7661(2) and 415 ILCS § 5/39.5(2)(c)(i).

41. By operating as a major source, General Iron is subject to the requirements of the CAA's Title V, 42 U.S.C. §§ 7661a-7661f, at the Facility.

42. Based on the December 12, 2017 response and the results of the emissions testing, the hammermill shredder at the Facility has maximum theoretical emissions rate of more than 100 tons per calendar year of VOM.

43. Based on the December 12, 2017 response and the results of the emissions testing, the hammermill shredder emits 25 tons or more of VOM per year.

44. To date, General Iron does not comply with the VOM control requirements of 35 IAC Part 218, Subpart TT, nor does it have in place a federally enforceable alternative control plan that qualifies for an exemption from these requirements.

45. By operating as a major stationary source without a Title V permit, General Iron has violated Section 502 of the CAA, the regulations at 40 C.F.R. §§ 70.1(b) and 70.7(b), and the Illinois Environmental Protection Act at 415 ILCS § 5/39.5(6)(b).

46. On July 16, 2019, General Iron completed installation of a regenerative thermal oxidizer (RTO) at the Facility.

Compliance Program

47. The RTO shall be appropriately designed, operated and maintained in a manner that ensures the minimum destruction efficiency of the RTO for VOM from the hammermill shredder is 98%.

48. Within 90 days of the effective date of this Order, General Iron must conduct a performance test to demonstrate the VOM destruction efficiency of the RTO.

49. At least 30 days prior to the date of the performance test, General Iron must submit to EPA for review and approval a proposed testing protocol describing the methods and procedures to be conducted during the test. General Iron shall conduct performance testing using, at a

minimum, EPA Methods 1 or 1A, 2 or 2A, 2B or 2C, 3, 4, and 25A, to demonstrate that the RTO achieves the required VOM destruction efficiency.

50. General Iron shall use the RTO operating data from a successful performance test to establish a set point temperature for the RTO that achieves the demonstrated VOM destruction efficiency of the RTO.

51. Within 60 days of the completion of the performance testing conducted according to the approved testing protocol, General Iron shall submit to EPA the results of the performance testing including:

    a. A summary of the results including inlet and outlet organic material concentrations, destruction efficiency of the RTO, visual observations of capture efficiency and RTO operating temperatures.

    b. A description of the facility operations at the time of the test, including operating parameters;

    c. A description of the sampling and analytical procedures; and

    d. All copies of data and measurements obtained during the testing.

52. Within 90 days of the completion of the performance testing, General Iron must submit a permit application to the Illinois EPA to incorporate the following conditions into a federally enforceable state operating permit (FESOP):

    a. Control Device: operate an RTO to control emissions from the hammermill shredder at the Facility;

    b. Operation requirements:

        i. Minimum combustion temperature must be maintained in the RTO, as determined by the performance test; and

ii. Minimum air flow or fan power must be maintained, as determined by the performance test;

c. Control equipment requirements: 98 percent or greater VOM destruction efficiency, by weight, of the RTO;

d. Emission limits: Annual VOM emission limits and RTO destruction efficiency requirements;

e. Monitoring requirements:

i. Continuous monitoring of temperature; and

ii. Continuous monitoring of air flow or fan power;

f. Recordkeeping requirements:

i. A log of the operating times for the shredder;

ii. A log of temperature and air flow or fan power operating records from continuous monitoring; and

iii. A log of any deviations from the operational limits for combustion temperature in the RTO.

53. General Iron must submit a copy of the FESOP permit application to EPA within 7 days of submitting the application to Illinois EPA.

54. General Iron must send all responses, deliverables, submittals or reports required by this Order to connolly.scott@epa.gov, and r5airenforcement@epa.gov. If electronic responses are not possible, send all documents to:

Attention: Compliance Tracker (AE-18J)
Air Enforcement and Compliance Assurance Branch
U.S. Environmental Protection Agency, Region 5
77 W. Jackson Boulevard
Chicago, Illinois 60604

General Provisions

55. This Order does not affect General Iron's responsibility to comply with other federal, state, and local laws.

56. This Order does not restrict EPA's authority to enforce the CAA and its implementing regulations.

57. Failure to comply with this Order may subject General Iron to penalties up to $99,681 per day for each violation under Section 113 of the CAA, 42 U.S.C. § 7413, and 40 C.F.R. Part 19.

58. The terms of this Order are binding on General Iron, its assignees and successors. General Iron must give notice of this Order to any successors in interest prior to transferring ownership and must simultaneously verify to EPA, at the above address, that it has given the notice.

59. General Iron may assert a claim of business confidentiality under 40 C.F.R. Part 2, Subpart B, for any portion of the information it submits to EPA. Information subject to a business confidentiality claim is available to the public only to the extent allowed by 40 C.F.R. Part 2, Subpart B. If General Iron fails to assert a business confidentiality claim, EPA may make all submitted information available, without further notice, to any member of the public who requests it. Emission data provided under Section 114 of the CAA, 42 U.S.C. § 7414, is not entitled to confidential treatment under 40 C.F.R. Part 2, Subpart B. "Emission data" is defined at 40 C.F.R. § 2.301.

60. This Order is not subject to the Paperwork Reduction Act, 44 U.S.C. § 3501 *et seq.*, because it seeks collection of information by an agency from specific individuals or entities as part of an administrative action or investigation. To aid in our electronic recordkeeping efforts,

please furnish an electronic copy on physical media such as compact disk, flash drive or other similar item. If it is not possible to submit the information electronically, submit the response to this Order without staples; paper clips and binder clips, however, are acceptable.

61. EPA may use any information submitted under this Order in an administrative, civil judicial, or criminal action.

62. General Iron agrees to the terms of this Order. General Iron waives any remedies, claims for relief, and otherwise available rights to judicial or administrative review that it may have with respect to any issue of fact or law set forth in this Order, including any right of judicial review under Section 307(b) of the CAA, 42 U.S.C. § 7607(b).

63. This Order is effective on the date of signature by the Director of the Enforcement and Compliance Assurance Division. This Order will terminate on the earlier of either two years from the effective date of the Order, provided that General Iron certifies that it has complied with all terms of the Order, or at the time General Iron certifies that it has complied with all terms of the Order and that it is no longer operating at the Facility.

General Iron Industries, Inc.

8/20/19

Date

Adam Labkon
Vice President
General Iron Industries, Inc.

United States Environmental Protection Agency

8/22/2019 Michael D. Harris

Date

Michael D. Harris
Acting Director
Enforcement and Compliance Assurance Division
U.S. Environmental Protection Agency, Region 5

CERTIFICATE OF MAILING

I certify that I sent the Administrative Consent Order, EPA-5-19-113(a)-IL-08, by certified mail, return receipt requested, to:

Adam Labkon
General Iron Industries, Inc.
1909 N. Clifton Ave.
Chicago, Illinois 60614

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Kent Mohr, Manager
Compliance Section
Bureau of Air
Illinois Environmental Protection Agency
Kent.Mohr@Illinois.gov

On the 22nd day of August 2019

Kathy Jones

Kathy Jones
Program Technician
AECAB, PAS

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November 2010

Environmental Technology Verification Report

FLIR SYSTEMS
GASFINDIR™ MIDWAVE (MW) CAMERA

Prepared by
Battelle

Battelle
The Business of Innovation

Under a cooperative agreement with

EPA U.S. Environmental Protection Agency

ETV ETV ETV

November 2010

Environmental Technology Verification Report

ETV Advanced Monitoring Systems Center

FLIR SYSTEMS
GASFINDIR™ MIDWAVE (MW) CAMERA

by
Brian Boczek and Amy Dindal, Battelle
John McKernan, U.S. EPA

Notice

The U.S. Environmental Protection Agency, through its Office of Research and Development, funded and managed, or partially funded and collaborated in, the research described herein. It has been subjected to the Agency's peer and administrative review. Any opinions expressed in this report are those of the author(s) and do not necessarily reflect the views of the Agency, therefore, no official endorsement should be inferred. Any mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Foreword

The EPA is charged by Congress with protecting the nation's air, water, and land resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, the EPA's Office of Research and Development provides data and science support that can be used to solve environmental problems and to build the scientific knowledge base needed to manage our ecological resources wisely, to understand how pollutants affect our health, and to prevent or reduce environmental risks.

The Environmental Technology Verification (ETV) Program has been established by the EPA to verify the performance characteristics of innovative environmental technology across all media and to report this objective information to permitters, buyers, and users of the technology, thus substantially accelerating the entrance of new environmental technologies into the marketplace. Verification organizations oversee and report verification activities based on testing and quality assurance protocols developed with input from major stakeholders and customer groups associated with the technology area. ETV consists of six environmental technology centers. Information about each of these centers can be found on the Internet at http://www.epa.gov/etv/.

Effective verifications of monitoring technologies are needed to assess environmental quality and to supply cost and performance data to select the most appropriate technology for that assessment. Under a cooperative agreement, Battelle has received EPA funding to plan, coordinate, and conduct such verification tests for "Advanced Monitoring Systems for Air, Water, and Soil" and report the results to the community at large. Information concerning this specific environmental technology area can be found on the Internet at http://www.epa.gov/etv/centers/center1.html.

Acknowledgments

The authors wish to acknowledge the contribution of the many individuals, without whom, this verification testing would not have been possible. Quality assurance (QA) oversight was provided by Michelle Henderson, U.S. EPA, and Zachary Willenberg, Battelle. We thank Mr. David Fashimpaur of BP, for hosting the laboratory testing phase of this verification test at the BP, Naperville, IL research complex. Also, we acknowledge the support of Mr. Jeffrey Panek and Dr. Paul Drayton of Innovative Environmental Solutions, Inc. for operating the leak generation equipment and performing data collection during the laboratory testing phase. We thank Ms. Julie Woodard, Ms. Fran Quinlan Falcon, and Mr. Barry Kelley of the Dow Chemical Company for providing the field test site and for supporting the verification test team during the field testing phase. We gratefully acknowledge the support of the American Chemistry Council (ACC) and the Texas Chemical Council (TCC) as collaborators to this verification test and would like to specifically thank Mr. Jim Griffin (ACC) and Ms. Christina Wisdom (TCC) for their personal dedication to this verification test. Finally, we want thank Mr. David Williams and Mr. Eben Thoma of the U.S. EPA for their review of the test/QA plan and/or this verification report.

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List of Abbreviations

ACC	American Chemistry Council
AMS	Advanced Monitoring Systems
CH_4	Methane
DQI	Data Quality Indicator
EPA	Environmental Protection Agency
ETV	Environmental Technology Verification
FLIR	FLIR Systems, Inc.
ft	Foot, feet
GC	Gas Chromatography
g/hr	Grams per hour
Hz	Hertz
IR	Infrared
kg/hr	Kilogram per hour
LOD	Limit of Detection
LW	Longwave
mm	Millimeter
mph	Miles per hour
MW	Midwave
NRMRL	National Risk Management Research Laboratory
PID	photoionization
ppmv	Parts per million by volume
QA	Quality assurance
QC	Quality control
QMP	Quality Management Plan
SF_6	Sulfur hexafluoride
TCC	Texas Chemical Council
TQAP	Test Quality Assurance Plan
TVA	Toxic Vapor Analyzer
U.S.	United States
VOC	Volatile organic compounds
°F	Degrees Fahrenheit

Chapter 1
Background

The U.S. Environmental Protection Agency (EPA) supports the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized testing organizations; with stakeholder groups consisting of buyers, vendor organizations, and permitters; and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance (QA) protocols to ensure that data of known and adequate quality are generated and that the results are defensible. The definition of ETV verification is to establish the performance of a technology under specific, pre-determined criteria or protocols and a strong quality management system. High quality data are assured through implementation of the ETV Quality Management Plan. <u>ETV does not endorse, certify, or approve technologies</u>.

The EPA's National Risk Management Research Laboratory (NRMRL) and its verification organization partner, Battelle, operate the Advanced Monitoring Systems (AMS) Center under ETV. The AMS Center recently evaluated the performance of the GasFindIR™ Midwave (MW) camera by FLIR Systems, Inc. (FLIR), a portable, passive infrared (IR) camera operating in the spectral range of 3 to 5 micrometers.

Chapter 2
Technology Description

This verification report provides results for the verification testing of FLIR's GasFindIR™ MW. Following is a description of the FLIR GasFindIR™ MW camera technology (hereafter referred to as FLIR GasFindIR™ MW), based on information provided by the vendor. The information provided below was not verified in this test. Figure 1 shows the FLIR GasFindIR™ MW camera.

The GasFindIR™ MW camera takes focal plane arrays and optical systems that are tuned to very narrow spectral infrared ranges to enable the camera to detect the energy emitted from certain gases. Images are processed and enhanced by the GasFindIR High Sensitivity Mode™ feature to show the presence of gases against stationary backgrounds. Gases that are detectable by the GasFindIR™ camera appear on screen as smoke.

