ILLINOIS Environmental Protection Agency
2014 Hazardous Waste Report
Form GM -- Generation and Management

US EPA ID : ILD087154555 IL. EPA ID : 0990850005

SECTION 1. WASTE DESCRIPTION

A. Waste Description: POLYSTYRENE WASTE FROM PIT CLEAN OUT

B. EPA Hazardous Waste Code(s) : D001

C. Source Code : G32 D. Form Code : W002 Management Method :

E. Waste Minimization Code: X

SECTION 2. QUANTITY GENERATED:

A. UOM : 1. Gallons Density : 12.00 lb/gal .

B. Quantity Generated in Current Reporting Year : 440.0

SECTION 3: QUANTITY MANAGED ON-SITE:

Did this location manage some or all of this waste in RCRA or UIC regulated treatment, recycling, or disposal units at this location? (DO NOT include RCRA exempt processes.) N

On-Site System1:Management Method : Quantity managed on-site this year : 0.0

On-Site System2:Management Method : Quantity managed on-site this year : 0.0

SECTION 4. OFF-SITE SHIPMENT

A. Was any of this waste shipped off site this reporting year? Y

SITE 1.

B. U.S. EPA ID No. of facility waste was shipped to : TXD055141378

C.Management method shipped to : H040

D. Total quantity shipped in this reporting year : 440.0

SITE 2.

B. U.S. EPA ID No. of facility waste was shipped to :

C. Management method shipped to :

D. Total quantity shipped in this reporting year : 0.0

SITE 3.

B. U.S. EPA ID No. of facility waste was shipped to :

C. Management method shipped to :

D. Total quantity shipped in this reporting year : 0.0

SITE 4.

B. U.S. EPA ID No. of facility waste was shipped to :

C. Management method shipped to :

D. Total quantity shipped in this reporting year : 0.0

SITE 5.

B. U.S. EPA ID No. of facility waste was shipped to :

C. Management method shipped to :

D. Total quantity shipped in this reporting year : 0.0

COMMENTS : N

RELEASED
DATE
RIN #
INITIALS

ANDREWS
ENGINEERING, INC.

RELEASED
DATE 11/12/19
RIN # 2019-008106
INITIALS JM

July 2, 2014

CONFIDENTIAL: FOR SETTLEMENT PURPOSES ONLY

Brian Marcinkus
Flint Hills, Peru Plant
501 Brunner St.
Peru, IL 61354

Re: Styrene Spill Remediation Sampling Results

Dear Mr. Marcinkus:

Andrews Engineering, Inc. (AEI) was contracted to perform sampling and analysis at the Flint Hills Plant, Peru, Illinois to determine the effectiveness of remediation activities necessitated by a recent Styrene release. AEI visited the facility on May 21, 2014 for an initial briefing and walkthrough of the project location.

On May 30, 2014, AEI mobilized to the site. After receiving the mandatory safety training, which was provided by the plant personnel, AEI staff and subcontractors proceeded to the spill area. Due to mechanical issues, only a total of five boring were conducted; AEI returned to the site on June 2, 2014 to complete three additional borings. In total, AEI advanced 8 borings through the recently placed clean fill (CA6 aggregate) into the underlying material. See Figures 1 and 2 depicting the plant location and boring plan of the release area.

A five-foot long, hollow sampling device was advanced using push technology. Using push technology, a continuous sample is retrieved and the procedure replicated until the desired depth is reached. Samples are retained within the hollow sampling device, which is lined with acetate (plastic) liners. The liners maintain the physical and chemical integrity of the material for purposes of preparing boring logs and collecting samples for laboratory analysis. For this project, laboratory analysis was limited to chemical analysis.

Once the sampling device is advanced to reach the sampling capacity it is backed out of the boring and split open to remove the acetate-protected soil core. At times, full recovery of a core sample is not possible due to obstructions such as dense fill material or natural occurring material that can clog the end of the sampling device. The length of the core is measured and the liner is split open using a field knife. A photoionization detector (PID) is passed over the length of the core to screen for target compounds. The core description, PID calibration and readings are recorded in the field log book, which is available upon request. A summary of the core sampling is described as follows:

- Boring/Sample S-1: Depth of 4 feet – washed stone/gravel/CA6 mix detected to a depth of 3.5 feet; brown/black clay/cinder/slag mix was detected from the remaining 3.5 to 4 feet. There were no detectable PID readings.

- Boring/Sample S-2: Depth of 4 feet – washed stone/gravel/CA6 mix detected the entire depth of the boring; no sample was collected. There were no detectable PID readings.

- Boring/Sample S-2A: Depth of 6 feet – washed stone/gravel/CA6 mix detected to a depth of 4.5 feet; black clay/cinder/slag mix with red brick was detected from the remaining 4.5 to 6 feet. There were no detectable PID readings.

3300 Ginger Creek Drive, Springfield, Illinois 62711 ◆ 217.787.2334 fax 217.787.9495 www.andrews-eng.com

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- Boring/Sample S-3: Depth of 6 feet – washed stone/gravel/CA6 mix detected to a depth of 5 feet; black clay/cinder/slag mix with red brick was detected from the remaining 5 to 6 feet. There were no detectable PID readings.

- Boring/Sample S-4: Depth of 4 feet – washed stone/gravel/CA6 mix detected to a depth of 3.25 feet; black clay/cinder/slag mix with red brick was detected from the remaining 3.25 to 4 feet. There were no detectable PID readings.

- Boring/Sample S-5A: Depth of 5 feet – washed stone/gravel/CA6 mix detected to a depth of 3 feet; black clay/cinder/slag mix with red brick was detected from the remaining 3 to 5 feet. There were no detectable PID readings.

- Boring/Sample S-6: Depth of 5 feet – washed stone/gravel/CA6 mix detected to a depth of 4.5 feet; black clay/cinder/slag mix with red brick was detected from the remaining 4.5 to 5 feet. There were no detectable PID readings.

- Boring/Sample S-7: Depth of 5 feet – washed stone/gravel/CA6 mix detected to a depth of 3.8 feet; black clay/cinder/slag mix with red brick was detected from 3.8 to 4.8 feet; red brick was detected the remaining 4.8 to 5 feet. There were no detectable PID readings.

- Boring/Sample S-8: Depth of 5 feet – washed stone/gravel/CA6 mix detected to a depth of 4.2 feet; black clay/cinder/slag mix with red brick was detected from 4.2 to 4.9 feet; red brick fill was detected the remaining 4.9 to 5 feet. There were no detectable PID readings.

All borings were advanced through the recently placed clean fill into the underlying fill and soils. As indicated above, concentrations of the target parameter Styrene were not detected using the PID as a screening tool. However, samples were collected at depth to confirm the field readings. No groundwater was encountered during the investigation; therefore, groundwater samples could not be obtained for analysis.

Laboratory analyses of the collected samples were non-detect or less than the most stringent remediation objectives listed in 35 Illinois Administrative Code, Part 742, Tiered Approach to Corrective Action Objectives (TACO) regulation. The sample results are compared to TACO objectives in the attached tables.

In summary, the field investigation and laboratory results indicate the remediation actions taken at the plant for the April 25, 2014 Styrene release were successful and no further remediation activities are necessary.

If additional information is needed, please do not hesitate to contact me at (217) 787-2334.

Sincerely,

Kenneth W. Liss, LPG
Vice President of Operations

KWL:sjb

Attachment—Figure and Tables

J:\2014\2014-122 (Flint Hills Peru Plant)\DOC\2014\Flint Hills Peru Styrene Spill Sampling Resultsdoc.docx
Reporting

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Table 1
Report Qualifiers and Acronyms for Analytical Tables
Flint Hills Resources
Peru, LaSalle County, Illinois

Report Qualifiers and Acronyms:

mg/kg = Milligrams per kilogram
ft = Feet
ND = Not Detected at or above the laboratory reporting limit.
1a = Tier 1 Soil Remediation Objectives for Residential Properties; Ingestion (TACO Appendix B, Table A).
1b = Tier 1 Soil Remediation Objectives for Residential Properties; Inhalation (TACO Appendix B, Table A).
2a = Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties; Ingestion for Industrial/Commercial Exposure Route (TACO Appendix B, Table B).
2b = Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties; Inhalation for Industrial/Commercial Exposure Route (TACO Appendix B, Table B).
3a = Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties; Ingestion for Construction Worker Exposure Route (TACO Appendix B, Table B).
3b = Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties; Inhalation for Construction Worker Exposure Route (TACO Appendix B, Table B).
4 = Tier 1 concentration for the Soil Component of the Groundwater Ingestion Exposure Route, Class I (TACO Appendix B, Tables A and B).

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Table 2
Soil Analytical Results
Flint Hills Resources
Peru, LaSalle County, Illinois

Sample ID	S-1		S-2A		S-3		S-4		[1a] Residential Ingestion	[1b] Residential Inhalation	[2a] Industrial/ Commercial Ingestion	[2b] Industrial/ Commercial Inhalation	[3a] Construction Worker Ingestion	[3b] Construction Worker Inhalation	[4] Class I Soil Component of the Groundwater Ingestion Exposure Route
Sample Depth (ft)	3.5-4		4.5-5.8		5-6		3.25-4								
Sample Date	5/30/2014		6/2/2014		5/30/2014		5/30/2014								
PID	0		0		0		0								
Matrix	Solid		Solid		Solid		Solid								
(mg/kg)															
Styrene	**0.0081**		ND		ND		ND		16,000	1,500	410,000	1,500	41,000	430	4

Sample ID	S-5A		S-6		S-7		S-8		[1a] Residential Ingestion	[1b] Residential Inhalation	[2a] Industrial/ Commercial Ingestion	[2b] Industrial/ Commercial Inhalation	[3a] Construction Worker Ingestion	[3b] Construction Worker Inhalation	[4] Class I Soil Component of the Groundwater Ingestion Exposure Route
Sample Depth (ft)	3-4		4.3-5		3.8-4.8		4.2-4.9								
Sample Date	6/2/2014		6/2/2014		6/2/2014		6/2/2014								
PID	0		0		0		0								
Matrix	Solid		Solid		Solid		Solid								
(mg/kg)															
Styrene	ND		ND		ND		**0.69**		16,000	1,500	410,000	1,500	41,000	430	4

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NOTE:
BACKGROUND IMAGE DERIVED FROM GOOGLE EARTH: MAY 23, 2013.

NO.	DATE	REVISIONS DESCRIPTION	BY

ANDREWS ENGINEERING, INC.
3300 Ginger Creek Drive, Springfield, IL 62711-7233
Tel (217) 787-2334 Fax (217) 787-9495
Pontiac, IL • Naperville, IL • Indianapolis, IN • Warrenton, MO
Professional Design Engineering and Land Surveying Firm #184-001541

APPROVED BY: KWL DESIGNED BY: KWL DRAWN BY: MPN

PROPOSED SOIL SAMPLING LOCATIONS

PLANS PREPARED FOR
FLINT HILLS RESOURCES
PERU, ILLINOIS

DATE: MAY 2014

PROJECT ID: 2014-122

SHEET NUMBER: 1

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EXPLANATION:

Ⓑ SOIL BORING LOCATION

SPILL LIMITS

N

0 10 20 40

SCALE: IN FEET

NOTES:

1. BACKGROUND IMAGE DERIVED FROM GOOGLE EARTH; MAY 23, 2013.
2. SOIL BORINGS PREFORMED ON 05/30/14 AND 06/02/14.

REVISIONS			
NO.	DATE	DESCRIPTION	BY

ANDREWS ENGINEERING, INC.
3300 Ginger Creek Drive, Springfield, IL 62711-7233
Tel (217) 787-2334 Fax (217) 787-9495
Pontiac, IL • Naperville, IL • Indianapolis, IN • Warrenton, MO
Professional Design Engineering and Land Surveying Firm #184-001541

APPROVED BY: KWL DESIGNED BY: KWL DRAWN BY: MPN

FINAL SOIL SAMPLING LOCATIONS

PLANS PREPARED FOR
FLINT HILLS RESOURCES
PERU, ILLINOIS

DATE: JUNE 2014

PROJECT ID: 2014-122

SHEET NUMBER: 2

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HUNTSMAN

Enriching lives through innovation

May 7, 2015

Brian Marcinkus
Flint Hills Resources, LP
501 Brunner Street
Peru, Illinois 61345

RE: NO FURTHER REMEDIATION LETTER FROM ILLINOIS EPA

Dear Brian,

As you will recall, I telephoned you on April 7, 2015, to inform you and Flint Hills Resources LP (FHR) that the Illinois EPA (IEPA) had determined that Huntsman's investigation and analysis of the limited subsurface styrene impacts, located in beneath FHR's aboveground storage tanks, warranted a "No Further Remediation" (NFR) letter.

This matter was originally disclosed to FHR as issue number 4.17.d.011 of Schedule 4.17 ("Onsite Releases of Hazardous Materials") of the "Amended and Restated Asset Purchase Agreement" between Huntsman and FHR, dated June 22, 2007. Additionally, responsibility to remedy this matter was assigned to Huntsman in Paragraph 3(a) of the Huntsman/FHR "Peru Ground Lease," dated August 1, 2007.

Huntsman is hereby notifying FHR that the IEPA, based on data submitted by Huntsman, has issued the above-referenced NFR letter dated April 23, 2015. A copy of the NFR letter is attached for your records. The key aspects of the NFR letter are described in the "Institutional Controls" section of "Preventive, Engineering, and Institutional Controls" (excerpted below):

- Any existing buildings or any future buildings constructed on the site must contain a full concrete slab-on-grade floor or full concrete basement floor and walls with no sumps.

- No person shall construct, install, maintain, or operate a well at the Remediation Site. All water supplies and water services for the Remediation Site must be obtained from a public water supply system. The provisions of this institutional control shall be applicable to all water usage (e.g., domestic, industrial/commercial uses and outdoor watering).

Please note that the "Remediation Site" area referred to in the NFR letter is limited to the approximately 1.7-acre "Styrene Tank Farm" at the Peru Facility. We are providing a copy of this NFR letter and its control provisions as a formal reminder of Provision 6(f) of the Peru Ground Lease, which states that "FHR shall not disturb Peru Environmental Contamination in a manner that could reasonably be expected to accelerate or change the nature of Huntsman Remediation activities."

8600 Gosling Road, The Woodlands, Texas 77381
Tel.: 1-281-719-7400 Fax.: 1-281-719-7500 www.huntsman.com

Pursuant to IEPA regulations, Huntsman is in the process of recording this letter, including all attachments, as a single instrument with the Office of the Recorder of LaSalle County.

Please be advised that monitoring wells MW-4, MW-5, MW-6, and MW-7, all installed outside the Styrene Tank Farm's secondary containment by ARCADIS on November 4-5, 2007, will be plugged and abandoned pursuant to IEPA requirements. Representatives from ARCADIS will contact you in the near future to effect this regulatory obligation. Monitoring wells MW-1, MW-2, and MW-3, installed by August Mack and located within the secondary containment boundaries, have already been abandoned.

Please feel free to contact me at 281-719-3010 if you have any questions or concerns. Additionally, please circulate this information within FHR as you feel it warrants.

Sincerely,

Lon Tullos
Manager - EHS Financial and Legacy Matters

Enclosure

cc: Dave Nutt (Huntsman)

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-2829
BRUCE RAUNER, GOVERNOR LISA BONNETT, DIRECTOR

(217) 524-3300

April 23, 2015

CERTIFIED MAIL
7012 0470 0001 2968 1691

Lon Tullos
Huntsman International LLC
8600 Gosling Road
The Woodlands, Texas 77381

Re: 0990850005 / LaSalle County
Peru / Flint Hills
Site Remediation/Technical Reports
No Further Remediation Letter

Dear Mr. Tullos:

The *Remedial Action Completion Report* (received March 2, 2015 / Log No. 15-58664), as prepared by ARCADIS U.S., Inc. for the above referenced Remediation Site, has been reviewed and approved by the Illinois Environmental Protection Agency ("Illinois EPA"). The remediation objectives approved for the site in accordance with 35 Illinois Administrative Code Part 742, including the indoor inhalation pathway, are above the existing concentrations of regulated substances and the above report shall serve as the approved Remedial Action Completion Report.

The Remediation Site, consisting of 1.7 acres, is located at 501 Brunner Street, Peru, Illinois. Pursuant to Section 58.10 of the Illinois Environmental Protection Act ("Act") (415 ILCS 5/1 et seq.), your request for a no further remediation determination is granted under the conditions and terms specified in this letter. The Remediation Applicant, as identified on the Illinois EPA's Site Remediation Program DRM-1 Form (July 3, 2008/ Log No. 08/38212), is Huntsman International LLC.

This focused No Further Remediation Letter ("Letter") signifies a release from further responsibilities under the Act for the performance of the approved remedial action. This Letter shall be considered prima facie evidence that the Remediation Site described in the attached Illinois EPA Site Remediation Program Environmental Notice and shown in the attached Site Base Map does not constitute a threat to human health and the environment for the specified recognized environmental conditions so long as the Site is utilized in accordance with the terms of this Letter.

Conditions and Terms of Approval

Level of Remediation and Land Use Limitations

1) The recognized environmental conditions characterized by the focused site investigation and successfully addressed, consist of the contaminants of concern identified in the attached Table A.

2) The Remediation Site is restricted to industrial/commercial land use.

3) The land use specified in this Letter may be revised if:

   a) Further investigation or remedial action has been conducted that documents the attainment of objectives appropriate for the new land use; and

   b) A new Letter is obtained and recorded in accordance with Title XVII of the Act and regulations adopted thereunder.

Preventive, Engineering, and Institutional Controls

The implementation and maintenance of the following controls are required as part of the approval of the remediation objectives for this Remediation Site.

Institutional Controls:

4) Any existing buildings or any future buildings constructed on the site must contain a full concrete slab-on-grade floor or full concrete basement floor and walls with no sumps.

5) No person shall construct, install, maintain, or operate a well at the Remediation Site. All water supplies and water services for the Remediation Site must be obtained from a public water supply system. The provisions of this institutional control shall be applicable to all water usage (e.g., domestic, industrial/commercial uses and outdoor watering).

Other Terms

6) Where the Remediation Applicant is not the sole owner of the Remediation Site, the Remediation Applicant shall complete the attached *Property Owner Certification of the No Further Remediation Letter under the Site Remediation Program* Form. This certification, by original signature of each property owner, or the authorized agent of the owner(s), of the Remediation Site or any portion thereof who is not a Remediation Applicant shall be recorded along with this Letter.

7) Further information regarding this Remediation Site can be obtained through a written request under the Freedom of Information Act (5 ILCS 140) to:

Illinois Environmental Protection Agency
Attn: Freedom of Information Act Officer
Division of Records Management #16
1021 North Grand Avenue East
Post Office Box 19276
Springfield, IL 62794-9276

8) Pursuant to Section 58.10(f) of the Act (415 ILCS 5/58.10(f)), should the Illinois EPA seek to void this Letter, the Illinois EPA shall provide notice to the current title holder and to the Remediation Applicant at the last known address. The notice shall specify the cause for the voidance, explain the provisions for appeal, and describe the facts in support of this cause. Specific acts or omissions that may result in the voidance of the Letter under Sections 58.10(e)(1)-(7) of the Act (415 ILCS 5/58.10(e)(1)-(7)) include, but shall not be limited to:

   a) Any violation of institutional controls or the designated land use restrictions;

   b) The failure to operate and maintain preventive or engineering controls or to comply with any applicable groundwater monitoring plan;

   c) The disturbance or removal of contamination that has been left in-place in accordance with the Remedial Action Plan. Access to soil contamination may be allowed if, during and after any access, public health and the environment are protected consistent with the Remedial Action Plan;

   d) The failure to comply with the recording requirements for this Letter;

   e) Obtaining the Letter by fraud or misrepresentation;

   f) Subsequent discovery of contaminants, not identified as part of the investigative or remedial activities upon which the issuance of the Letter was based, that pose a threat to human health or the environment;

   g) The failure to pay the No Further Remediation Assessment Fee within forty-five (45) days after receiving a request for payment from the Illinois EPA;

   h) The failure to pay in full the applicable fees under the Review and Evaluation Services Agreement within forty-five (45) days after receiving a request for payment from the Illinois EPA.

9) Pursuant to Section 58.10(d) of the Act, this Letter shall apply in favor of the following persons:

   a) Huntsman International LLC;

   b) The owner and operator of the Remediation Site;

   c) Any parent corporation or subsidiary of the owner of the Remediation Site;

d) Any co-owner, either by joint-tenancy, right of survivorship, or any other party sharing a relationship with the owner of the Remediation Site;

e) Any holder of a beneficial interest of a land trust or inter vivos trust, whether revocable or irrevocable, involving the Remediation Site;

f) Any mortgagee or trustee of a deed of trust of the owner of the Remediation Site or any assignee, transferee, or any successor-in-interest thereto;

g) Any successor-in-interest of the owner of the Remediation Site;

h) Any transferee of the owner of the Remediation Site whether the transfer was by sale, bankruptcy proceeding, partition, dissolution of marriage, settlement or adjudication of any civil action, charitable gift, or bequest;

i) Any heir or devisee of the owner of the Remediation Site;

j) Any financial institution, as that term is defined in Section 2 of the Illinois Banking Act and to include the Illinois Housing Development Authority, that has acquired the ownership, operation, management, or control of the Remediation Site through foreclosure or under the terms of a security interest held by the financial institution, under the terms of an extension of credit made by the financial institution, or any successor-in-interest thereto; or

k) In the case of a fiduciary (other than a land trustee), the estate, trust estate, or other interest in property held in a fiduciary capacity, and a trustee, executor, administrator, guardian, receiver, conservator, or other person who holds the remediated site in a fiduciary capacity, or a transferee of such party.

10) This letter, including all attachments, must be recorded as a single instrument within forty-five (45) days of receipt with the Office of the Recorder of LaSalle County. For recording purposes, the Illinois EPA Site Remediation Program Environmental Notice attached to this Letter should be the first page of the instrument filed. This Letter shall not be effective until officially recorded by the Office of the Recorder of LaSalle County in accordance with Illinois law so that it forms a permanent part of the chain of title for the Huntsman International LLC property.

11) Within thirty (30) days of this Letter being recorded by the Office of the Recorder of LaSalle County, a certified copy of this Letter, as recorded, shall be obtained and submitted to the Illinois EPA to:

Ms. P.J. Gebhardt
Illinois Environmental Protection Agency
Bureau of Land/RPMS #24
1021 North Grand Avenue East
Post Office Box 19276
Springfield, IL 62794-9276

12) In accordance with Section 58.10(g) of the Act, a No Further Remediation Assessment Fee based on the costs incurred for the Remediation Site by the Illinois EPA for review and evaluation services will be applied in addition to the fees applicable under the Review and Evaluation Services Agreement. Request for payment of the No Further Remediation Assessment Fee will be included with the billing statement.

If you have any questions regarding the Flint Hills Resources property, you may contact the Illinois EPA project manager, Barbara Landers at 217-557-6939 or barb.landers@illinois.gov.

Sincerely,

Joyce L. Munie, P.E., Manager
Remedial Project Management Section
Division of Remediation Management
Bureau of Land

Attachments: Illinois EPA Site Remediation Program Environmental Notice
Site Base Map
Table A: Regulated Substances of Concern
Property Owner Certification of No Further Remediation Letter under the Site Remediation Program Form
Instructions for Filing the NFR Letter

cc: Stephen Vasas
ARCADIS U.S., Inc.
222 South Main Street Suite 300
Akron, Ohio 44308

Bureau of Land File
Ms. P.J. Gebhardt

PREPARED BY:

Name: Lon Tullos
Huntsman International LLC

Address: 8600 Gosling Road
The Woodlands, Texas 77381

RETURN TO:

Name: Lon Tullos
Huntsman International LLC

Address: 8600 Gosling Road
The Woodlands, Texas 77381

This Environmental No Further Remediation Letter must be submitted by the remediation applicant within 45 days of its receipt, to the Office of the Recorder of LaSalle County.

Illinois State EPA Number: 0990850005

Huntsman International LLC, the Remediation Applicant, whose address is 8600 Gosling Road, The Woodlands, Texas 77381 has performed investigative and/or remedial activities for the remediation site depicted on the attached Site Base Map and identified by the following:

1. Legal description or Reference to a Plat Showing the Boundaries:

Parcel One:

That part of 20 acre Lots 5, 6 and 7 in the Southeast Quarter of Section 16, Township 33 North, Range 1, East of the Third Principal Meridian, in the City of Peru, LaSalle County, Illinois, described as follows:

Commencing at the Southeast corner of the Southeast Quarter of the aforesaid Section 16; thence North 01 degree 21 minutes 14 seconds West along the East line of said Quarter Section for a distance of 1,139.74 feet to a point on Brunner Street; thence South 81 degrees 48 minutes 34 seconds West for a distance of 900.30 feet; thence North 08 degrees 35 minutes 53 seconds West for a distance of 30.00 feet to a point on the North right-of-way line of Brunner Street, said point being the point of beginning; thence South 81 degrees 47 minutes 13 seconds West along said right-of-way line for a distance of 425.06 feet; thence South 82 degrees 28 minutes 36 seconds West along said right-of-way line for a distance of 811.72 feet; thence North 07 degrees 31 minutes 45 seconds West for a distance of 28.00 feet; thence North 75 degrees 34 minutes 15 seconds East for a distance of 291.30 feet; thence North 82 degrees 28 minutes 15 seconds East for a

distance of 235.55 feet; thence North 07 degrees 31 minutes 45 seconds West for a distance of 29.08 feet to a point 15.00 feet South of the centerline of the Chicago, Rock Island and Pacific Railway Company's most Southerly track; thence North 77 degrees 44 minutes 40 seconds East for a distance of 22.96 feet; thence North 81 degrees 07 minutes 33 seconds East for a distance of 50.02 feet; thence North 85 degrees 12 minutes 04 seconds East for a distance of 27.52 feet; thence North 87 degrees 17 minutes 14 seconds East for a distance of 71.85 feet; thence North 88 degrees 17 minutes 32 seconds East for a distance of 99.98 feet; thence North 89 degrees 33 minutes 08 seconds East for a distance of 99.95 feet; thence South 89 degrees 51 minutes 22 seconds East for a distance of 100.13 feet; thence South 89 degrees 21 minutes 17 seconds East for a distance of 37.00 feet; thence South 87 degrees 27 minutes 45 seconds East for a distance of 49.86 feet; thence South 83 degrees 55 minutes 22 seconds East for a distance of 50.10 feet; thence South 81 degrees 54 minutes 12 seconds East for a distance of 25.02 feet; thence South 83 degrees 25 minutes 17 seconds East for a distance of 24.95 feet; thence South 87 degrees 09 minutes 59 seconds East for a distance of 24.86 feet; thence North 89 degrees 06 minutes 40 seconds East for a distance of 25.10 feet; thence North 86 degrees 44 minutes 51 seconds East for a distance of 9.92 feet to the point of beginning, situated in the City of Peru, LaSalle County, State of Illinois.

Parcel Two:

That part of the Southeast Quarter of Section 16 and the North Half of Section 21, all in Township 33 North, Range 1, East of the Third Principal Meridian, in the City of Peru, LaSalle County, Illinois, described as follows: Commencing at the Southeast corner of the Southeast Quarter of the aforesaid Section 16; thence West along the long established and accepted Section line for a distance of 1,972.81 feet to a pin in a concrete monument; thence North 69.93 feet to a point on the Northerly right-of-way line of the Chicago, Burlington and Quincy Railroad, said point being the point of beginning; thence Westerly along the Northerly line of said Railroad right-of-way for a distance of 441.04 feet; thence South 00 degrees 37 minutes 00 seconds East for a distance of 142.56 feet; thence North 79 degrees 48 minutes 00 seconds West for a distance of 40.72 feet; thence South 00 degrees 37 minutes 00 seconds East for a distance of 519.00 feet more or less to the center thread of the Illinois River; thence Northwesterly along said center thread for a distance of 330.00 feet more or less; thence North 00 degrees 37 minutes 00 seconds West for a distance of 335.00 feet, more or less, to a point on the North bank of the Illinois River, said point also being on the North line of the Northwest Quarter of the aforesaid Section 21; thence North 88 degrees 28 minutes 52 seconds East along said North line for a distance of 78.65 feet more or less to the Northeast corner of the Northwest Quarter of said Section 21; thence North 01 degree 24 minutes 02 seconds West along the West line of the Northeast Quarter of the aforesaid Section 16 for a distance of 38.16 feet to a point 40.00 feet South of the Southerly right-of-way line of the aforesaid Chicago, Burlington and Quincy Railroad; thence South 77 degrees 24 minutes 30 seconds East and parallel to the Southerly right-of-way line of the said Railroad for a distance of 93.75 feet; thence South 78 degrees 17 minutes 30 seconds East and parallel to the Southerly right-of-way line of said Railroad for a distance of 100.00 feet to a point on the West right-of-way line of River Dock Road; thence South 79 degrees 14 minutes 00 seconds East along the Southerly terminus of said River Dock Road right-of-way for a distance of 20.38 feet to a point on the Easterly right-of-way line of said River Dock Road; thence North 00 degrees 37 minutes 00 seconds West along said Easterly right-of-way line for a distance of 142.72 feet to a jog in said right-of-way; thence South 79

degrees 48 minutes 00 seconds East along said right-of-way jog for a distance of 20.38 feet; thence North 00 degrees 37 minutes 00 seconds West along said Easterly right-of-way line for a distance of 134.83 feet; thence North 25 degrees 20 minutes 00 seconds East along said Easterly right-of-way line for a distance of 298.90 feet; thence North along said Easterly right-of-way line for a distance of 200.00 feet; thence North 20 degrees 53 minutes 00 seconds West along said Easterly right-of-way line for a distance of 100.00 feet to a point on the Southerly right-of-way line of Brunner Street; thence North 67 degrees 54 minutes 00 seconds East along said Southerly right-of-way line for a distance of 46.11 feet; thence North 82 degrees 28 minutes 36 seconds East along said right-of-way line for a distance of 953.23 feet; thence North 81 degrees 47 minutes 13 seconds East along said right-of-way line for a distance of 512.84 feet; thence South 01 degree 22 minutes 42 seconds East for a distance of 6.44 feet; thence South 01 degree 37 minutes 06 seconds East, for a distance of 242.09 feet; thence South 45 degrees 46 minutes 15 seconds East for a distance of 38.69 feet; thence South 47 degrees 18 minutes 50 seconds East for a distance of 168.72 feet to a point on the Northerly right-of-way line of the Chicago, Burlington and Quincy Railroad; thence Southwesterly along said right-of-way line for a distance of 1,471.19 feet to the point of beginning, excepting therefrom the right-of-way of the Chicago, Burlington and Quincy Railroad at River Dock Road, situated in the City of Peru, LaSalle County, State of Illinois.

2. Common Address: 501 Brunner Street, Peru, Illinois 61354

3. Real Estate Tax Index/Parcel Index Number: 17-16-422-024, 17-16-442-025, and 17-16-442-026

4. Remediation Site Owner: Huntsman International LLC

5. Land Use: Industrial/Commercial

6. Site Investigation: focused

See NFR letter for other terms.

(Illinois EPA Site Remediation Program Environmental Notice)

LOCATION	EASTING	NORTHING
A	323171.00	4576969.00
B	323171.00	4776898.00
C	323034.00	4576910.00
D	323034.00	4576970.00

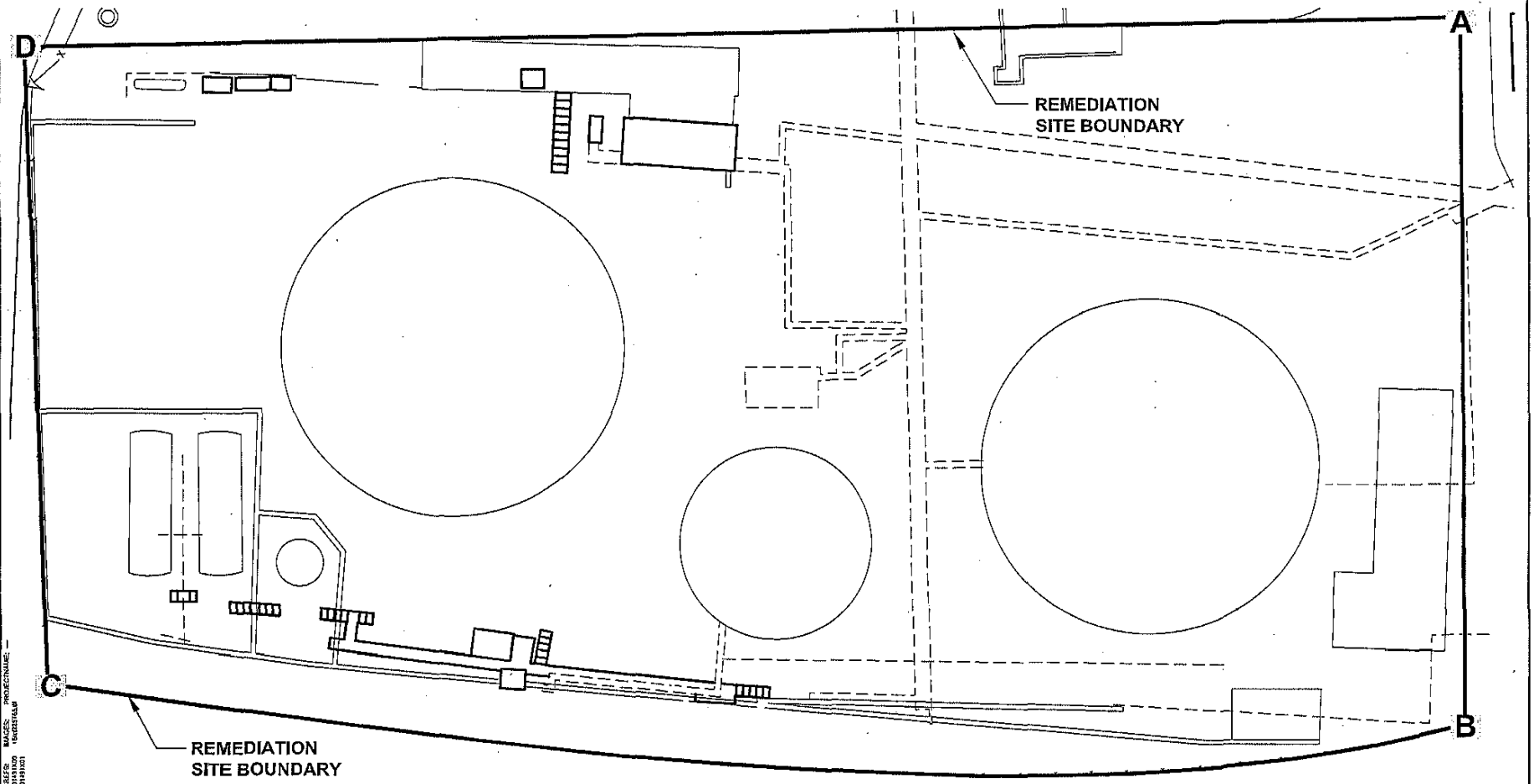
0 30' 60'
GRAPHIC SCALE

0990850005/LASALLE COUNTY
PERU, FLINT HILLS
SITE REMEDIATION/TECHNICAL REPORT

SITE BASE MAP
DATE: APRIL 6, 2015

ARCADIS

FIGURE
2



NOTES:

REMEDIATION SITE INSTITUTIONAL CONTROLS AND LAND-USE RESTRICTIONS:

1. INDUSTRIAL/COMMERCIAL LAND-USE RESTRICTION,

2. ANY EXISTING BUILDINGS OR FUTURE BUILDINGS, AS DEFINED BY 35 ILLINOIS ADMINISTRATIVE CODE 742, CONSTRUCTED ON THE SITE MUST CONTAIN A FULL CONCRETE SLAB-ON-GRADE FLOOR OR FULL CONCRETE BASEMENT FLOOR AND WALLS WITH NO SUMPS.