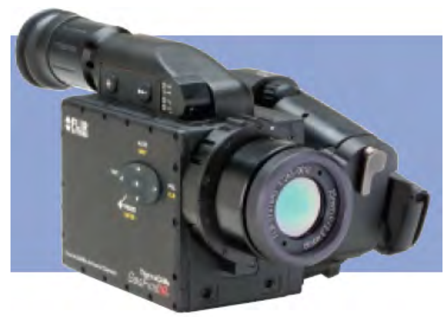

Figure 1. FLIR GasFindIR™ MW Camera

GasFindIR™ MW camera is designed for use in harsh industrial environments and operates in wide temperature ranges. The GasFindIR™ MW camera is a real-time infrared camera that scans at 30 hertz (Hz) or 30 images per second. The camera includes a 25-millimeter (mm) wide-angle lens for scanning of a variety of components and operations. For longer-range needs, 50-mm and 100-mm lenses are available from FLIR Systems.

Chapter 3
Test Design and Procedures

3.1 Test Overview

This verification test was conducted according to procedures specified in the *Test/QA Plan for Verification of Leak Detection and Repair Technologies*[1](TQAP) and adhered to the quality system defined in the ETV AMS Center Quality Management Plan (QMP).[2] Battelle conducted this verification test with support from British Petroleum (BP), Innovative Environmental Solutions, Inc., The Dow Chemical Company, Sage Environmental Consulting, and Enthalpy Analytical, Inc.

This verification test simulated gas leaks of various chemicals in a controlled laboratory environment. The ability of the FLIR GasFindIR™ MW camera to qualitatively detect gas leaks of select chemicals species by visual images under controlled environmental conditions – including varied stand-off distances, wind speeds, and background materials – was verified and the method detection limits under each test condition were determined. This passive IR camera has not been evaluated under the ETV Program for other compounds or species other than those tested under this verification test. The potential exists for the identification of other species that have an IR absorbance feature(s) in this spectral range under ideal test conditions.

Additionally during laboratory testing, the ability of the FLIR GasFindIR™ MW camera to qualitatively detect the gas leak by visual images relative to a quantitative concentration measurement made by a portable monitoring device acceptable under *U.S. EPA Method 21 – Determination of Volatile Organic Compound (VOC) Leaks*[3] for the determination of VOC leaks from process equipment was verified for each chemical at each test condition during laboratory testing. During laboratory testing, acceptable under U.S. EPA Method 21 meant that the portable monitoring device met all of the performance requirements of Section 6 in U.S. EPA Method 21 with the exception of those requirements related to a specific leak definition concentration specified in any applicable regulation. A specific leak definition concentration was not used to qualify leaks during laboratory testing in a regulatory sense.

This verification test also verified the ability FLIR GasFindIR™ MW camera to detect gas leaks of various chemicals relative to a portable monitoring device acceptable under U.S. EPA Method 21 under "real world" conditions at a chemical plant in Freeport, TX. During field testing, acceptable under U.S. EPA Method 21 meant that the portable monitoring device met all of the performance requirements of Section 6 in U.S. EPA Method 21; a specific leak definition concentration of 500 parts per million by volume (ppmv) was utilized. Reference sampling was conducted to determine the mass rate of specific chemical species emitted from each leaking component observed with the FLIR GasFindIR™ MW camera and with the portable monitoring device acceptable under U.S. EPA Method 21.

This verification test of the GasFindIR™ MW camera was conducted October 20 through October 24, 2008 at the BP research complex in Naperville, Illinois (laboratory testing) and December 1 through December 5, 2008 at the Dow Chemical Company plants (field testing) in Freeport, TX in compliance with the data quality requirements in the AMS Center Quality Management Plan (QMP). The TQAP for this verification test indicated that field testing would be conducted at two field sites. Due to production scheduling issues, a second field site could not be obtained in a timely manner and this verification test was completed using only one field test location. Confirmation from a second field site was obtained during the writing of these reports and field testing occurred outside of this verification test in March 2010. The reader is encouraged to contact either FLIR Systems or the Texas Chemical Council (TCC) to obtain the results of testing completed at the second field site. As indicated in the test/QA plan, the testing conducted satisfied EPA QA Category III requirements. The test/QA plan, the verification statement, and this verification report were reviewed by the following experts.

- Dave Fashimpaur, BP
- Julie Woodward, Dow Chemical
- Jim Griffin, American Chemistry Council
- Christina Wisdom, Texas Chemical Council
- Eben Thoma, U.S. EPA.

One technical expert came to the laboratory testing, and one technical expert came to the field site to observe testing. Verification testing was conducted by appropriately trained personnel following the safety and health guidelines for BP and Dow's facilities.

The GasFindIR™ MW camera was verified by evaluating the following four parameters.

- Method detection limit – The minimum mass leak rate that three separate individuals can observe using the GasFindIR™ MW camera under controlled laboratory conditions. This parameter was not evaluated during the field testing phase.

- Detection of chemical gas species relative to a portable monitoring device – The ability of the GasFindIR™ MW camera to qualitatively detect a gas leak by visual images relative to a quantitative concentration measurement made by a portable monitoring device acceptable under U.S. EPA Method 21. This parameter was evaluated in both the laboratory and field testing phases.

- Confounding factors effect – Background materials, wind speed, and stand-off distance were carefully controlled during laboratory testing to observe their effects on the method detection limit. During field testing, these variables as well as meteorological conditions were recorded.

- Operational factors – Factors such as ease of use, technology cost, user-friendliness of vendor software, and troubleshooting/downtime were evaluated.

Due to unavailability of a second FLIR GasFindIR™ MW camera during the laboratory and field testing portions of this verification test, inter-unit comparability could not be completed during laboratory and field testing.

A FLIR GasFindIR™ LW camera was used during a portion of both the laboratory and field testing. This camera was not evaluated against the entire suite of chemicals used in the laboratory portion of this verification testing; rather the vendor used the FLIR GasFindIR™ LW camera for 1,3-butadiene, acetic acid, and acrylic acid because these compounds have an absorption peak within the 10 to 11 micrometer operating wavelength of the FLIR GasFinderIR™ LW camera. The camera was evaluated in the field for all chemical gas leaks identified, regardless of whether the gas leak contained compounds with an absorption peak within the 10 to 11 micrometer operating wavelength of the FLIR GasFinderIR™ LW camera on the days that the camera was available to the verification test team. Because the FLIR GasFindIR™ LW camera was not used during the entire portion of the laboratory and field testing phases of this verification test, test results obtained with the FLIR GasFindIR™ LW camera are not included in the body of this verification report. Rather, the results obtained with the FLIR GasFindIR™ LW camera are included as an appendix to this report for reference by the reader.

Prior to the start of the verification test, FLIR setup the FLIR GasFinderIR™ MW camera according to their recommended configuration for optimal performance.

3.2 Experimental Design

3.2.1 Detection of a Chemical Gas Leak Using FLIR GasFindIR™

During both the laboratory testing and field testing, the FLIR GasFindIR™ MW camera was operated by a representative of FLIR. This verification test used two additional confirming individuals beyond the camera operator to confirm the observation of a leak in an effort to eliminate potential operator bias. The two additional confirming individuals were the Battelle verification test coordinator and an additional verification test team member. The use of three individuals to observe a chemical leak with the FLIR GasFindIR™ MW camera is not standard practice when using the FLIR GasFindIR™ MW camera; typical operation relies on a single camera operator to observe the presence of a chemical gas leak.

The detection of a chemical gas leak in either the laboratory or field setting was determined by the camera operator, as well as two confirming individuals who reported the results qualitatively as either “detect” or “non-detect” observation. All three individuals must have agreed on the results for the observation to be considered a “detect.” When all three individuals did not agree on a detection, the observation was reported as a “non-detect.” A non-detect was also recorded if the camera operator did not observe a detection (i.e., no confirmation of a non-detect was performed). Each observation was conducted using the eye piece of the FLIR GasFindIR™ MW camera.

The TQAP for this verification test required that camera observers have five seconds to identify the origin of the leak or be able to track the plume back to the leaking component when observing chemical gas leaks (i.e., identify the source of the leak). However, during laboratory and field testing, the observers were allowed two minutes. This change was made during laboratory testing to account for system hysteresis and upon discovering that several liquid compounds at very low flow rates did not generate a continuous plume. Rather, the leaks were observable as intermittent “puffs” of chemicals emanating from the valve at a frequency on the order of 10 seconds to two minutes. This time lag resulted from lower syringe pump feed rate settings, and the reduced hot nitrogen carrier gas volume flow rates.

3.2.2 Method Detection Limit

Method detection limits were determined only in the laboratory portion of this verification test. To determine the method detection limit, a known mass leak rate from the packing of a 1-inch valve attached to certified gas cylinders and calibrated flow meters was set at a nominally detectable level either specified by the vendor's limit of detection (LOD) for a particular test condition, or based on previous literature by Panek et al.[4] When all three observers identified the leak, the leak rate was reduced by the testing staff using calibrated flow meters. Once a leak rate that was not identifiable by all three people was reached, the mass emission rate was again increased using the calibrated flow meters to the level where all three could again identify the leak using the FLIR technology (i.e. passive infrared imager). This rate was then established as the method detection limit for the passive infrared imager under the tested conditions. This process was completed for every testing trial identified in Section 3.2.3. Table 1 identifies the type of chemical leaks evaluated with the FLIR technology during laboratory testing.

Table 1. Chemical Leaks Evaluated with the FLIR GasFindIR^{TM} MW Camera During Laboratory Testing

Chemical	Chemical Group
1,3-butadiene	Olefin
Acetic acid	Acetate
Acrylic acid	Acid
Benzene	Aromatic
Methylene chloride (dichloromethane)	Chlorinated
Ethylene	Olefin
Methanol	Alcohol
Pentane	Alkane
Propane	Alkane
Styrene	Aromatic

The TQAP for this verification test stated that propylene dichloride (1,2-dichloropropane) and hydrochloric acid would also be used during laboratory testing. The stock solution of propylene dichloride was suspected by laboratory personnel of having been cross-contaminated by a different chemical compound. A second stock solution of propylene dichloride could not be obtained from a chemical vendor before the conclusion of laboratory testing. Thus, propylene dichloride was not used during laboratory testing. The laboratory staff also expressed concerns of causing damage to the delivery syringe in the chemical delivery system with the use of hydrochloric acid. Because hydrochloric acid could not be delivered through the chemical delivery system without causing damage to the system, a known leak rate could not be generated during laboratory analysis, therefore hydrochloric acid was not evaluated.

3.2.3 Confounding Factors

Because passive IR imagers such as the FLIR technology rely on the physical characteristics of the environment and the molecules being imaged to create an image viewed by the operator (via temperature/emissivity differences between naturally occurring ambient IR radiation and the thermal emission or absorption of the leaking gas), environmental characteristics may confound the measurement. For example, if there is not sufficient thermal emission or absorption by the leaking gas, the passive IR imager may not be able to detect a leak against the ambient thermal background.

During laboratory testing, experimental factors of background materials, wind speed, and stand-off distance were altered for each chemical tested. These experimental factors were chosen, because the performance of passive imagers is dependent on physical characteristics of the leak, atmospheric conditions, and background materials. The change of background material demonstrates the ability of the FLIR GasFindIR™ MW camera to detect the leak with a background scene similar to petrochemical process piping and vessels (curved metal gas cylinders) and with a background that is different than the leaking component and more uniform in nature (cement board – representing control buildings, sidewalks, and other uniform flat background surfaces). The wind speed variations and the stand-off distances inform on the atmospheric and optical pathway effects on the method detection limit, and in turn on real-world limitations. Table 2 presents the specific test conditions evaluated during laboratory testing.

It was originally intended that all test conditions would be completed for all chemicals; however, it was not possible for 1,3-butadiene, acrylic acid, methylene chloride, methane, and styrene for the following reasons.

Previous testing of the FLIR GasFindIR™ MW camera using methane had been completed by the laboratory facility outside of the verification test. Consequently, methane was used during test equipment setup to confirm that the equipment produced method detection limits for methane that were consistent with those produced during previous testing by the laboratory.