3. NO PERSON SHALL CONSTRUCT, INSTALL, MAINTAIN, OR OPERATE A WELL AT THE REMEDIATION SITE. ALL WATER SUPPLIES AND WATER SERVICES FOR THE REMEDIATION SITE MUST BE OBTAINED FROM PUBLIC WATER SUPPLY SYSTEM. THE PROVISIONS OF TIS INSTITUTIONAL CONTROL SHALL BE APPLICABLE TO ALL WATER USAGE (E.G. DOMESTIC INDUSTRIAL/COMMERCIAL USES AND OUTDOOR WATERING).

LOCATION	EASTING	NORTHING
A	323171.00	4576969.00
B	323171.00	4776898.00
C	323034.00	4576910.00
D	323034.00	4576970.00

LEGEND

REMEDIATION AREA BOUNDARY

REMEDIATION SITE BOUNDARY ONSITE GROUNDWATER USE RESTRICTION IS PROPOSED FOR THE REMEDIATION SITE BOUNDARY

0 30' 60'

GRAPHIC SCALE

09908500005/LASALLE COUNTY
PERU, FLINT HILLS
SITE REMEDIATION/TECHNICAL REPORT

INSTITUTIONAL CONTROLS MAP
DATE: APRIL 2ND, 2015

ARCADIS

FIGURE 12

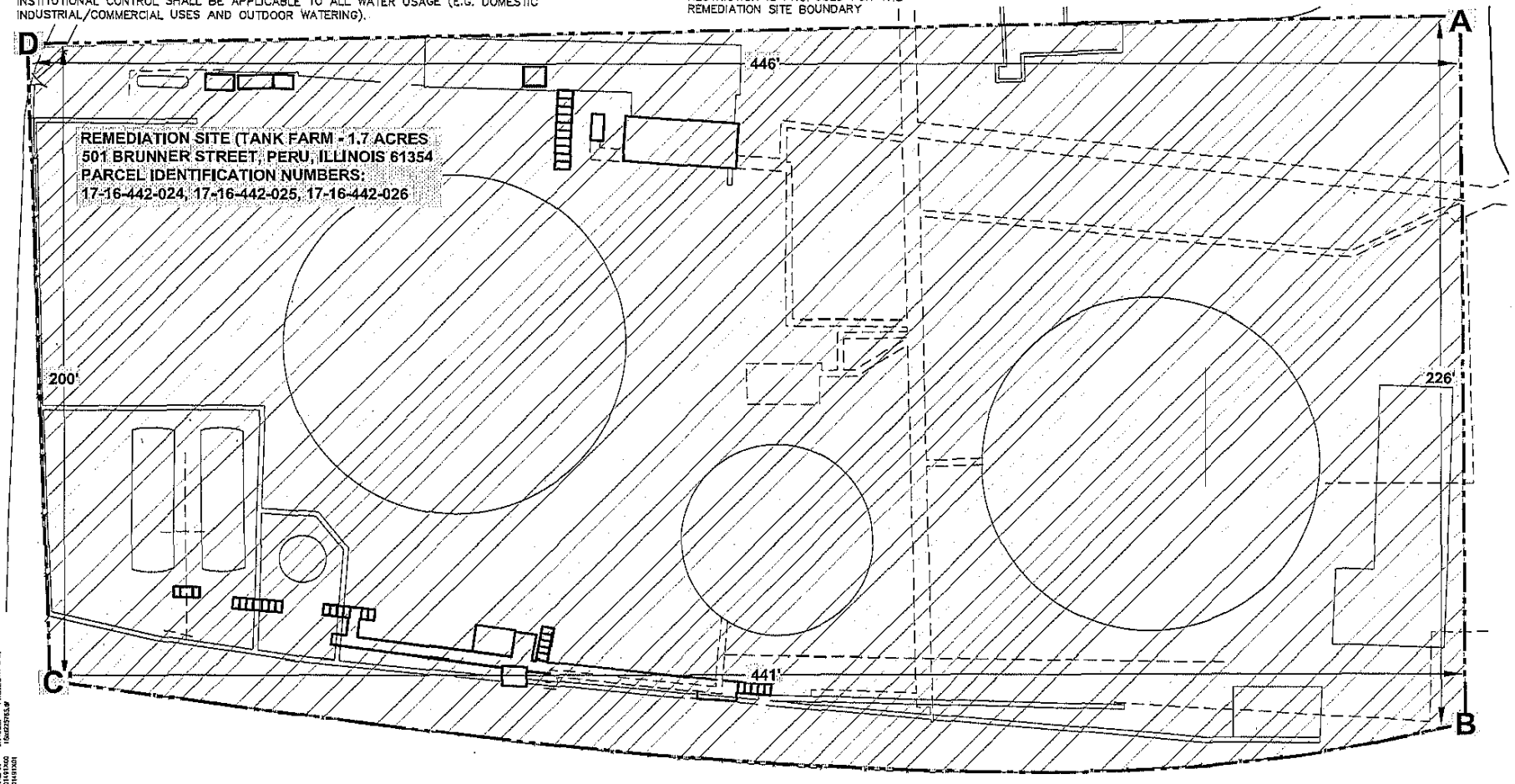


TABLE A: Regulated Substances of Concern

0990850005 / LaSalle County
Peru / Flint Hills
Site Remediation/Technical Reports

Volatile Organic Compounds (VOCs)	
CAS No.	**Compound Name**
100-42-5	Styrene

PROPERTY OWNER CERTIFICATION OF THE NFR LETTER UNDER THE SITE REMEDIATION PROGRAM

Where the Remediation Applicant (RA) is not the sole owner of the remediation site, the RA shall obtain the certification by original signature of each owner, or authorized agent of the owner(s), of the remediation site or any portion thereof who is not an RA. The property owner(s), or the duly authorized agent of the owner(s) must certify, by original signature, the statement appearing below. This certification shall be recorded in accordance with Illinois Administrative Code 740.620.

Include the full legal name, title, the company, the street address, the city, the state, the ZIP code, and the telephone number of all other property owners. Include the site name, street address, city, ZIP code, county, Illinois inventory identification number and real estate tax index/parcel index number.

A duly authorized agent means a person who is authorized by written consent or by law to act on behalf of a property owner including, but not limited to:

1. For corporations, a principal executive officer of at least the level of vice-president;
2. For a sole proprietorship or partnership, the proprietor or a general partner, respectively; and
3. For a municipality, state or other public agency, the head of the agency or ranking elected official.

For multiple property owners, attach additional sheets containing the information described above, along with a signed, dated certification for each. All property owner certifications must be recorded along with the attached NFR letter.

Property Owner Information

Owner's Name: _____

Title: _____

Company: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____ Phone: _____

Site Information

Site Name: _____

Site Address: _____

City: _____ State: _____ Zip Code: _____ County: _____

Illinois inventory identification number: _____

Real Estate Tax Index/Parcel Index No. _____

I hereby certify that I have reviewed the attached No Further Remediation Letter and that I accept the terms and conditions and any land use limitations set forth in the letter.

Owner's Signature: _____ Date: _____

SUBSCRIBED AND SWORN TO BEFORE ME
this _____ day of _____, 20__

_____
Notary Public

The Illinois EPA is authorized to require this information under Sections 415 ILCS 5/58 - 58.12 of the Environmental Protection Act and regulations promulgated thereunder. If the Remediation Applicant is not also the sole owner of the remediation site, this form must be completed by all owners of the remediation site and recorded with the NFR Letter. Failure to do so may void the NFR Letter. This form has been approved by the Forms Management Center. All information submitted to the Site Remediation Program is available to the public except when specifically designated by the Remediation Applicant to be treated confidentially as a trade secret or secret process in accordance with the Illinois Compiled Statutes, Section 7(a) of the Environmental Protection Act, applicable Rules and Regulations of the Illinois Pollution Control Board and applicable Illinois EPA rules and guidelines.

Notice to Remediation Applicant

Please follow these instructions when filing the NFR letter with the County Recorder's Office

Instructions for Filing the NFR Letter

The following documents must be filed:

A. Body of the NFR Letter (contains appropriate terms and conditions, tables, etc.)
B. Attachments to NFR letter
- Illinois EPA Site Remediation Program Environmental Notice (Legal Description and PIN of property)
- Maps of the site
- Table A: Regulated Substances of Concern (if applicable.)
- Property Owner Certification

C. A copy of the ordinance, if applicable, used to address groundwater contamination

1. Place the Illinois EPA Site Remediation Program Environmental Notice on top of the NFR prior to giving it to the Recorder.

2. If you are not the owner (record title holder) of the property on the date of filing of this NFR, you must attach a **completed** owner's certification form signed by the owner of the property at the time of filing (e.g., if the property recently sold, the new owner must sign).

3. If any of the terms and conditions of the NFR letter references a groundwater ordinance, you must record a copy of the groundwater ordinance with the NFR letter.

4. If any of the terms and conditions of the NFR letter references a highway agreement, you must record the highway agreement if specifically required by the municipality granting the agreement.

5. Within thirty (30) days of this NFR Letter being recorded by the Office of the Recorder of the County in which the property is located, a certified copy of this Letter, as recorded, shall be obtained and submitted to the Illinois EPA to:

   P.J. Gebhardt
   Illinois Environmental Protection Agency
   Bureau of Land/RPMS
   1021 North Grand Avenue East
   Post Office Box 19276
   Springfield, IL 62794-9276

6. **Remove this page from the NFR letter, prior to recording.**

If you have any questions call (217) 524-3300 and speak with the "project manager on-call" in the Site Remediation Program.

RELEASED
DATE
RIN #
INITIALS

ioMosaic

Minimizing risk. Maximizing potential.™

Reactor Dump Line to Pit Evaluation and Redesign

Peru, Illinois EPS Facility

RELEASED
DATE 11/12/19
RIN # 2019-008700
INITIALS JM

PRIVELEGED AND CONFIDENTIAL – PREPARED AT THE REQUEST OF COUNSEL
ATTORNEY-CLIENT PRIVELEGE AND/OR ATTORNEY WORK PRODUCT

Report to: Flint Hills Resources

FLINT HILLS resources®

Date: May 14, 2014

Notice:

This report was prepared by ioMosaic for the account of Flint Hills Resources (FHR). This report represents ioMosaic's best judgment in light of information made available to us. Opinions in this report are based in part upon data and information provided by FHR and / or FHR's advisors and affiliates. The reader is advised that ioMosaic has not independently verified the data or the information contained therein. This report must be read in its entirety. The reader understands that no assurances can be made that all liabilities have been identified. This report does not constitute a legal opinion.

No person has been authorized by ioMosaic to provide any information or make any representation not contained in this report. Any use the reader makes of this report, or any reliance upon or decisions to be made upon this report are the responsibility of the reader. ioMosaic does not accept any responsibility for damages, if any, suffered by the reader based upon this report.

ioMosaic Reference: ioMosaic Project #14105

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Proprietary Information Use or disclosure of data contained on this sheet is subject to the restriction on the title page of this document.

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Executive Summary

At the request of Flint Hills Resources (FHR) Peru, Illinois Expandable Polystyrene (EPS) facility, ioMosaic evaluated the validity of redesigning the dump lines from the Building 4 Reactors (E-R-14/15/16/17/18) to the containment pit on the south side of Building 4. The primary objective of the evaluation was to determine if the redesigned piping will adequately flow the contents of the reactor to the containment pit and assess the trajectory of the liquid exiting the pipe to ensure the contents are contained within the pit in the event of an operator initiated or Safety Instrumented System (SIS) initiated dump. Additionally, FHR requested that the current dump lines from Reactors 14, 15, 16, 17, and 18 to the containment pit be modeled to provide a basis of comparison to the proposed redesigned piping.

The original dump line design routes the reactor contents to the building exterior, approximately 18 ft above grade, with the end segment directed down toward the pit at either a 30° or 45° angle. The piping redesign evaluated by ioMosaic includes replacing the 30° or 45° elbow with a 90° elbow and approximately 10 ft of NPS 14 pipe oriented vertically down toward the pit, expanded to NPS 20 with an additional 8 ft of pipe to the top of the containment pit. A 45° elbow is fitted to the end of the pipe. Refer to Appendix A for the piping layout details.

Two dump cases were considered at the request of FHR: the dump initiated with reactor contents at (1) 205°F and 20 psig and (2) 210°F and 5 psig. The evaluation was performed at multiple stages throughout the reaction, using the recipe for product 5454 as a basis; the five stages considered were (1) 0% of the styrene reacted, (2) 25% mass of styrene reacted to polystyrene, (3) 50% reacted, (4) 75% reacted, and (5) 100% of the initial mass of styrene reacted to polystyrene.

FHR is in the process of designing and implementing a foam spray system to cover the containment pit following a reactor dump. Based on guidance from FHR personnel, the foam spray system is expected to be initiated within 5 minutes of a reactor dump. With this information, the liquid pool resulting from a reactor dump to the containment pit was evaluated. The liquid pool was used to evaluate the liquid level in the containment pit following a reactor dump; additionally, the evaporation rate of styrene and the resulting vapor cloud from the release were modeled for two stability classes: (1) D5 and (2) F2. The vapor cloud was conservatively evaluated at 10 minutes following the release. Refer to Appendices B through Y for results of all cases evaluated.

It is recommended to install the proposed dump line piping to work in tandem with the foam spray system as a short term design with consideration for a long term solution of a quench or containment vessel designed to adequately handle emergency effluent from the reactors.

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Introduction

Purpose of Study

At the request of Flint Hills Resources (FHR) Peru, Illinois Expandable Polystyrene (EPS) facility, ioMosaic evaluated the validity of redesigning the dump lines from the Building 4 Reactors (E-R-14/15/16/17/18) to the containment pit on the south side of Building 4. The primary objective of the evaluation was to determine if the redesigned piping will adequately flow the contents of the reactor to the containment pit and assess the trajectory of the liquid exiting the pipe to ensure the contents are contained within the pit in the event of an operator initiated or Safety Instrumented System (SIS) initiated dump. Additionally, FHR requested that the current dump lines from Reactors 14, 15, 16, 17, and 18 to the containment pit be modeled to provide a basis of comparison to the proposed redesigned piping.

Study Scope

The scope of this study includes the dump lines of Reactors 14, 15, 16, 17, and 18 within Building 4 to the containment pit located outside of Building 4, on the south side.

Process Description

Reactors 14, 15, 16, 17, and 18 are located within Building 4. They are operated under a semi-batch process to convert styrene monomer to expandable polystyrene (EPS) beads using suspension polymerization techniques.

Multiple safeguards are in place surrounding the reactors, including an emergency dump line from the reactor bottom that is routed outside of Building 4 to the containment pit. The dump lines are controlled by a sliding gate valve that may be opened either by operator control or the Safety Instrumented System (SIS).

Upon initiation of a reactor's contents being dumped to the containment pit, the slide gate on the reactor bottoms line opens, and the reactor contents travel from the reactor through the NPS 8 bottom nozzle which is expanded to NPS 10 upstream of the slide gate valve, expanded again to NPS 14 downstream of the valve, and released to the atmosphere outside of Building 4 approximately 18 feet above grade at an angle of either 45° (Reactors 14, 15, and 18) or 30° (Reactors 16 and 17), directed toward the containment pit. Refer to Appendix A for piping layout details.

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Approach

FHR supplied ioMosaic with information needed to perform the analysis, including the piping layout details for the reactor dump lines to the pit for all five reactors (E-R-14/15/16/17/18), the containment pit dimensions, and the recipe, energy balance, and reaction details for product 5454, which is the product evaluated per guidance from FHR personnel. As the reactor systems are within the scope of the planned emergency relief systems (ERS) evaluation, the reactor details were already in ioMosaic's possession.

Two dump cases were considered at the request of FHR: the dump initiated with reactor contents at (1) 205°F and 20 psig and (2) 210°F and 5 psig. The evaluation was performed at multiple stages throughout the reaction, using the recipe for product 5454 as a basis; the five stages considered were (1) 0% of the styrene reacted, (2) 25% mass of styrene reacted to polystyrene, (3) 50% reacted, (4) 75% reacted, and (5) 100% of the initial mass of styrene reacted to polystyrene.

The conditions listed above were evaluated for the liquid trajectory from the exit of the dump line piping into the pit to ensure that the liquid released is contained within the pit. In addition to evaluating the currently installed reactor lines to pit, FHR requested that a proposed piping redesign be evaluated for the liquid trajectory.

The piping redesign evaluated by ioMosaic includes the current reactor dump lines up to the 30° or 45° elbow at the end of the piping. The end elbow was replaced with a 90° elbow and approximately 10 ft of NPS 14 pipe oriented vertically down toward the pit, expanded to NPS 20, and extended an additional 8 ft to the top of the containment pit. A 45° elbow is fitted to the end of the pipe. Refer to Appendix A for the piping layout details.

FHR is in the process of designing and implementing a foam spray system to cover the containment pit following a reactor dump. Based on guidance from FHR personnel, the foam spray system is expected to be initiated within 5 minutes of a reactor dump. With this information, the liquid pool resulting from a reactor dump to the containment pit was evaluated in addition to the liquid trajectory exiting the pipe following a release. The liquid pool was used to evaluate the liquid level in the containment pit following a reactor dump; additionally, the evaporation rate of styrene and the resulting vapor cloud from the release were modeled.

Two stability classes were considered in the dispersion analysis: (1) D5 at 5 m/s (16.40 ft/s) and (2) F2 at 2 m/s (6.56 ft/s) wind speeds. The vapor cloud was conservatively evaluated at 10 minutes following the release. A 10 minute dispersion duration is conservative because the foam is expected to actuate instantaneously and no later than 5 minutes post-release.

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Results

For each piping layout considered (E-R-14/15/16/17/18 dump line to pit and the proposed dump line piping redesign), four graphical results are reported: (1) jet trajectory, (2) liquid pool depth, (3) styrene evaporation rate, and (4) styrene vapor cloud dispersion.

The results for the jet trajectory are reported in Appendices B through G. Each piping layout considers reactor conditions of (1) 20 psig and 205°F and (2) 5 psig and 210°F at 0% styrene reacted, 25% reacted, 50% reacted, 75% reacted, and 100% reacted for stability classes D5 and F2.

The results for the liquid pool depth are shown in Appendices H through M. Results for the styrene evaporation rate are listed in Appendices N through S, and results for styrene vapor cloud dispersion are shown in Appendices T through Y. Each piping layout considers reactor conditions of (1) 20 psig and 205°F and (2) 5 psig and 210°F for stability classes D5 and F2. As the styrene evaporation rate and styrene vapor cloud are the areas of interest, these results were evaluated at 0% and 25% of the initial mass of styrene reacted as less styrene is present the further along the reaction is.

The liquid trajectory worst case results for each piping layout system evaluated are listed in Table 1 below. The associated figures for each case are referenced within the table and available in Appendices B through Y.

Table 1: Jet Trajectory – Worst Case – 0% Reacted; 20 psig and 205°F

Piping Layout	Release Angle	Max Downwind Distance, ft	Stability Class	Figure Reference
Proposed Layout	45°	0.24	F2	Figure 1
From E-R-14	45°	3.68	D5	Figure 18
From E-R-15	45°	3.70	D5	Figure 38

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Piping Layout	Release Angle	Max Downwind Distance, ft	Stability Class	Figure Reference
From E-R-16	30°	3.07	D5	Figure 58
From E-R-17	30°	3.07	D5	Figure 78
From E-R-18	45°	3.68	D5	Figure 98

The liquid pool depth for all layouts and cases considered was less than 0.5 ft, which is significantly less than the containment pit depth of approximately 4.5 ft below grade. Based on guidance from FHR personnel, the containment pit has the capacity to hold up to six reactor contents with no more than three reactor contents in the pit at any one time. Therefore, overfilling of the pit is not expected.

The worst case styrene evaporation rate for piping configurations evaluated was for the scenario considering 0% of the styrene reacted for the D5 stability class and 5 psig and 210°F in the reactor. The peak styrene evaporation rate for each of these cases is 37.6 lb/min. Refer to Figure 167, Figure 175, Figure 183, Figure 191, and Figure 199 for the graphical results for the proposed redesign, E-R-14, E-R-15, E-R-16, E-R-17, and E-R-18 layout configurations, respectively.

For all piping configurations considered, the worst case for the styrene vapor cloud dispersion was evaluated at 0% styrene reacted, F2 stability class, and 20 psig at 205°F in the reactor. The footprint with the concentration levels equal to ERPG-1, 2, and 3 (50 ppm, 250 ppm, and 1000 ppm, respectively) are shown below.

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Figure 214: Vapor Cloud Dispersion – PROPOSED Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

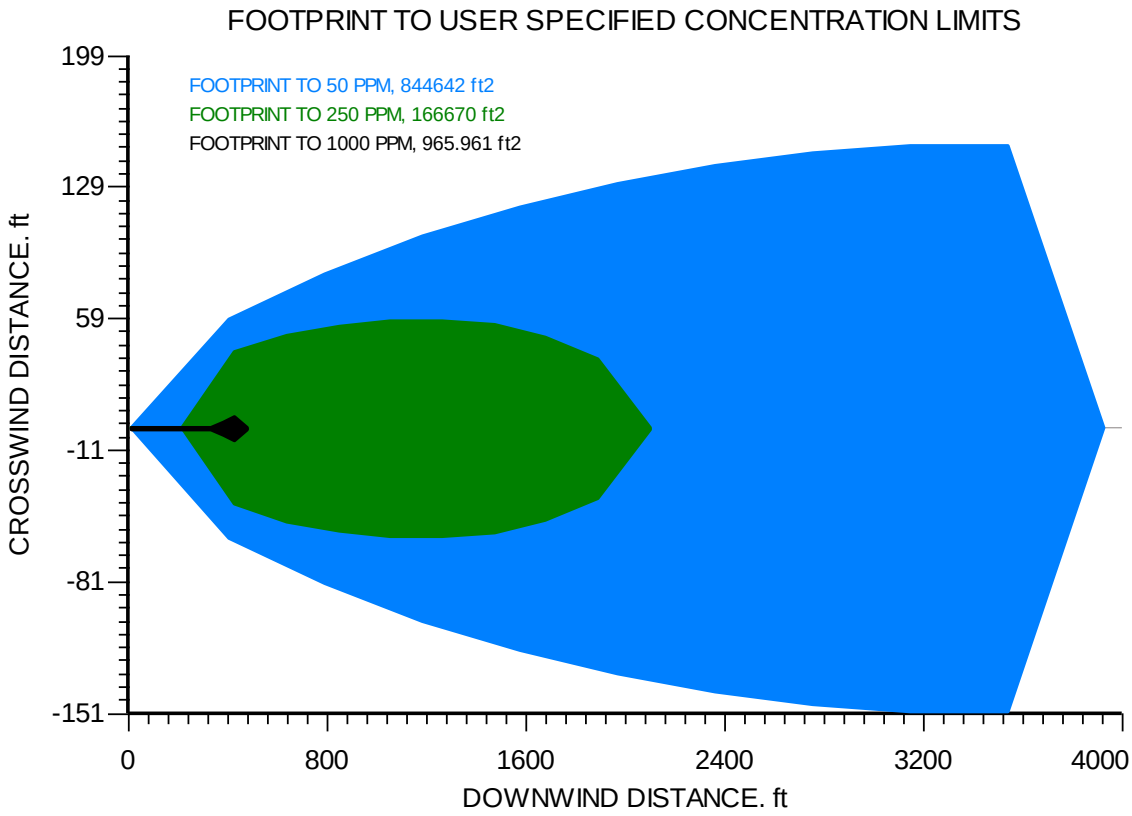

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Figure 222: Styrene Evaporation Rate – E-R-14 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

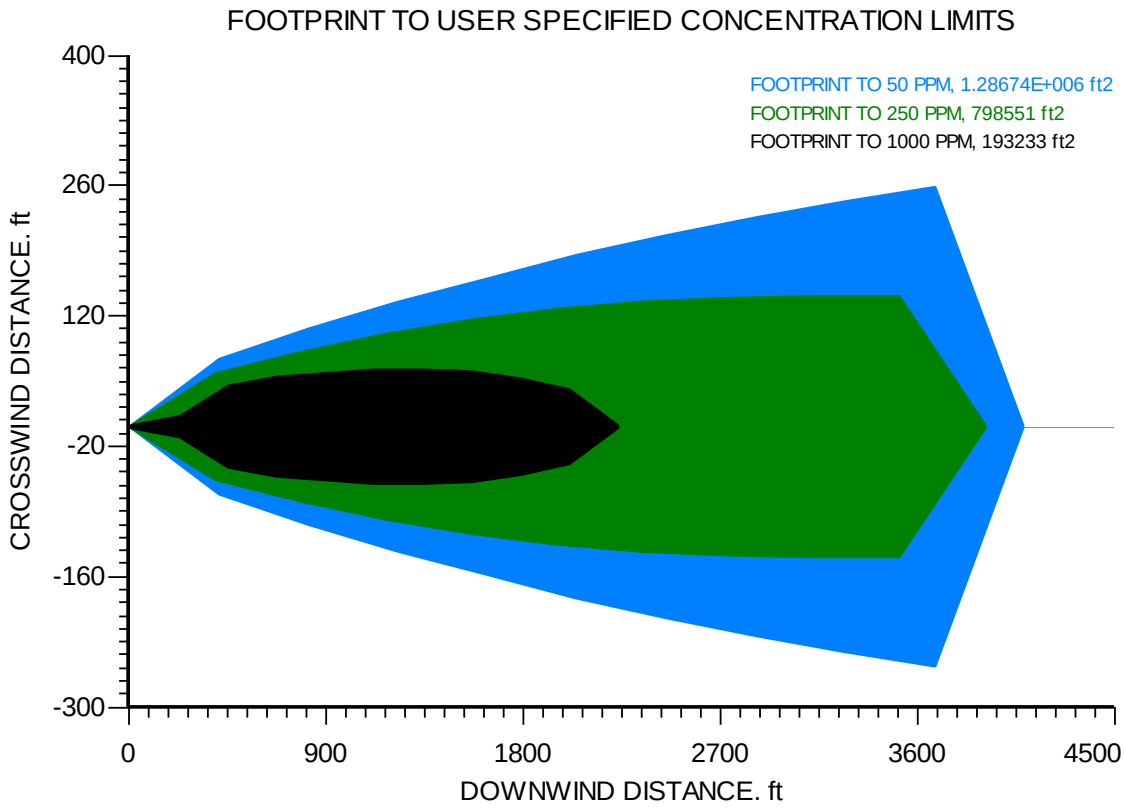

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Figure 230: Styrene Evaporation Rate – E-R-15 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

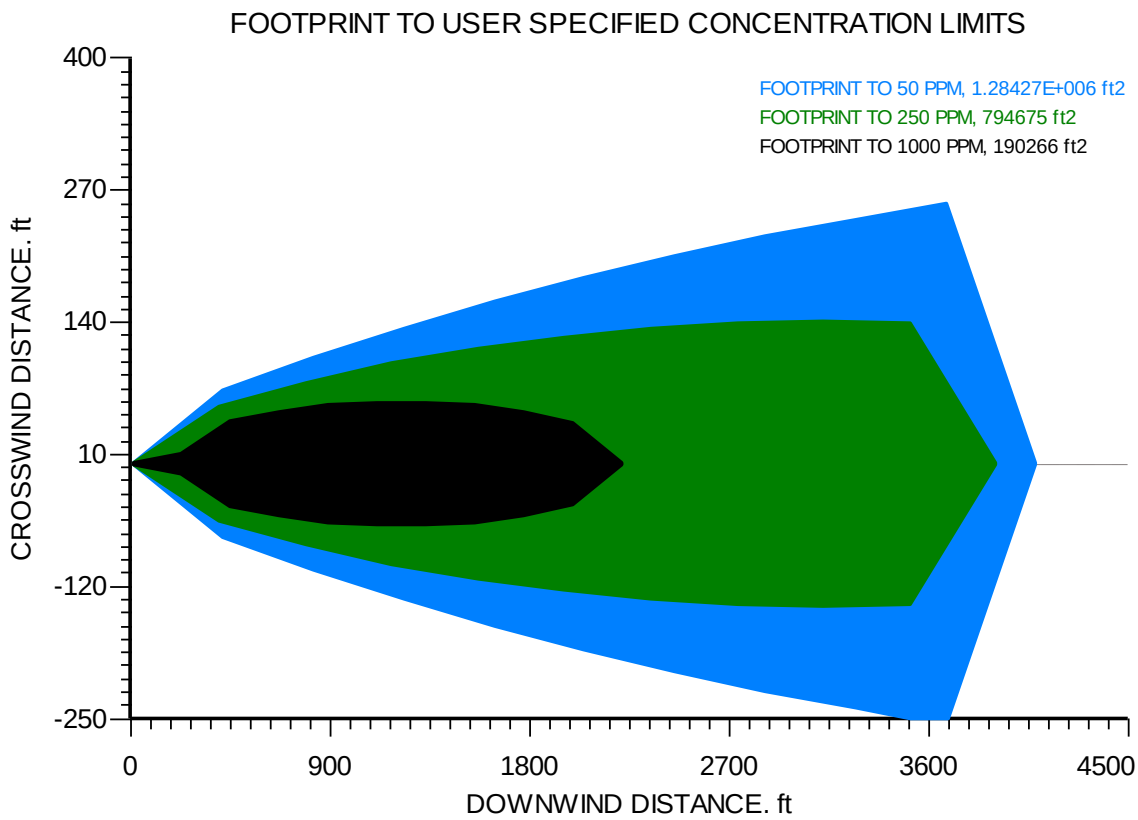

Figure 238: Styrene Evaporation Rate – E-R-16 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

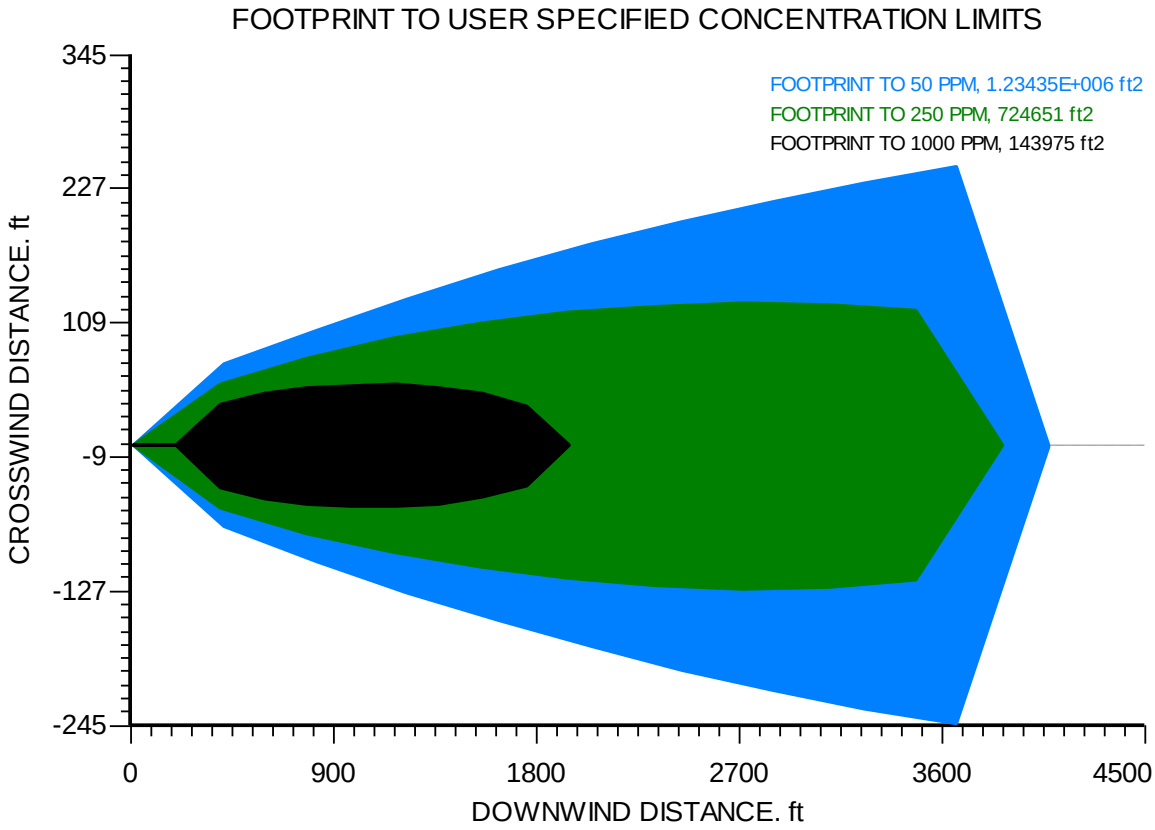

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Figure 246: Styrene Evaporation Rate – E-R-17 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

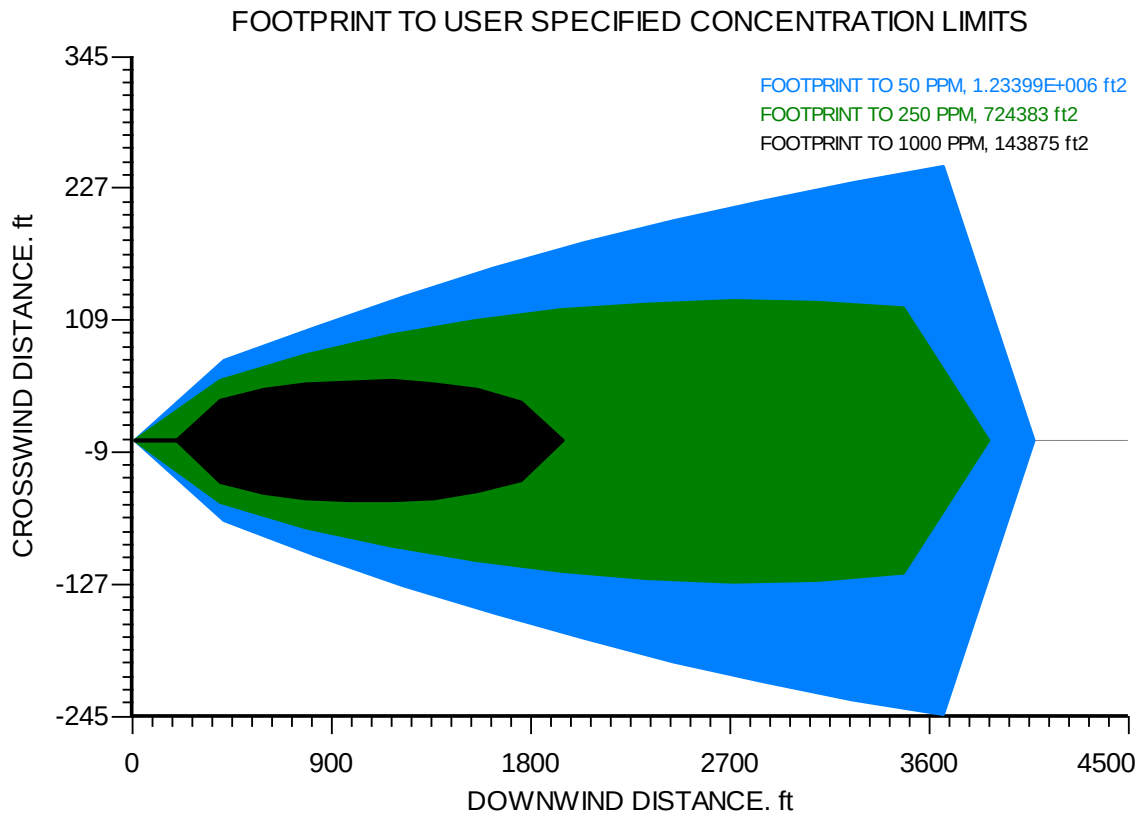
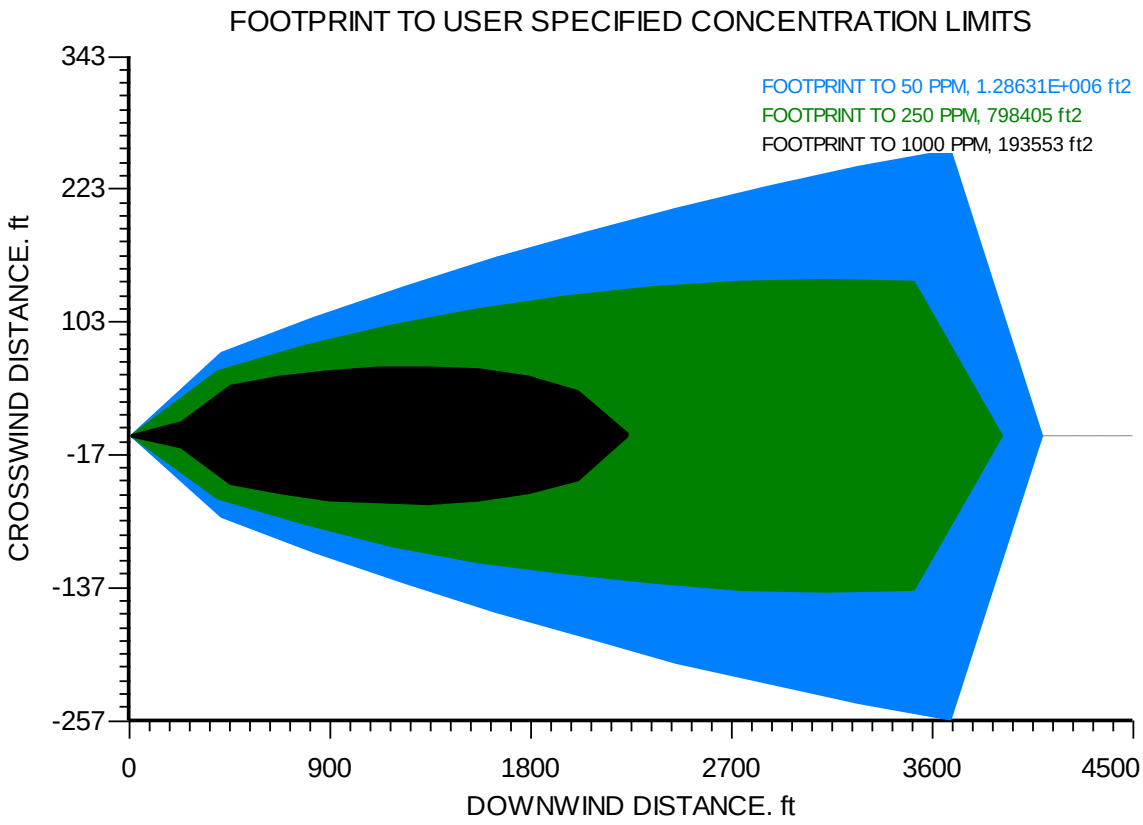
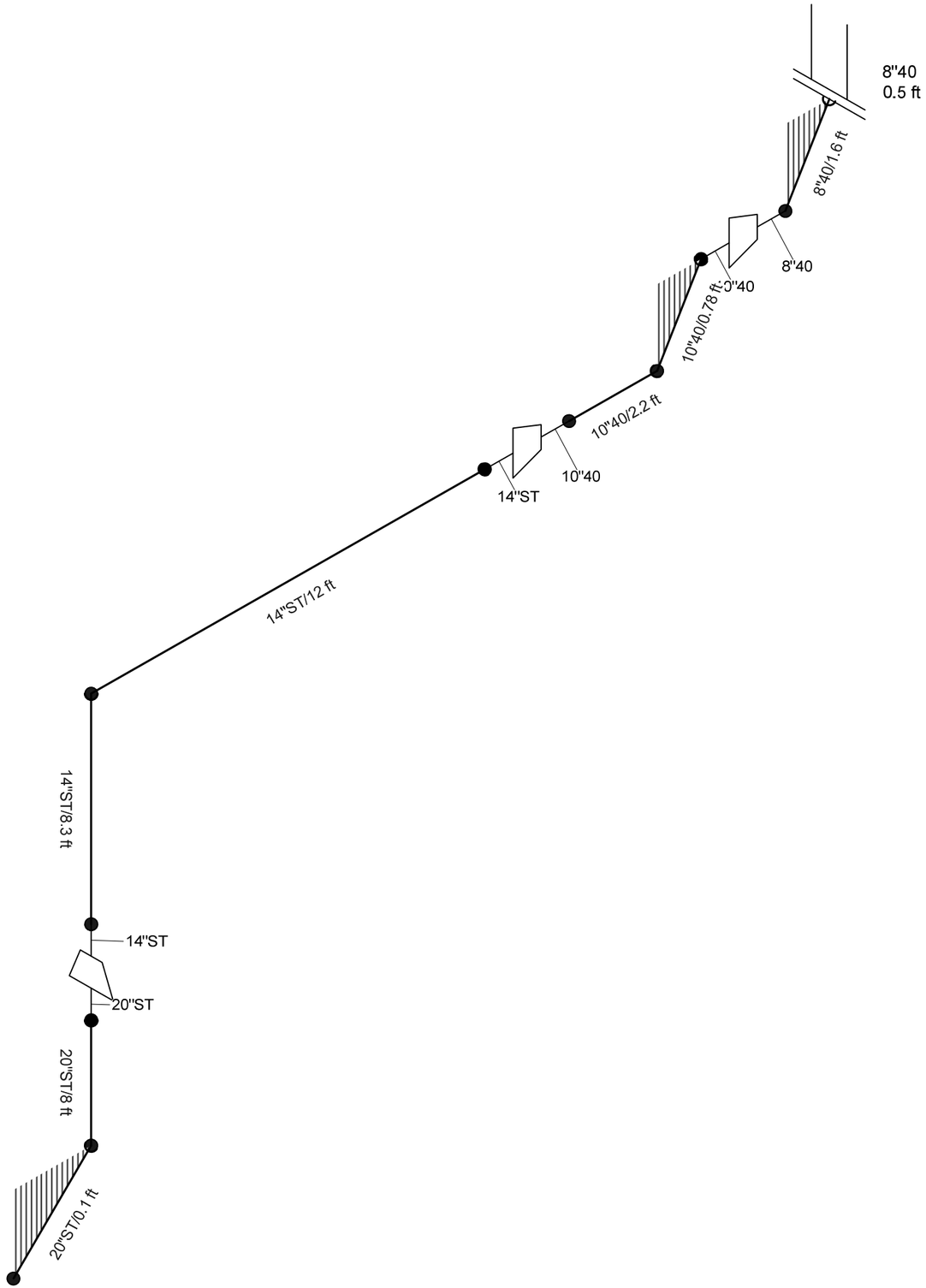


Figure 254: Styrene Evaporation Rate – E-R-18 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F



Appendix A: Piping Layouts and Pit Dimensions



NOTES	
Item	Description

CLIENT

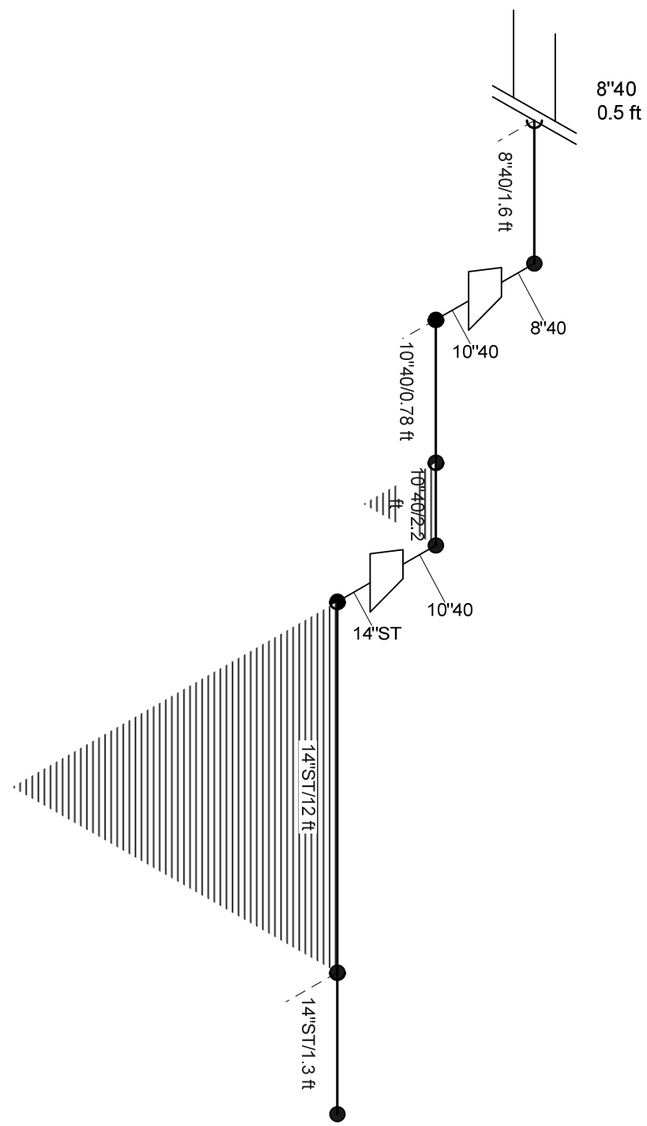
FHR Peru, IL

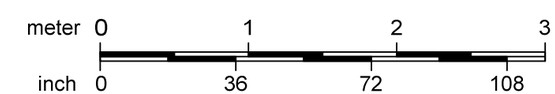
FLINT HILLS resources

PROJECT 13177

AREA	DRAWING NUMBER	SHT	REV
BLDG4	PROPOSED REACTOR DUMP LINE TO PIT	1	1

NOTES	
Item	Description





CLIENT

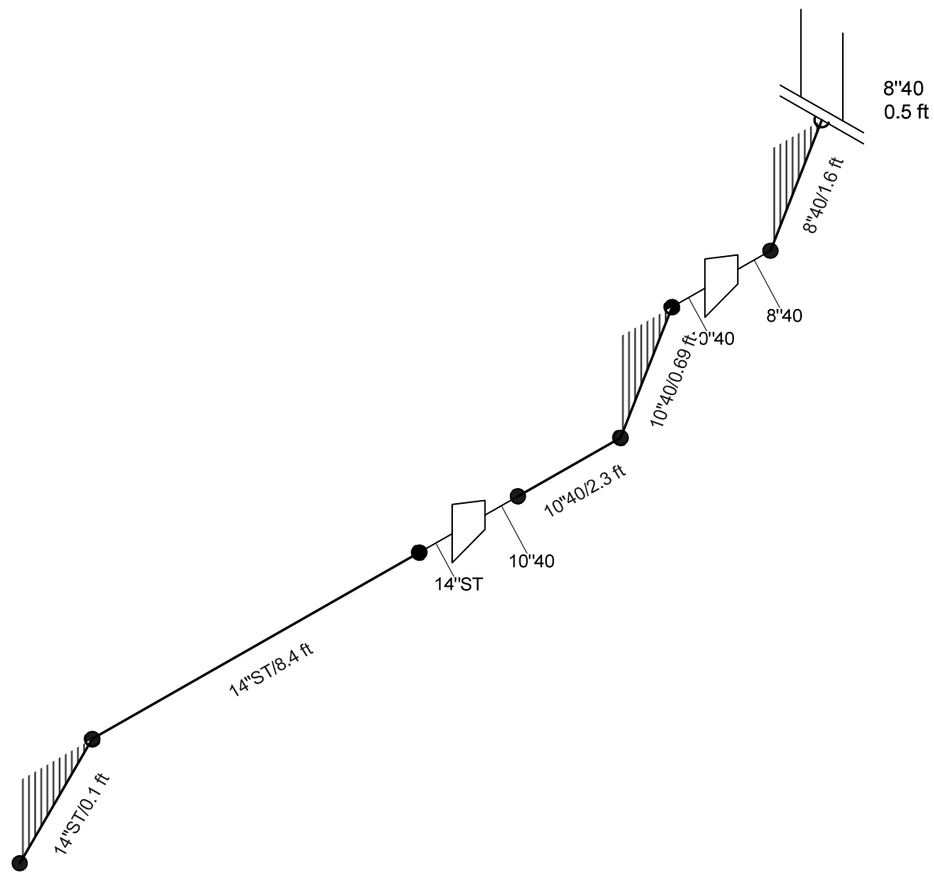
FHR Peru

FLINT HILLS resources

PROJECT 14105

AREA	DRAWING NUMBER	SHT	REV
BLDG4	E-R-14 DUMP LINE	1	1

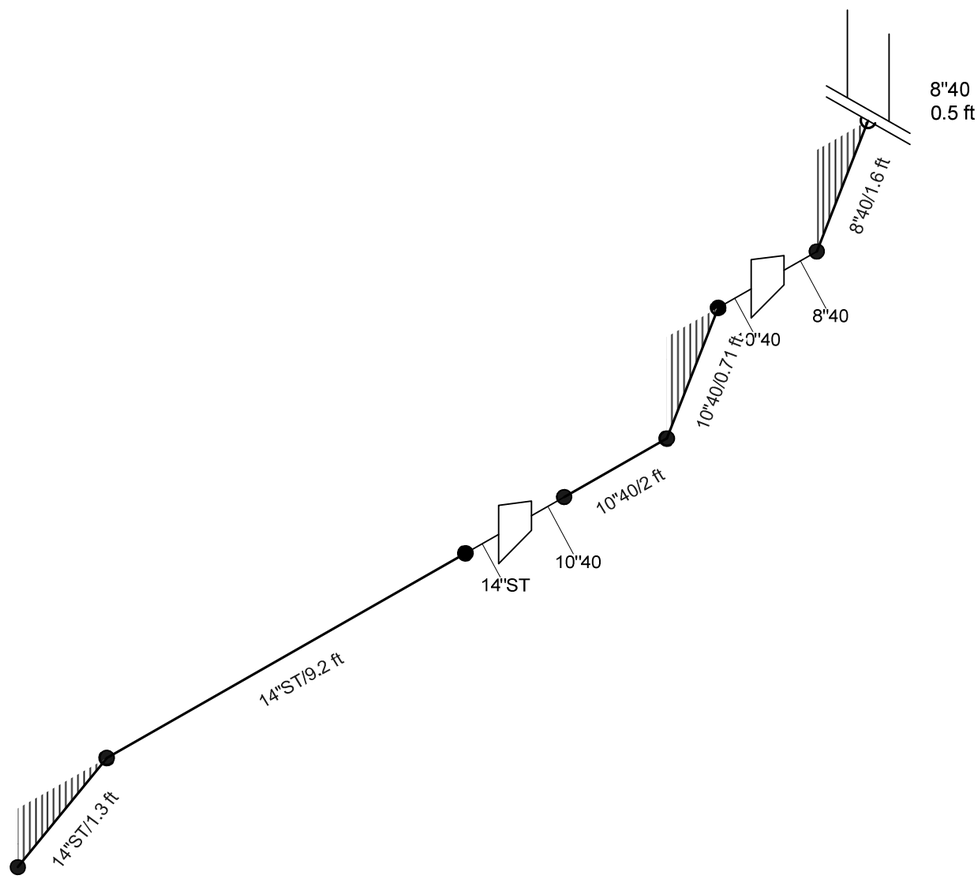
NOTES	
Item	Description



meter 0 1 2 3
inch 0 36 72 108

CLIENT			
FHR Peru			
FLINT HILLS resources	PROJECT 14105		
AREA	DRAWING NUMBER	SHT	REV
BLDG4	E-R-15 DUMP LINE	1	1

NOTES	
Item	Description



meter 0 1 2 3

inch 0 36 72 108

CLIENT

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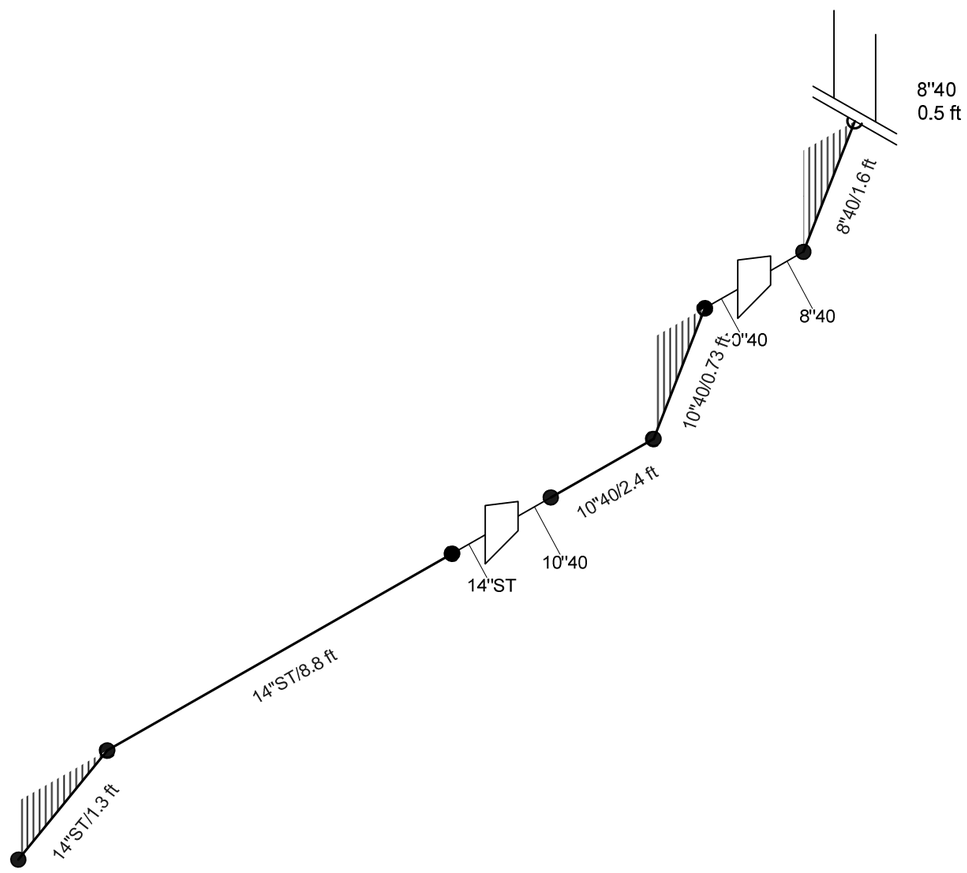
PROJECT 14105

AREA	DRAWING NUMBER	SHT	REV
BLDG4	E-R-16 DUMP LINE	1	1

NOTES	
Item	Description



meter 0 1 2 3

inch 0 36 72 108

CLIENT

FHR Peru

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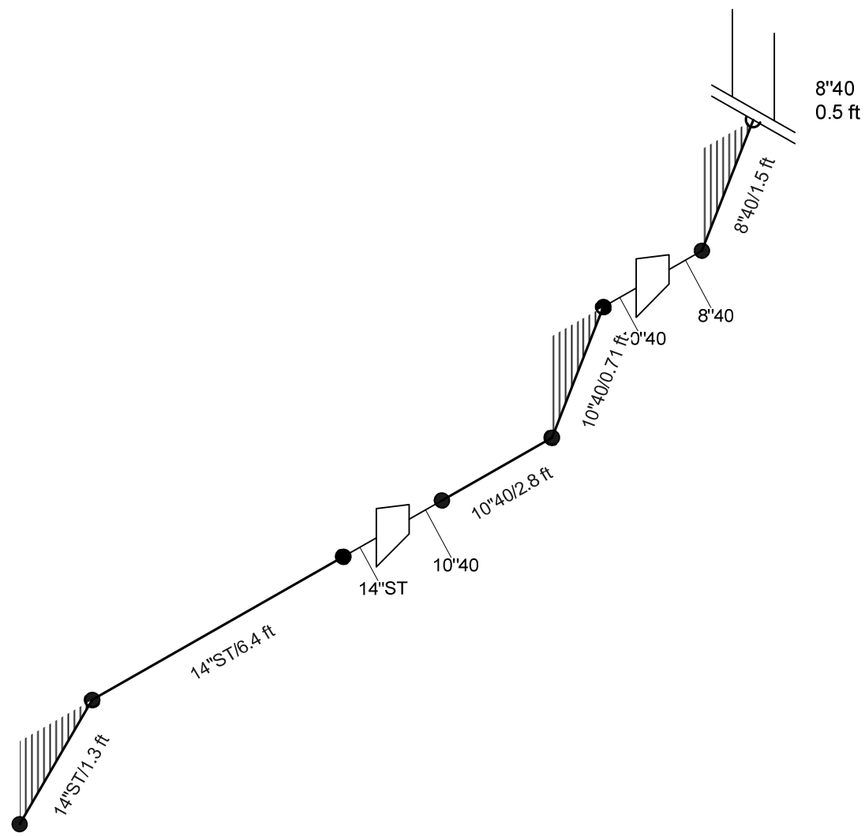
PROJECT 14105

AREA	DRAWING NUMBER	SHT	REV
BLDG4	E-R-17 DUMP LINE	1	1

NOTES	
Item	Description



meter 0 1 2 3
inch 0 36 72 108

CLIENT

FHR Peru

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PROJECT 14105

AREA	DRAWING NUMBER	SHT	REV
BLDG4	E-R-18 DUMP LINE	1	1

FLINT HILLS resources

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1.3 E-R-15 DUMP TO PIT
1.4 E-R-16 DUMP TO PIT
1.5 E-R-17 DUMP TO PIT
1.6 E-R-18 DUMP TO PIT

SECTION 2 **2.0 Piping Isometrics Components: Segments, Fittings, Reducers, Relief Devices, Pumps, and Compressors**

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2.40 REDUCER 16.DUMP.05-EXP
2.41 REDUCER 17.DUMP.02-EXP
2.42 REDUCER 17.DUMP.05-EXP

2.43 REDUCER 18.DUMP.02-EXP
2.44 REDUCER 18.DUMP.05-EXP
2.45 REDUCER PROPOSED.DUMP.08-EXP

PROPOSED RXR DUMP TO PIT
Proposed Dump Line to Pit

SECTION: 1.1

PID/PFD Reference E1F014-3

Number of segments 11
Number of rupture disks 0
Number of relief valves 0

Approximate total piping flow resistanc 2910/NRe + 2.9 + 1.4/ID

Total piping mass. lb 1913.432
Total piping volume. ft3 37.940
Total piping length. ft 36.980

1st piping segment elevation relative t 0.000 <<< All segment elevations are reported with respect to vessel bottom.

Piping Node Name	Node Type	Start Elevation. ft	End Elevation. ft	Length. ft	Flow area. in2	Flow diameter. ft	Angle. Deg	Flow Solver
14.DUMP.00	Segment	0.000	0.000	0.500	50.027	0.665	0.00	Normal
14.DUMP.01	Segment	0.000	0.000	1.583	50.027	0.665	0.00	Normal
14.DUMP.02-EXP	Expander	0.000	0.000	1.016	78.854	0.835	0.00	
14.DUMP.03	Segment	0.000	0.000	0.781	78.854	0.835	0.00	Normal
14.DUMP.04	Segment	0.000	0.000	2.167	78.854	0.835	0.00	Normal
14.DUMP.05-EXP	Expander	0.000	0.000	1.083	137.886	1.104	0.00	
PROPOSED.DUMP.06	Segment	0.000	0.000	11.751	137.886	1.104	0.00	Normal
PROPOSED.DUMP.07	Segment	0.000	-8.333	8.333	137.886	1.104	-90.00	Normal
PROPOSED.DUMP.08-EXP	Expander	-8.333	-10.000	1.667	291.039	1.604	-90.00	
PROPOSED.DUMP.09	Segment	-10.000	-18.000	8.000	291.039	1.604	-90.00	Normal
PROPOSED.DUMP.10	Segment	-18.000	-18.071	0.100	291.039	1.604	-45.00	Normal

E-R-14 DUMP TO PIT

SECTION: 1.2 **E-R-14 Dump Line to Pit**

PID/PFD Reference E1F014-3

Number of segments 8
Number of rupture disks 0
Number of relief valves 0

Approximate total piping flow resistanc 2110/NRe + 2.7 + 1.2/ID

Total piping mass. lb 893.737
Total piping volume. ft3 14.867
Total piping length. ft 20.214

1st piping segment elevation relative t 0.000 <<< All segment elevations are reported with respect to vessel bottom.

Piping Node Name	Node Type	Start Elevation. ft	End Elevation. ft	Length. ft	Flow area. in2	Flow diameter. ft	Angle. Deg	Flow Solver
14.DUMP.00	Segment	0	0.000	0.500	50.027	0.665	0.00	Normal
14.DUMP.01	Segment	0	0.000	1.583	50.027	0.665	0.00	Normal
14.DUMP.02-EXP	Expander	0	0.000	1.016	78.854	0.835	0.00	
14.DUMP.03	Segment	0	0.000	0.781	78.854	0.835	0.00	Normal
14.DUMP.04	Segment	0	0.000	2.167	78.854	0.835	0.00	Normal
14.DUMP.05-EXP	Expander	0	0.000	1.083	137.886	1.104	0.00	
14.DUMP.06	Segment	0	0.000	11.751	137.886	1.104	0.00	Normal
14.DUMP.07	Segment	0	-0.943	1.333	137.886	1.104	-45.00	Normal

E-R-15 DUMP TO PIT

SECTION: 1.3 **E-R-15 Emergency Dump to Pit**

PID/PFD Reference E1F015-03

Number of segments 8
Number of rupture disks 0
Number of relief valves 0

Approximate total piping flow resistanc 2110/NRe + 2.7 + 1.2/ID

Total piping mass. lb 642.057
Total piping volume. ft3 10.448
Total piping length. ft 15.652

1st piping segment elevation relative t 0.000 <<< All segment elevations are reported with respect to vessel bottom.

Piping Node Name	Node Type	Start Elevation. ft	End Elevation. ft	Length. ft	Flow area. in2	Flow diameter. ft	Angle. Deg	Flow Solver
15.DUMP.00	Segment	0	0.000	0.500	50.027	0.665	0.00	Normal
15.DUMP.01	Segment	0	0.000	1.625	50.027	0.665	0.00	Normal
15.DUMP.02-EXP	Expander	0	0.000	1.042	78.854	0.835	0.00	
15.DUMP.03	Segment	0	0.000	0.688	78.854	0.835	0.00	Normal
15.DUMP.04	Segment	0	0.000	2.260	78.854	0.835	0.00	Normal
15.DUMP.05-EXP	Expander	0	0.000	1.083	137.886	1.104	0.00	
15.DUMP.06	Segment	0	0.000	8.355	137.886	1.104	0.00	Normal
15.DUMP.07	Segment	0	-0.071	0.100	137.886	1.104	-45.00	Normal

E-R-16 DUMP TO PIT

SECTION: 1.4 **E-R-16 Emergency Dump to Pit**

PID/PFD Reference E1F016-03

Number of segments 8
Number of rupture disks 0
Number of relief valves 0

Approximate total piping flow resistanc 2110/NRe + 2.7 + 1.2/ID

Total piping mass. lb 742.240
Total piping volume. ft3 12.252
Total piping length. ft 17.406

1st piping segment elevation relative t 0.000 <<< All segment elevations are reported with respect to vessel bottom.

Piping Node Name	Node Type	Start Elevation. ft	End Elevation. ft	Length. ft	Flow area. in2	Flow diameter. ft	Angle. Deg	Flow Solver
16.DUMP.00	Segment	0	0.000	0.500	50.027	0.665	0.00	Normal
16.DUMP.01	Segment	0	0.000	1.604	50.027	0.665	0.00	Normal
16.DUMP.02-EXP	Expander	0	0.000	1.042	78.854	0.835	0.00	
16.DUMP.03	Segment	0	0.000	0.708	78.854	0.835	0.00	Normal
16.DUMP.04	Segment	0	0.000	1.969	78.854	0.835	0.00	Normal
16.DUMP.05-EXP	Expander	0	0.000	1.083	137.886	1.104	0.00	
16.DUMP.06	Segment	0	0.000	9.167	137.886	1.104	0.00	Normal
16.DUMP.07	Segment	0	-0.667	1.333	137.886	1.104	-30.00	Normal

E-R-17 DUMP TO PIT

SECTION: 1.5 **E-R-17 Emergency Dump to Pit**

PID/PFD Reference E1F017-03

Number of segments 8
Number of rupture disks 0
Number of relief valves 0

Approximate total piping flow resistanc 2110/NRe + 2.7 + 1.2/ID

Total piping mass. lb 741.393
Total piping volume. ft3 12.161
Total piping length. ft 17.479

1st piping segment elevation relative t 0.000 <<< All segment elevations are reported with respect to vessel bottom.

Piping Node Name	Node Type	Start Elevation. ft	End Elevation. ft	Length. ft	Flow area. in2	Flow diameter. ft	Angle. Deg	Flow Solver
17.DUMP.00	Segment	0	0.000	0.500	50.027	0.665	0.00	Normal
17.DUMP.01	Segment	0	0.000	1.646	50.027	0.665	0.00	Normal
17.DUMP.02-EXP	Expander	0	0.000	1.000	78.854	0.835	0.00	
17.DUMP.03	Segment	0	0.000	0.729	78.854	0.835	0.00	Normal
17.DUMP.04	Segment	0	0.000	2.375	78.854	0.835	0.00	Normal
17.DUMP.05-EXP	Expander	0	0.000	1.083	137.886	1.104	0.00	
17.DUMP.06	Segment	0	0.000	8.813	137.886	1.104	0.00	Normal
17.DUMP.07	Segment	0	-0.667	1.333	137.886	1.104	-30.00	Normal

E-R-18 DUMP TO PIT

SECTION: 1.6 **E-R-18 Emergency Dump to Pit**

PID/PFD Reference E1F018-03

Number of segments 8
Number of rupture disks 0
Number of relief valves 0

Approximate total piping flow resistanc 2110/NRe + 2.7 + 1.2/ID

Total piping mass. lb 623.831
Total piping volume. ft3 10.052
Total piping length. ft 15.396

1st piping segment elevation relative t 0.000 <<< All segment elevations are reported with respect to vessel bottom.

Piping Node Name	Node Type	Start Elevation. ft	End Elevation. ft	Length. ft	Flow area. in2	Flow diameter. ft	Angle. Deg	Flow Solver
18.DUMP.00	Segment	0	0.000	0.500	50.027	0.665	0.00	Normal
18.DUMP.01	Segment	0	0.000	1.521	50.027	0.665	0.00	Normal
18.DUMP.02-EXP	Expander	0	0.000	1.021	78.854	0.835	0.00	
18.DUMP.03	Segment	0	0.000	0.708	78.854	0.835	0.00	Normal
18.DUMP.04	Segment	0	0.000	2.813	78.854	0.835	0.00	Normal
18.DUMP.05-EXP	Expander	0	0.000	1.083	137.886	1.104	0.00	
18.DUMP.06	Segment	0	0.000	6.417	137.886	1.104	0.00	Normal
18.DUMP.07	Segment	0	-0.943	1.333	137.886	1.104	-45.00	Normal

Piping Segment Name	TAG	Reference	Material	OD. ft	ID. ft	Length. ft	Angle	K1	Kinf	Kid	Roughness. ft
14.DUMP.00	NA	NA	STEEL	0.719	0.665	0.500	0.000	160.000	0.500	0.000	0.000500
14.DUMP.01	NA	NA	STEEL	0.719	0.665	1.583	0.000	800.000	0.400	0.400	0.000500
14.DUMP.03	NA	NA	STEEL	0.896	0.835	0.781	0.000	500.000	0.150	0.150	0.000500
14.DUMP.04	NA	NA	STEEL	0.896	0.835	2.167	0.000	150.000	0.500	0.500	0.000500
14.DUMP.06	NA	NA	STEEL	1.167	1.104	11.751	0.000	500.000	0.150	0.150	0.000500
14.DUMP.07	NA	NA	STEEL	1.167	1.104	1.333	-45.000	0.000	1.000	0.000	0.000500
15.DUMP.00	NA	NA	STEEL	0.719	0.665	0.500	0.000	160.000	0.500	0.000	0.000500
15.DUMP.01	NA	NA	STEEL	0.719	0.665	1.625	0.000	800.000	0.400	0.400	0.000500
15.DUMP.03	NA	NA	STEEL	0.896	0.835	0.688	0.000	500.000	0.150	0.150	0.000500
15.DUMP.04	NA	NA	STEEL	0.896	0.835	2.260	0.000	150.000	0.500	0.500	0.000500
15.DUMP.06	NA	NA	STEEL	1.167	1.104	8.355	0.000	500.000	0.150	0.150	0.000500
15.DUMP.07	NA	NA	STEEL	1.167	1.104	0.100	-45.000	0.000	1.000	0.000	0.000500
16.DUMP.00	NA	NA	STEEL	0.719	0.665	0.500	0.000	160.000	0.500	0.000	0.000500
16.DUMP.01	NA	NA	STEEL	0.719	0.665	1.604	0.000	800.000	0.400	0.400	0.000500
16.DUMP.03	NA	NA	STEEL	0.896	0.835	0.708	0.000	500.000	0.150	0.150	0.000500
16.DUMP.04	NA	NA	STEEL	0.896	0.835	1.969	0.000	150.000	0.500	0.500	0.000500
16.DUMP.06	NA	NA	STEEL	1.167	1.104	9.167	0.000	500.000	0.150	0.150	0.000500
16.DUMP.07	NA	NA	STEEL	1.167	1.104	1.333	-30.000	0.000	1.000	0.000	0.000500
17.DUMP.00	NA	NA	STEEL	0.719	0.665	0.500	0.000	160.000	0.500	0.000	0.000500
17.DUMP.01	NA	NA	STEEL	0.719	0.665	1.646	0.000	800.000	0.400	0.400	0.000500
17.DUMP.03	NA	NA	STEEL	0.896	0.835	0.729	0.000	500.000	0.150	0.150	0.000500
17.DUMP.04	NA	NA	STEEL	0.896	0.835	2.375	0.000	150.000	0.500	0.500	0.000500
17.DUMP.06	NA	NA	STEEL	1.167	1.104	8.813	0.000	500.000	0.150	0.150	0.000500
17.DUMP.07	NA	NA	STEEL	1.167	1.104	1.333	-30.000	0.000	1.000	0.000	0.000500
18.DUMP.00	NA	NA	STEEL	0.719	0.665	0.500	0.000	160.000	0.500	0.000	0.000500
18.DUMP.01	NA	NA	STEEL	0.719	0.665	1.521	0.000	800.000	0.400	0.400	0.000500
18.DUMP.03	NA	NA	STEEL	0.896	0.835	0.708	0.000	500.000	0.150	0.150	0.000500
18.DUMP.04	NA	NA	STEEL	0.896	0.835	2.813	0.000	150.000	0.500	0.500	0.000500
18.DUMP.06	NA	NA	STEEL	1.167	1.104	6.417	0.000	500.000	0.150	0.150	0.000500
18.DUMP.07	NA	NA	STEEL	1.167	1.104	1.333	-45.000	0.000	1.000	0.000	0.000500
PROPOSED.DUMP.06	NA	NA	STEEL	1.167	1.104	11.751	0.000	800.000	0.200	0.200	0.000500
PROPOSED.DUMP.07	NA	NA	STEEL	1.167	1.104	8.333	-90.000	0.000	0.000	0.000	0.000500
PROPOSED.DUMP.09	NA	NA	STEEL	1.667	1.604	8.000	-90.000	500.000	0.150	0.150	0.000500
PROPOSED.DUMP.10	NA	NA	STEEL	1.667	1.604	0.100	-45.000	0.000	1.000	0.000	0.000500