Table 2. Test Conditions Evaluated During Laboratory Testing

	Laboratory Test Conditions											
Chemical Species	10 ft stand-off distance; 0-mph wind speed; cement board background	10 ft stand-off distance; 0-mph wind speed; curved metal gas cylinder background	10 ft stand-off distance; 2.5-mph wind speed; cement board background	10 ft stand-off distance; 2.5-mph wind speed; curved metal gas cylinder background	10 ft stand-off distance; 5-mph wind speed; cement board background	10 ft stand-off distance; 5-mph wind speed; curved metal gas cylinder background	30 ft stand-off distance; 0-mph wind speed; cement board background	30 ft stand-off distance; 0-mph wind speed; curved metal gas cylinder background	30 ft stand-off distance; 2.5-mph wind speed; cement board background	30 ft stand-off distance; 2.5-mph wind speed; curved metal gas cylinder background	30 ft stand-off distance; 5-mph wind speed; cement board background	30 ft stand-off distance; 5-mph wind speed; curved metal gas cylinder background
1,3-butadiene	✓	✓					✓	✓				
Acetic acid	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Acrylic acid	✓	✓					✓	✓				
Benzene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Methylene chloride	✓	✓	✓	✓			✓	✓				
Ethylene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Methanol	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pentane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Propane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Styrene	✓	✓					✓	✓				

The 2.5 and 5-mile per hour (mph) wind speed test conditions were not completed for acrylic acid. After completion of the 0-mph wind speed test condition, laboratory personnel indicated that the acrylic acid was dissolving the rubber plunger gasket in the liquid delivery syringe in the vapor generator system. Laboratory personnel indicated that the rubber seemed to be "dissolving" inside the syringe and the syringe was no longer providing a steady flow of acrylic acid into the chemical delivery system. Additional testing using this compound was abandoned due to safety and chemical handling concerns.

The 2.5 and 5-mph wind speed test conditions were not completed for 1,3-butadiene and styrene due to safety and potential exposure concerns. During laboratory setup the week prior to verification testing, the exhaust of the test apparatus, which feeds into the general laboratory building exhaust, was balanced and smoke tested to ensure that compounds leaking from the system were captured in either the vertical hood canopy mounted over the leaking component or the downwind hood mounted adjacent to the test system. Unbeknownst to laboratory personnel, the building general exhaust system was operating at a lower setting during air balancing and smoke testing due to decreased occupancy in the building. During the week of the test, the general building exhaust was increased due to the presence of the test compounds entering the exhaust system. The change in building exhaust flows caused the capture of the chemical compound by the overhead hood and the hood mounted next to the test system to decrease. A possible solution to the lack of capture and control by the local hoods could have been to outfit

all personnel in respirators. However, documentation of respirator fit testing was not available for test team members. Respirators could not be used without this documentation.
To address this problem, the leaking valve was placed next to the side hood during wind speed testing and testing of those chemical compounds which are liquids at standard conditions commenced in order of increasing boiling point. Upon completion of wind testing for acetic acid, the laboratory had a slight odor of acetic acid. This indicated to laboratory personnel that locating the leaking valve next to the side hood during wind speed testing did not adequately capture all of the chemical compounds exhausting from the test system. Rebalancing of the hood was attempted, but the problem was caused by an increase in general building exhaust, rather than at the local hoods. At this point, wind speed testing of 1,3-butadiene and styrene was abandoned because these compounds have higher chemical toxicity and exposure by the verification test team, vendor, and laboratory staff to these compounds would have occurred during wind speed testing.

During methylene chloride testing, several of the wind speed tests and background tests were not conducted because the method detection limit for lower wind speed (or background) conditions exceeded the highest reliable flow rate capable of being provided by the chemical leak delivery system at test conditions which were expected to produce a lower method detection limit (refer to Section 6.3 for discussion of the observed influence of confounding factors). For example, a 5-mph wind speed test was not conducted at a 10 ft stand-off distance with a cement board background because the method detection limit exceeded the highest reliable flow rate of the chemical delivery system for the 10 ft stand-off distance, cement board background, and 2.5-mph.

3.2.4 Detection of a Chemical Gas Species Relative to a Portable Monitoring Device

The detection of a single chemical gas leak in either the laboratory or field environments was determined by the operator as well as two confirming individuals as previously described in Section 3.2.1 and reported qualitatively as either "detect" or "non-detect."

During laboratory testing a portable monitoring device, a factory-calibrated Industrial Scientific IBRID MX6 with photoionization (PID) sensor and SP6 motorized sampling pump, acceptable under U.S. EPA Method 21, sampled the leak after the method detection limit was determined for the specified test conditions. During laboratory testing, "acceptable under U.S. EPA Method 21" meant that the PID met all of the performance requirements of Section 6 in U.S. EPA Method 21 with the exception of those requirements related to a specific leak definition concentration specified in any applicable regulation. A specific leak definition concentration was not used to qualify leaks during laboratory testing in a regulatory sense.

During field testing a portable monitoring device, a Thermo-Environmental Toxic Vapor Analyzer (TVA), acceptable under U.S. EPA Method 21 was used to screen each leaking component as part of the bagging reference method used. During field testing, "acceptable under U.S. EPA Method 21" meant that the TVA met all of the performance requirements of Section 6 in U.S. EPA Method 21; a specific leak definition of 500 ppmv was utilized.

3.2.5 Field Testing Procedures

Field testing was conducted to allow for performance evaluation under "real world" conditions. Chemicals that were tested in the laboratory were targeted for evaluation at the field sites. The mass flow rates of field leaks were quantitatively determined by a reference method called *EPA*

Protocol for Equipment Leak Emission Estimates,[5] referred to as the "bagging method." Specific details and procedures for this reference method are provided in the TQAP for this verification test. This method involves completely enclosing the leak with non-permeable material, collecting the leak with ambient air entering the bag, and performing mass measurement of the bagged leak by an analytical method. Only those leaks above the field test-assigned 500 ppmv leak definition concentration, as measured by the Thermo-Environmental TVA, were observed with the passive infrared imagers and collected as reference samples under this verification test.

The verification test team moved through the plant screening for possible leaking components using the Thermo-Environmental TVA. Once a leak was detected with the portable monitoring device, leak characteristics and environmental factors such as type of component, background material, temperature, and time were recorded qualitatively. Meteorological data were retrieved from the nearest meteorological station, which was on Dow Chemical's site. As space permitted, the camera operator took readings at three stand-off distances (10, 30, and greater than 30 ft if possible). Every reading was verified by an additional two confirming individuals and recorded as either "detect" or "non-detect" as specified in Section 3.2.1. Once the camera had scanned the leak, the bagging team members (Sage Environmental Consulting) commenced collecting duplicate reference samples of the leak into evacuated SUMMA canisters. Reference sampling concluded with a final screening by the TVA to verify that the leak concentration had not changed from the beginning to the end of testing the component. Only those leaks which showed less than a 20% difference between the pre- and post-screening with the TVA were considered consistent enough to report in the results without a data qualifier. The concentration of the collected reference samples was determined according to the analytical method in U.S. EPA Method 18 – *Measurement of Gaseous Organic Compound Emissions by Gas Chromatography*.[6] Upon conclusion of the five days of field testing, all reference samples were shipped to Enthalpy Analytical, Inc. for U.S. EPA Method 18 analysis.

3.3 Qualitative Evaluation Parameters

Operational factors such as maintenance needs, ease of use, data output, and software requirements were documented based on observations by Battelle.

Chapter 4
Quality Assurance/Quality Control

QA/quality control (QC) procedures were performed in accordance with the QMP for the AMS Center and the TQAP for this verification test. As noted throughout Chapter 3, there were deviations from the TQAP, but the work was performed as described in the previous sections. None of the deviations from the test/QA plan resulted in any adverse impacts on the quality of the data produced by this verification test. QA/QC procedures and results are described in the following subchapters.

4.1 Reference Method Quality Control

Laboratory testing did not use a specified reference method for determining the leak rate of the test conditions. Rather, certified gas cylinders and laboratory grade liquid compounds were used with calibrated flow meters and a calibrated syringe pump to generate a known leak rate in terms of mass per unit time from the leaking valve. As a laboratory QC measure, laboratory personnel, randomly and without the knowledge of the camera operator or the additional confirming individuals, increased or decreased the mass leak rate to reduce the opportunity to predetermine an outcome. In addition, laboratory blanks (i.e., pure nitrogen gas) and replicate tests were used to reduce uncertainties and verify method detection limits established in prior tests.

The field testing portion of this verification test used accepted methods to generate reference samples. Reference samples were collected using *EPA Protocol for Equipment Leak Emission Estimates* and the concentrations of compounds in the collected reference samples were determined according to the analytical method in U.S. EPA Method 18 *Measurement of Gaseous Organic Compound Emissions by Gas Chromatography*.

The quality of the reference measurements collected during field testing was assured by adherence to the requirements of the data quality indicators (DQIs) and criteria for the reference collection and analytical method critical measurements, including requirements to perform initial calibrations and calibration checks of the portable monitoring device acceptable under U.S. EPA Method 21, confirming the leak rates changed less than 20% before and after bagging, assessing the bias and accuracy of the bagging procedure, and assessing the bias and accuracy of the gas chromatography (GC) laboratory analysis by developing calibration curves traceable to certified gas standards, and performing positive and negative control checks. The following sections present key data quality results from these methods.

4.1.1 Bias and Accuracy of Sample Screening Measurements Using Portable Monitoring Device

A DQI is established in the TQAP for this verification test for the bias and accuracy of sample screening measurements using a portable monitoring device. This DQI is assessed by performing calibrations of the Thermo-Environmental TVA used to screen leaking components during the field portion of the verification test and analyzing calibration check samples. During laboratory testing the portable monitoring device was an Industrial Scientific IBRID MX6 with PID sensor and SP6 motorized sampling pump which was supplied calibrated from the instrument supplier; per the TQAP for this verification test, no additional calibrations were performed during laboratory testing.

Calibration of the TVA was conducted using various levels of certified methane (CH_4)-in-air gas standards. The TQAP for this verification test required the use of five calibration points (an un-spiked gas standard plus four additional concentrations); however, only three additional gas standard concentrations were obtained. Because component leaks were only bagged as reference samples if their concentration was greater than 500 ppmv and because the calibration response of the TVA was evaluated using an un-spiked gas standard (0 ppmv) and three additional concentrations of gas standards (500, 1000, and 9600 ppmv) thereby bounding the 500 ppmv reference sample bagging threshold, there was no effect on data quality.

The calibration response of the TVA was analyzed at the start and end of each verification test day or if the overall TVA sensitivity changed by greater than 10% (based on the calibration check data, which are presented in Table 5). The minimum acceptance criterion for this reference method DQI was that the TVA calibration response must agree within 10% of the concentration of each gas standard. Table 3 presents the results of all TVA calibration responses collected during this verification test. Inspection of the data present in Table 3 shows that all calibration response measurements were confirmed to be within 10% of the calibration gas standard concentration.

The TQAP for this verification test required that a calibration check sample be analyzed using one concentration of the calibration gas standards at a minimum frequency of 5% of all bagged reference samples collected. Sixteen calibration check samples were analyzed with the TVA during the course of field testing and nine duplicate reference samples were collected resulting in a calibration check sample frequency of 178% of all bagged reference samples collected (i.e., 16 calibration check samples completed during the collection of nine duplicate reference samples). These checks were performed more frequently to ensure no drifting of the instrument occurred during downtimes to ensure optimum performance. The minimum acceptance criterion specified in the TQAP for this verification test is that the check standard must be within less than or equal to a 10% change in response from the previous calibration of the TVA. If the calibration check sample showed a change in response greater than 10%, then recalibration of the TVA was performed and any affected reference sample components collected would be rescreened. During this verification test, calibration check samples were performed using a certified 500 ppmv CH_4-in-air gas standard. Table 4 presents the results of all calibration check standards performed during verification testing. Inspection of the data presented in Table 4 indicate that reference samples 08A and 08B should have been rescreened after recalibration of the TVA and, therefore, are considered suspect data and reported with a data qualifier.

Table 3. TVA Calibration Responses

	Calibration Gas Standard Concentration (ppmv CH_4)			
	0	500	1000	9600
Date [Time]	TVA Output Concentration (ppmv CH_4)[b]	TVA Calibration Response (as % Error)[c]		
12/1/2008 [13:33][a]	0.70	0.40	-1.3	-0.80
12/2/2008 [09:01]	0.40	-0.80	-0.10	-0.60
12/2/2008 [14:08]	1.0	1.2	1.0	2.1
12/2/2008 [16:05]	1.0	5.6	4.2	4.2
12/3/2008 [08:41]	0.80	-1.4	ND	-0.70
12/3/2008 [09:30]	0.70	-0.60	-4.4	-4.9
12/3/2008 [10:12]	0.80	-1.2	-0.60	0.10
12/3/2008 [17:06]	0.60	-7.2	-8.2	-8.0
12/4/2008 [10:04]	0.60	-0.60	-0.30	-1.0
12/4/2008 [13:20]	ND	ND	-0.10	-0.30
12/4/2008 [16:12]	0.60	-0.80	-1.5	-1.0
12/4/2008 [17:23]	0.20	-1.4	-1.7	-1.1
12/5/2008 [08:59]	0.60	ND	-0.70	-0.70
12/5/2008 [11:20]	1.2	4.0	3.0	-8.3
12/5/2008 [14:01]	0.20	3.4	3.3	-3.1

(a) An end-of-day TVA response was not collected on 12/1/2008. Data for leak location 1 is included but flagged because there are acceptable reference and bagging measurements.
(b) Concentration data presented for un-spiked gas standard, since % error calculation is not possible. This point is used in calibrating the Thermo-Environmental TVA.
(c) Percent (%) error is calculated as [(TVA calibration response, ppmv CH_4 – Calibration Gas Standard Concentration, ppmv CH_4)/ Calibration Gas Standard Concentration, ppmv CH_4] x 100%.
ND - Not detected

4.1.2 Confirmation of Detected Leaks

A DQI is established in the TQAP for this verification test for the confirmation of detected leaks. This DQI is assessed by analyzing the concentration of a leaking component before and after bagging the component. These measurements were completed for all leaking components which were bagged and collected as reference samples. The acceptance criterion for this DQI is that the pre and post screening measurements collected with the TVA agree within 20%. Table 5 presents the results of all pre- and post-bagging measurements completed during the collection of reference samples.