Fittings Summary	Fitting Type	K1	Kinf	Kid	Number
14.DUMP.00	Entrance	160	0.5	0	1
14.DUMP.01	Tee used as elbow, long radius, threaded	800	0.4	0.4	1
14.DUMP.03	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
14.DUMP.04	Tee, run through, flanged/welded	150	0.5	0.5	1
14.DUMP.06	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
14.DUMP.07	Exit	0	1	0	1
15.DUMP.00	Entrance	160	0.5	0	1
15.DUMP.01	Tee used as elbow, long radius, threaded	800	0.4	0.4	1
15.DUMP.03	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
15.DUMP.04	Tee, run through, flanged/welded	150	0.5	0.5	1
15.DUMP.06	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
15.DUMP.07	Exit	0	1	0	1
16.DUMP.00	Entrance	160	0.5	0	1
16.DUMP.01	Tee used as elbow, long radius, threaded	800	0.4	0.4	1
16.DUMP.03	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
16.DUMP.04	Tee, run through, flanged/welded	150	0.5	0.5	1
16.DUMP.06	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
16.DUMP.07	Exit	0	1	0	1
17.DUMP.00	Entrance	160	0.5	0	1
17.DUMP.01	Tee used as elbow, long radius, threaded	800	0.4	0.4	1
17.DUMP.03	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
17.DUMP.04	Tee, run through, flanged/welded	150	0.5	0.5	1
17.DUMP.06	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
17.DUMP.07	Exit	0	1	0	1
18.DUMP.00	Entrance	160	0.5	0	1
18.DUMP.01	Tee used as elbow, long radius, threaded	800	0.4	0.4	1
18.DUMP.03	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
18.DUMP.04	Tee, run through, flanged/welded	150	0.5	0.5	1
18.DUMP.06	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
18.DUMP.07	Exit	0	1	0	1

PROPOSED.DUMP.06	90 deg elbow, long-radius (R/D=1.5), all ty	800	0.2	0.2	1
PROPOSED.DUMP.09	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
PROPOSED.DUMP.10	Exit	0	1	0	1

Reducer Name	Material	Inlet Diameter. ft	Exit Diameter. ft	Length. ft	Angle	Roughness . ft
14.DUMP.02-EXP	STEEL	0.665	0.835	1.016	0.000	0.000500
14.DUMP.05-EXP	STEEL	0.835	1.104	1.083	0.000	0.000500
15.DUMP.02-EXP	STEEL	0.665	0.835	1.042	0.000	0.000500
15.DUMP.05-EXP	STEEL	0.835	1.104	1.083	0.000	0.000500
16.DUMP.02-EXP	STEEL	0.665	0.835	1.042	0.000	0.000500
16.DUMP.05-EXP	STEEL	0.835	1.104	1.083	0.000	0.000500
17.DUMP.02-EXP	STEEL	0.665	0.835	1.000	0.000	0.000500
17.DUMP.05-EXP	STEEL	0.835	1.104	1.083	0.000	0.000500
18.DUMP.02-EXP	STEEL	0.665	0.835	1.021	0.000	0.000500
18.DUMP.05-EXP	STEEL	0.835	1.104	1.083	0.000	0.000500
PROPOSED.DUMP.08-EXP	STEEL	1.104	1.604	1.667	-90.000	0.000500

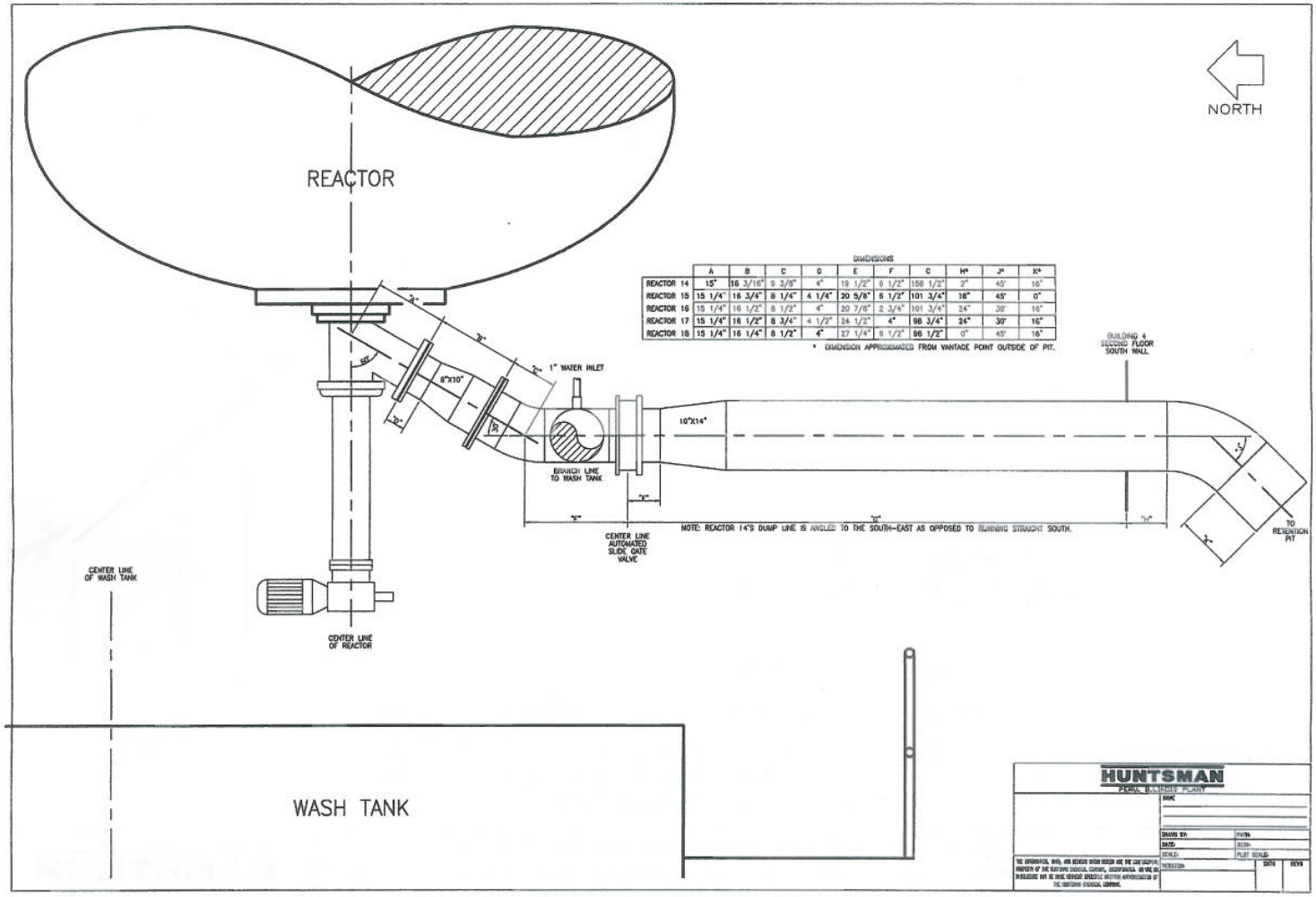
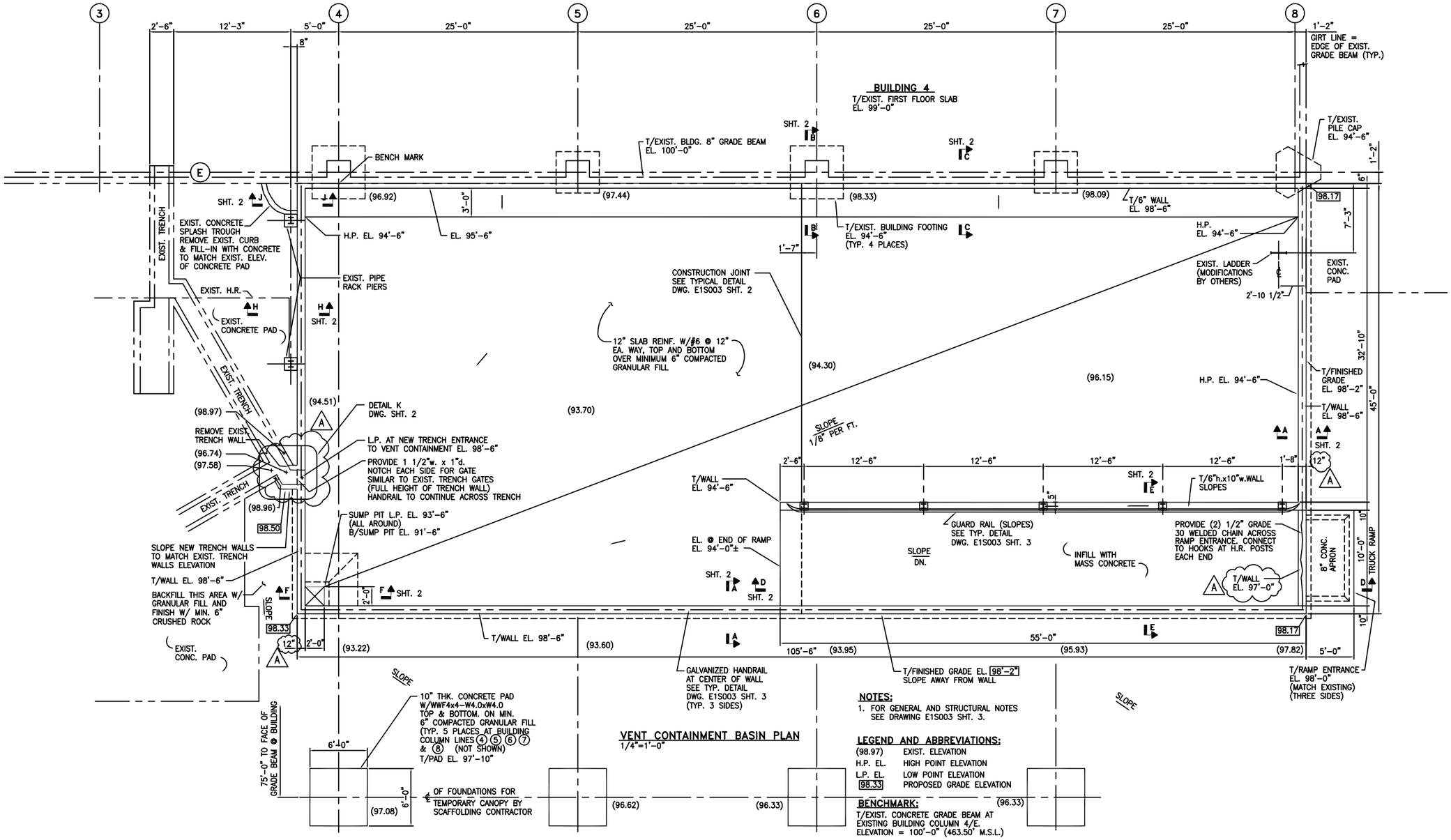


Figure A-1 Reactor dump line.



VENT CONTAINMENT BASIN PLAN

1/4"=1'-0"

NOTES:

1. FOR GENERAL AND STRUCTURAL NOTES SEE DRAWING E1S003 SHT. 3.

LEGEND AND ABBREVIATIONS:

(98.97)	EXIST. ELEVATION
H.P. EL.	HIGH POINT ELEVATION
L.P. EL.	LOW POINT ELEVATION
98.33	PROPOSED GRADE ELEVATION

BENCHMARK:

T/EXIST. CONCRETE GRADE BEAM AT EXISTING BUILDING COLUMN 4/E. ELEVATION = 100'-0" (463.50' M.S.L.)

Flint Hills Resources

PERU, ILLINOIS PLANT

REV	DATE	DESCRIPTION
A	01/00	AS-BUILT

NAME: BLDG 4 VENT CONTAINMENT BASIN PLAN

DRAWN BY: AMB | CONTROL DRAW: B4

DATE: 5/4/99 | N/A

SCALE: 3/16"=1'-0" | PLOT SCALE: 1=64

VERSION: A | SHT# 1 | REV# A

E1S003

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Appendix B: Results – PROPOSED Piping Layout to Pit – Liquid Release Jet Profile

Figure 1: Liquid Release Jet Profile – Proposed Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

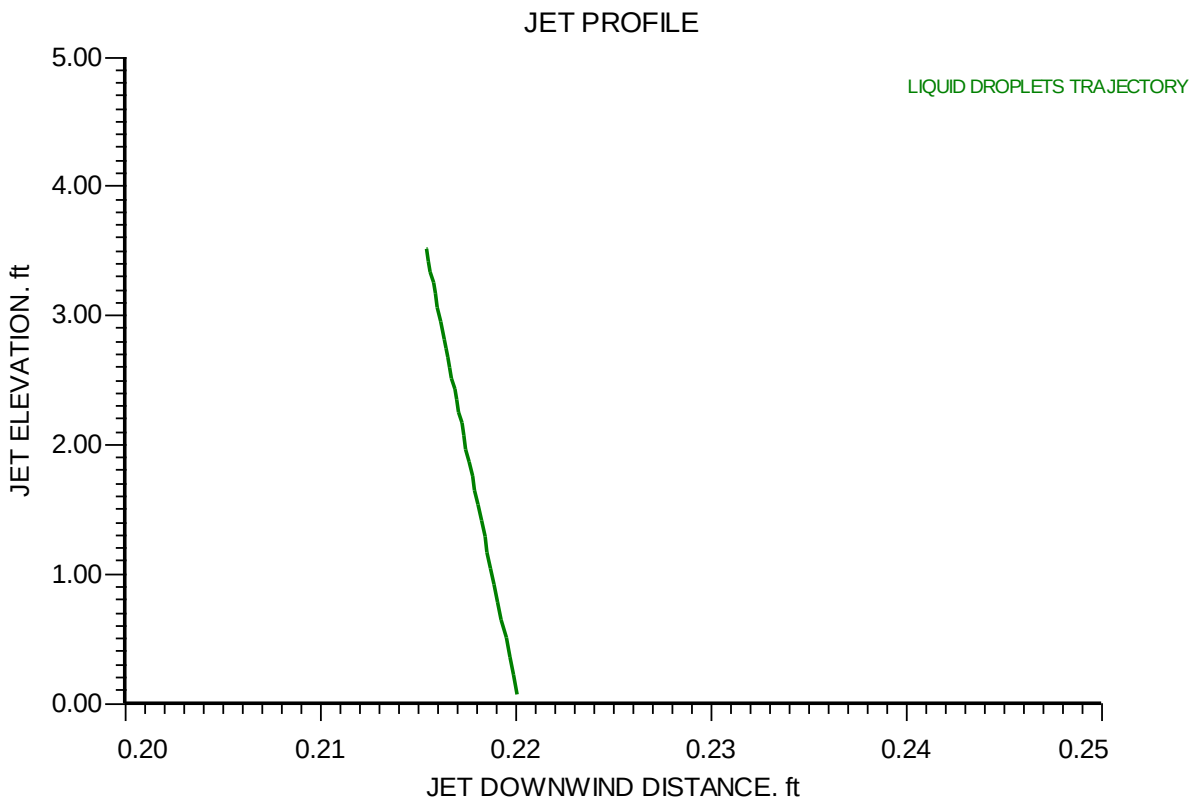


Figure 2: Liquid Release Jet Profile – Proposed Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

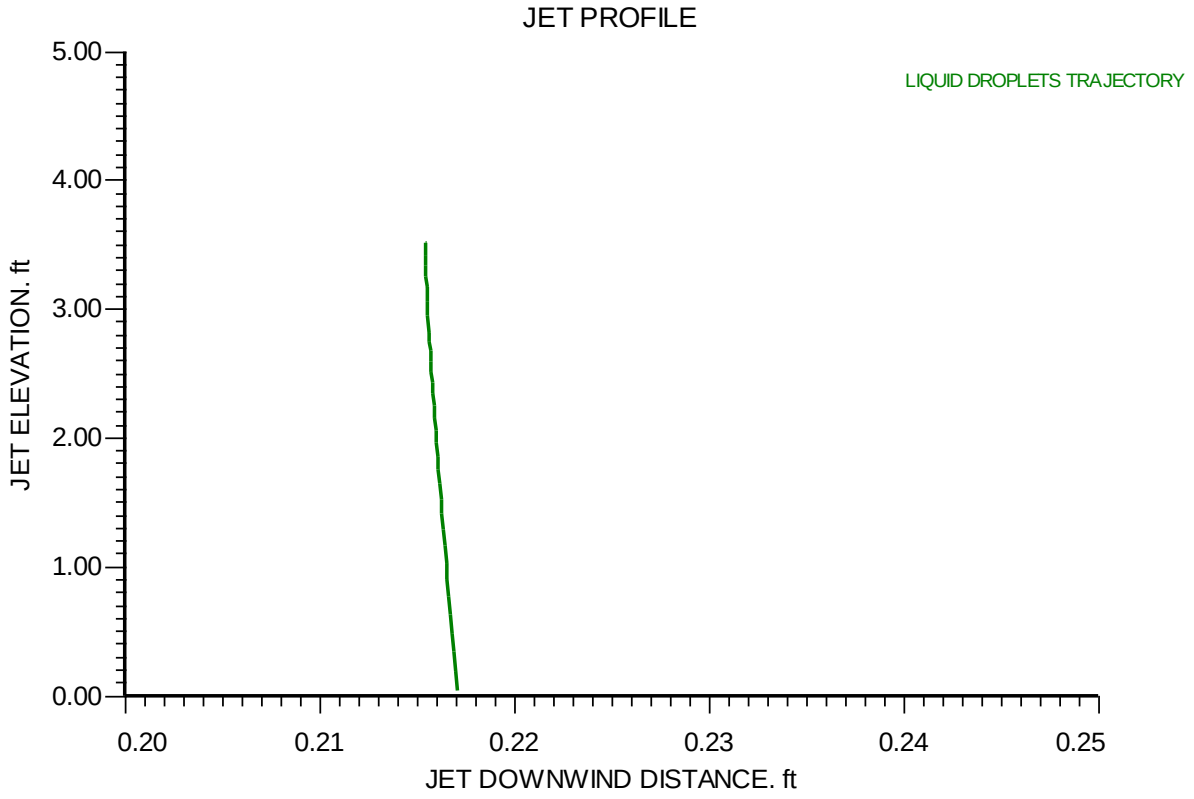


Figure 3: Liquid Release Jet Profile – Proposed Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

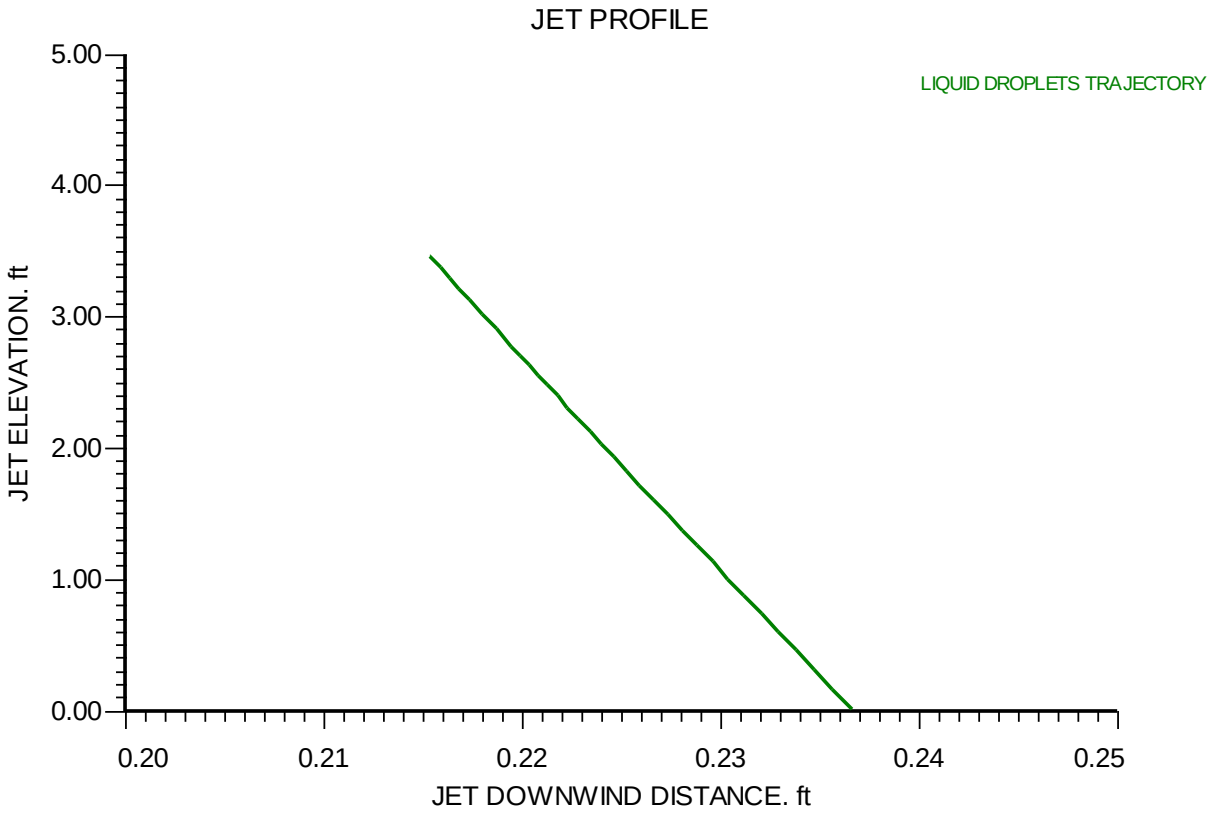


Figure 4: Liquid Release Jet Profile – Proposed Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

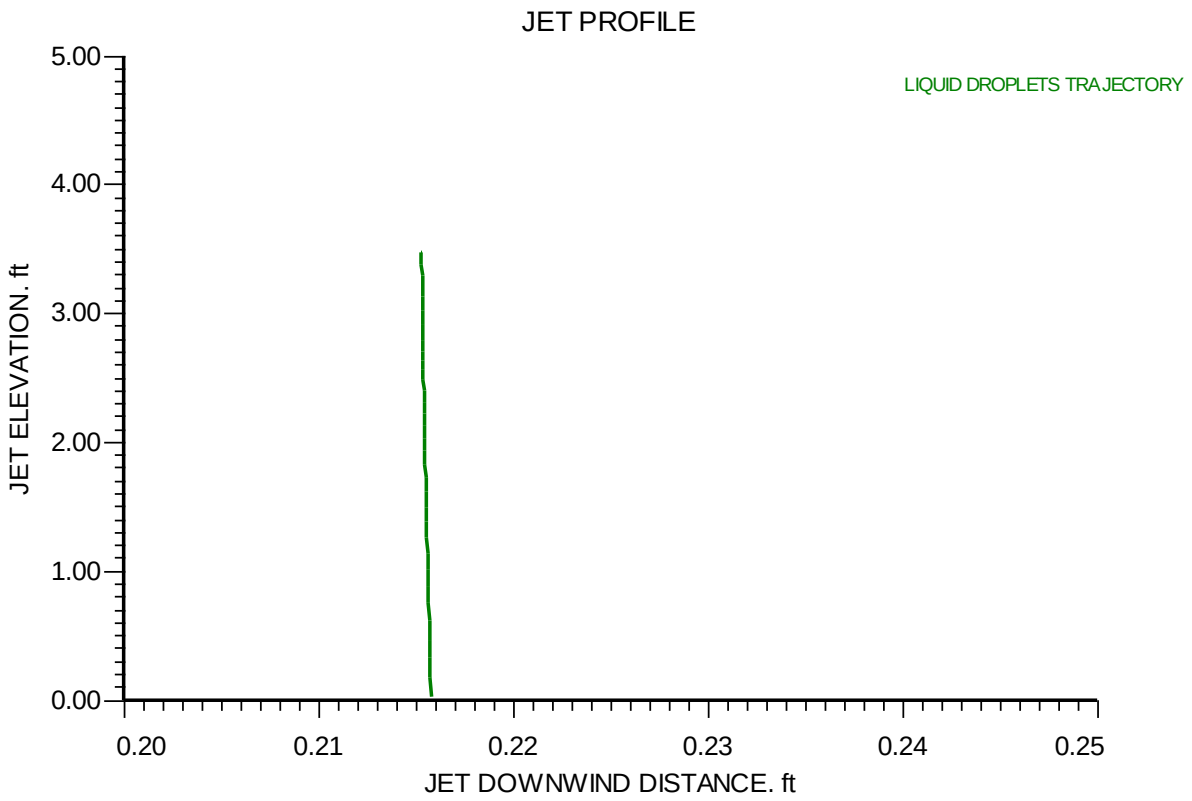


Figure 5: Liquid Release Jet Profile – Proposed Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

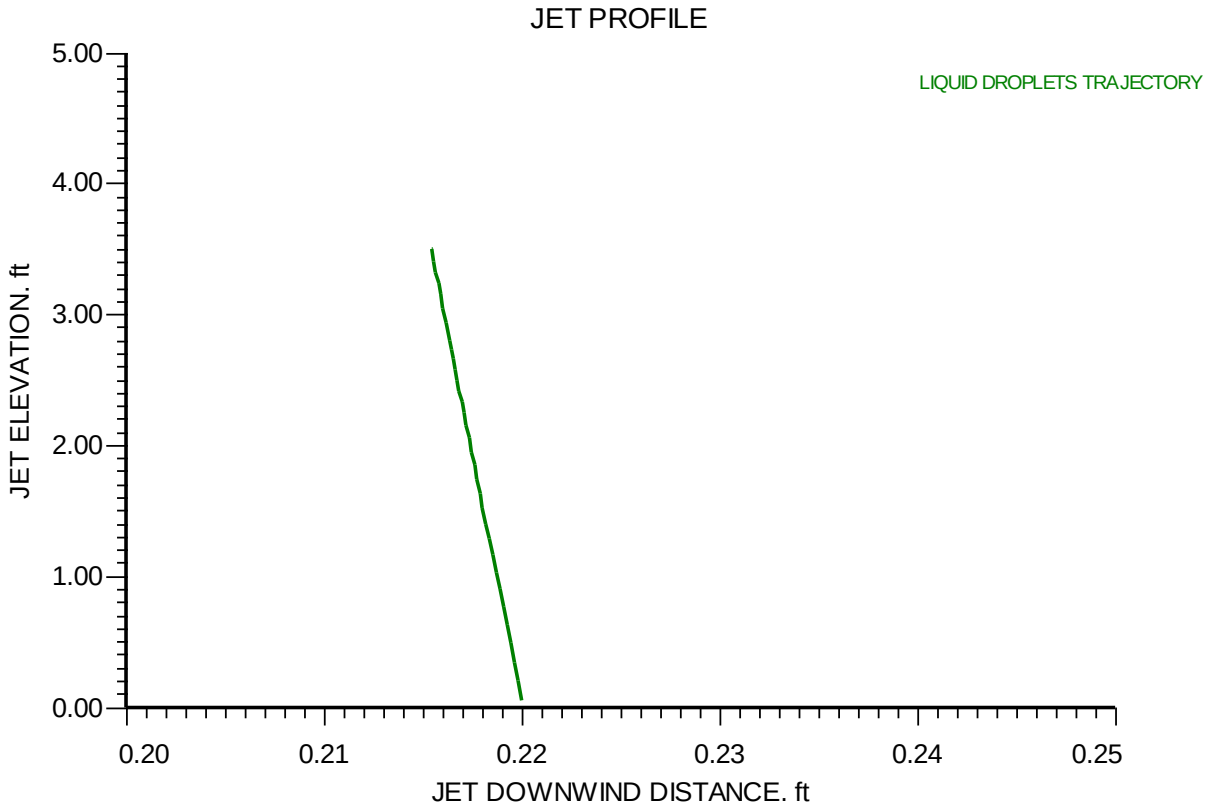


Figure 6: Liquid Release Jet Profile – Proposed Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

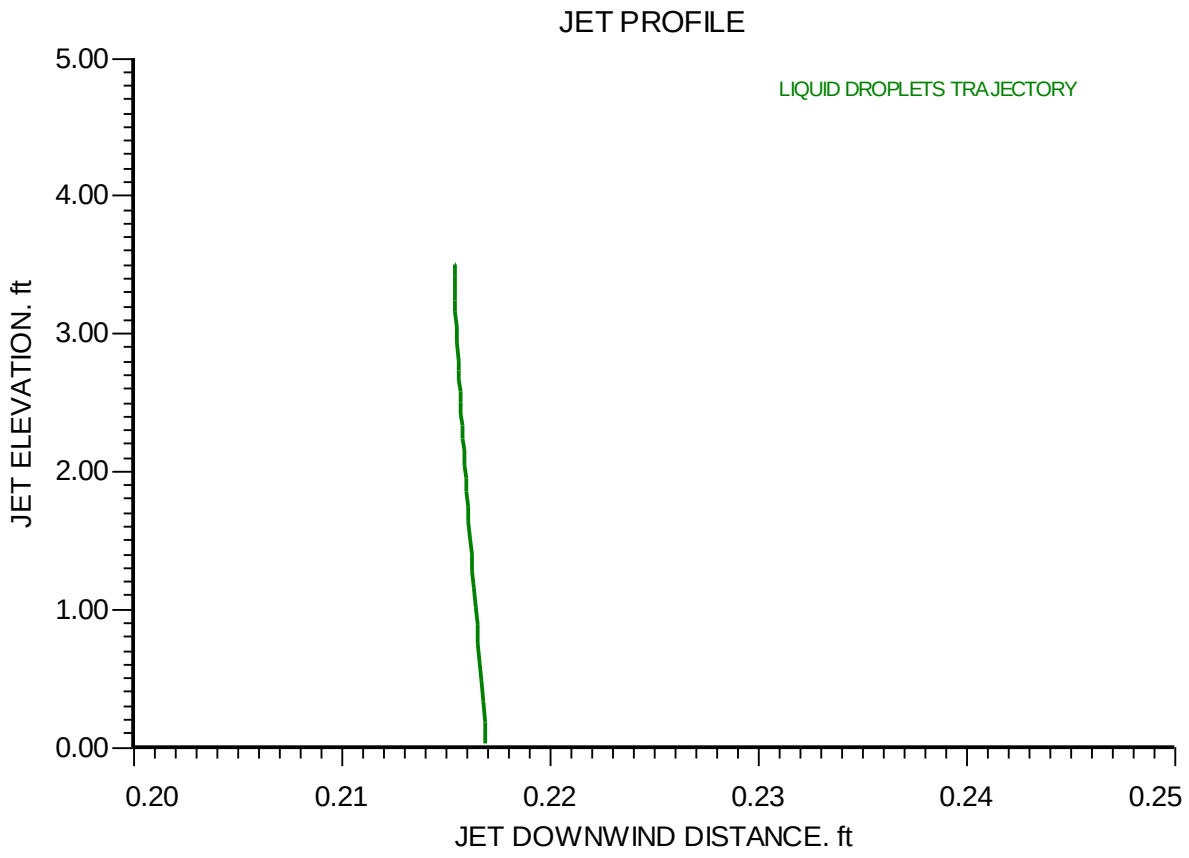


Figure 7: Liquid Release Jet Profile – Proposed Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

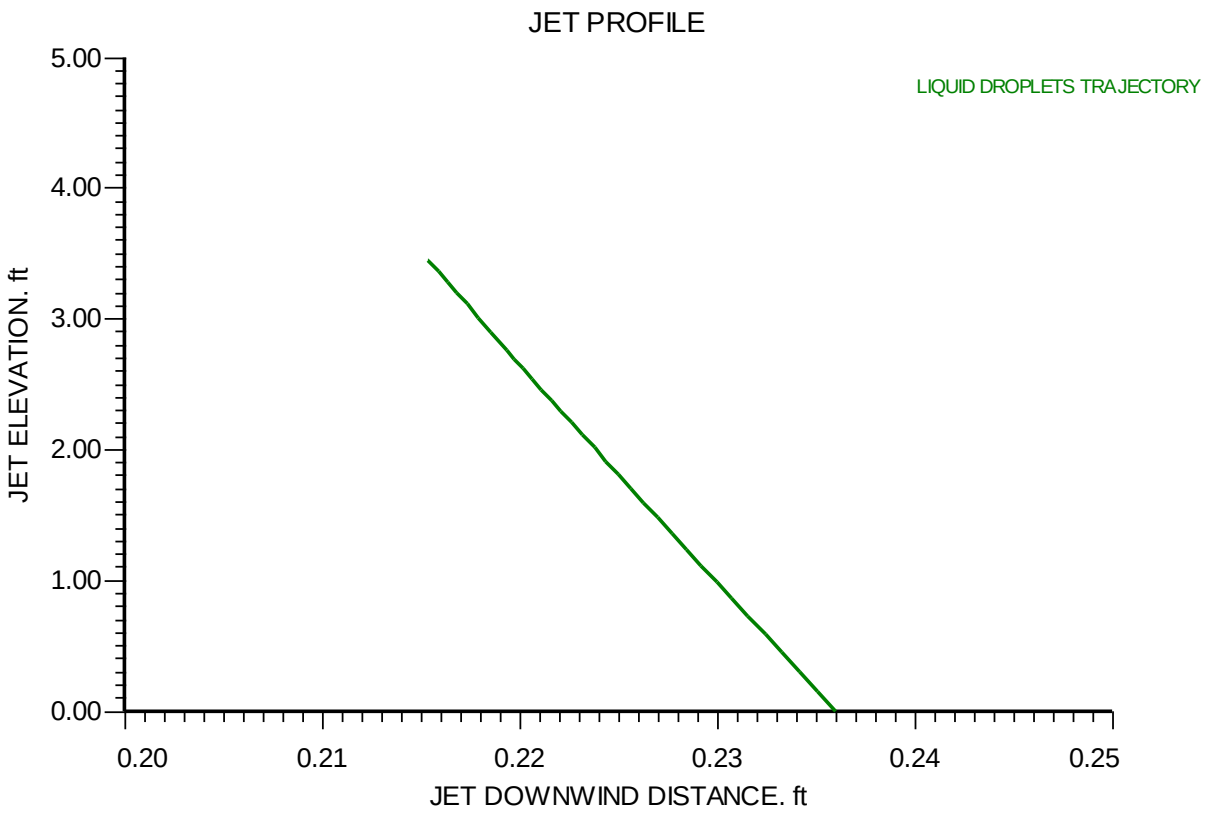


Figure 8: Liquid Release Jet Profile – Proposed Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F

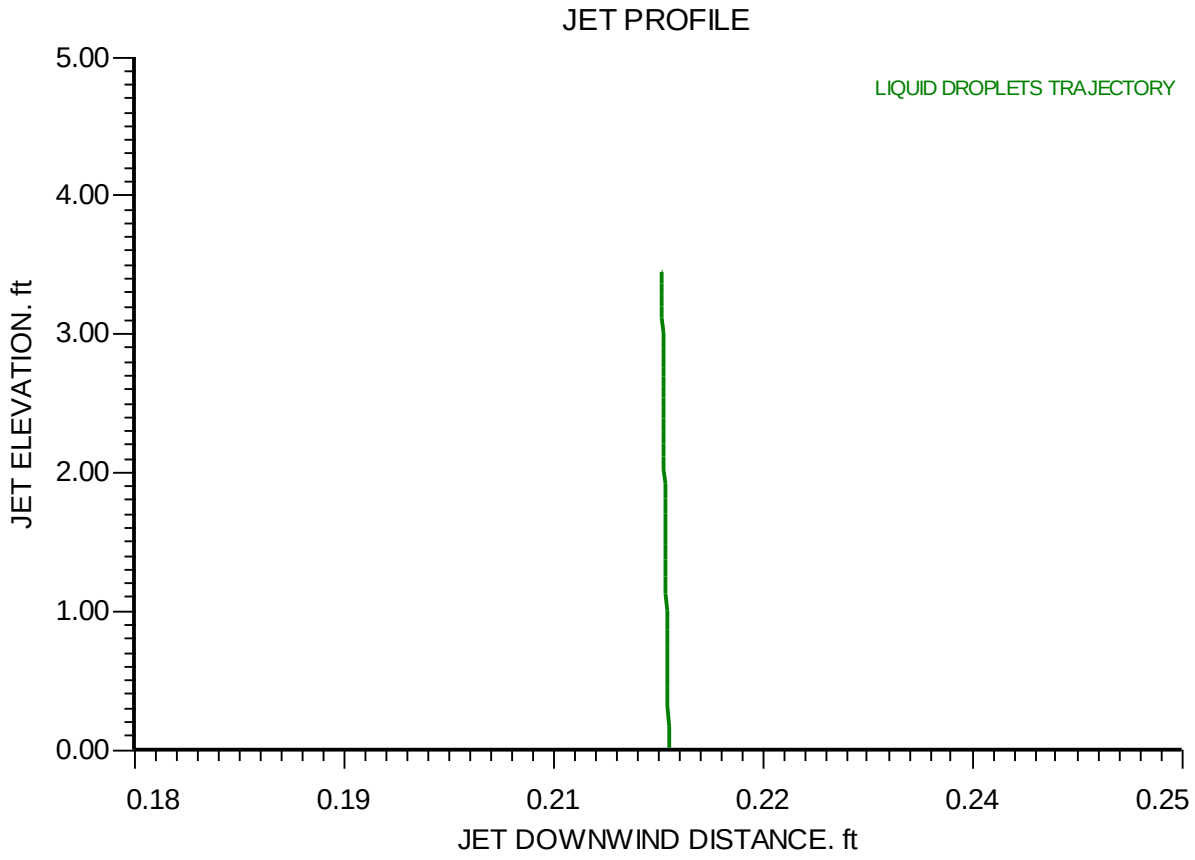


Figure 9: Liquid Release Jet Profile – Proposed Layout – 50% Reacted; D5 Stability Class; 20 psig and 205°F