4.1.3 Bias and Accuracy of Enclosure Equilibration Gas

A DQI is established in the TQAP for this verification test for bias and accuracy of the enclosure equilibration gas. This DQI requires that if the blow-through bagging procedure is used to collect reference samples, then the equilibration gas in the bag is collected and analyzed for contamination prior to collection of reference samples. During the verification testing, reference samples were collected using the vacuum-method which does not require the use of an equilibration gas; therefore, this DQI was not applicable.

Table 4. TVA Calibration Check Samples

Date [Time]	Calibration Check Response (as % Error)[a]	Comments
12/2/2008 [11:17]	0.40	
12/2/2008 [12:15]	-5.2	
12/2/2008 [14:05]	-16	Recalibration only. No rescreening necessary because no reference samples had been collected between this calibration check sample and TVA calibration.
12/2/2008 [14:08]	1.2	
12/2/2008 [15:10]	1.4	
12/2/2008 [15:43]	2.0	
12/3/2008 [9:23]	64	Found leak; recalibrated only. No rescreening necessary because reference samples had yet to be collected this day.
12/3/2008 [10:30]	0.80	
12/3/2008 [11:32]	-0.60	
12/3/2008 [13:57]	0.60	
12/3/2008 [15:45]	0.60	
12/4/2008 [11:43]	1.6	
12/4/2008 [13:23]	-17	Recalibration only. No rescreening necessary because no reference samples had been collected between this calibration check sample and the previous check.
12/4/2008 [15:30]	24	Recalibration only. Reference samples 08A and 08B were inadvertently not rescreened and are therefore considered suspect and results reported with qualifier.
12/4/2008 [17:25]	-1.4	
12/5/2008 [10:38]	-3.0	

(a) Percent (%) error is calculated as [(TVA calibration check response, ppmv CH_4 – Calibration Gas Standard Concentration, 500 ppmv CH_4)/ Calibration Gas Standard Concentration, 500 ppmv CH_4] x 100%.

Table 5. Confirmation of Detected Leaks by TVA

Reference Sample Numbers	Concentration Measured by TVA (ppmv CH_4)			Comments
	Pre-bagging	Post-bagging	Relative % Difference[b]	
01C, 01D	>100,000[a]	>100,000[a]	0%	
02A, 02B	20,500	20,500	0%	
03A, 03B	>100,000[a]	>100,000[a]	0%	
05A, 05B	>100,000[a]	>100,000[a]	0%	
06A, 06B	18,000	23,000	24%	Data is considered suspect and results reported with qualifier.
07A, 07B	18,000	17,000	5.7%	
08A, 08B	8,000	8,000	0%	
09A, 09B	800	870	8.4%	
10A, 10B	>100,000[a]	>100,000[a]	0%	

(a) The concentration of the leak at the component was high enough to cause the TVA to flameout. Concentration estimated as greater than 100,000 ppmv CH_4.
(b) Relative percent (%) difference calculated using the following calculation:

$$\text{Relative \% difference} = \frac{2 \times |\text{Pre} - \text{bagging concentration} - \text{Post bagging concentration}|}{\text{Pre} - \text{bagging concentration} + \text{Post bagging concentration}} \times 100\%$$

4.1.4 Bias and Accuracy of Bagging Procedure

A DQI is established in the TQAP for this verification test for the bias and accuracy of the bagging procedure. This DQI is assessed by bagging an artificial leak at a known rate in the middle of the analytical calibration curve. The procedure followed is that specified in U.S. EPA *Protocol for Equipment Leak Emission Estimates* using certified CH_4-in-air gas standards and calibrated flow meters. This DQI indicator was assessed at the beginning and end of the week of field sampling. An acceptance criterion of 80 to 120% recovery is required for the bagging equipment to pass the known leak rate test. Table 6 presents the results of the known leak rate test. As shown in Table 6, this DQI was met before and after reference sampling.

Table 6. Known Leak Rate Test Results

Date [Time]	Leak Rate Level	Emission Rate (kilogram per hour [kg/hr] CH_4) Theoretical	Measured	% Recovery[(a)]
		Pre-Test		
11/28/2008 [12:45]	Low	4.31×10^{-4}	4.23×10^{-4}	98%
11/28/2008 [12:20]	High	1.75×10^{-3}	1.60×10^{-3}	91%
		Post-Test		
12/5/2008 [14:35]	Low	1.25×10^{-3}	1.32×10^{-3}	106%
12/5/2008 [14:43]	High	2.43×10^{-3}	2.50×10^{-3}	103%

(a) Percent (%) Recovery is calculated as (measured emission rate, kg/hr CH_4) / (theoretical emission rate, kg/hr CH_4) x 100%

4.1.5 Bias and Accuracy of Gas Chromatography Analytical Method

A DQI is established in the TQAP for this verification test for the bias and accuracy of the GC analytical method used to quantify the concentration of leaks collected during reference sampling. This DQI was assessed through initial calibration, and by performing positive and negative control samples. These assessments are discussed in the following paragraphs.

Initial Calibration. Initial calibration of the GC was conducted by using various levels of certified calibration gases starting with an un-spiked gas standard and then a minimum of four additional concentrations of gas standards. The TQAP for this verification test required that the initial calibration be performed at the start and end of every analytical sequence or if overall instrument sensitivity changed by greater than 10%. To ensure accuracy of the initial calibration, the instrument must be calibrated using certified gas standards. The minimum acceptance criteria specified for this assessment is that all gas standards must be within 2% of their certified value.

The analytical laboratory that performed the GC analytical method (Enthalpy Analytical, Inc.) purchased gas standards with certification accuracies of ± 2%, as specified by the gas supplier. In addition, the GC analytical laboratory produced diluted gas standards from these purchased standards using a gas dilution system compliant with U.S. EPA Method 205[(7)] which specifies gas dilution systems must produce calibration gases whose measured values are within ± 2% of the predicted levels from a certified gas standard.

Positive Control Checks. The TQAP for this verification test required that positive control checks be performed at a minimum frequency of 10% of all samples tested using one concentration of calibration gas standard. The minimum acceptance criteria for positive control checks is that the positive control check response is less than or equal to a 10% change in response from the initial calibration after adjustment of the overall instrument sensitivity. Forty sample measurements were conducted by the GC analytical laboratory using triplicate injections and 19 positive control checks were performed exceeding the minimum frequency of 10% of samples tested. The results of the positive control checks are provided in Table 7. As demonstrated by Table 7, all positive control checks met this acceptance criterion.

Negative Control Checks. The TQAP for this verification test required that negative control checks be performed at a minimum frequency of one out of every 10 samples tested. The minimum acceptance criterion for this assessment is that all negative control responses must remain lower than the lowest calibration standard for the chemical analyzed. Forty sample measurements were conducted by the GC analytical laboratory using triplicate injections and four negative control checks were performed meeting the minimum frequency of one negative control check per 10 samples analyzed. All negative control checks performed were non-detect for the compounds analyzed indicating an analytical result below the method detection limit for the compound. The method detection limit for methane, ethylene, styrene, benzene, 1,3-butadiene, methylene chloride, and propylene dichloride was 1.00 ppmv for each compound.

4.2 Audits

Two types of audits were performed during the verification test, a technical systems audit (TSA) of the verification test procedures, and a data quality audit. Because of the nature of bagging reference method, a performance evaluation audit, as is usually performed to confirm the accuracy of the reference method, was not applicable for this verification test. Audit procedures for the TSA and the data quality audit are described further below.

4.2.1 Technical Systems Audit

The Battelle AMS Center Quality Manager performed a TSA during both the laboratory and field testing portions of this verification test to ensure that the verification test was performed in accordance with the QMP for the AMS Center and the test/QA plan.

The TSA of the laboratory portion of the verification test was performed on October 22, 2008. During this TSA, the Battelle AMS Center Quality Manager observed the test procedures used to determine method detection limits and the response of the Industrial Scientific IBRID MX6 with PID sensor and SP6 motorized sampling pump at the each method detection limit. These procedures were observed during some of the testing conducted with acrylic acid, benzene, dichloromethane (methylene chloride), and styrene. The TSA of the field testing portion of the verification test was performed on December 3, 2008. During this TSA, the Battelle AMS Center Quality Manager observed the procedures of the bagging reference method, including the confirmation of the detected leaks by means of pre- and post-bagging screening of the leaking component with the Thermo-Environmental TVA, construction of the bagging enclosure, and duplicate reference sample collection, as well as audited the observations of the leak component with camera. In addition, the Battelle AMS Center Quality Manager observed both the performance of a calibration drift check and recalibration as well as an end-of-day calibration response check of the Thermo-Environmental TVA.

Table 7. Summary of Positive Control Check Responses

Positive Control Check Sample ID	Compounds Measured by GC Method	Expected Response (Picoampere Second)	Actual Response (Picoampere Second)	Percent Error[a]
GC100pg167 #2	Benzene	39.8	39.3	-1.1%
GC100pg167 #2	Benzene	39.8	39.0	-1.9%
GC100pf169F #4	Ethylene	13.7	13.8	+0.39%
	1,3-butadiene	27.3	26.9	-1.6%
GC100pf169F #4	Ethylene	13.7	13.7	-0.61%
	1,3-butadiene	27.3	26.7	-2.4%
GC100pf169F #4	Ethylene	13.7	13.5	-1.6%
	1,3-butadiene	27.3	26.3	-3.9%
GC100pf169F #4	Ethylene	13.7	13.4	-2.4%
	1,3-butadiene	27.3	25.7	-5.8%
GC100pf169F #4	Ethylene	13.7	13.7	-0.44%
	1,3-butadiene	27.3	26.9	-1.5%
GC100pf169F #4	Ethylene	13.7	13.8	+0.39%
	1,3-butadiene	27.3	27.2	-0.43%
GC102pg44 #3	Methane	22.4	22.8	+1.6%
GC102pg44 #3	Methane	22.4	22.7	+1.3%
GC100pg169 #2	Methane	7.10	6.95	-2.1%
GC100pg169 #2	Methane	7.10	6.73	-5.3%
GC100pg169 #3	Methane	15.9	15.3	-3.4%
GC100pg169 #4R	Methane	15.9	15.5	-2.5%
GC100pg169 #4R	Methane	15.9	15.8	-0.39%
GC102pg52 #4	Pentane	122	127	+4.2%
	Methylene chloride	17.6	17.7	+0.60%
	Benzene	148	150	+1.1%
	Propylene dichloride	36.1	35.4	-2.1%
	Styrene	31.9	34.0	+6.7%
GC102pg52 #4	Pentane	122	125	+2.7%
	Methylene chloride	17.6	17.3	-1.9%
	Benzene	148	147	-0.75%
	Propylene dichloride	36.1	34.4	-4.6%
	Styrene	31.9	32.7	+2.4%
GC102pg52 #4	Pentane	67.7	67.5	-0.35%
	Methylene chloride	10.2	9.86	-3.4%
	Benzene	82.0	79.5	-3.1%
	Propylene dichloride	21.0	20.5	-2.9%
	Styrene	17.8	18.4	+3.8%
GC102pg52 #4	Pentane	67.7	70.3	+3.7%
	Methylene chloride	10.2	10.2	+0.16%
	Benzene	82.0	82.3	+0.35%
	propylene dichloride	21.1	21.2	+0.49%
	Styrene	17.8	18.6	+4.5%

(a) Percent error is calculated as [(Actual Peak Response, peak area – Expected Response, peak area)/ Expected Response, peak area] x 100%.

The TSA of both the laboratory and field testing portions resulted in one finding and one observation. The finding identified that only one field test (at a chemical plant) has been conducted as part of this verification test as opposed to the two field sites (one a chemical plant and the other a petrochemical plant) identified in the TQAP for this verification test. The observation noted documentation errors and improvements to the manner in which data were recorded were discussed on-site with the Verification Test Coordinator; immediate changes based on the discussed improvements were implemented.

A TSA report was prepared, and a copy was distributed to the EPA AMS Center Quality Manager.

4.2.2 Data Quality Audit

Records generated in the verification test received a one-over-one review before these records were used to calculate, evaluate, or report verification results. Data were reviewed by a Battelle technical staff member involved in the verification test. The person performing the review added his/her initials and the date to a hard copy of the record being reviewed.