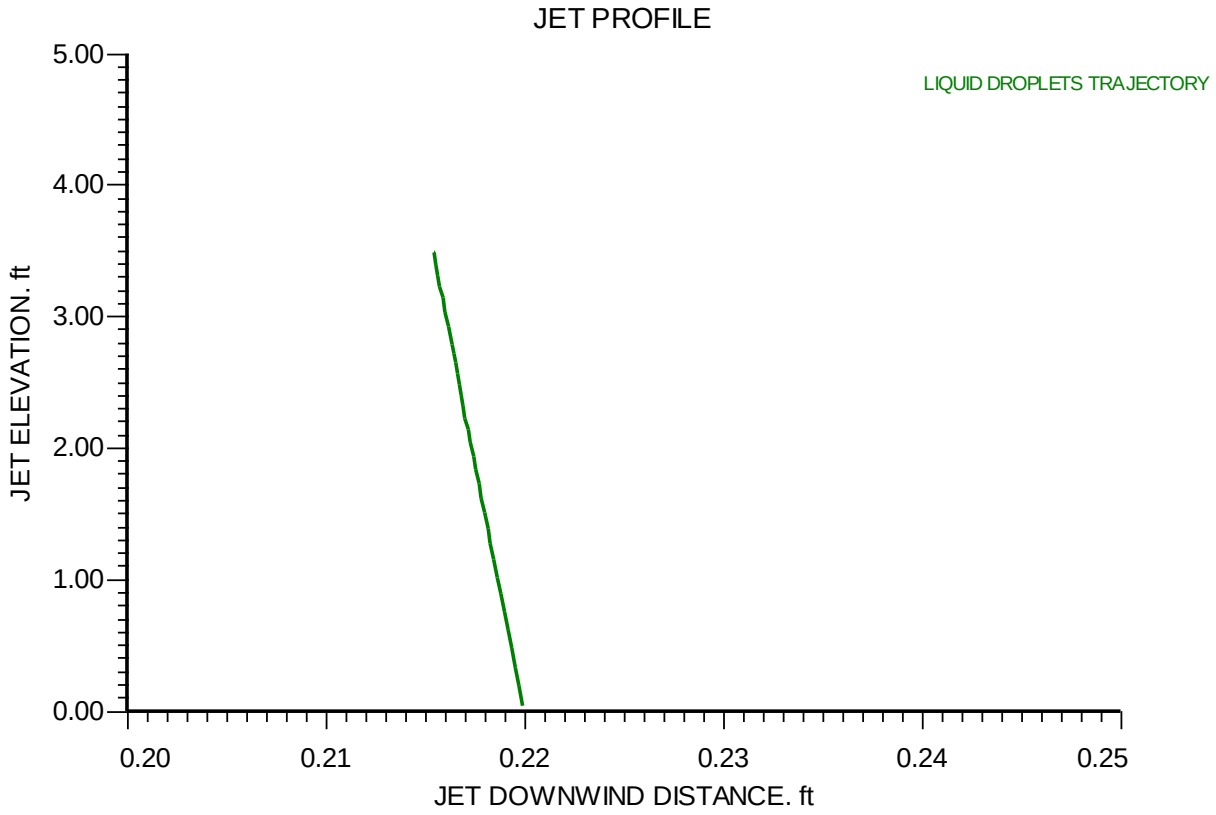


Figure 10: Liquid Release Jet Profile – Proposed Layout – 50% Reacted; F2 Stability Class; 5 psig and 210°F

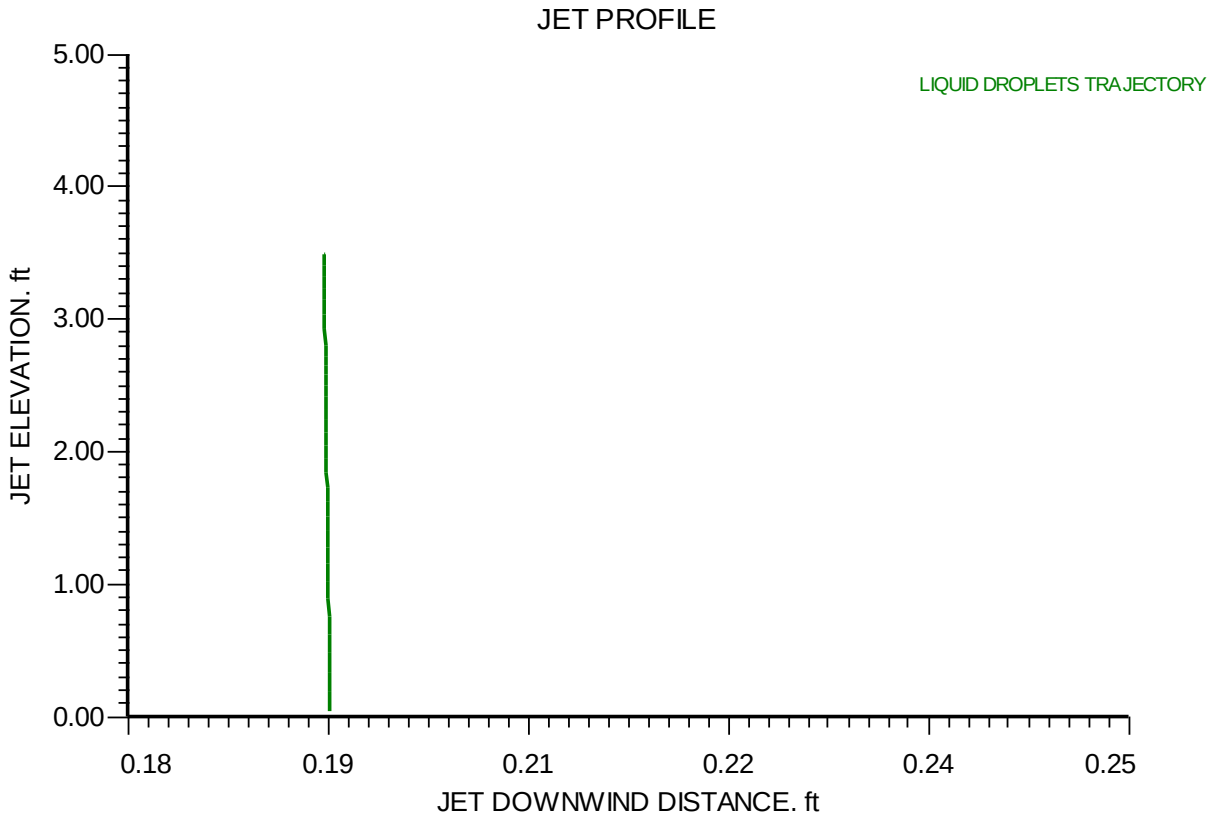


Figure 11: Liquid Release Jet Profile – Proposed Layout – 75% Reacted; F2 Stability Class; 20 psig and 205°F

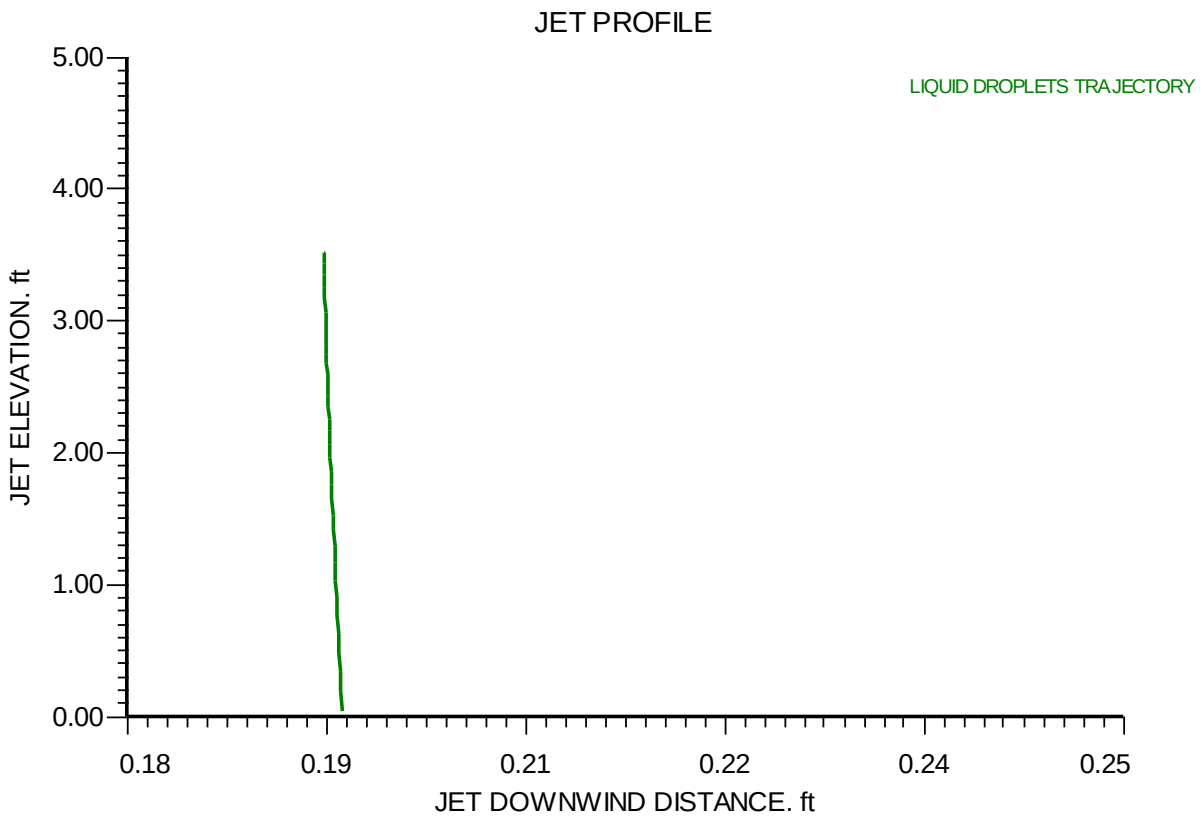


Figure 12: Liquid Release Jet Profile – Proposed Layout – 75% Reacted; F2 Stability Class; 5 psig and 210°F

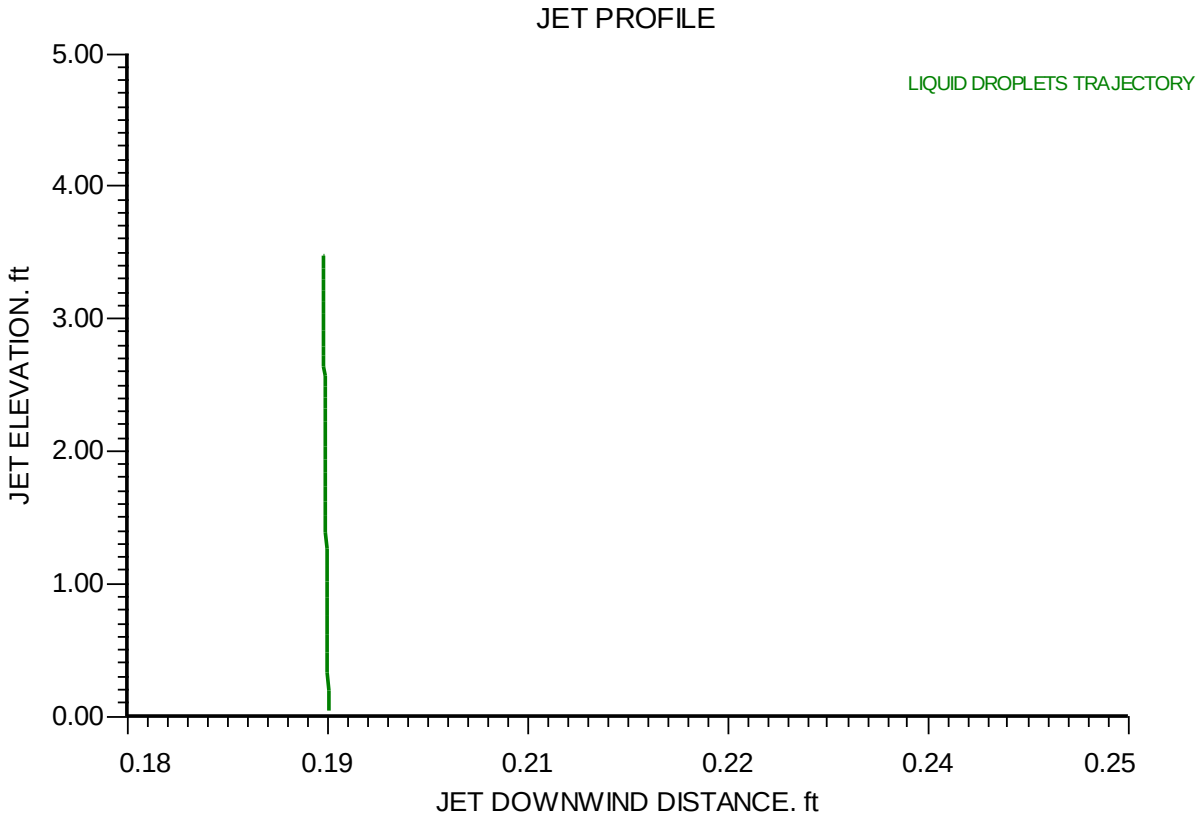


Figure 13: Liquid Release Jet Profile – Proposed Layout – 100% Reacted; D5 Stability Class; 20 psig and 205°F

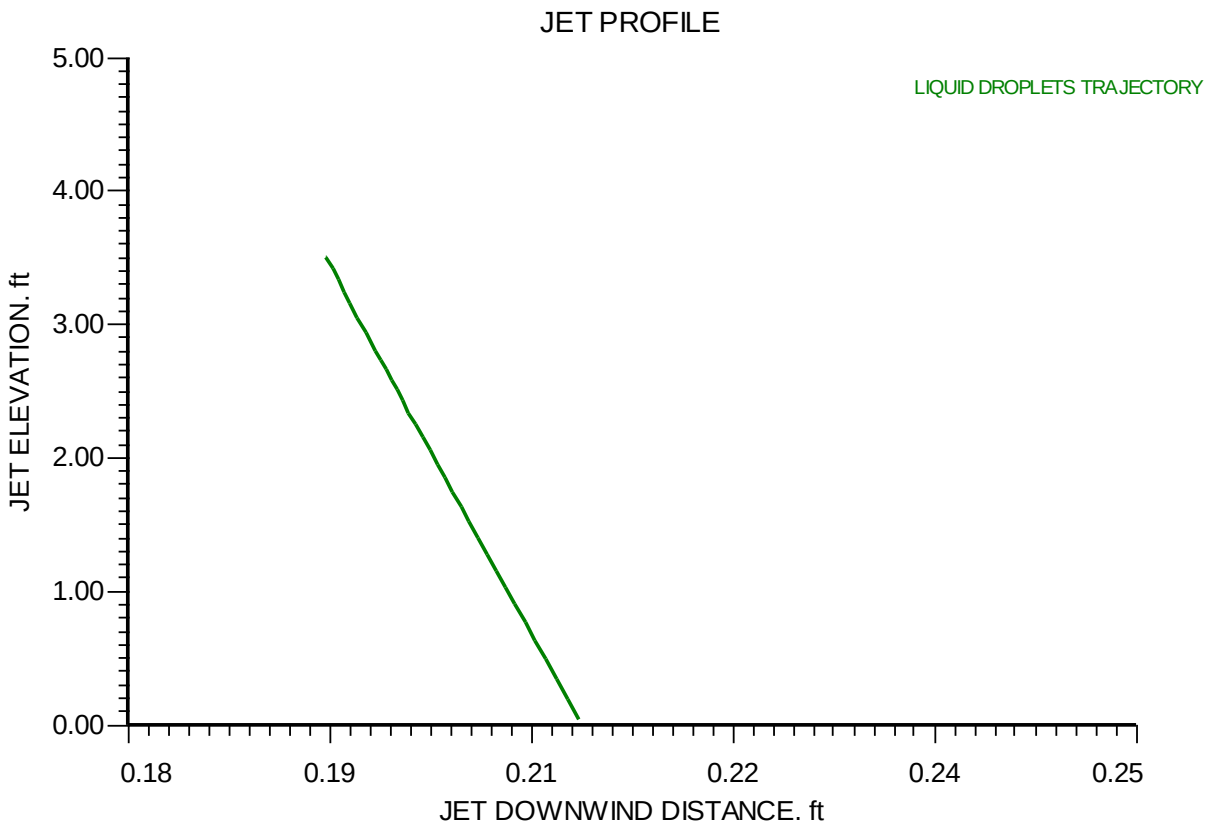


Figure 14: Liquid Release Jet Profile – Proposed Layout – 100% Reacted; F2 Stability Class; 20 psig and 205°F

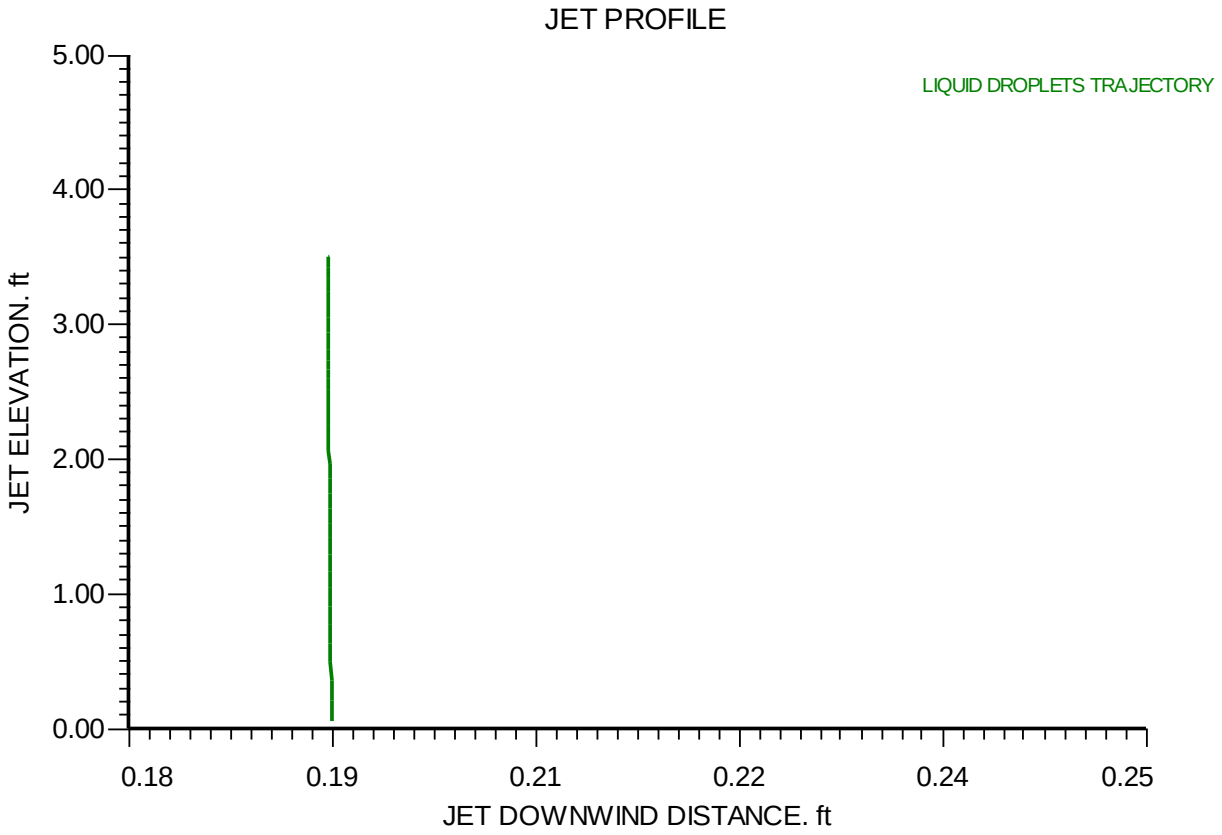


Figure 15: Liquid Release Jet Profile – Proposed Layout – 100% Reacted; D5 Stability Class; 5 psig and 210°F

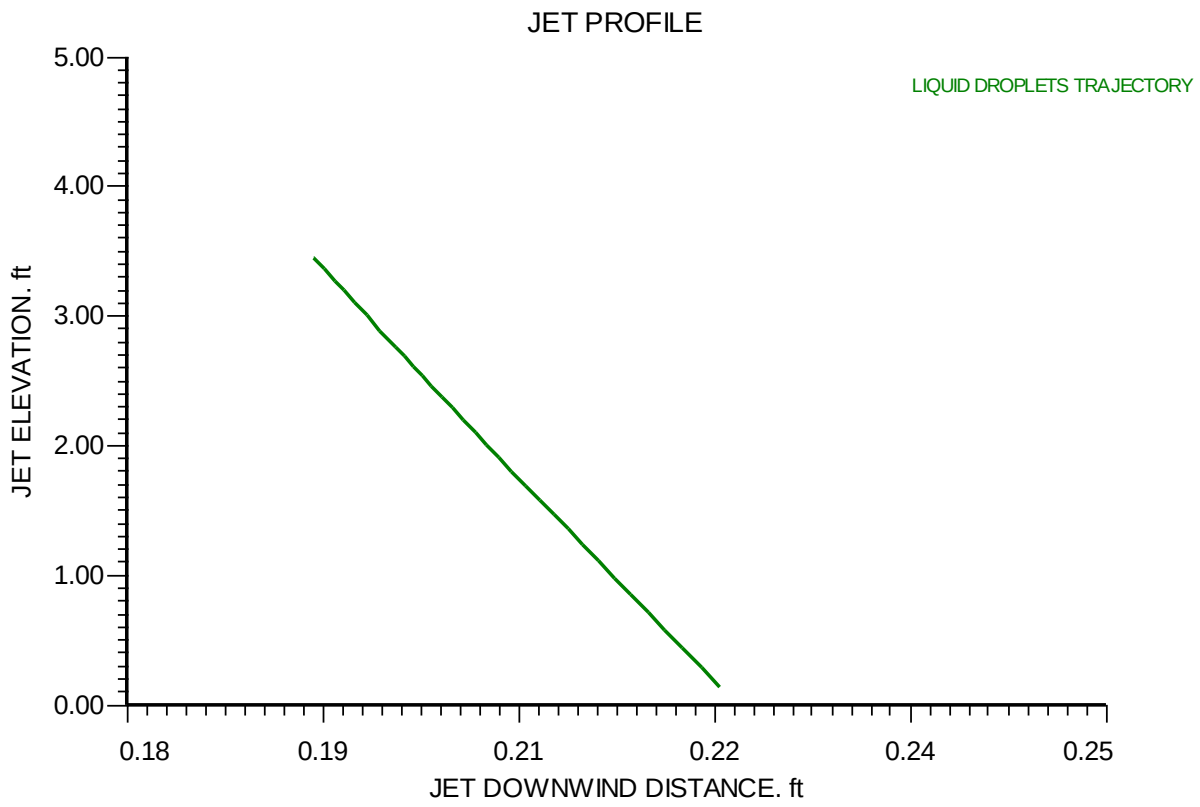
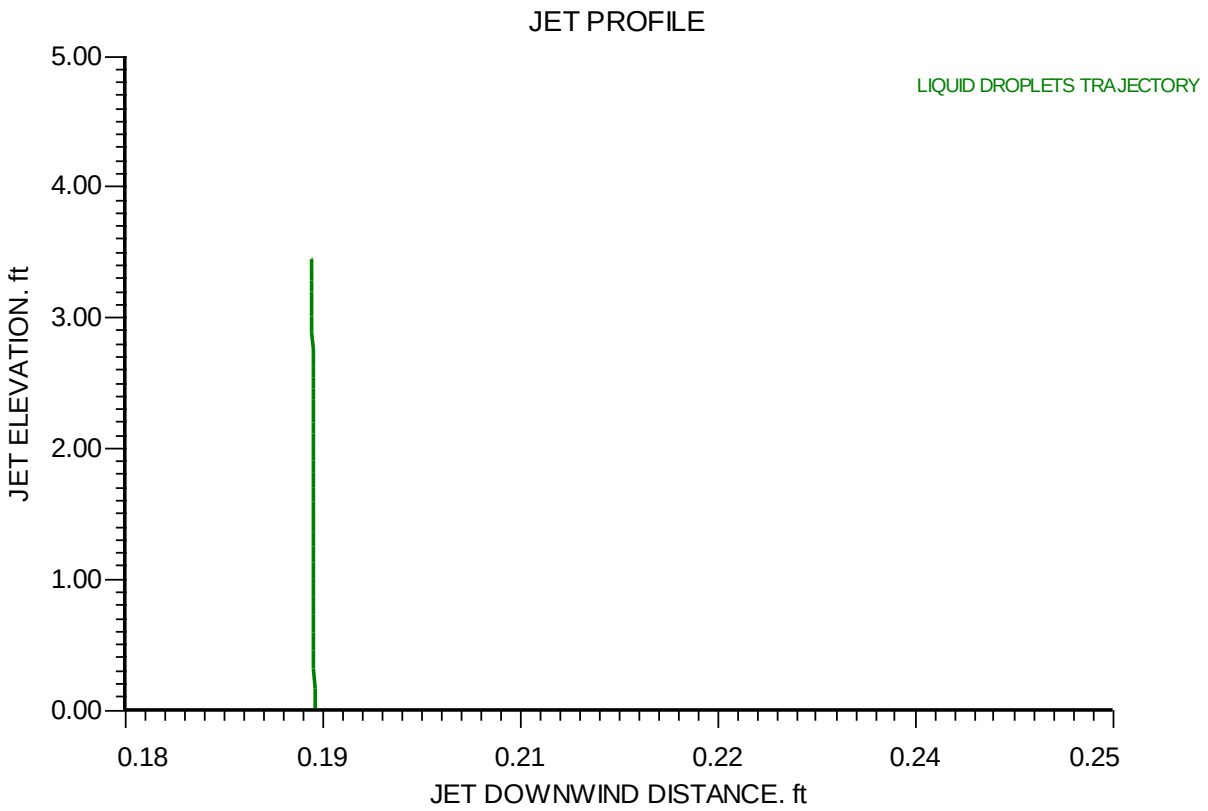


Figure 16: Liquid Release Jet Profile – Proposed Layout – 100% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix C: Results – E-R-14 Piping Layout to Pit – Liquid Release Jet Profile

Figure 17: Liquid Release Jet Profile – E-R-14 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

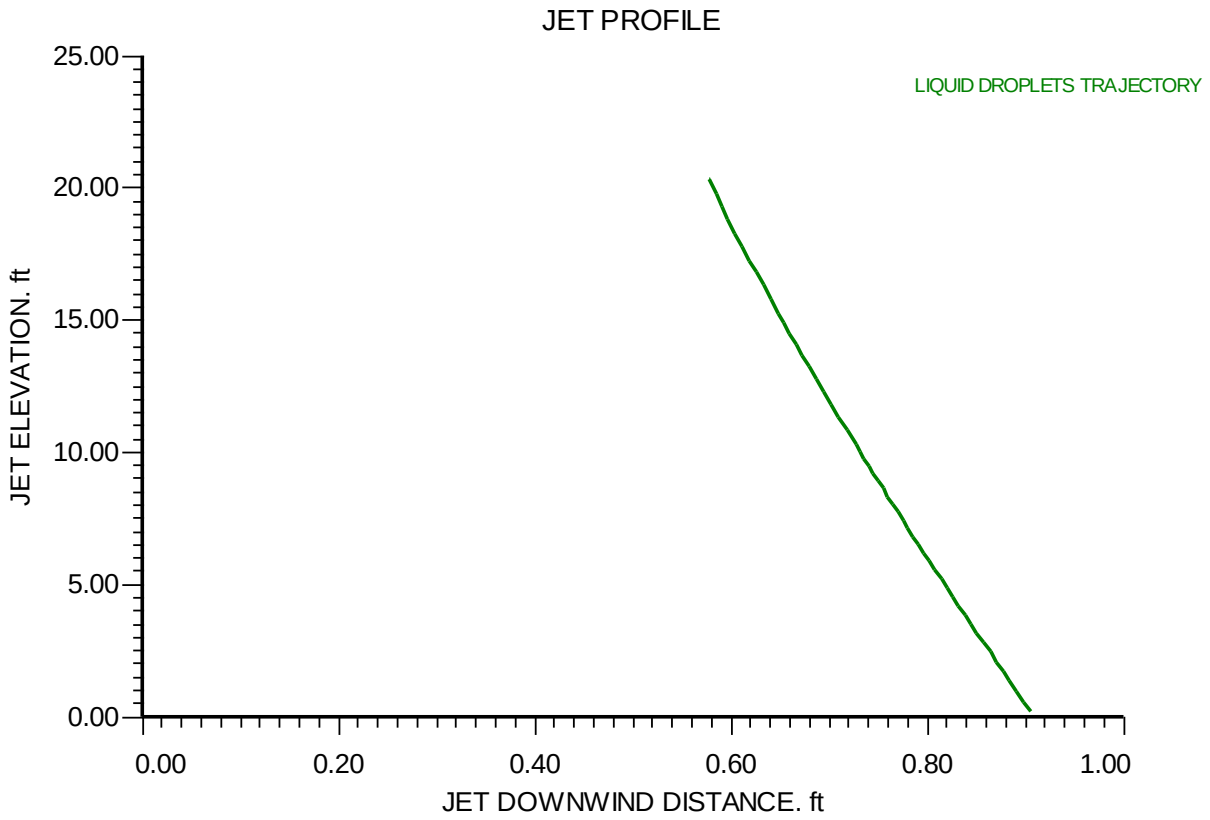


Figure 18: Liquid Release Jet Profile – E-R-14 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

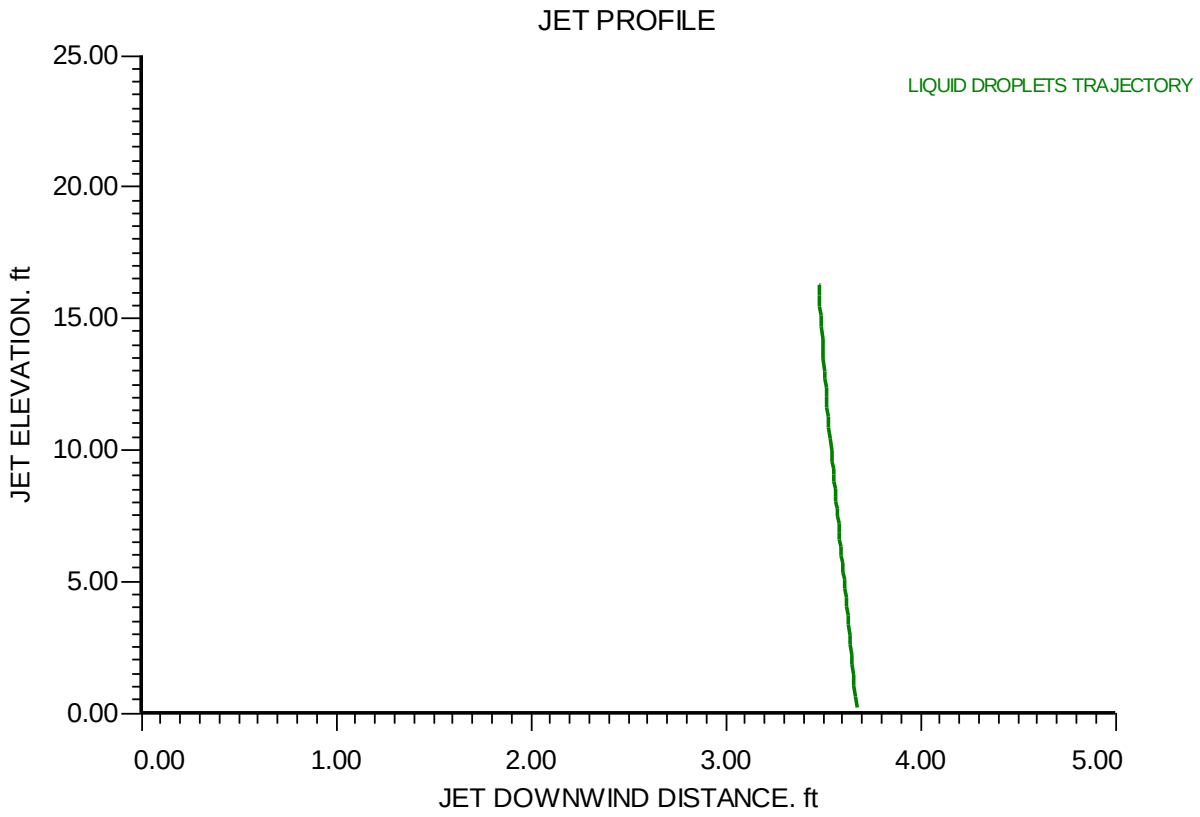


Figure 19: Liquid Release Jet Profile – E-R-14 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

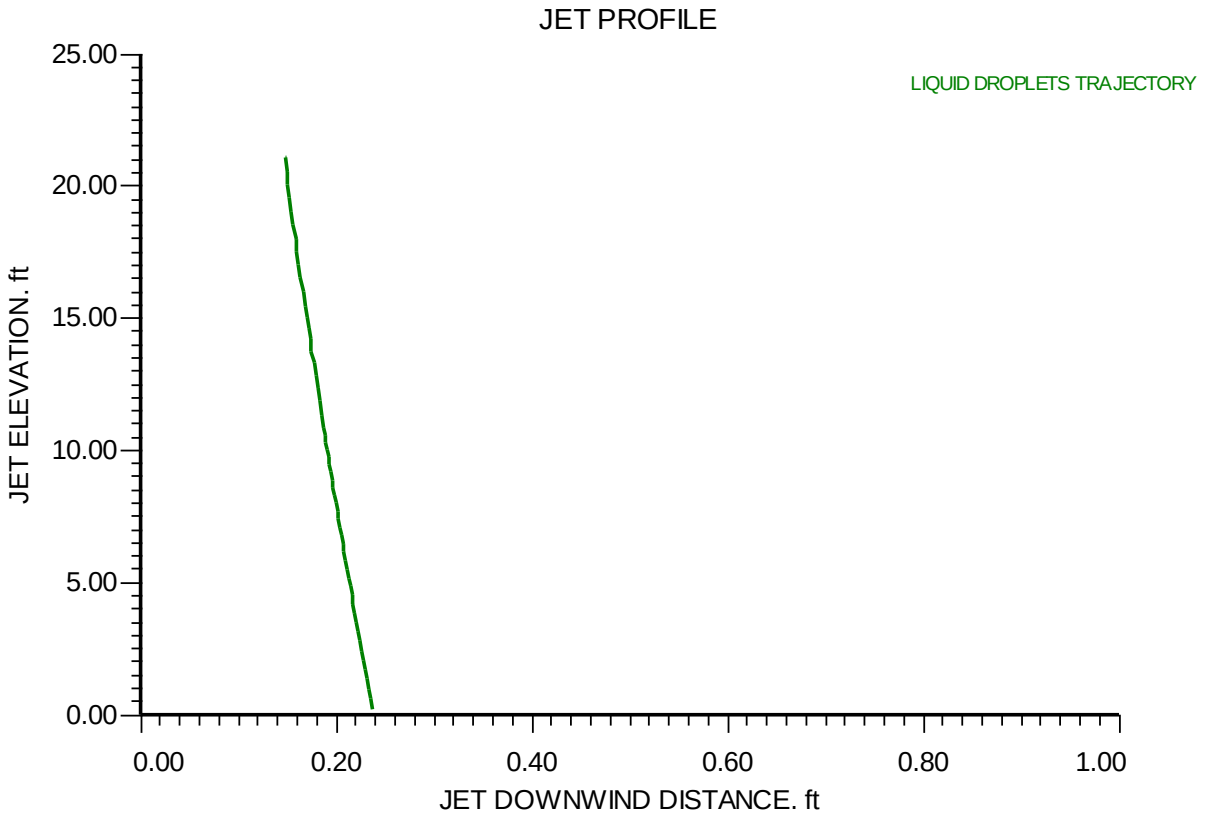


Figure 20: Liquid Release Jet Profile – E-R-14 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

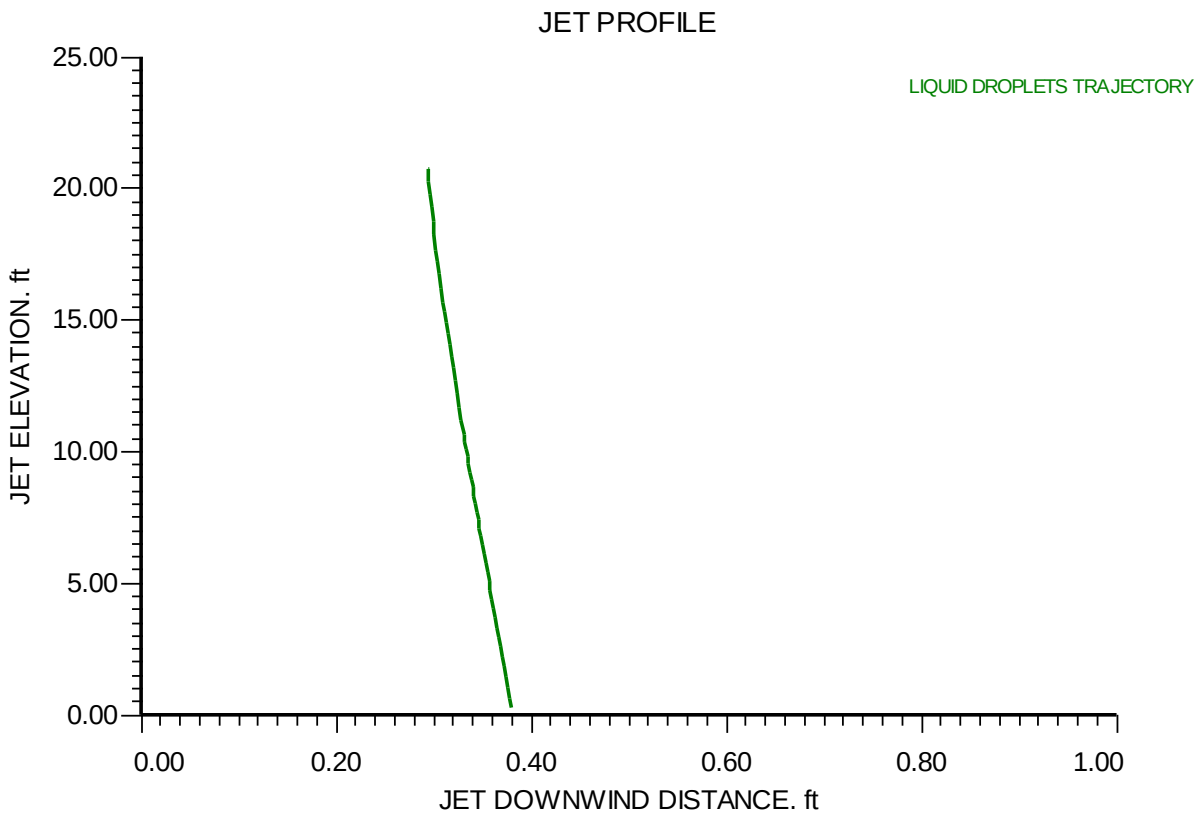


Figure 21: Liquid Release Jet Profile – E-R-14 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

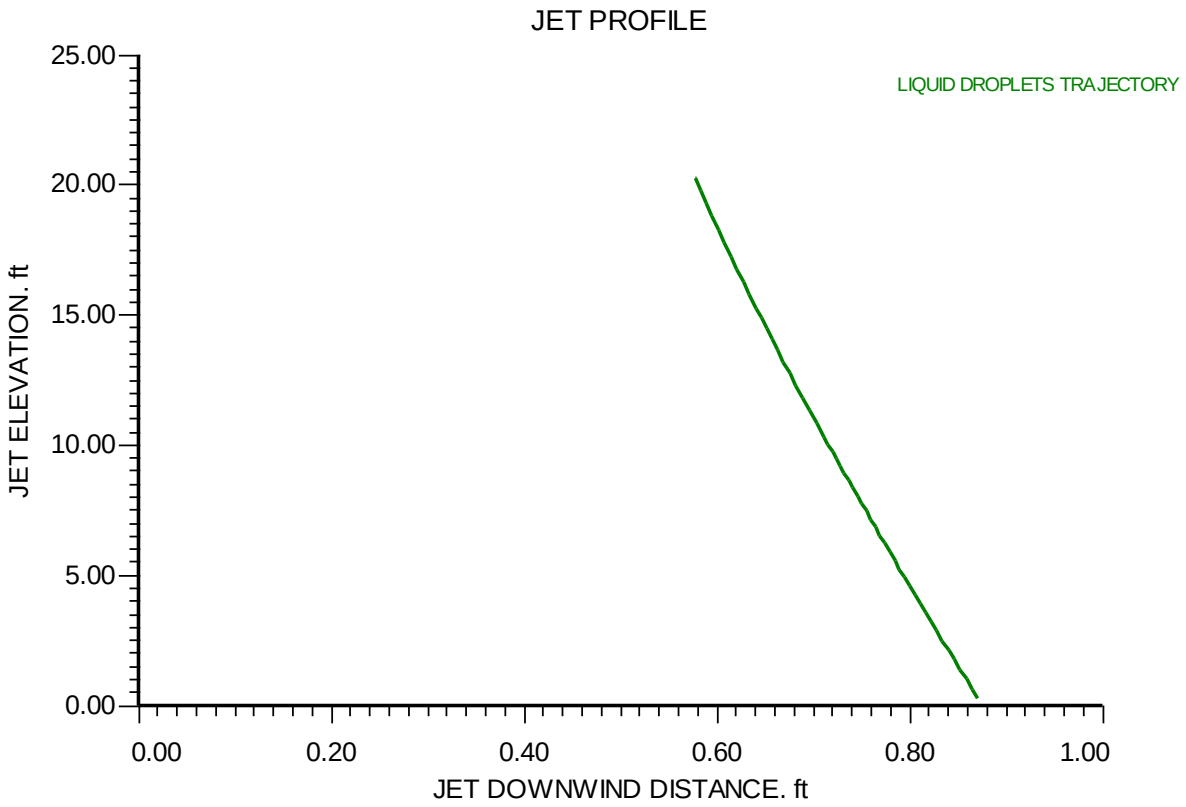


Figure 22: Liquid Release Jet Profile – E-R-14 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

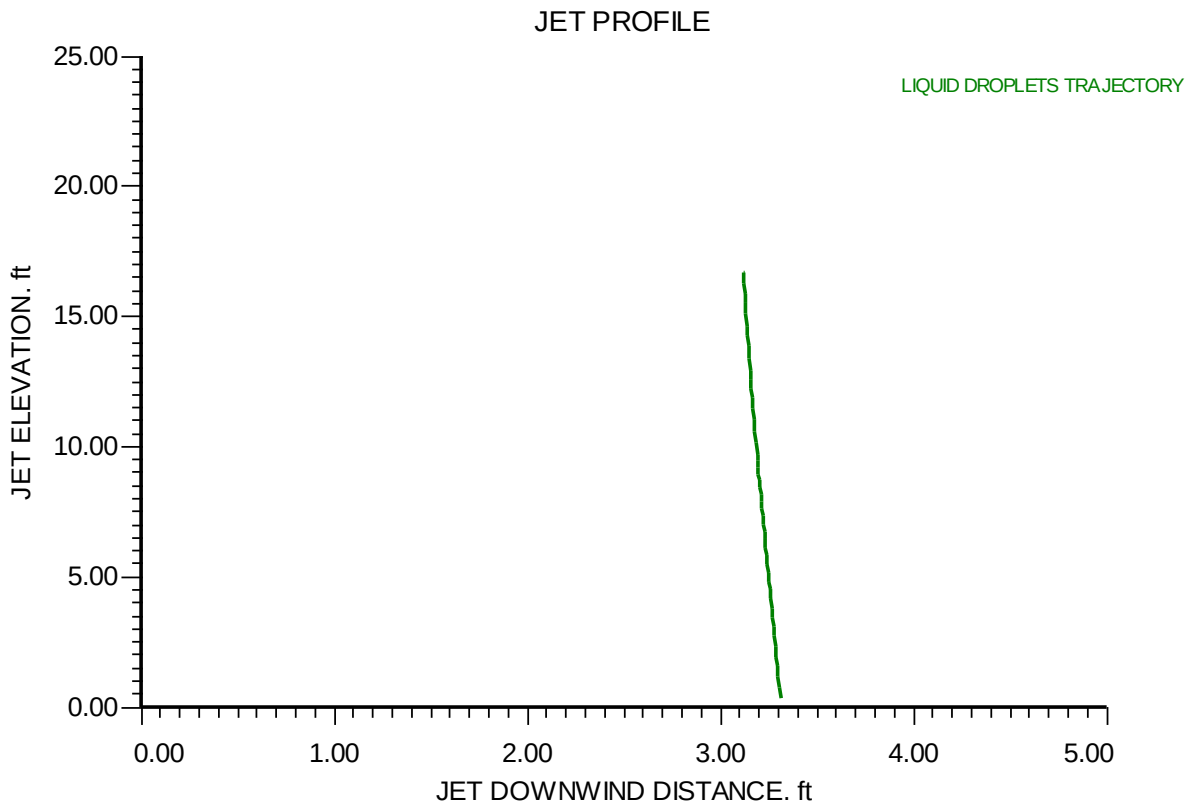


Figure 23: Liquid Release Jet Profile – E-R-14 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

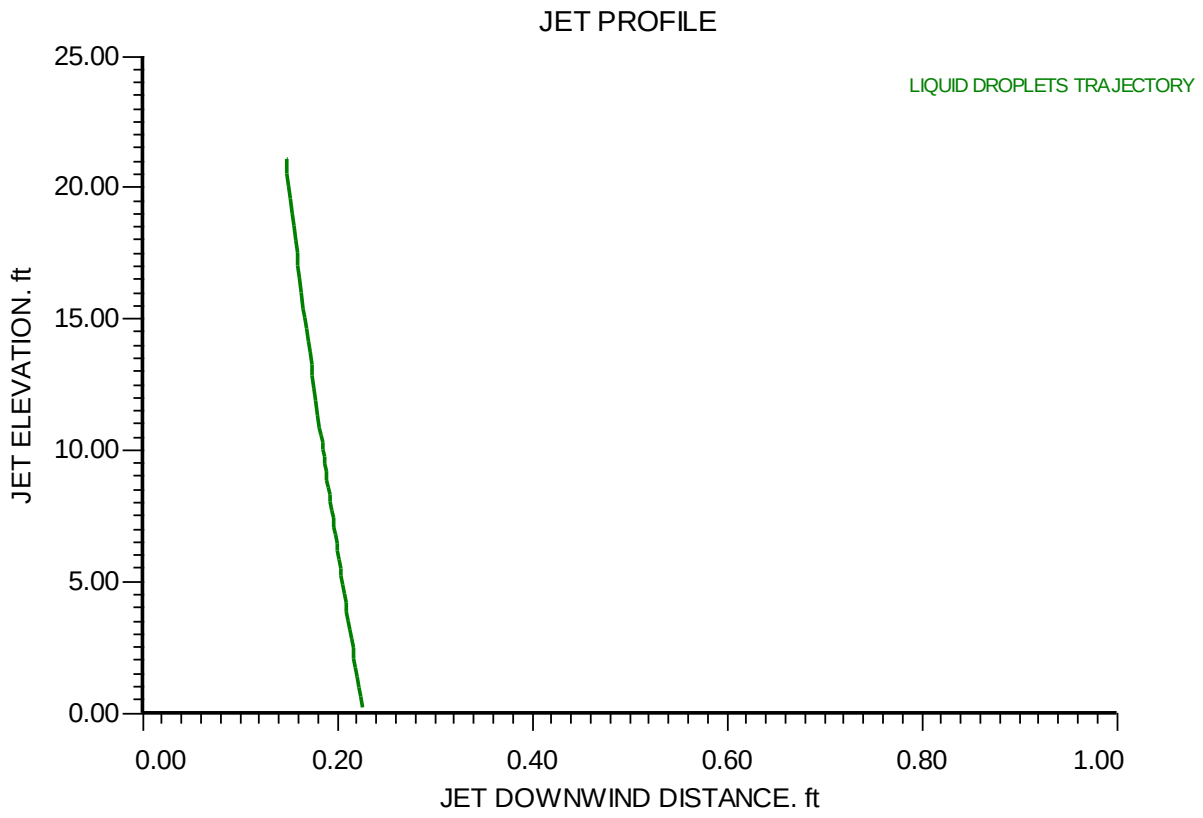


Figure 24: Liquid Release Jet Profile – E-R-14 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F

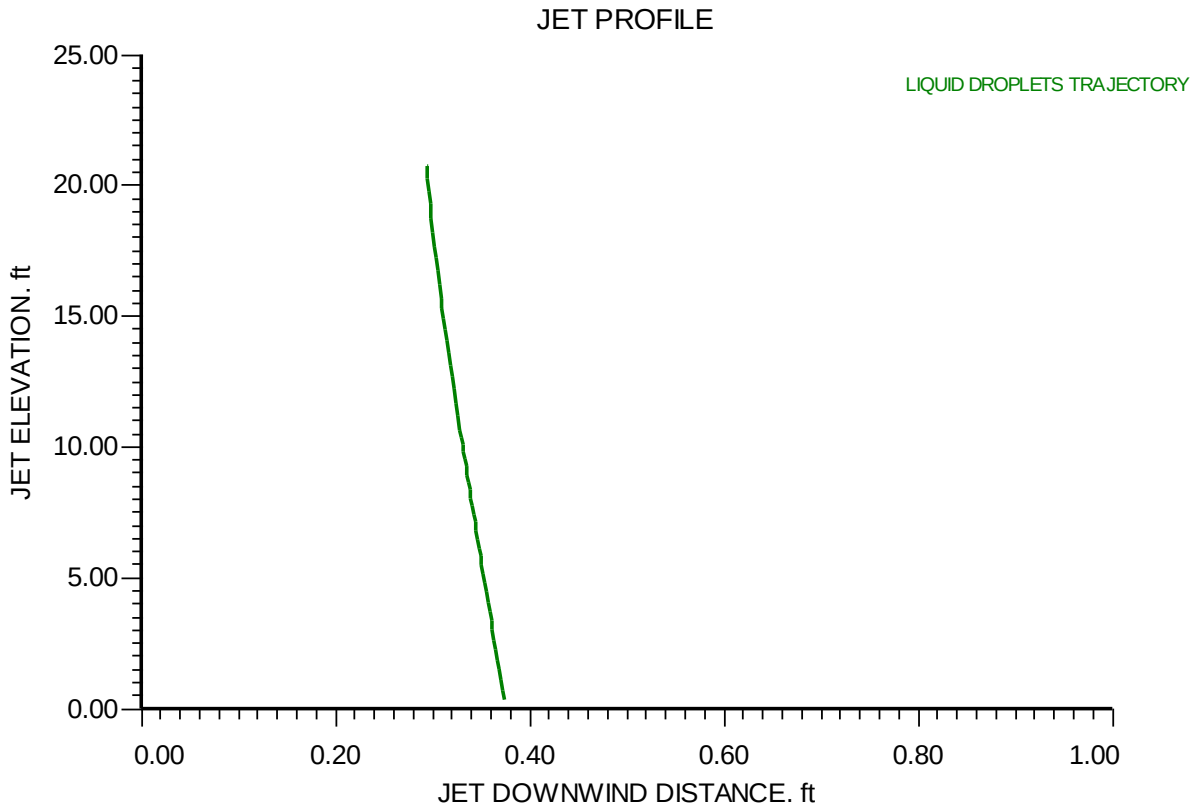


Figure 25: Liquid Release Jet Profile – E-R-14 Layout – 50% Reacted; D5 Stability Class; 20 psig and 205°F

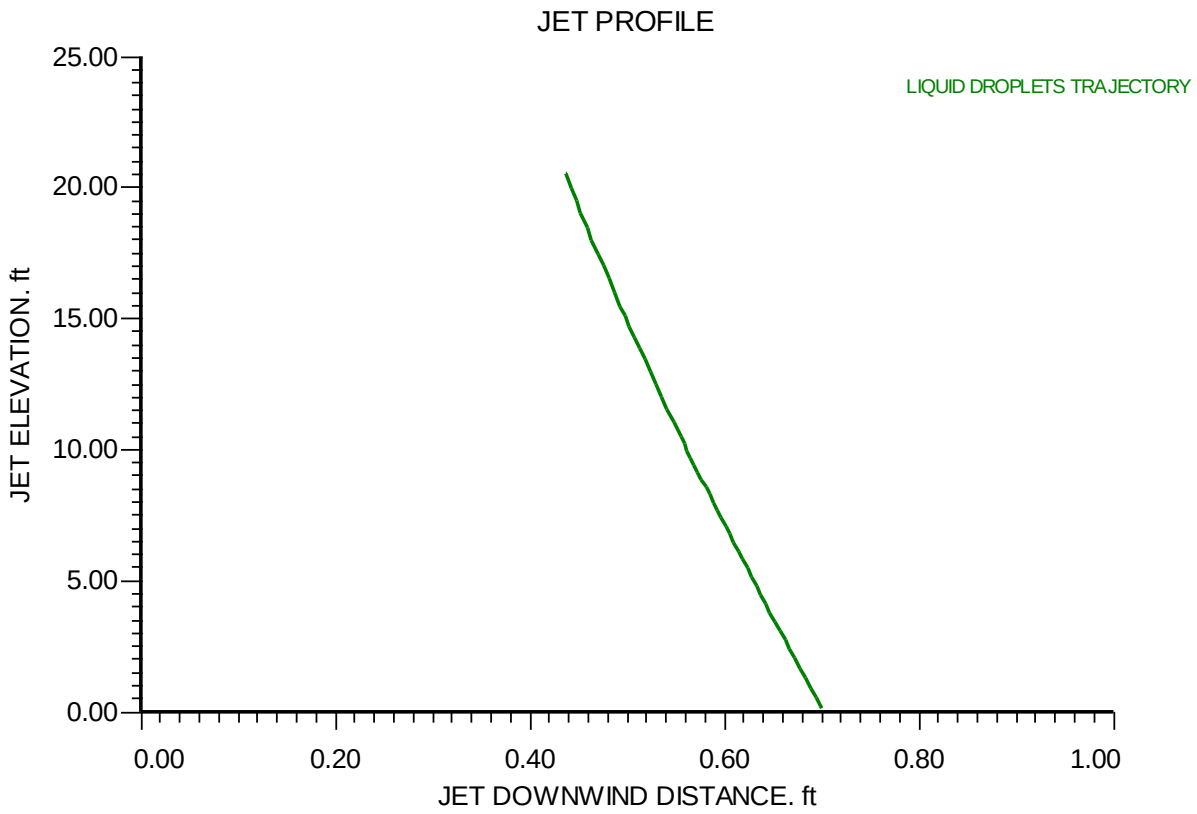


Figure 26: Liquid Release Jet Profile – E-R-14 Layout – 50% Reacted; F2 Stability Class; 20 psig and 205°F

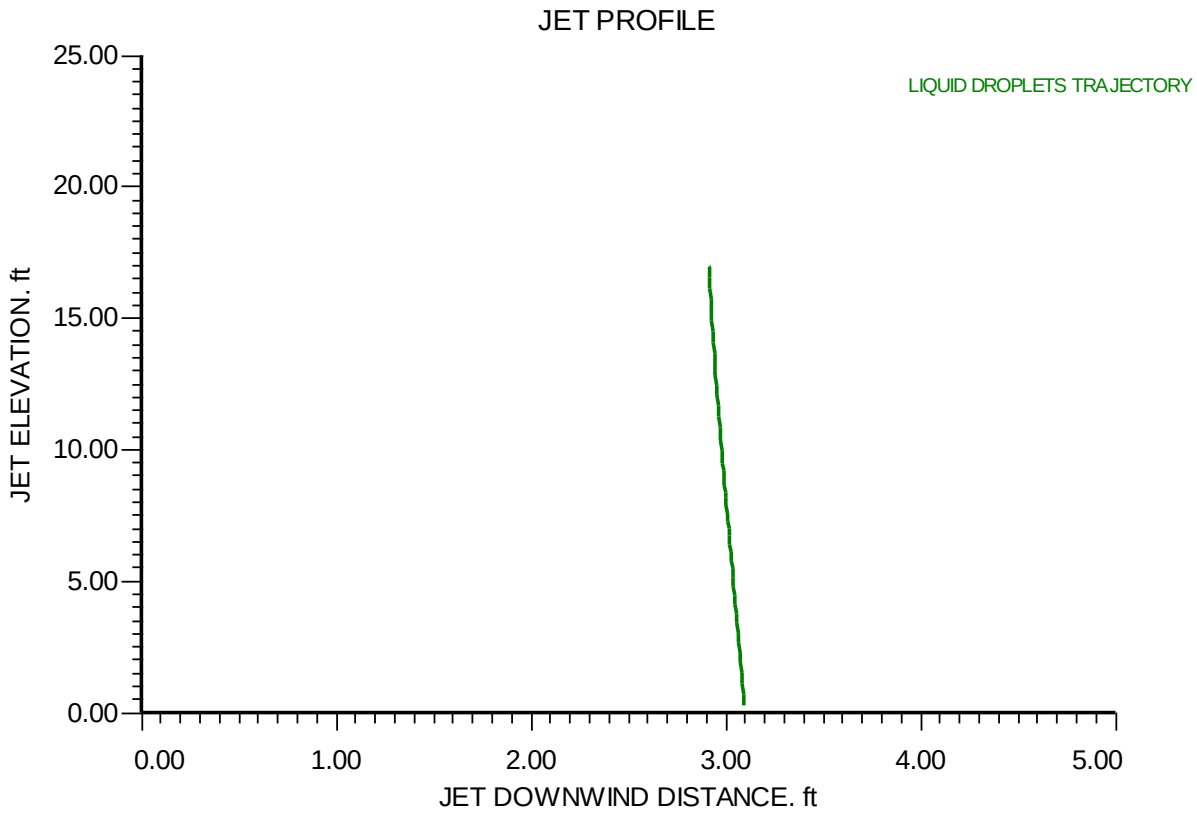


Figure 27: Liquid Release Jet Profile – E-R-14 Layout – 50% Reacted; D5 Stability Class; 5 psig and 210°F

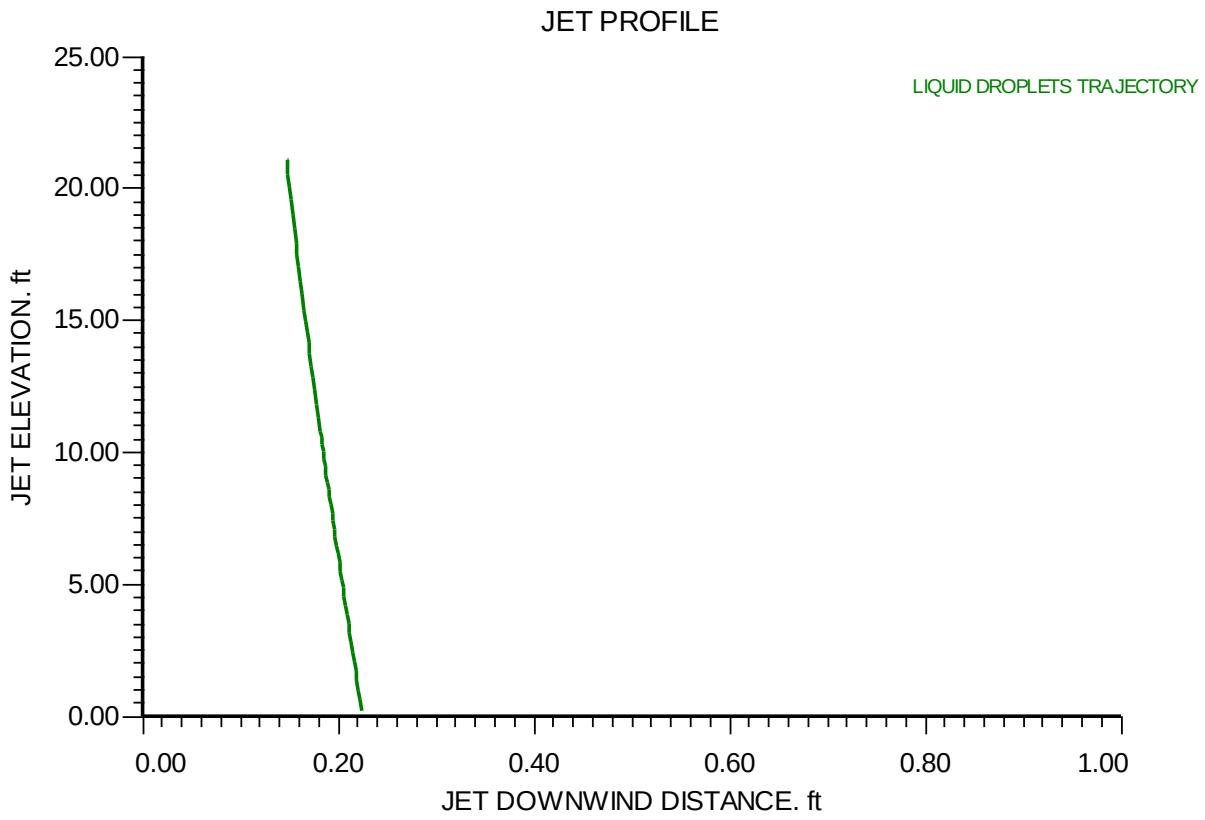


Figure 28: Liquid Release Jet Profile – E-R-14 Layout – 50% Reacted; F2 Stability Class; 5 psig and 210°F

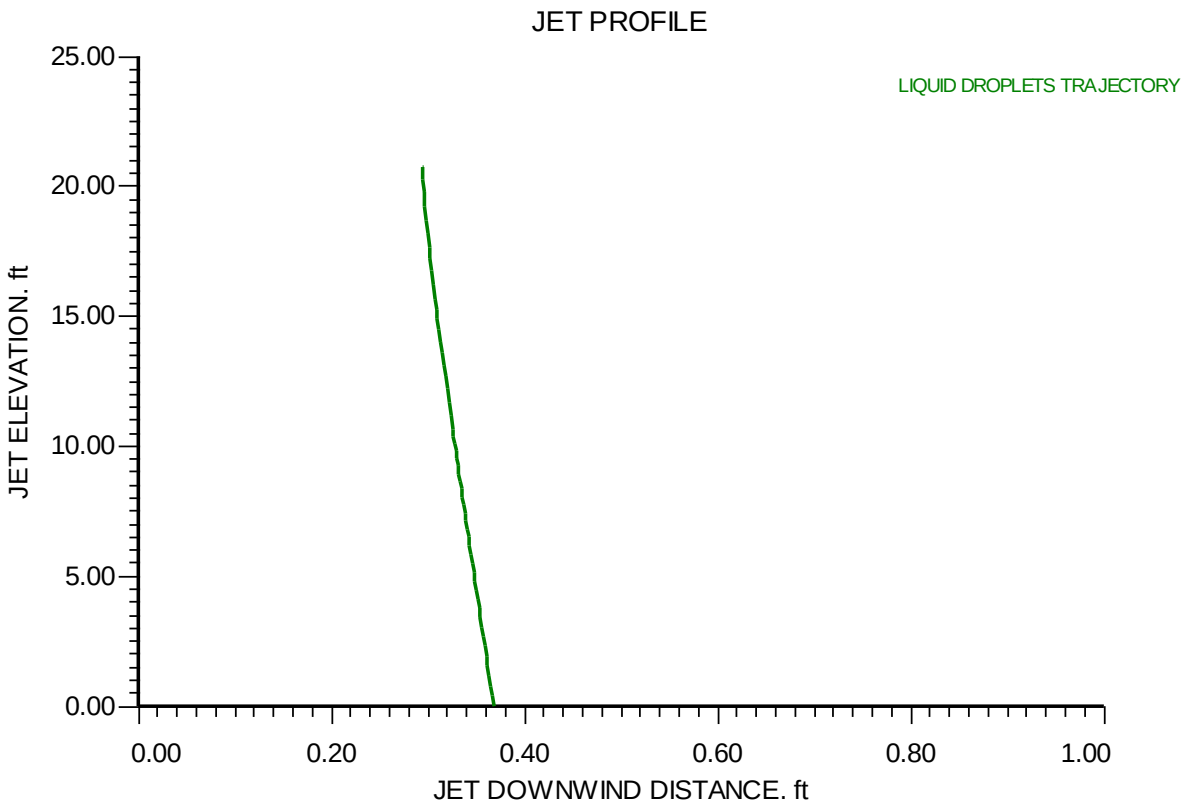


Figure 29: Liquid Release Jet Profile – E-R-14 Layout – 75% Reacted; D5 Stability Class; 20 psig and 205°F

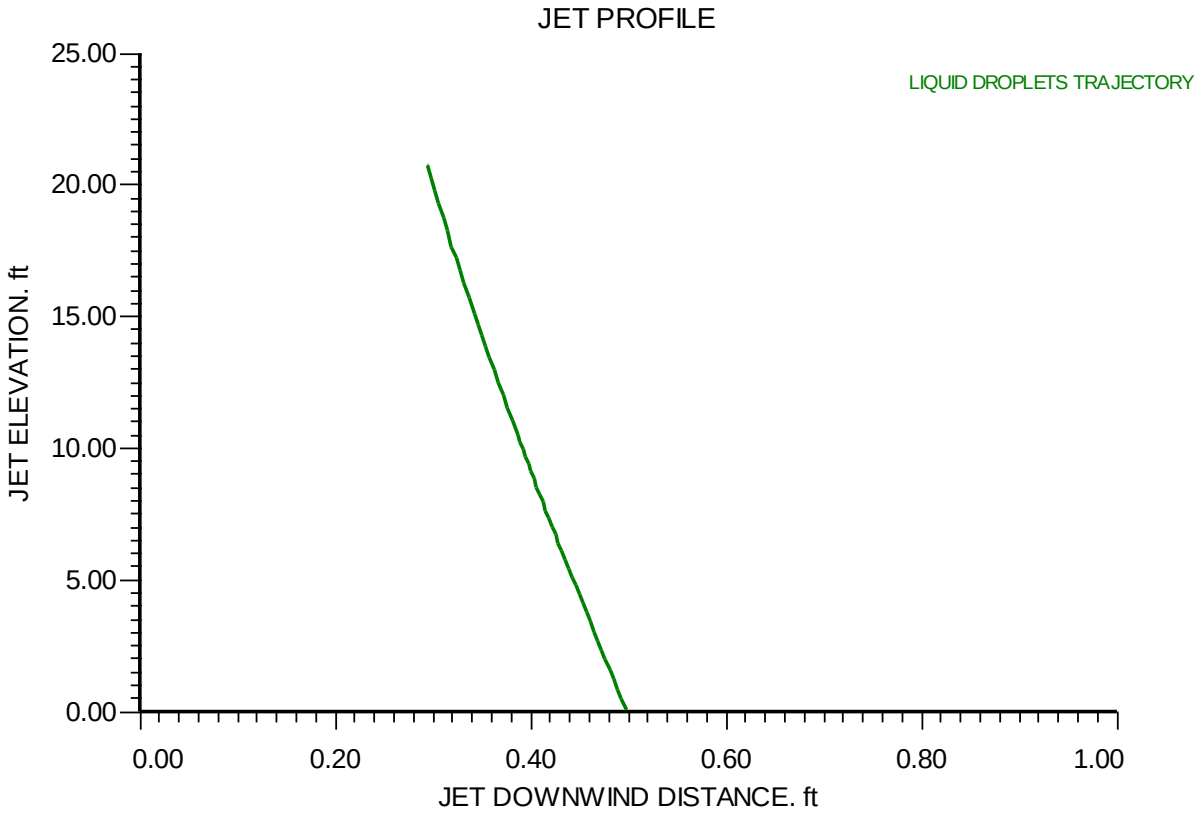


Figure 30: Liquid Release Jet Profile – E-R-14 Layout – 75% Reacted; F2 Stability Class; 20 psig and 205°F

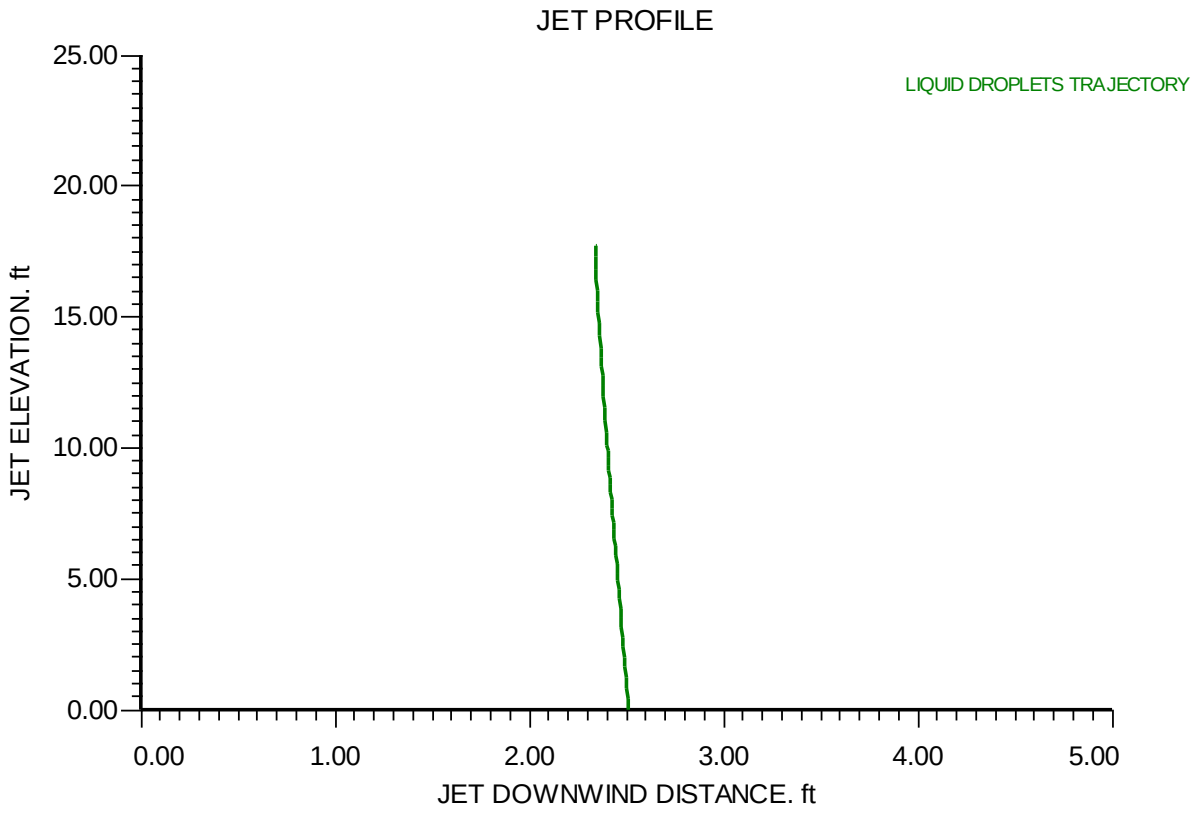


Figure 31: Liquid Release Jet Profile – E-R-14 Layout – 75% Reacted; D5 Stability Class; 5 psig and 210°F