100% of the verification test data were reviewed for quality by the Verification Test Coordinator, and at least 10% of the data acquired during the verification test were audited. The data were traced from the initial acquisition, through reduction and statistical analysis, to final reporting to ensure the integrity of the reported results. All calculations performed on the data undergoing the audit were checked.

The data quality audit resulted in four findings (on three separate topics) that were addressed related to the documentation of the number of confirming individuals at the method detection limits in the laboratory phase raw data, exclusion from the verification report of concentration measurements made by the PID sensor for dichloromethane (methylene chloride), methanol, and propane during the laboratory phase of this verification test, and data transcription errors.

A data audit report was prepared, and a copy was distributed to the EPA AMS Center Quality Manager.

Chapter 5
Statistical Methods

The statistical methods used to evaluate the quantitative performance factors listed in Section 3.2 are presented in this chapter. Qualitative observations were also used to evaluate verification test data.

5.1 Method Detection Limit

The method detection limit was assessed using the procedures described in Section 3.2.2 and the TQAP for this verification test. The overall detection limit variation was calculated as the standard deviation of the method detection limits determined under all the conditions tested for each chemical of interest. The equation for standard deviation is as follows:

$$S_x = \left[\frac{1}{n-1}\sum_{k=1}^{n}(C_k - \bar{C})^2\right]^{0.5} \quad (1)$$

where S_x is the standard deviation of all method detection limits determined for chemical x, n is the number of replicate samples, C_k is the leak rate measured for the kth sample, and is the average leak rate of the replicate samples. If the sample sizes were small (n < 10), standard deviations provide a biased estimate of variability. Therefore the range is provided when there were fewer than 10 samples collected.

5.2 Percent Agreement

Percent agreement was used to assess the agreement between the FLIR GasFindIR™ cameras and the monitoring device acceptable under U.S. EPA Method 21 in the laboratory for each compound tested. The inverse of the percent agreement is the percentage of the results that the technology would detect a leak when U.S. EPA Method 21 would not. The equation for percent agreement is as follows:

$$Percent\ Agreement = \frac{A}{T} \times 100\%$$

where A the number of tests that both units agree and T is the total number of tests. To determine if both the monitoring device acceptable under U.S. EPA Method 21 and the FLIR GasFindIR™ camera agreed, the method detection limits at each test condition were first reviewed. If the method detection limit of the FLIR GasFindIR™ camera was below the highest reliable flow rate of the chemical delivery system (reported as ≤), then the FLIR GasFindIR™ camera was noted as being able to detect the chemical gas leak under those specified test conditions. Similarly, if the method detection limit of the FLIR GasFindIR^{TM} camera was equal to or above the highest reliable flow rate of the chemical delivery system (reported as ≥), then the FLIR GasFindIR^{TM} camera was noted as not being able to detect the chemical gas leak under those specified test conditions.

Next, the response of the monitoring device acceptable under U.S. EPA Method 21 was reviewed for the same test conditions. If the monitoring device acceptable under U.S. EPA Method 21 produced a response greater than zero, the monitoring device was considered capable of detecting the chemical gas leak. Similarly, if the monitoring device acceptable under U.S. EPA Method 21 produced a response equal to zero, the monitoring device was considered incapable of detecting the chemical gas leak.

The responses of the FLIR GasFindIR^{TM} MW camera and the monitoring device acceptable under U.S. EPA Method 21 under the same test conditions were compared. If both the FLIR GasFindIR^{TM} MW camera and the monitoring device acceptable under U.S. EPA Method 21 proved capable of detecting the chemical gas leak, then both units were considered to have agreed under the specific test condition. Likewise, if either the FLIR GasFindIR^{TM} MW camera or the monitoring device acceptable under U.S. EPA Method 21 proved incapable of detecting the chemical gas leak under the specified test conditions, then the units were considered to have disagreed. Test conditions, under which a response from the either the FLIR GasFindIR^{TM} MW camera or the monitoring device acceptable under U.S. EPA Method 21 were not obtained, were excluded from the comparison.

Chapter 6
Test Results

As mentioned previously, this verification test included both quantitative and qualitative evaluations. The quantitative evaluation was conducted to assess the method detection limits of the FLIR GasFindIR^{TM} MW camera, the detection of chemical gas species relative to a portable monitoring device acceptable under U.S. EPA Method 21, as well as, by testing the influence of confounding factors. The qualitative evaluation was performed to document the operational aspects of FLIR GasFindIR^{TM} MW camera used during verification testing. The following sections provide the results of the quantitative and qualitative evaluations.

6.1 Method Detection Limit

The method detection limit of each chemical compound was determined according to the procedures discussed in Section 3.2.2. Table 8 through Table 11 present the method detection limits of each chemical compound determined during laboratory testing. Table 8 through Table 11 identify each test condition evaluated (i.e., stand-off distance, background material, and wind speed), the temperatures of the laboratory and of the chemical leak, the response of the portable monitoring device acceptable under U.S. EPA Method 21, and the method detection limits for each test condition. Table 12 summarizes the range of method detection limits in units of grams per hour (g/hr) found during the laboratory testing as well as presents the overall detection limit variation for each compound. The overall detection limit variation presented in Table 12 was calculated using Equation 1 in Chapter 5.

Table 8. FLIR GasFindIR™ MW Method Detection Limits at 10 Feet Stand-off Distance with a Cement Board Background

Compound	Wind Speed (mph)[a]	Ambient Temp. (ºF)	Leak Temp. (ºF)	M21 Device Conc. (ppmv)	Method Detection Limit (g/hr)
1,3-butadiene	0	70.3	70.9	843	1.3
Acetic acid	0	72.7	82.1	4.0	≤ 0.02 [b]
	2.5	75.1	85.5	526	≤ 4.6 [b]
	5	75.0	80.4	32	≤ 4.6 [b]
Acrylic acid	0	71.2	84.8	4.9	0.92
Benzene	0	72.7	89.3	220	0.70
	2.5	74.3	81.7	737	11
	5	74.4	77.5	684	28
Methylene chloride	0	70.9	79.2	N.A.[g]	18
	2.5	72.3	78.4	N.A.[g]	> 70[c]
Ethylene	0	71.4	71.9	No data[d]	1.4
	0[e]	70.9	71.2	No data[d]	0.70
	0[f]	71.1	71.5	No data[d]	0.35
	2.5	71.4	72.2	253	68
	5.0	71.3	72.1	554	83
Methanol	0	71.3	77.0	N.A.[g]	0.35
	2.5	70.1	88.8	N.A.[g]	2.8
	5.0	70.1	82.0	N.A.[g]	14
Pentane	0	72.1	79.0	1.7	≤ 0.28[b]
	0[e]	71.7	77.6	No data[d]	≤ 0.28 [b]
	0[f]	71.9	80.1	No data[d]	≤ 0.28 [b]
	2.5	71.3	83.4	45	8.3
	2.5[e]	71.3	82.2	18	2.2
	2.5[f]	71.4	81.9	0.20	0.28
	5.0	71.1	78.6	77	28
	5.0[e]	71.0	77.3	26	9.4
	5.0[f]	70.8	76.8	12	4.1
Propane	0	71.0	70.6	N.A.[g]	≤ 0.44 [b]
	2.5	71.8	71.8	N.A.[g]	4.4
	5.0	71.3	71.6	N.A.[g]	8.2
Styrene	0	71.8	82.4	212	0.70

(a) The leak was viewed using the camera's standard lens (25-mm) at these conditions unless otherwise noted.
(b) Leak observable at the lowest reliable flow rate capable of being supplied by the chemical delivery system.
(c) The leak could not be detected below the highest reliable flow rate supplied by the delivery system.
(d) No data – the leak concentration was inadvertently not collected by laboratory personnel using the M21 device.
(e) The leak was viewed using the optional 50-mm lens at these conditions.
(f) The leak was viewed using the optional 100-mm lens at these conditions.
(g) N.A. – not applicable. The ionization potential of this compound is higher than is capable of detection by the device used. Therefore, any raw data measured with this device is not reported in this table.

Table 9. FLIR GasFindIR^{TM} MW Method Detection Limits at 30 Feet Stand-off Distance with a Cement Board Background

Compound	Wind Speed (mph)[(a)]	Ambient Temp. (ºF)	Leak Temp. (ºF)	M21 Device Conc. (ppmv)	Method Detection Limit (g/hr)
1,3-butadiene	0	71.0	71.8	876	1.6
Acetic acid	0	70.8	88.7	1.8	≤ 0.02 [(b)]
	2.5	74.8	85.5	7.8	≤ 4.6[(b)]
	5	74.8	79.9	7.8	≤ 4.6 [(b)]
Acrylic acid	0[(c)]	71.7	92.0	0.80	0.92
Benzene	0[(c)]	71.4	76.2	203	0.35
	2.5[(c)]	74.5	82.8	323	15
	5[(c)]	74.8	78.7	1042	31
Methylene chloride	0[(c)]	69.9	87.7	N.A.[(d)]	4.9
Ethylene	0	71.3	71.8	No data[(e)]	3.8
	0[(f)]	70.5	71.1	No data[(e)]	2.1
	0[(c)]	70.1	70.4	No data[(e)]	1.1
	2.5	71.3	72.2	287	83
	5.0	71.2	72.0	241	243
Methanol	0[(c)]	71.8	77.9	N.A.[(d)]	0.28
	2.5[(c)]	72.4	90.4	N.A.[(d)]	2.1
	5[(c)]	70.2	81.4	N.A.[(d)]	19
Pentane	0[(c)]	72.0	77.1	17	≤ 0.28 [(b)]
	2.5[(c)]	71.3	85.6	84	8.3
	5[(c)]	69.9	80.0	46	17
Propane	0[(c)]	70.5	70.6	N.A.[(d)]	≤ 0.44 [(b)]
	2.5[(c)]	71.8	71.7	N.A.[(d)]	3.3
	5[(c)]	71.9	71.7	N.A.[(d)]	6.3
Styrene	0[(c)]	71.4	77.1	85	0.35

(a) The leak was viewed using the camera's standard lens (25-mm) at these conditions unless otherwise noted.
(b) Leak observable at the lowest reliable flow rate capable of being supplied by the chemical delivery system.
(c) The leak was viewed using the optional 100-mm lens at these conditions.
(d) N.A. – not applicable. The ionization potential of this compound is higher than is capable of detection by the device used. Therefore, any raw data measured with this device is not reported in this table.
(e) No data – the leak concentration was inadvertently not collected by laboratory personnel using the M21 device.
(f) The leak was viewed using the optional 50-mm lens at these conditions.

Table 10. FLIR GasFindIR™ MW Method Detection Limits at 10 Feet Stand-off with a Curved Metal Gas Cylinder Background

Compound	Wind Speed (mph)[(a)]	Ambient Temp. (ºF)	Leak Temp. (ºF)	M21 Device Conc. (ppmv)	Method Detection Limit (g/hr)
1,3-butadiene	0	70.0	70.8	≥ 2,000	2.7
Acetic acid	0	72.8	80.6	2.9	≤ 0.02 [(b)]
	2.5[(c)]	74.8	85.7	1.3	≤ 4.6 [(b)]
	5[(c)]	74.8	78.7	29	≤ 4.6 [(b)]
Acrylic acid	0	71.7	93.9	20	1.2
Benzene	0	72.6	86.2	364	0.70
	2.5	74.4	82.0	33	11
	5	74.2	77.9	227	35
Methylene chloride	0	70.7	81.0	N.A.	18
	2.5	74.2	82.1	N.A.	> 70[(d)]
Ethylene	0	71.4	71.4	No data[(e)]	1.7
	2.5	71.1	72.1	225	68
	5	71.4	72.1	600	122
Methanol	0	71.3	95.0	N.A.[(f)]	0.35
	2.5	70.5	91.8	N.A.[(f)]	3.1
	5	70.4	81.6	N.A.[(f)]	17
Pentane	0	71.6	87.1	8.0	0.44
	2.5	71.9	85.8	58	8.3
	5	72.1	80.5	142	19
Propane	0	70.7	71.4	N.A.	≤ 0.44 [(g)]
	2.5	71.9	71.9	N.A.	7.1
	5	70.9	71.5	N.A.	13
Styrene	0	72.1	82.8	104	0.70

(a) The leak was viewed using the camera's standard lens (25-mm) at these conditions unless otherwise noted.
(b) Leak observable at the lowest reliable flow rate capable of being supplied by the chemical delivery system.
(c) The leak was viewed using the optional 100-mm lens at these conditions.
(d) The leak could not be detected below the highest reliable flow rate supplied by the delivery system.
(e) No data – the leak concentration was inadvertently not collected by laboratory personnel using the M21 device.
(f) N.A. – not applicable. The ionization potential of this compound is higher than is capable of detection by the device used. Therefore, any raw data measured with this device is not reported in this table.
(g) Leak observable at the lowest reliable flow rate capable of being supplied by the chemical delivery system.