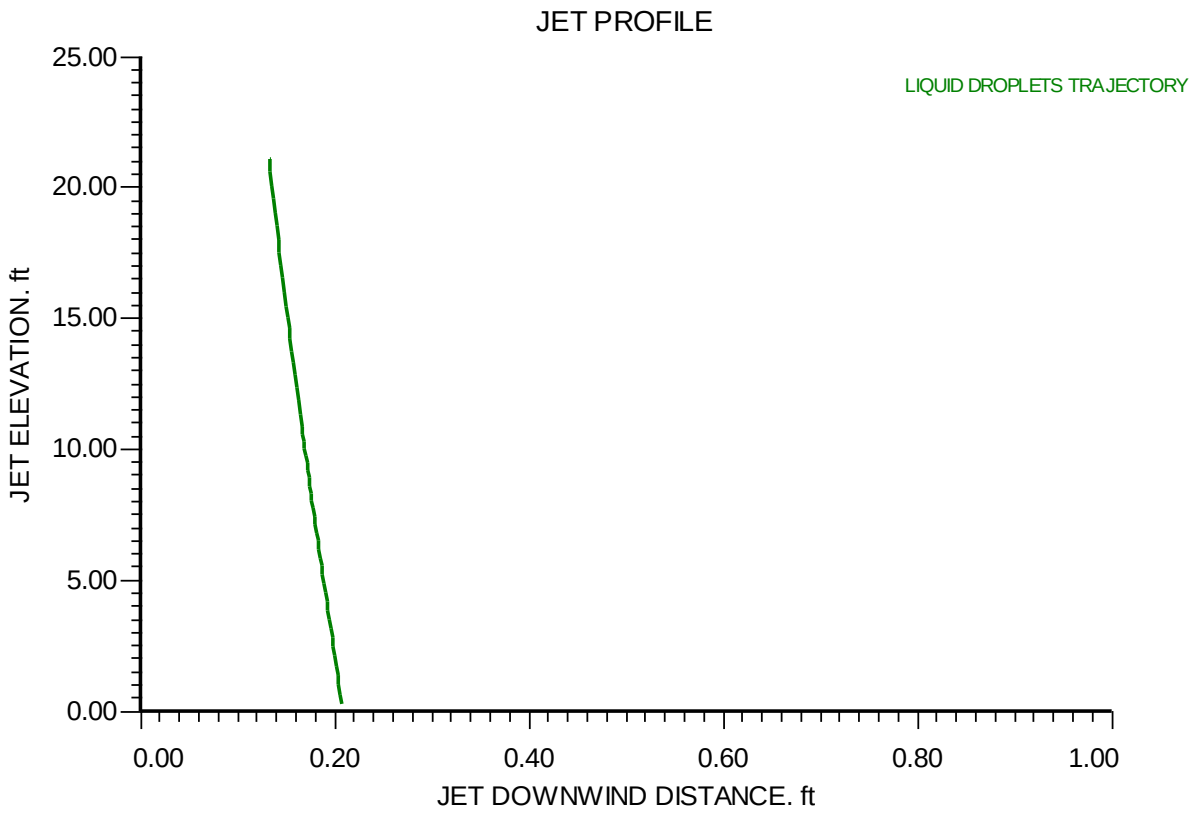


Figure 32: Liquid Release Jet Profile – E-R-14 Layout – 75% Reacted; F2 Stability Class; 5 psig and 210°F

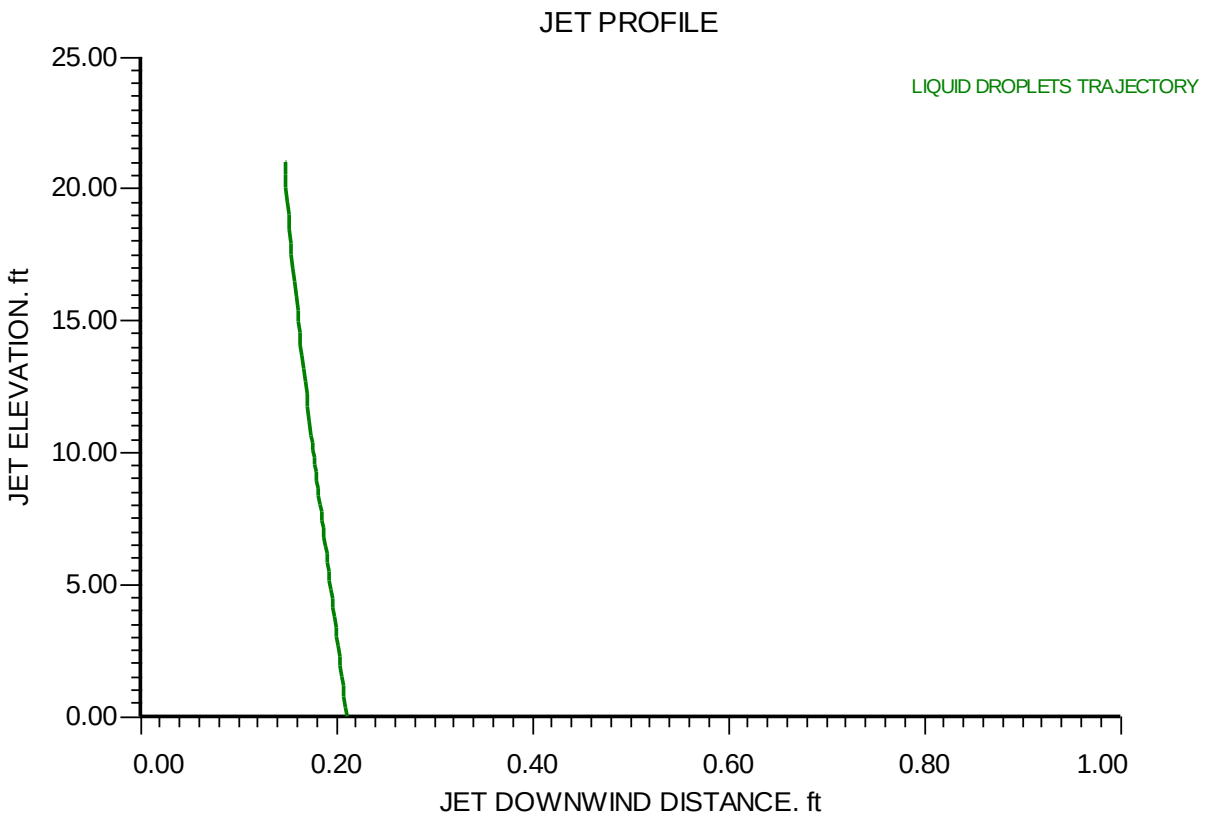


Figure 33: Liquid Release Jet Profile – E-R-14 Layout – 100% Reacted; D5 Stability Class; 20 psig and 205°F

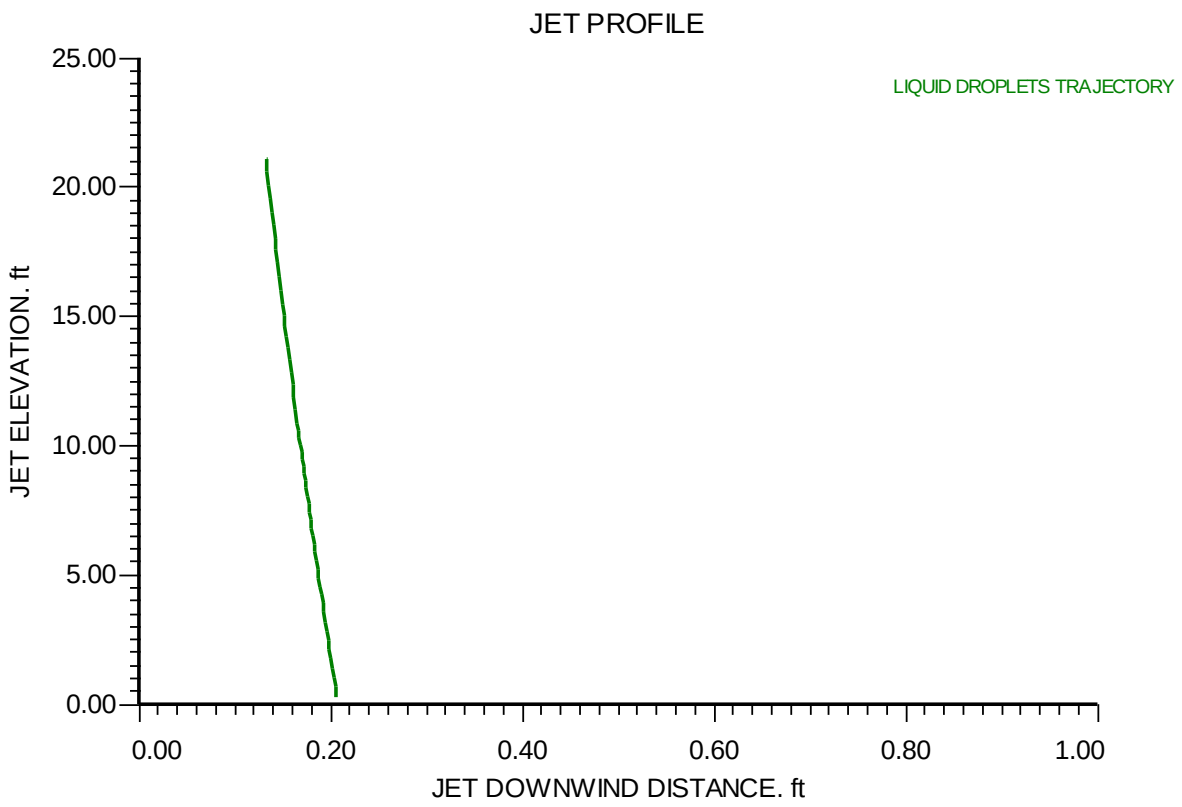
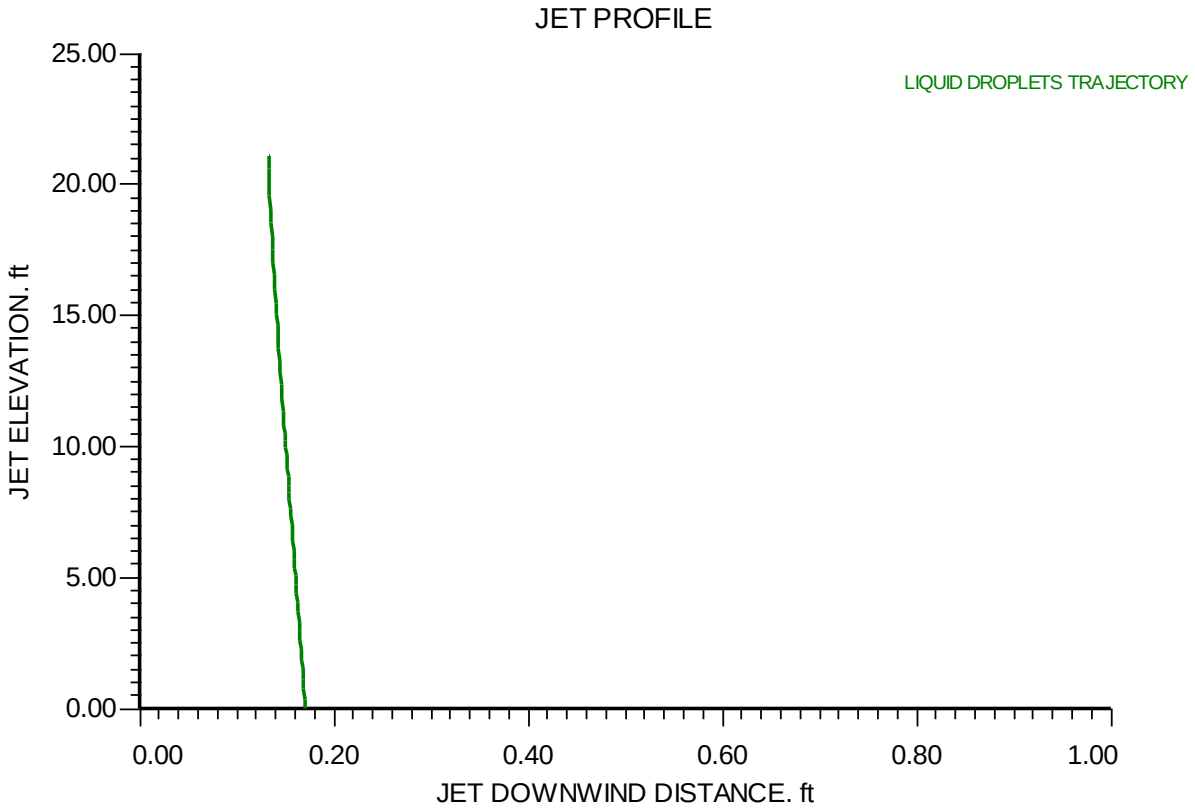


Figure 34: Liquid Release Jet Profile – E-R-14 Layout – 100% Reacted; F2 Stability Class; 20 psig and 205°F



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ATTORNEY-CLIENT PRIVELEGE AND/OR ATTORNEY WORK PRODUCT

Figure 35: Liquid Release Jet Profile – E-R-14 Layout – 100% Reacted; D5 Stability Class; 5 psig and 210°F

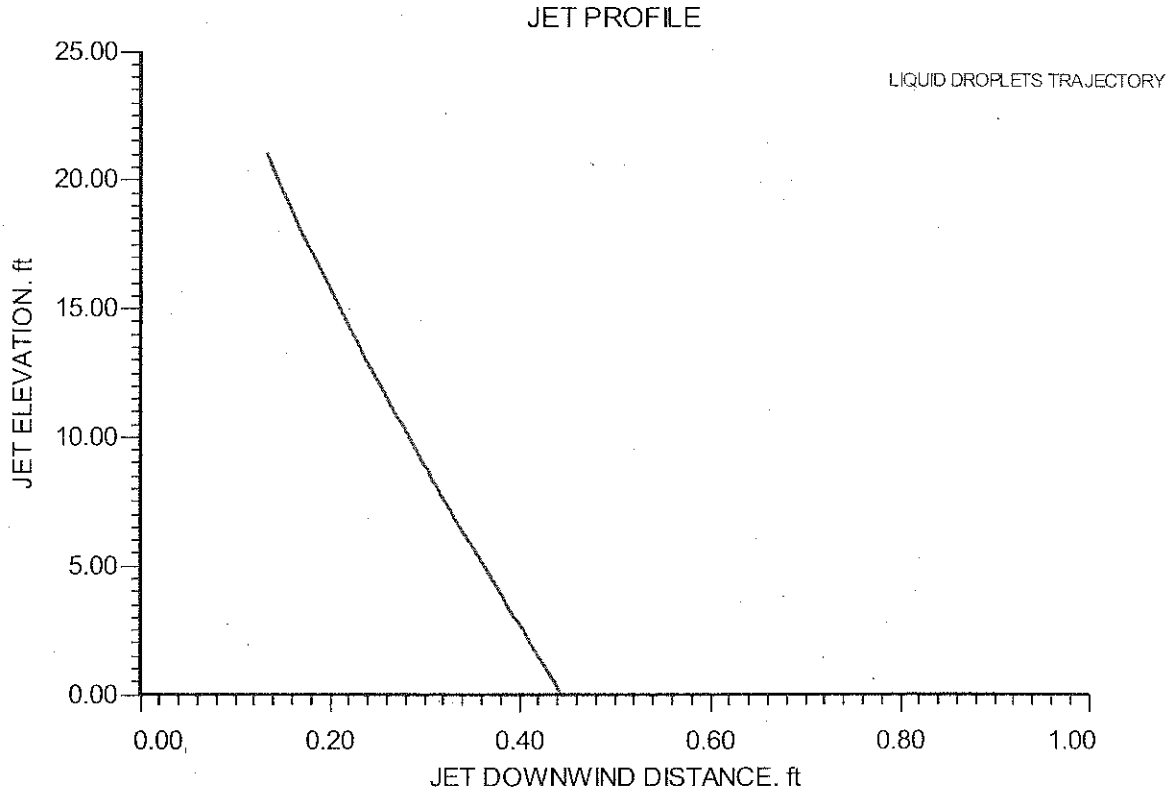
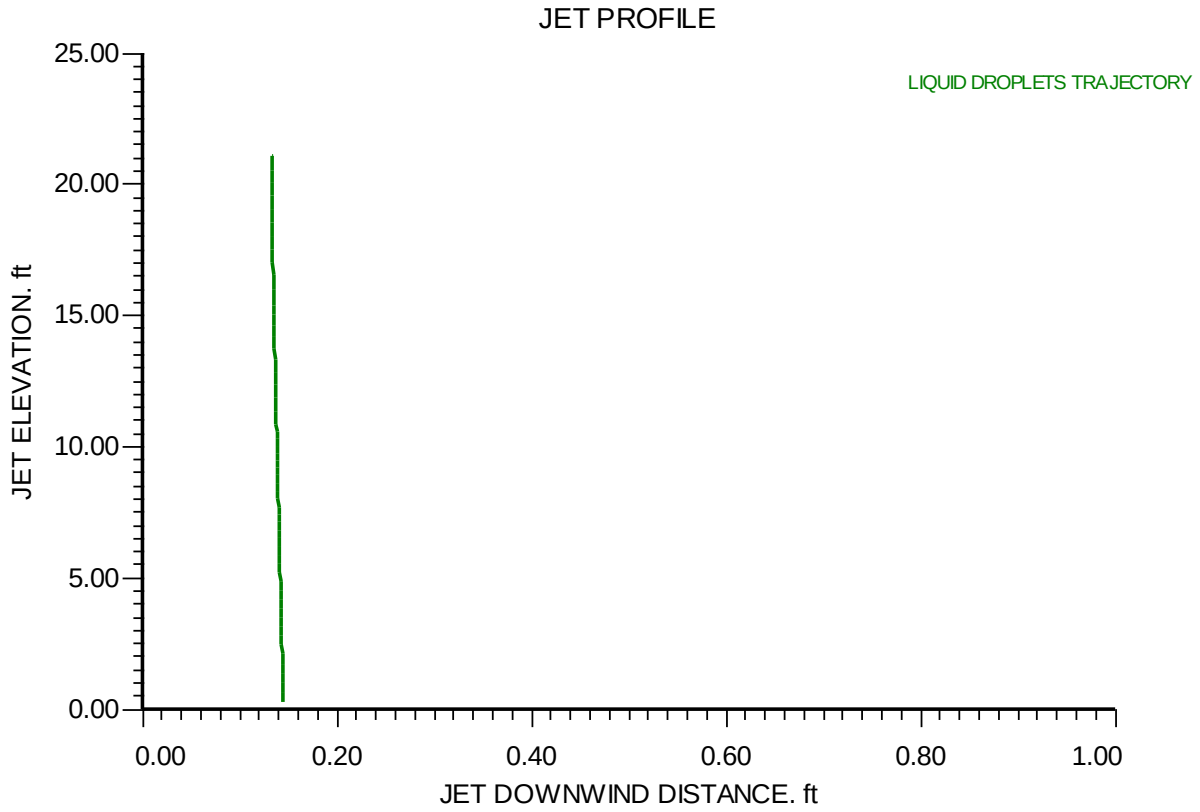


Figure 36: Liquid Release Jet Profile – E-R-14 Layout – 100% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix D: Results – E-R-15 Piping Layout to Pit – Liquid Release Jet Profile

Figure 37: Liquid Release Jet Profile – E-R-15 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

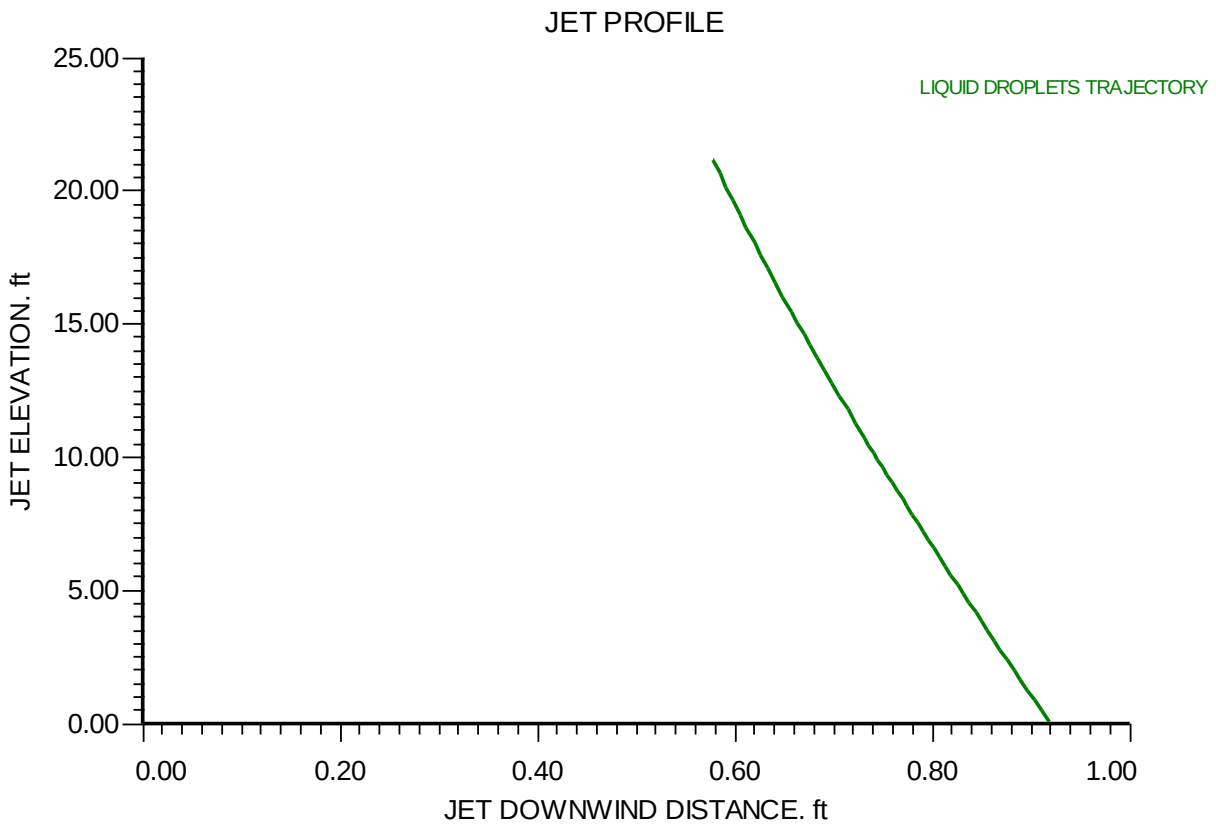


Figure 38: Liquid Release Jet Profile – E-R-15 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

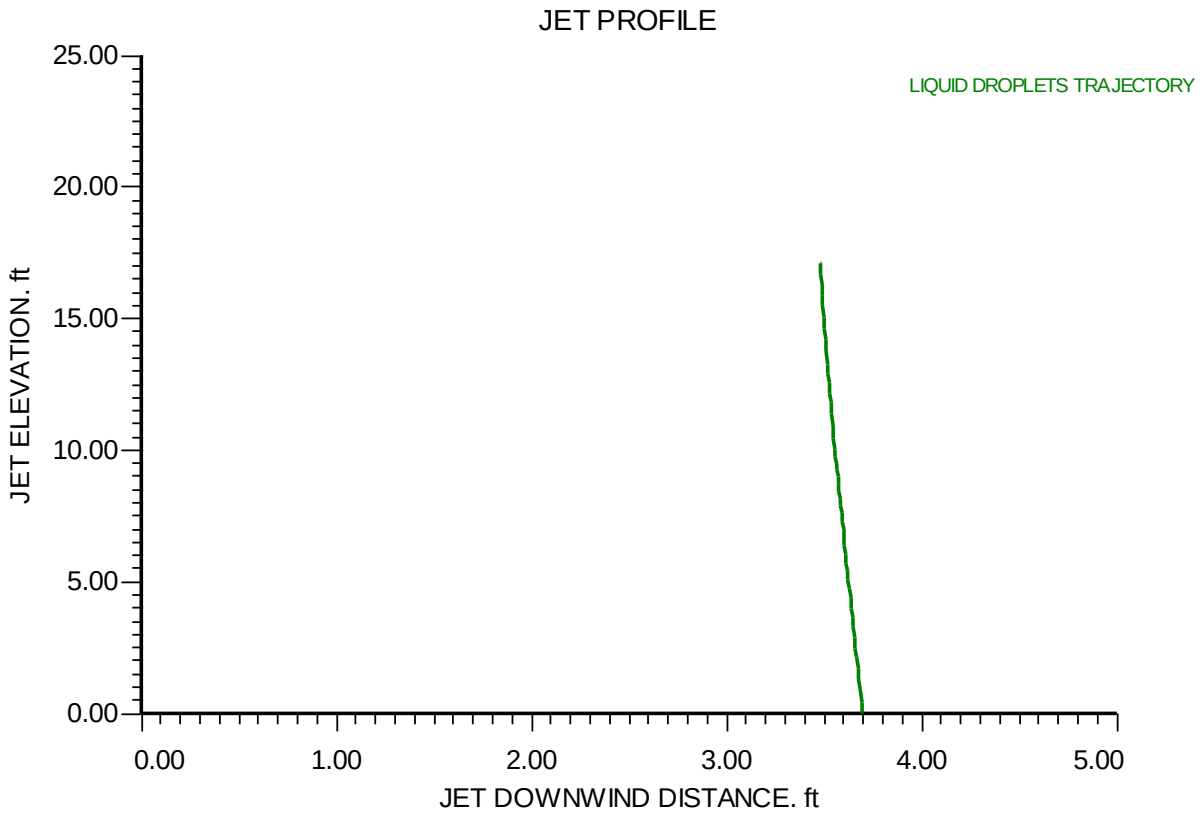


Figure 39: Liquid Release Jet Profile – E-R-15 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

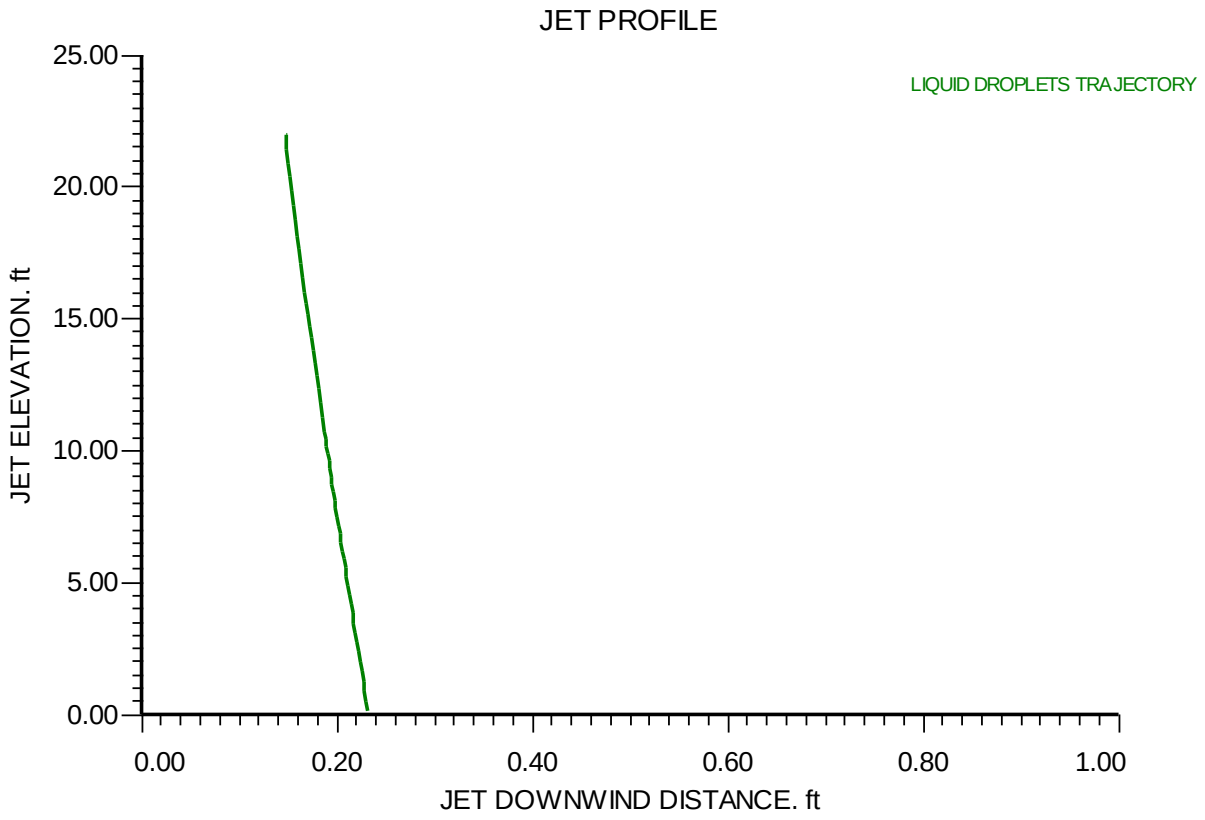


Figure 40: Liquid Release Jet Profile – E-R-15 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

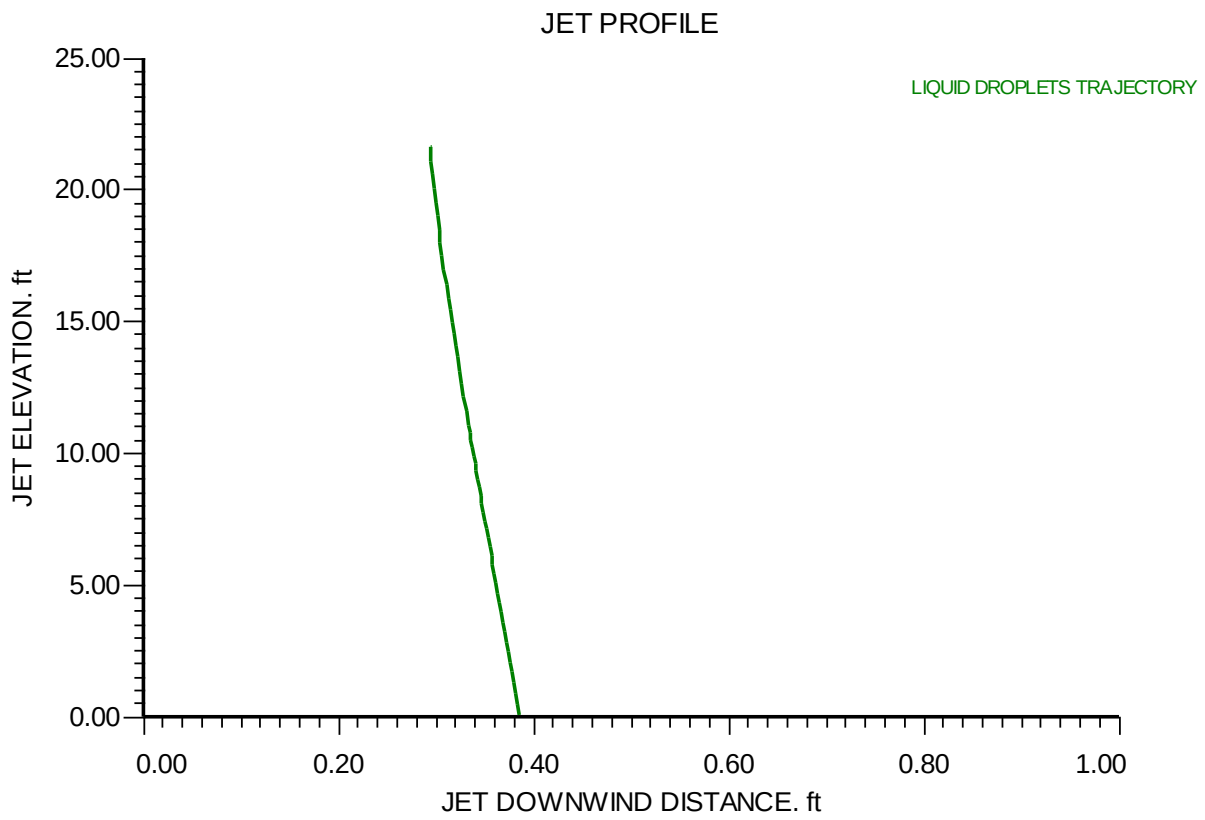


Figure 41: Liquid Release Jet Profile – E-R-15 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

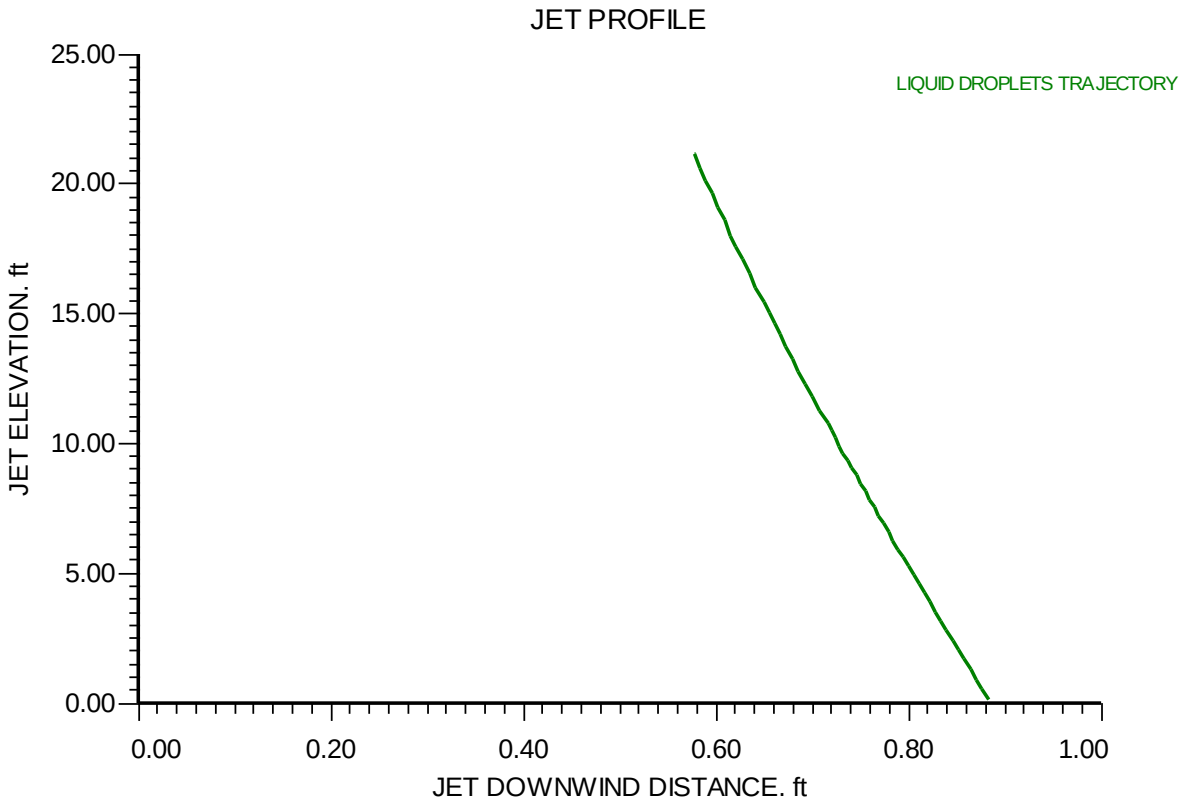


Figure 42: Liquid Release Jet Profile – E-R-15 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