Table 11. FLIR GasFindIR™ MW Method Detection Limits at 30 Feet Stand-off Distance with a Curved Metal Gas Cylinder Background

Compound	Wind Speed (mph)[a]	Ambient Temp. (ºF)	Leak Temp. (ºF)	M21 Device Conc. (ppmv)	Method Detection Limit (g/hr)
1,3-butadiene	0	71.1	71.9	468	1.6
Acetic acid	0	71.0	83.6	2.2	≤ 0.02 [b]
	2.5[c]	74.7	88.0	161	≤ 4.6 [b]
	5[c]	74.7	78.3	No data[d]	≤ 4.6 [b]
Acrylic acid	0[c]	70.7	80.2	1.2	0.92
Benzene	0[c]	71.9	86.1	337	0.77
	2.5[c]	74.9	82.0	526	16
	5[c]	75.0	80.6	521	35
Methylene chloride	0[c]	69.6	80.8	N.A.[e]	11
Ethylene	0	71.3	72.1	No data[d]	7.0
	0[f]	71.4	72.0	No data[d]	5.2
	2.5	71.3	72.2	571	156
	5	71.3	72.1	473	278
Methanol	0	71.7	81.4	N.A.[e]	0.35
	2.5	71.2	88.7	N.A.[e]	2.8
	5	70.3	82.6	N.A.[e]	22
Pentane	0[c]	71.9	78.2	18	≤ 0.28 [b]
	2.5[c]	74.0	85.3	19	2.8
	5[c]	71.6	81.3	61	17
Propane	0[c]	70.3	69.9	N.A.[e]	≤ 0.44 [b]
	2.5[c]	70.9	71.4	N.A.[e]	3.3
	5[c]	70.7	71.7	N.A.[e]	6.6
Styrene	0[c]	72.8	88.3	No data[d]	0.70

(a) The leak was viewed using the camera's standard lens (25-mm) at these conditions unless otherwise noted.
(b) Leak observable at the lowest reliable flow rate capable of being supplied by the chemical delivery system.
(c) The leak was viewed using the optional 100-mm lens at these conditions.
(d) No data – the leak concentration was inadvertently not collected by laboratory personnel using the M21 device.
(e) N.A. – not applicable. The ionization potential of this compound is higher than is capable of detection by the device used. Therefore, any raw data measured with this device is not reported in this table.
(f) The leak was viewed using the optional 50-mm lens at these conditions.

Table 12. FLIR GasFindIR^{TM} MW Range of Method Detection Limits and Overall Method Detection Limit Variation (g/hr)[(a)]

Compound	Minimum	Maximum	Overall Variation[(b)]
1,3-butadiene	1.3	2.7	
Acetic acid	≤ 0.02	≤ 4.6[(c), (d)]	2.3
Acrylic acid	0.92	1.2	
Benzene	0.35	35[(d)]	14
Dichloromethane (methylene chloride)	4.9	> 70[(c)]	
Ethylene	0.35	278[(d)]	88
Methanol	0.28	22[(d)]	8.5
Pentane	≤ 0.28	28[(d)]	8.2
Propane	≤ 0.44	13[(d)]	3.8
Styrene	0.35	0.70	

(a) Minimum and maximum values shown were measured at a 0-mph wind speed unless otherwise noted.
(b) When sample sizes are small (N < 10), standard deviations provide a biased estimate of the variability, therefore only the range is provided when there were fewer than 10 method detection limits determined.
(c) Measured at a 2.5-mph wind speed condition.
(d) Measured at a 5-mph wind speed condition.

6.2 Detection Agreement to a Portable Monitoring Device

The detection of a single chemical gas leak in either the laboratory or field environments was determined by the operator as well as two confirming individuals as discussed in Section 3.2.1. The leak rate was know from certified gas cylinders and calibrated flow meters in the laboratory, or was determined through the bagging method during field testing. During both the laboratory and field tests, a portable monitoring device acceptable under U.S. EPA Method 21 was used to sample the leaks. The following sections present results on the ability of the FLIR GasFindIR^{TM} MW camera to detect a chemical gas species relative to a portable monitoring device acceptable under U.S. EPA Method 21.

6.2.1 Laboratory Testing

Table 13 presents the percent agreement between the ability of the FLIR GasFindIR^{TM} MW camera and of a portable monitoring device acceptable under U.S. EPA Method 21 to detect a chemical gas leak under the conditions tested. Percent agreement was calculated according to Equation 2 in Chapter 5. The calculation of percent agreement excludes those laboratory test conditions for which a response was not collected using a portable monitoring device acceptable under U.S. EPA Method 21. In addition, percent agreement was not evaluated for methylene chloride, methane, methanol, and propane because these compounds have an ionization potential greater than that which could be supplied by the Industrial Scientific IBRID MX6 with PID sensor.

Table 13. Summary of Detection Agreement Between FLIR GasFindIR™ MW Camera and a Method 21 Portable Monitoring Device

Compound	No. of Tests in which Agreed	Total No. of Tests Completed	Percent Agreement
1,3-butadiene	4	4	100%
Acetic acid	11	11	100%
Acrylic acid	4	4	100%
Benzene	12	12	100%
Ethylene	8	8	100%
Pentane	16	16	100%
Styrene	3	3	100%

6.2.2 Field Testing

During field testing, nine leaking components were viewed using the FLIR GasFindIR™ MW camera using the procedures described in Section 3.2.1. Table 14 identifies whether each chemical species gas leak was observed by the FLIR GasFindIR™ MW camera and the concentration of the leak as determined by a portable monitoring device acceptable under U.S. EPA Method 21. In addition, these tables identify the type of component that was leaking, the average chemical-specific mass leak rate from the component as determined by reference sampling, the distance the leak was observed, and the wind speed. Daily meteorological conditions were obtained from Dow Chemical's on-site weather station. Although the wind speed and daily maximum and minimum temperatures were obtained from this weather station, the actual wind speed and ambient and background temperatures at each leak location at the time of observation are unknown. Additional discussions describing each leak location are provided in the following sections.

Leak Location 1. A leak was identified originating from a 3-inch plug in service with a process stream containing ethane, ethylene, methane, and propane. Screening of the component with the TVA caused an over range reading (estimated as > 100,000 ppmv). The leak was viewed and detected with the FLIR GasFindIR™ MW camera at stand-off distance of 12 ft with the sun at the observers back. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for ethylene and methane concentrations. Daily weather conditions, as reported by the on-site weather station, were clear conditions, a daily minimum and maximum temperature of 41 and 61 degrees Fahrenheit (°F), respectively, with wind out of the east at up to 8 mph.

Table 14. Summary of Field Testing Results Using the FLIR GasFindIR™ MW Camera

Leak Location	Leaking Component Type	Wind Speed (mph)	Stand-off Distance (ft)	M21 Device Screening Conc. (ppmv)	Leak Detected by Camera?	Bagging Results: Average Leak Rate (g/hr)
1	3-inch Plug	8	12	>100,000	Yes	8.79 (methane) 4.31 (ethylene)
2	¼-inch Tube	21	10 30	20,500	No No	0.951 (ethylene)
3	½-inch Connector	21	10 30 45	>100,000	Yes Yes Yes	2.32 x 10^{-3} (ethylene) 7.78 (methane)
5	6-inch Block Valve	21	10	>100,000	No	5.24 x 10^{-2} (ethylene) 8.68 x 10^{-3} (styrene) 0.077 (benzene)
6	8-inch Block Valve	21	10	20,500	No	3.44[(a)] (benzene)
7	Control Valve Flange	18	10	17,500	No	1.95 x 10^{-3} (ethylene) 0.282 (benzene)
8	2-inch Block Valve	18	10	8,000[(b)]	No	1.92[(b)] (1,3-butadiene)
9	1-inch Valve Plug	18	10	835	No	0.350 (methylene chloride)
10	6-inch Pressure Relief Valve	5	10	>100,000	No	6.78 (propylene dichloride)

(a) As reported in Table 5, the pre- and post-bagging leak concentrations, as measured by the TVA, differed by 24.4%. This exceeds the minimum acceptance criterion of 20% for the DQI for the confirmation of detected leaks. Thus, this data is considered suspect and reported with this data qualifier.

(b) As reported in Table 4, the calibration check response for the TVA, conducted after screening this component, resulted in a 24% difference. This exceeded the minimum acceptance criterion of 10% for the DQI for the bias and accuracy of sample screening measurements using a portable monitoring device. After recalibration of the TVA, the leak concentration from this component was not reconfirmed with the TVA. Thus, this data is considered suspect and reported with this data qualifier.

Leak Location 2. A leak was identified originating from a ¼-inch tube in service with a process stream containing ethane and ethylene. Screening of the component with the TVA resulted in a concentration reading of 20,500 ppmv. The leak was viewed with the FLIR GasFindIR™ MW camera at stand-off distances of 10 and 30 ft with the sun to the left of the observer. The camera did not detect the leak at either stand-off distance. Wind direction at the location was noted as originating from behind the observer and the site was shaded by piping and other equipment. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for ethylene concentration. Daily weather conditions, as reported by the on-site weather station, were clear conditions, a daily minimum and maximum temperature of 42 and 70 °F with wind out of the south southeast at 21 mph.

Leak Location 3. A leak was identified originating from a ½-inch connector in service with a process stream containing acetylene, ethane, ethylene, methane, propane, and propylene. Screening of the component with the TVA caused an over range reading (estimated as > 100,000 ppmv). The leak was viewed with the FLIR GasFindIR™ MW camera at stand-off distances of 10, 30, and 45 ft, with the sun to the right of the observer. The FLIR GasFindIR™ MW camera detected the leak at each of the three stand-off distances. Wind direction at the location was noted as originating from the right of the observer and the site was shaded by piping and other equipment. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for ethylene and methane concentrations. Daily weather conditions, as reported by the on-site weather station, were clear conditions, a daily minimum and maximum temperature of 42 and 70 °F with wind out of the south southeast at 21 mph.

The average mass leak rate of ethylene measured at this leak location was 2.23×10^{-3} g/hr. This value is below the lowest ethylene method detection limit measured with the FLIR GasFindIR™ MW camera during the laboratory phase of this verification test.

Leak Location 4. Leak location 4 contained a leaking component that was misidentified as being in service with styrene. This sample location was confirmed to be in ethylbenzene service and thus no analytical results are reported for this leak location. The FLIR GasFindIR™ MW camera was able to detect this leak.

Leak Location 5. A leak was identified originating from a 6-inch block valve in service with a process stream containing benzene, ethane, ethylene, ethylbenzene, styrene, and toluene. Screening of the component with the TVA caused an over range reading (estimated as > 100,000 ppmv). The leak was viewed with the FLIR GasFindIR™ MW camera at a stand-off distance of 10 ft; the leak could not be detected at this distance. The site was shaded and the viewing background was concrete. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for benzene, ethylene, and styrene concentrations. Daily weather conditions, as reported by the on-site weather station were clear conditions, a daily minimum and maximum temperature of 48 and 79 °F with wind out of the north at 21 mph.

The average mass leak rates of ethylene, styrene, and benzene measured at this leak location were 5.24×10^{-2}, 8.68×10^{-3}, and 0.077 g/hr, respectively. These values are all below the lowest method detection limits measured with the FLIR GasFindIR™ MW cameras for these compounds during the laboratory phase of this verification test.

Leak Location 6. A leak was identified originating from an 8-inch block valve in service with a process stream containing benzene, toluene, hexane, and other aromatic hydrocarbons. Screening of the component with the TVA resulted in a concentration reading of 20,500 ppmv. The leak was viewed with the FLIR GasFindIR™ MW camera at a stand-off distance of 10 ft with the sun to the right of the camera observer; the leak could not be detected at this distance. The site was an exterior location and weather conditions were noted as slightly overcast with moderate wind originating from the right of the observer. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for benzene concentration. Daily weather conditions, as reported by the on-site weather station were clear conditions, a daily minimum and maximum temperature of 48 and 79 °F with wind out of the north at 21 mph.

Leak Location 7. A leak was identified originating from a control valve flange in service with a process stream containing benzene, butane, butylbenzene, all isomers of diethylbenzene, ethane, ethylbenzene, ethylene, hexane, toluene, and other aromatic hydrocarbons. Screening of the component with the TVA resulted in a concentration reading of 17,500 ppmv. The leak was viewed with the FLIR GasFindIR™ MW camera at a stand-off distance of 10 ft with the sun behind the camera observer; the leak could not be detected at this distance. The site was located on the second deck of the chemical plant and weather conditions were qualitatively noted as very windy. The viewing background was other plant piping and equipment. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for benzene and ethylene concentrations. Daily weather conditions, as reported by the on-site weather station, were partly cloudy conditions, a daily minimum and maximum temperature of 43 and 65 °F with wind out of the north at 18 mph.

The average mass leak rates of ethylene and benzene measured at this leak location were 1.95×10^{-3} and 0.282 g/hr, respectively. These values are all below the lowest method detection limits measured with the FLIR GasFindIR™ MW camera for these compounds during the laboratory phase of this verification test.

Leak Location 8. A leak was identified originating from a 2-inch block valve in service with a process stream containing 1,3-butadiene. Screening of the component with the TVA resulted in a concentration reading of 8,000 ppmv. The leak was viewed with the FLIR GasFindIR™ MW camera at a stand-off distance of 10 ft; the leak could not be detected at this distance. The site was an exterior location on a marine vapor recovery line at a marine vapor recovery system and weather conditions were qualitatively noted to be very windy and overcast. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for 1,3-butadiene concentration. Daily weather conditions, as reported by the on-site weather station, were partly cloudy conditions, a daily minimum and maximum temperature of 43 and 65 °F with wind out of the north at 18 mph.

Leak Location 9. A leak was identified originating from a 1-inch valve plug in service with a process stream containing methylene chloride. Screening of the component with the TVA resulted in a concentration reading of 835 ppmv. The leak was viewed with the FLIR GasFindIR™ MW camera at a stand-off distance of 10 ft; the leak could not be detected at this distance. The site was an exterior location and weather conditions were qualitatively noted as overcast with calm winds. The viewing background was concrete ground and a few metal pipe supports. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for methylene chloride concentration. Daily weather conditions, as reported by the on-site weather station, were partly cloudy conditions, a daily minimum and maximum temperature of 43 and 65 °F with wind out of the north at 18 mph.

The average mass leak rate of methylene chloride measured at this leak location was 0.350 g/hr. This value is below the lowest ethylene method detection limit measured with the FLIR GasFindIR™ MW camera during the laboratory phase of this verification test.

Leak Location 10. A leak was identified originating from a 6-inch pressure relief valve in service with a process stream containing 1,2,3-trichloropropane, 2,3-dichloropropanol, 2-methyl-2-pentenal, 1-chloro-2,3-epoxypropane, and propylene dichloride. Screening of the component with the TVA caused an over range reading (estimated as > 100,000 ppmv). The leak was viewed with the FLIR GasFindIR^{TM} MW camera at a stand-off distance of 10 ft; the leak could not be detected at this distance. The site was an exterior location (on top of a storage tank platform) and weather conditions were qualitatively noted as overcast, breezy, and cold. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for propylene dichloride concentration. Daily weather conditions, as reported by the on-site weather station, were partly cloudy conditions, a daily minimum and maximum temperature of 41 and 50 °F with wind out of the north at 5 mph.

6.3 Confounding Factors

The method detection limits generated during laboratory testing presented in Table 8 through Table 11 were inspected to identify general trends that the confounding factors of stand-off distance, wind speed, and background materials impart on the method detection limits for the gaseous chemical species leaks observed using the FLIR GasFindIR^{TM} MW camera. In addition, the effect of lens size was also inspected. The following general trends were noted when using the FLIR GasFindIR^{TM} MW camera.

- Stand-off Distance – Method detection limits generally increased as the viewing distance increased
- Wind Speed – Method detection limits generally increased with increased wind speed
- Background Materials– Method detection limits were generally lower when viewed against the cement board background. Two exceptions to this observation were noted when viewing ethylene. The first occurred when viewing the leak at a 10 ft distance at a 5-mph wind speed with the standard 25-mm lens. The second occurred when viewing the leak at a 30 ft distance at a 2.5-mph wind speed with the optional 100-mm lens.
- Camera Lens – Method detection limits generally decreased with an increase in camera lens size

During field testing, confounding factors were recorded either quantitatively or qualitatively and are reported in Table 14 and Table 15. A rigid analysis of the influence of confounding factors was not undertaken using field testing data, however, it is generally noted that because the cameras detected only a few of the chemical leaks in the field, the confounding factors of wind speed, stand-off distance, and background materials affected the detection capability of the cameras.

6.4 Operational Factors

The FLIR GasFindIR^{TM} MW camera was found to be easily set up in a small, two ft by two ft area and deployed within approximately 10 minutes for portable gas leak observations. In terms of field portability, the camera was light in weight (approximately 4.6 pounds with battery and camera), easily carried by one person and was provided with a rugged shipping case for transportation.

The FLIR GasFindIR^{TM} MW camera may be powered with either an AC adaptor for stationary applications or with a six volt, 4200 milliampere-hour nickel-metal hydride battery for mobile field observations. The battery for the camera was used and held its charge when performing visual screening of leaking components. The FLIR GasFindIR™ MW camera comes equipped with a standard 25-mm camera lens; optional 50-mm and 100-mm lenses may be purchased separately for use with the camera. The camera observer sees the infrared image through a standard eyepiece when using both the FLIR GasFindIR™ MW camera; these images are also recordable to any off-the-shelf video recorder for image storage.

Ease of use was not investigated with a newly trained operator, as the vendor operated the FLIR GasFindIR™ MW camera during both laboratory and field testing. Verification test team members, however, did observe that both cameras were operated by the camera operator with relative ease. The FLIR GasFindIR™ MW camera is not intrinsically safe, and cannot be used in explosive atmospheres or environments.

During this verification test, all chemical leaks were required to be observed by the camera operator and two additional confirming individuals to be considered as “detected” by the camera. During verification testing, there were instances where either one or two of the three observers (not the required three) were able to observe the chemical leak. This indicates that the ability of the operator using the camera to positively identify the chemical leak may have an influence on the operation of the camera.

The cost of the FLIR GasFindIR™ MW camera is $64,950. The base price of the camera includes an intelligent battery charger and three lithium ion batteries, an alternating current power supply, a video cable, a personal video recorder and battery, audio/video cable for the personal video recorder, camera neck strap, shipping/carrying case, and operating manual.

The cost of optional 50 and 100-millimeter lenses for the FLIR GasFindIR™ MW camera are $7,500 and $9,950, respectively.

Chapter 7
Performance Summary

Method Detection Limits. Method detection limits were determined during the laboratory testing. Table 15 summarizes the minimum and maximum method detection limit obtained during laboratory testing using the FLIR GasFindIR™ MW camera. Specific details, including the test conditions at which these method detection limits were obtained and the lens size used, are provided in Table 8 through Table 11 in Chapter 6. The overall detection limit variations for each chemical obtained using each camera are presented in Table 12 in Chapter 6.

Detection of Chemical Gas Species Relative to a Portable Monitoring Device. The ability of the FLIR GasFindIR™ MW camera to detect a gaseous leak of a chemical relative to a portable monitoring device acceptable under U.S. EPA Method 21 was assessed during both laboratory and field testing. During laboratory testing, after the method detection limit had been reached for a particular chemical under the specified test conditions, the leak was sampled by the portable monitoring device. Table 15 presents the percent agreement between the ability of the FLIR GasFindIR™ MW camera and of a portable monitoring device acceptable under U.S. EPA Method 21 to detect a chemical gas leak under the conditions tested in the laboratory.

During field testing a portable monitoring device acceptable under U.S. EPA Method 21 was used to screen each leaking component as part of the bagging reference method used. Table 16 reports the responses of the portable screening device when screening leaking components, identifies whether the FLIR GasFindIR™ MW camera was able to detect the chemical leak from the leaking component, and reports the chemical-specific mass rate of emissions from the leaking component as obtained through the bagging method.

Confounding Factors. Stand-off distance, wind speed, and background materials generally impacted the performance of the FLIR GasFindIR™ MW camera (e.g., increasing the stand-off distance from the leak increased the method detection limits). Changing to an optional magnifying camera lens that can be purchased separately lowered the method detection limit. Details of the effects of confounding factors may be found in Section 6.3.

Table 15. Summary of FLIR GasFindIR™ MW Camera Method Detection Limits[(a)] and Percent Agreement with a Method 21 Monitoring Device During Laboratory Testing

	Method Detection Limit (g/hr)		Agreement with Method 21 Monitoring Device	
Compound	Minimum	Maximum	Total No. of Tests Performed	Percent Agreement
1,3-butadiene	1.3	2.7	4	100%
Acetic acid	≤ 0.02	≤ 4.6[(b), (c)]	11	100%
Acrylic acid	0.92	1.2	4	100%
Benzene	0.35	35[(c)]	12	100%
Methylene chloride	4.9	> 70[(c)]	No data[(d)]	
Ethylene	0.35	278[(c)]	8	100%
Methanol	0.28	22[(c)]	No data[(d)]	
Pentane	≤ 0.28	28[(c)]	16	100%
Propane	≤ 0.44	13[(c)]	No data[(d)]	
Styrene	0.35	0.70	3	100%

(a) Minimum and maximum method detection limits shown were measured at a 0-mph wind speed unless otherwise noted.
(b) Measured at a 2.5-mph wind speed.
(c) Measured at a 5-mph wind speed.
(d) Percent agreement was not evaluated for methylene chloride, methanol, and propane because these compounds have an ionization potential greater than the energy which could be supplied by the Industrial Scientific IBRID MX6 with PID sensor.

Operational Factors. The FLIR GasFindIR™ MW camera was found to be easily setup and ready to deploy in 10 minutes. The camera is light (4.6 pounds or less) and operated on batteries when performing visual screening of leaking components. The camera may also utilize optional lenses that can be used to further magnify the images. Because the camera was operated by FLIR and there were some disagreements on detections with the two other confirming individuals, the ability of the operator may influence the operation of the camera. The FLIR GasFindIR™ MW camera is not intrinsically safe, and cannot be used in explosive atmospheres or environments.

The cost of the FLIR GasFindIR™ MW camera is $64,950 and includes an intelligent battery charger and three lithium ion batteries, an alternating current power supply, a video cable, a personal video recorder and battery, audio/video cable for the personal video recorder, camera neck strap, shipping/carrying case, and operating manual.

The cost of optional 50 and 100-millimeter lenses for the FLIR GasFindIR™ MW camera are $7,500 and $9,950, respectively.

Table 16. Summary of Field Testing Results Using the FLIR GasFindIR^{TM} MW Camera

Leak Location	Leaking Component Type	Wind Speed (mph)	Stand-off Distance (ft)	M21 Device Screening Conc. (ppmv)	Leak Detected by Camera?	Bagging Results: Average Leak Rate (g/hr)
1	3-inch Plug	8	12	>100,000	Yes	8.79 (methane) 4.31 (ethylene)
2	¼-inch Tube	21	10 30	20,500	No No	0.951 (ethylene)
3	½-inch Connector	21	10 30 45	>100,000	Yes Yes Yes	2.32×10^{-3} (ethylene) 7.78 (methane)
5	6-inch Block Valve	21	10	>100,000	No	5.24×10^{-2} (ethylene) 8.68×10^{-3} (styrene) 0.077 (benzene)
6	8-inch Block Valve	21	10	20,500	No	3.44[(a)] (benzene)
7	Control Valve Flange	18	10	17,500	No	1.95×10^{-3} (ethylene) 0.282 (benzene)
8	2-inch Block Valve	18	10	8,000[(b)]	No	1.92[(b)] (1,3-butadiene)
9	1-inch Valve Plug	18	10	835	No	0.350 (methylene chloride)
10	6-inch Pressure Relief Valve	5	10	>100,000	No	6.78 (propylene dichloride)

(a) As reported in Table 5, the pre- and post-bagging leak concentrations, as measured by the TVA, differed by 24.4%. This exceeds the minimum acceptance criterion of 20% for the DQI for the confirmation of detected leaks. Thus, this data is considered suspect and reported with this data qualifier.

(b) As reported in Table 4, the calibration check response for the TVA, conducted after screening this component, resulted in a 24% difference. This exceeded the minimum acceptance criterion of 10% for the DQI for the bias and accuracy of sample screening measurements using a portable monitoring device. After recalibration of the TVA, the leak concentration from this component was not reconfirmed with the TVA. Thus, this data is considered suspect and reported with this data qualifier.

Chapter 8
References

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3. *EPA Method 21- Detection of Volatile Organic Compound Leaks*, EPA-600/2-18-110; U.S. EPA, September 1981.

4. Panek, J., P. Drayton, and D. Fashimpaur. *Controlled Laboratory Sensitivity and Performance Evaluation of Optical Leak Imaging Infrared Cameras for Identifying Alkane, Alkene, and Aromatic Compounds,* Proceedings of the 99th Annual Conference and Exposition of the Air and Waste Management Association, New Orleans, June 20 – 23, 2006, Manuscript number 06-A-159-AWMA, Curran Associates, Inc., Red Hook, New York, March 2007.

5. *EPA Protocol for Equipment Leak Emissions Estimates*, EPA-453/R-95-017; U.S. EPA: Research Triangle Park, NC, November 1995.

6. *EPA Method 18 – Measurement of Gaseous Organic Compound Emissions by Gas Chromatography*, 40 CFR, Part 60, Appendix A; April, 1994.

7. EPA Method 205 – *Verification of Gas Dilution Systems for Field Instrument Calibrations,* 40 CFR, Part 51, Appendix M, September, 1996.

Appendix A
FLIR GasFindIR™ LW Camera Results

A FLIR GasFindIR™ LW camera underwent a limited amount of testing during both the laboratory and field testing phases of this verification test. The FLIR GasFindIR™ LW camera was not evaluated against the entire suite of chemicals used in the laboratory portion of this verification testing; rather the vendor used the FLIR GasFindIR™ LW camera for 1,3-butadiene, acetic acid, and acrylic acid because these compounds have an absorption peak within the 10 – 11 micrometer operating wavelength of the FLIR GasFindIR™ LW camera. The camera was evaluated in the field for all chemical gas leaks identified, regardless of whether the gas leak contained compounds with an absorption peak within the 10 – 11 micrometer operating wavelength of the FLIR GasFindIR™ LW camera, on only those days that the camera was available to the verification test team during field testing.

A.1 Method Detection Limit

The method detection limit for 1,3-butadiene, acetic acid, and acrylic acid was determined according to the procedures discussed in Section 3.2.2. Tables A1 through A4 present the method detection limits of each these compounds determined during laboratory testing. Tables A1 through A4 identify each test condition evaluated (i.e., stand-off distance, background material, and wind speed), the temperatures of the laboratory and of the chemical leak, the response of the portable monitoring device acceptable under U.S. EPA Method 21, and the method detection limits for each test condition. Table A5 summarizes the range of method detection limits in units of gram per hour (g/hr) found during the laboratory testing as well as presents the overall detection limit variation for each compound. The overall detection limit variation presented in Table A5 was calculated using Equation 1 in Chapter 5.

Table A1. FLIR GasFindIR™ LW Method Detection Limits at 10 Feet Stand-off Distance with a Cement Board Background

Compound	Wind Speed (mph)[(a)]	Ambient Temp. (°F)	Leak Temp. (°F)	M21 Device Conc. (ppmv)	Method Detection Limit (g/hr)
1,3-butadiene	0	70.1	71.2	≥ 2,000	2.7
Acetic acid	0	72.7	82.1	4.0	0.02
	2.5	75.1	85.5	526	≤ 4.6 [(b)]
	5	75.0	80.4	32	≤ 4.6 [(b)]
Acrylic acid	0	71.2	84.8	4.9	0.92

(a) The leak was viewed using the camera's standard lens (50-mm) at these conditions unless otherwise noted.
(b) Leak observable at the lowest reliable flow rate capable of being supplied by the chemical delivery system.

Table A2. FLIR GasFindIR™ LW Method Detection Limits at 30 Feet Stand-off Distance with a Cement Board Background

Compound	Wind Speed (mph)[a]	Ambient Temp. (ºF)	Leak Temp. (ºF)	M21 Device Conc. (ppmv)	Method Detection Limit (g/hr)
1,3-butadiene	0	71.7	72.1	≥ 2,000	13
	0	70.8	88.7	1.8	0.02
Acetic acid	2.5	74.8	85.5	7.8	≤ 4.6 [b]
	5	74.9	80.5	17	14
Acrylic acid	0	71.7	92.0	0.8	0.92

(a) The leak was viewed using the camera's standard lens (50-mm) at these conditions unless otherwise noted.
(b) Leak observable at the lowest reliable flow rate capable of being supplied by the chemical delivery system.

Table A3. FLIR GasFindIR™ LW Method Detection Limits at 10 Feet Stand-off with a Curved Metal Gas Cylinder Background

Compound	Wind Speed (mph)[a]	Ambient Temp. (ºF)	Leak Temp. (ºF)	M21 Device Conc. (ppmv)	Method Detection Limit (g/hr)
1,3-butadiene	0	70.2	71.0	≥ 2,000	3.4
	0	72.8	80.6	2.9	0.02
Acetic acid	2.5	74.8	85.7	1.3	≤ 4.6 [b]
	5	74.8	78.7	29	≤ 4.6 [b]
Acrylic acid	0	71.4	97.7	1.2	≤ 0.46 [b]

(a) The leak was viewed using the camera's standard lens (50-mm) at these conditions unless otherwise noted.
(b) Leak observable at the lowest reliable flow rate capable of being supplied by the chemical delivery system.

Table A4. FLIR GasFindIR™ LW Method Detection Limits at 30 Feet Stand-off Distance with a Curved Metal Gas Cylinder Background

Compound	Wind Speed (mph)[a]	Ambient Temp. (ºF)	Leak Temp. (ºF)	M21 Device Conc. (ppmv)	Method Detection Limit (g/hr)
1,3-butadiene	0	71.0	71.9	≥ 2,000	13
	0	71.0	83.6	2.2	0.02
Acetic acid	2.5	74.7	88.0	161	≤ 4.6 [b]
	5	74.7	77.9	28	18
Acrylic acid	0	70.7	80.2	1.2	0.92

(a) The leak was viewed using the camera's standard lens (50-mm) at these conditions unless otherwise noted.
(b) Leak observable at the lowest reliable flow rate capable of being supplied by the chemical delivery system.

Table A5. FLIR GasFindIR™ LW Range of Method Detection Limits and Overall Method Detection Limit Variation (g/hr)[a]

Compound	Minimum	Maximum	Overall Variation[b]
1,3-butadiene	2.7	13	
Acetic acid	0.02	18[D]	5.7
Acrylic acid	≤ 0.46	0.92	

(a) Minimum and maximum values shown were measured at a 0-mph wind speed unless otherwise noted.
(b) When sample sizes are small (N < 10), standard deviations provide a biased estimate of the variability, therefore only the range is provided when there were fewer than 10 method detection limits were determined.

A.2 Detection Agreement to a Portable Monitoring Device

The detection of a single chemical gas leak in either the laboratory or field environments was determined by the operator as well as two confirming individuals as discussed in Section 3.2.1. The leak rate was known from certified gas cylinders and calibrated flow meters in the laboratory, or was determined through the bagging method during field testing. During both the laboratory and field tests, a portable monitoring device acceptable under U.S. EPA Method 21 was used to sample the leaks. The following sections present results on the ability of the FLIR GasFindIR™ LW camera to detect a chemical gas species relative to a portable monitoring device acceptable under U.S. EPA Method 21.

A.2.1 Laboratory Testing

Table A6 presents the percent agreement between the ability of the FLIR GasFindIR™ LW camera and of a portable monitoring device acceptable under U.S. EPA Method 21 to detect a chemical gas leak under the conditions tested. Percent agreement was calculated according to Equation 2 in Chapter 5. The calculation of percent agreement excludes those laboratory test conditions for which a response was not collected using a portable monitoring device acceptable under U.S. EPA Method 21.

Table A6. Summary of Detection Agreement Between FLIR GasFindIR™ LW Camera and a Method 21 Portable Monitoring Device

Compound	No. of Tests in which Agreed	Total No. of Tests Completed	Percent Agreement
1,3-Butadiene	4	4	100%
Acetic acid	12	12	100%
Acrylic acid	4	4	100%

A.2.2 Field Testing

During field testing, three leaking components were viewed using the FLIR GasFindIR™ LW camera using the procedures described in Section 3.2.1. Table A7 identifies whether each chemical species gas leak was observed by the FLIR GasFindIR™ LW camera and the concentration of the leak as determined by a portable monitoring device acceptable under U.S. EPA Method 21. In addition, these tables identify the type of component that was leaking, the average chemical-specific mass leak rate from the component as determined by reference sampling, the distance the leak was observed and the wind speed. Daily meteorological conditions were obtained from Dow's on-site weather station. Although the wind speed and daily maximum and minimum temperatures were obtained from this meteorological tower, the actual wind speed and ambient and background temperatures at each leak location at the time of observation are unknown. Additional discussions describing each leak location are provided in the following sections.

Leak Location 2. A leak was identified originating from a ¼-inch tube in service with a process stream containing ethane and ethylene. Screening of the component with the TVA resulted in a concentration reading of 20,500 ppmv. The leak was viewed with the FLIR GasFindIR™ LW camera at stand-off distances of 10 and 30 ft with the sun to the left of the observer. The camera did not detect the leak at either stand-off distance. Wind direction at the location was noted as originating from behind the observer and the site was shaded by piping and other equipment. The leak was bagged and a duplicate reference sample was collected into two

Table A7. Summary of Field Testing Results Using the FLIR GasFindIR™ LW Camera

Leak Location	Leaking Component Type	Wind Speed (mph)	Stand-off Distance (ft)	M21 Device Screening Conc. (ppmv)	Leak Detected by Camera?	Bagging Results: Average Leak Rate (g/hr)
2	¼-inch Tube	21	10 30	20,500	No No	0.951 (ethylene)
3	½-inch Connector	21	10 30 45	>100,000	Yes Yes Yes	2.32×10^{-3} (ethylene) 7.78 (methane)
5	6-inch Block Valve	21	10	>100,000	No	5.24×10^{-2} (ethylene) 8.68×10^{-3} (styrene) 0.077 (benzene)

evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for ethylene concentration. Daily weather conditions, as reported by the on-site weather station, were clear conditions, a daily minimum and maximum temperature of 42 and 70 °F with wind out of the south southeast at 21 mph.

Leak Location 3. A leak was identified originating from a ½-inch connector in service with a process stream containing acetylene, ethane, ethylene, methane, propane, and propylene. Screening of the component with the TVA caused an over range reading (estimated as > 100,000 ppmv). The leak was viewed with the FLIR GasFindIR™ LW camera at stand-off distances of 10, 30, and 45 ft with the sun to the right of the observer. The FLIR GasFindIR™ LW camera detected the leak at each of the three stand-off distances. Wind direction at the location was noted as originating from the right of the observer and the site was shaded by piping and other equipment. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for ethylene and methane concentrations. Daily weather conditions, as reported by the on-site weather station, were clear conditions, a daily minimum and maximum temperature of 42 and 70 °F with wind out of the south southeast at 21 mph.

Leak Location 5. A leak was identified originating from a 6-inch block valve in service with a process stream containing benzene, ethane, ethylene, ethylbenzene, styrene, and toluene. Screening of the component with the TVA caused an over range reading (estimated as > 100,000 ppmv). The leak was viewed with the FLIR GasFindIR™ LW camera at a stand-off distance of 10 ft; the leak could not be detected at this distance. The site was shaded and the viewing background was concrete. The leak was bagged and a duplicate reference sample was collected into two evacuated SUMMA canisters. The SUMMA canisters were shipped to the off-site GC laboratory and analyzed for benzene, ethylene, and styrene concentrations. Daily weather conditions, as reported by the on-site weather station, were clear conditions, a daily minimum and maximum temperature of 48 and 79 °F with wind out of the north at 21 mph.

A.3 Confounding Factors

The method detection limits generated during laboratory testing presented in Table A1 through Table A4 were inspected to identify general trends that the confounding factors of stand-off distance, wind speed, and background materials impart on the method detection limits for the gaseous chemical species leaks observed using the FLIR GasFindIR™ LW camera. The following general trends were noted when using the FLIR GasFindIR™ LW camera.

- Stand-off Distance – Method detection limits generally increased as the viewing distance increased;
- Wind Speed – Method detection limits generally increased with increased wind speed;
- Background Materials – Method detection limits were generally lower when viewed against the cement board background. An exception to this observation was noted when viewing acrylic acid at a 10 ft distance at a 0-mph wind speed with the standard 50-mm lens.

A.4 Operational Factors

The FLIR GasFindIR™ LW camera was found to be easily setup in a small, two ft by two ft area and deployed within approximately 10 minutes for portable gas leak observations. In terms of field portability, the camera was light in weight (approximately six pounds with battery and camera), easily carried by one person and was provided with a rugged shipping case for transportation.

The FLIR GasFindIR™ LW cameras may be powered with either an AC adaptor for stationary applications or with a six volt, 4200 milliampere-hour nickel-metal hydride battery for mobile field observations. The battery for each camera was used and held its charge through the whole of each testing day. The FLIR GasFindIR™ LW camera comes equipped with a standard 50-mm camera lens. The camera observer sees the infrared image through a standard eyepiece when using both the FLIR GasFindIR™ LW cameras; these images are also recordable to any off-the-shelf video recorder for image storage.

Ease of use was not investigated with a newly trained operator, as the vendor operated both the FLIR GasFindIR™ LW cameras during the both laboratory and field testing. Verification test team members, however, did observe that the camera was operated by the camera operator with relative ease. The FLIR GasFindIR™ LW camera is not intrinsically safe, and cannot be used in explosive atmospheres or environments.

During this verification test, all chemical leaks were required to be observed by the camera operator and two additional confirming individuals to be considered as “detected” by the camera. During verification testing, there were instances where either one or two of the three observers (not the required three) were able to observe the chemical leak. This indicates that the ability of the operator using the camera to positively identify the chemical leak may have an influence on the operation of the camera.

The cost of the FLIR GasFindIR™ LW camera is $80,000. The base price of the camera includes an intelligent battery charger and three lithium ion batteries, an alternating current power supply, a video cable, a personal video recorder and battery, audio/video cable for the personal video recorder, camera neck strap, shipping/carrying case, and operating manual.