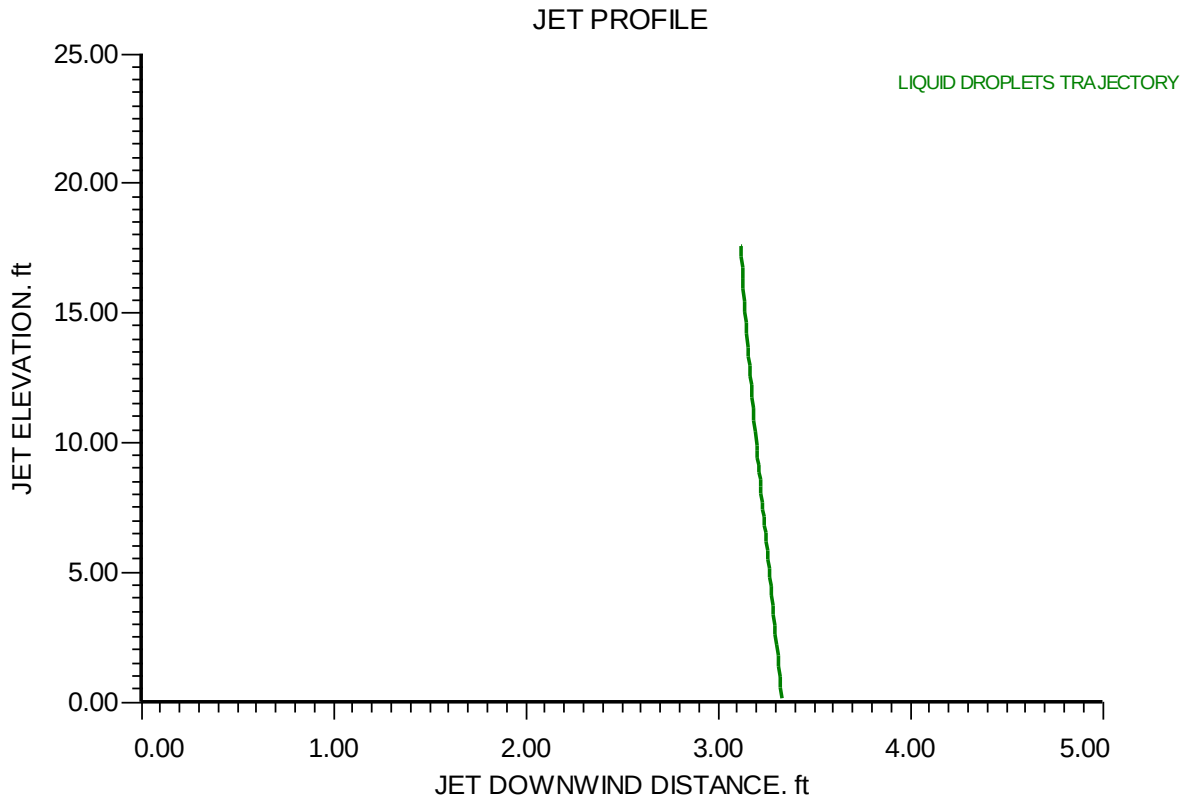


Figure 43: Liquid Release Jet Profile – E-R-15 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

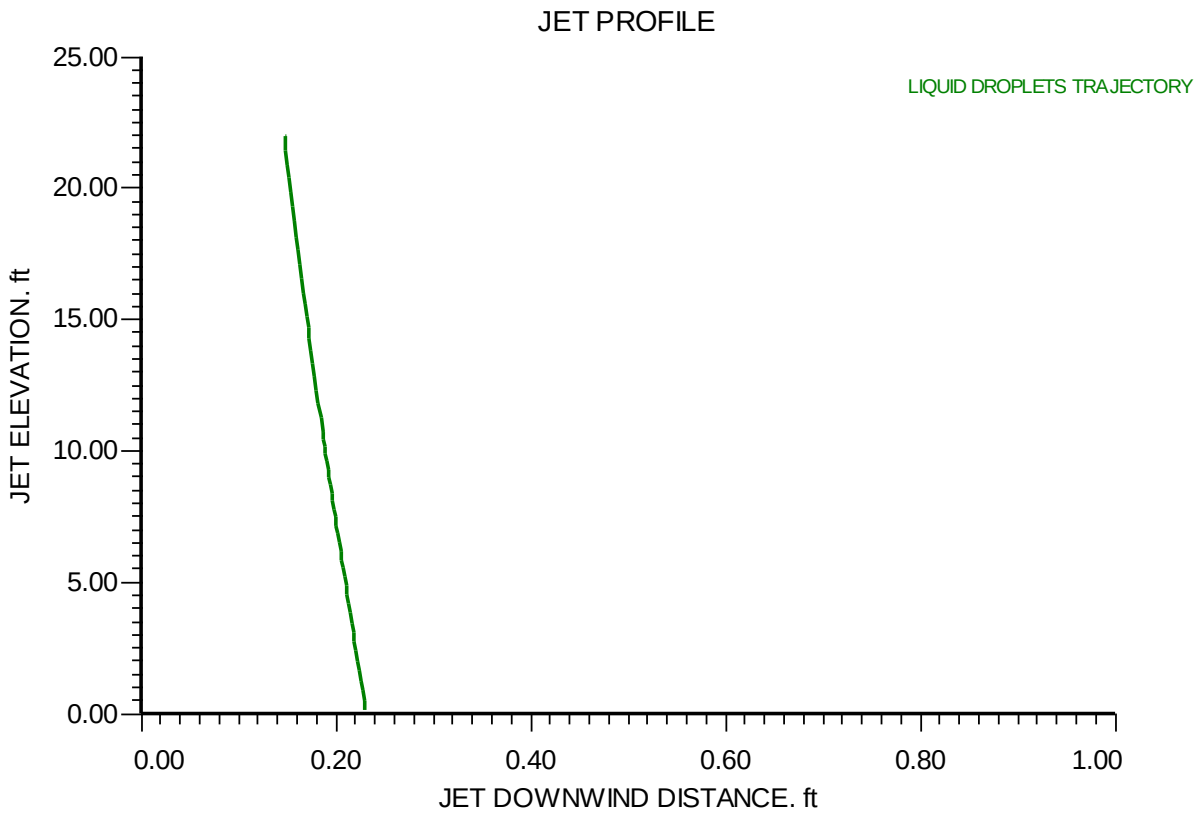


Figure 44: Liquid Release Jet Profile – E-R-15 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F

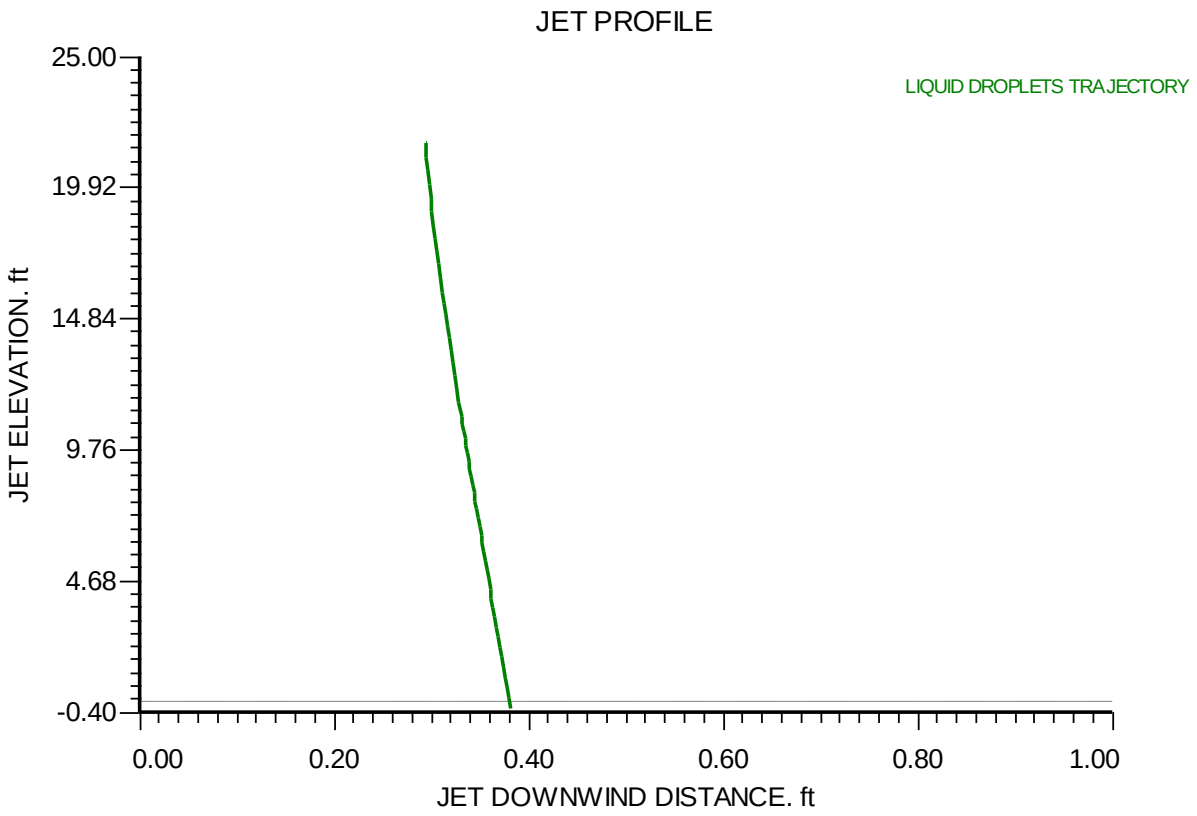


Figure 45: Liquid Release Jet Profile – E-R-15 Layout – 50% Reacted; D5 Stability Class; 20 psig and 205°F

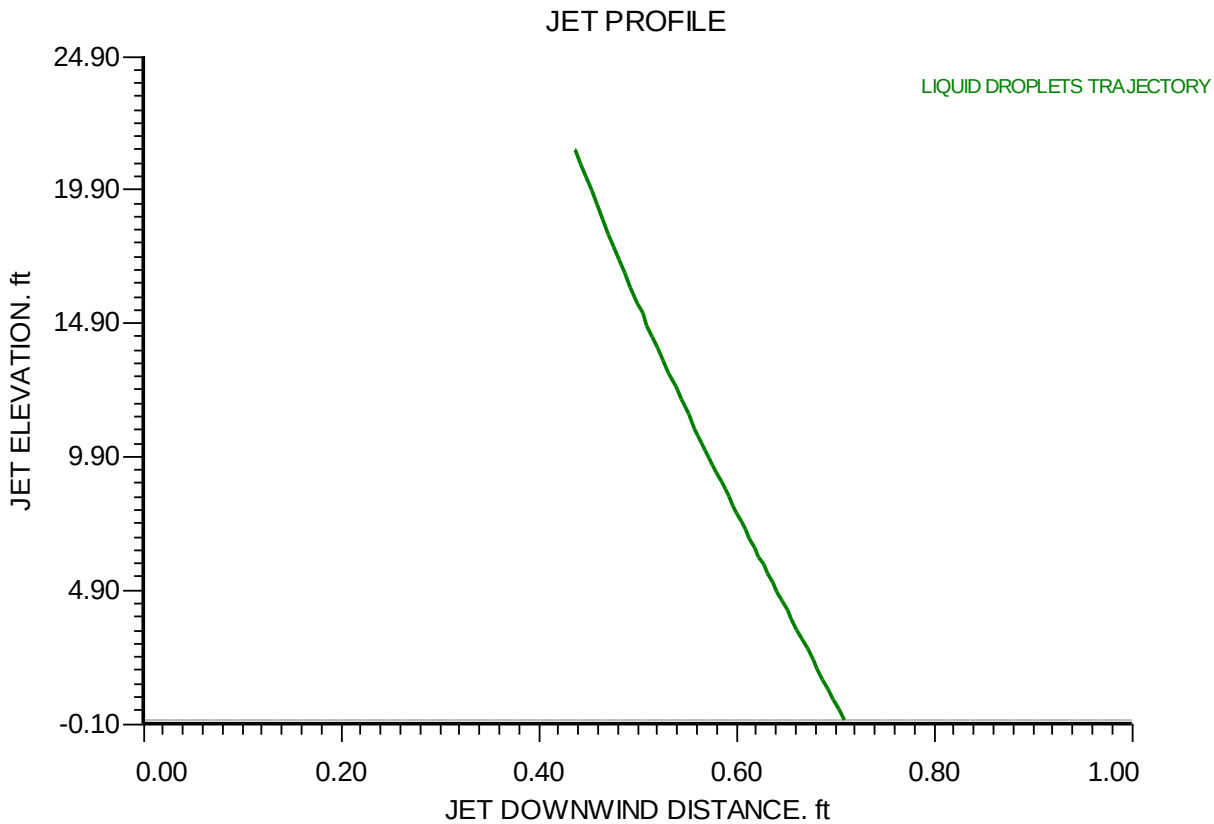


Figure 46: Liquid Release Jet Profile – E-R-15 Layout – 50% Reacted; F2 Stability Class; 20 psig and 205°F

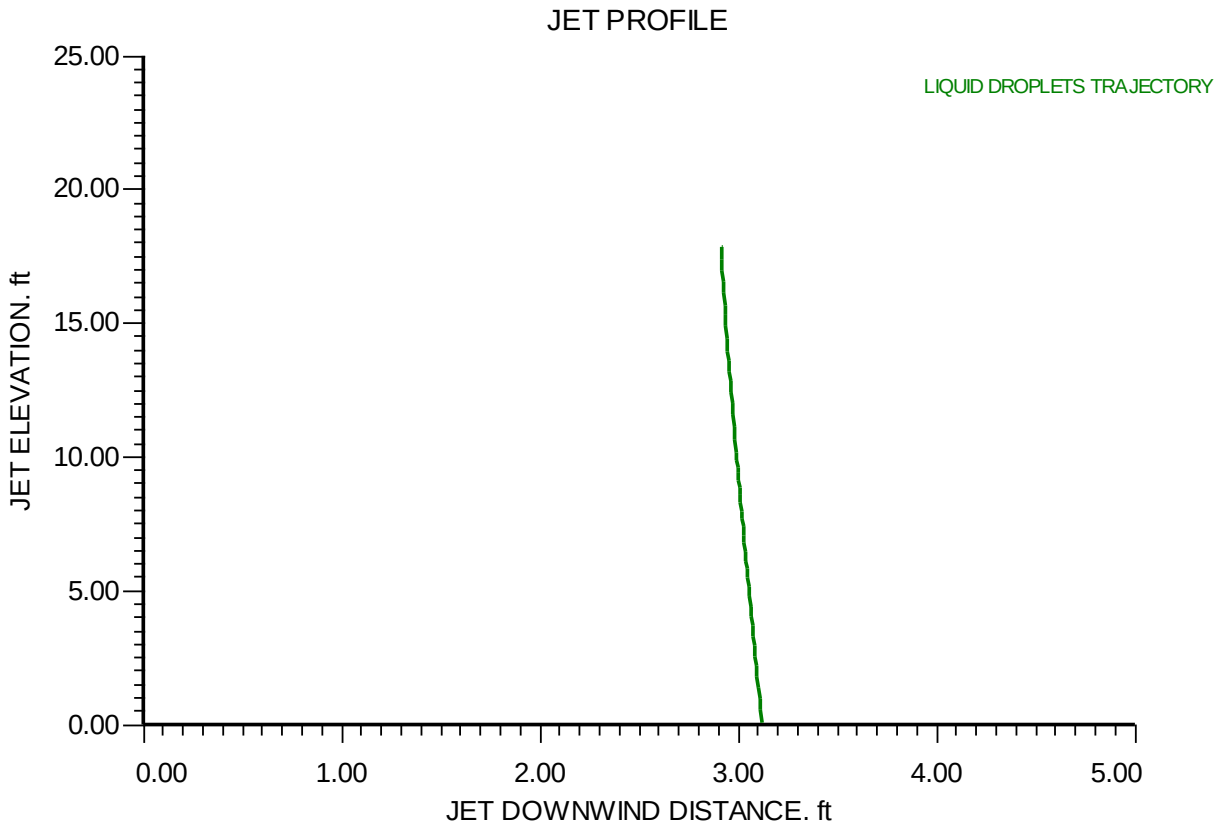


Figure 47: Liquid Release Jet Profile – E-R-15 Layout – 50% Reacted; D5 Stability Class; 5 psig and 210°F

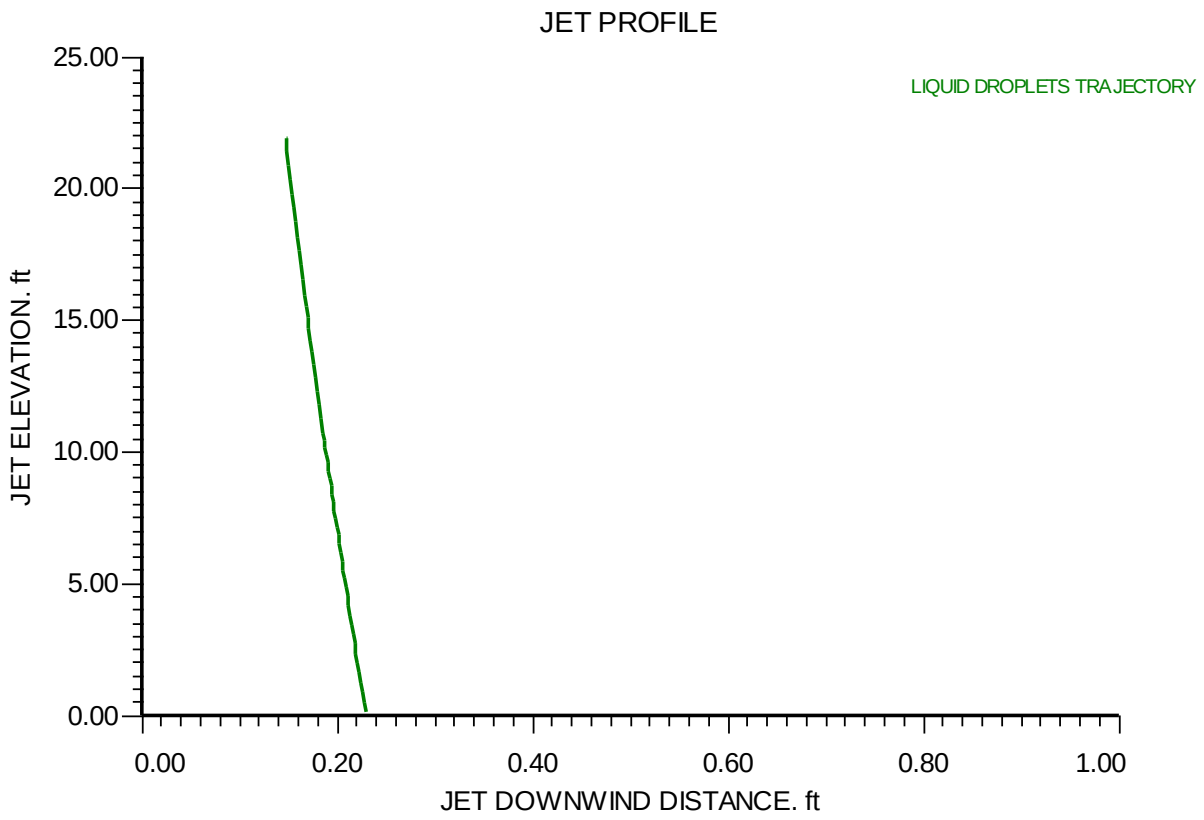


Figure 48: Liquid Release Jet Profile – E-R-15 Layout – 50% Reacted; F2 Stability Class; 5 psig and 210°F

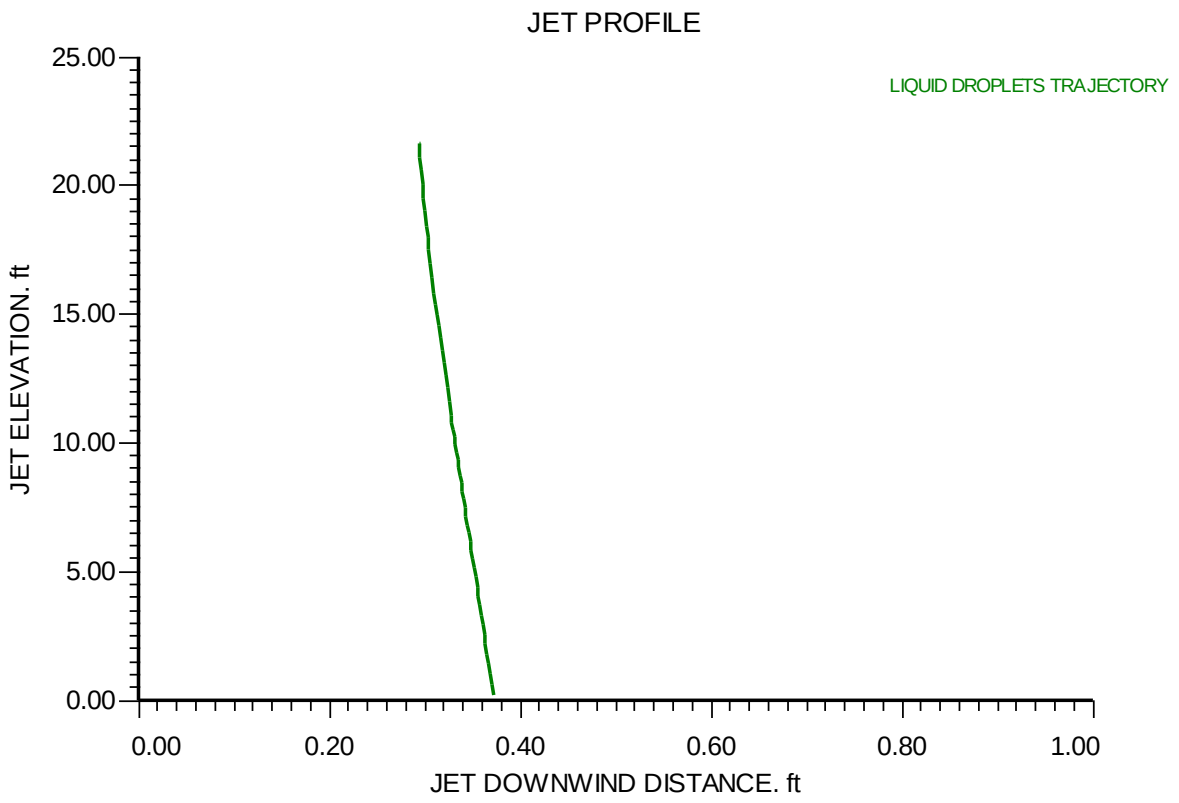


Figure 49: Liquid Release Jet Profile – E-R-15 Layout – 75% Reacted; D5 Stability Class; 20 psig and 205°F

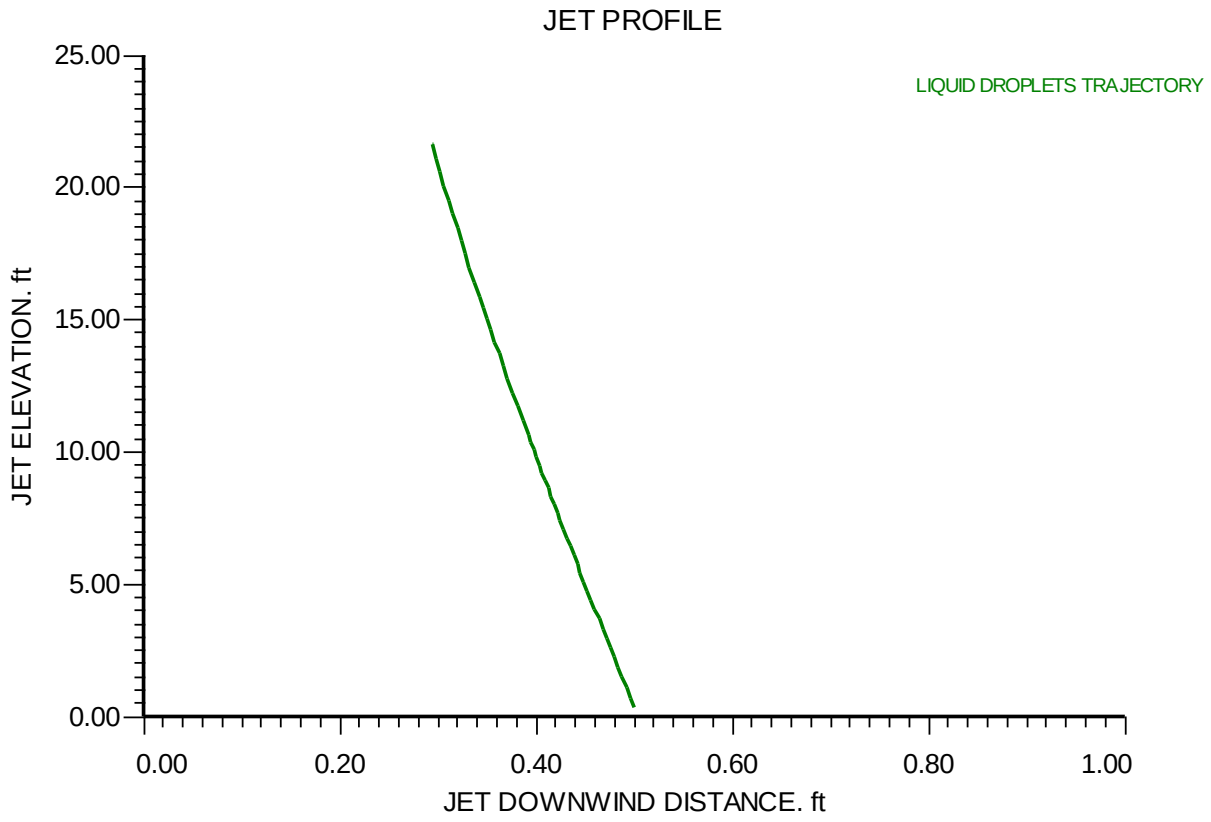


Figure 50: Liquid Release Jet Profile – E-R-15 Layout – 75% Reacted; F2 Stability Class; 20 psig and 205°F

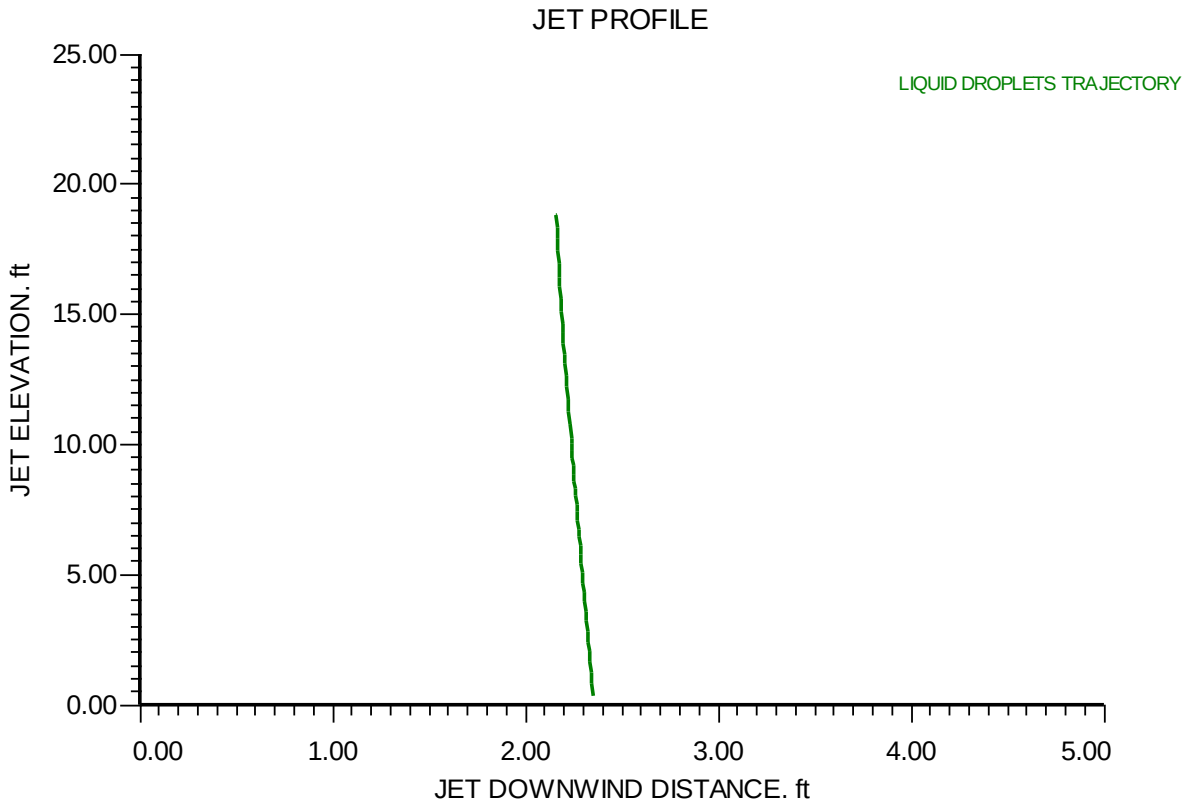


Figure 51: Liquid Release Jet Profile – E-R-15 Layout – 75% Reacted; D5 Stability Class; 5 psig and 210°F

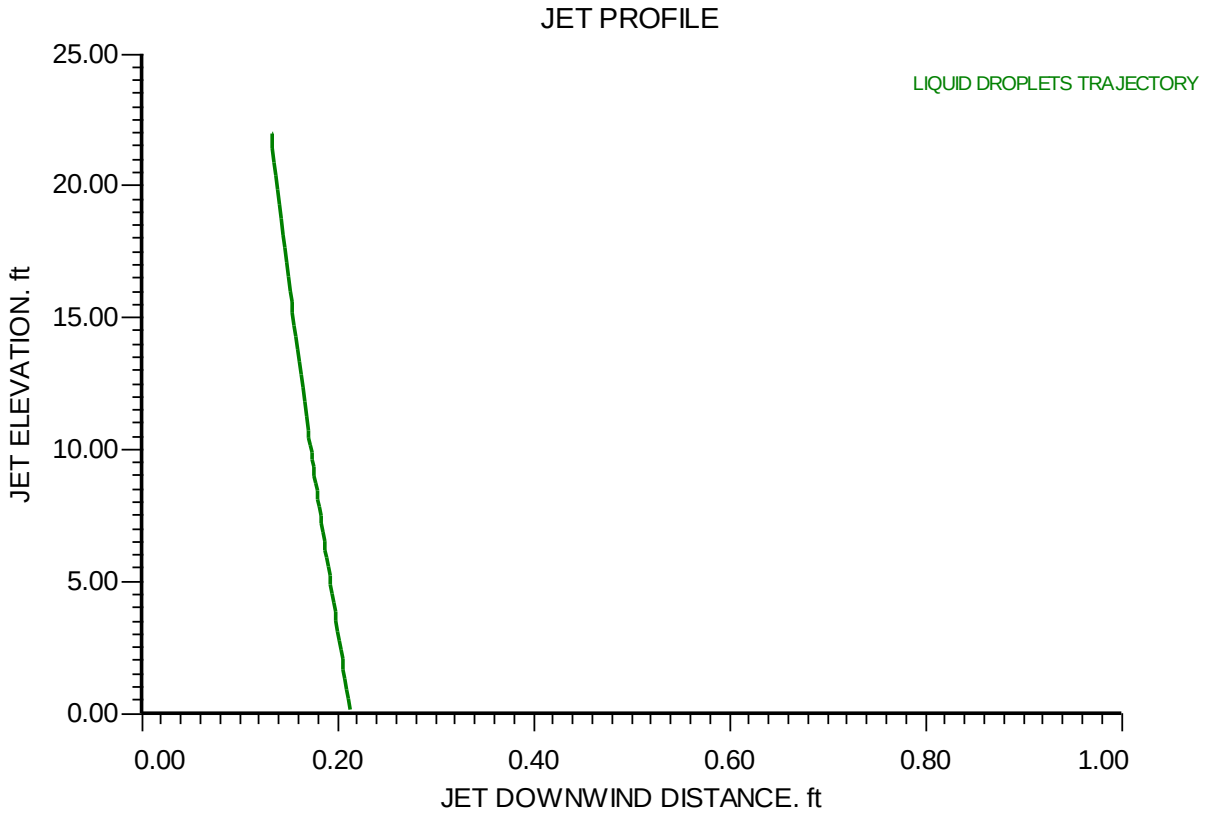


Figure 52: Liquid Release Jet Profile – E-R-15 Layout – 75% Reacted; F2 Stability Class; 5 psig and 210°F

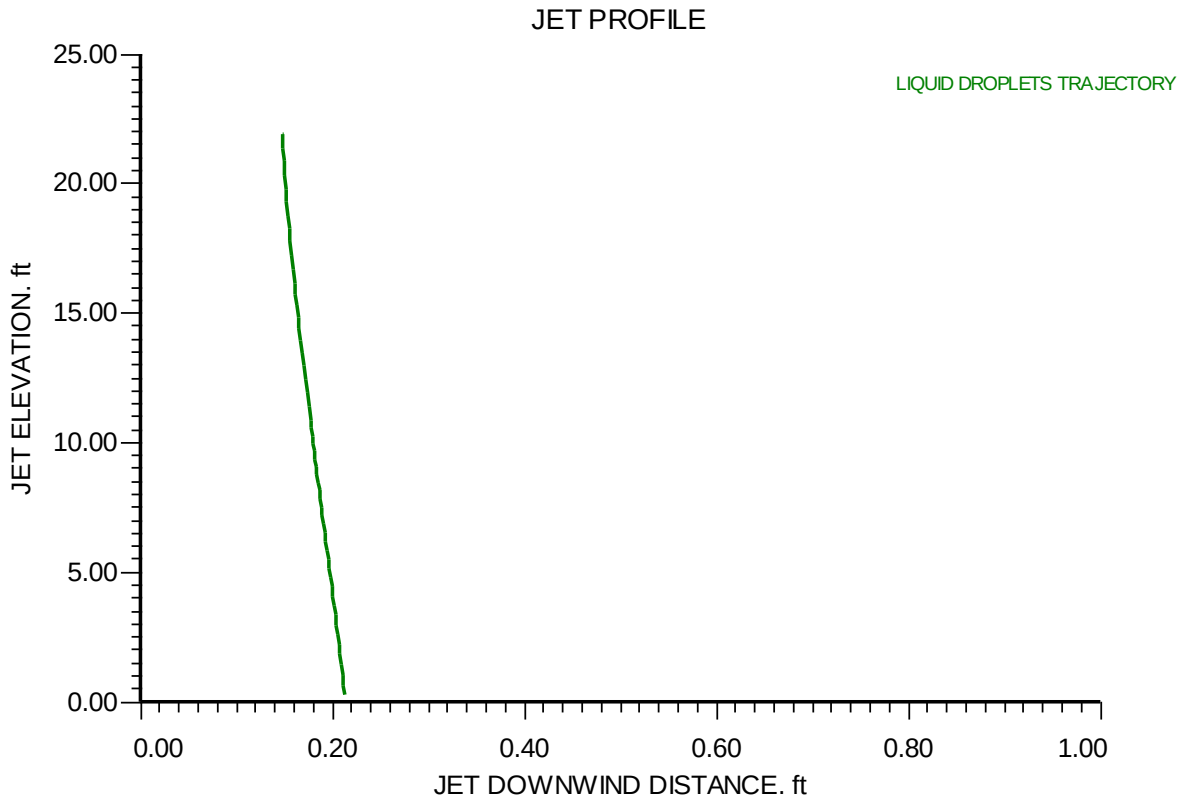


Figure 53: Liquid Release Jet Profile – E-R-15 Layout – 100% Reacted; D5 Stability Class; 20 psig and 205°F

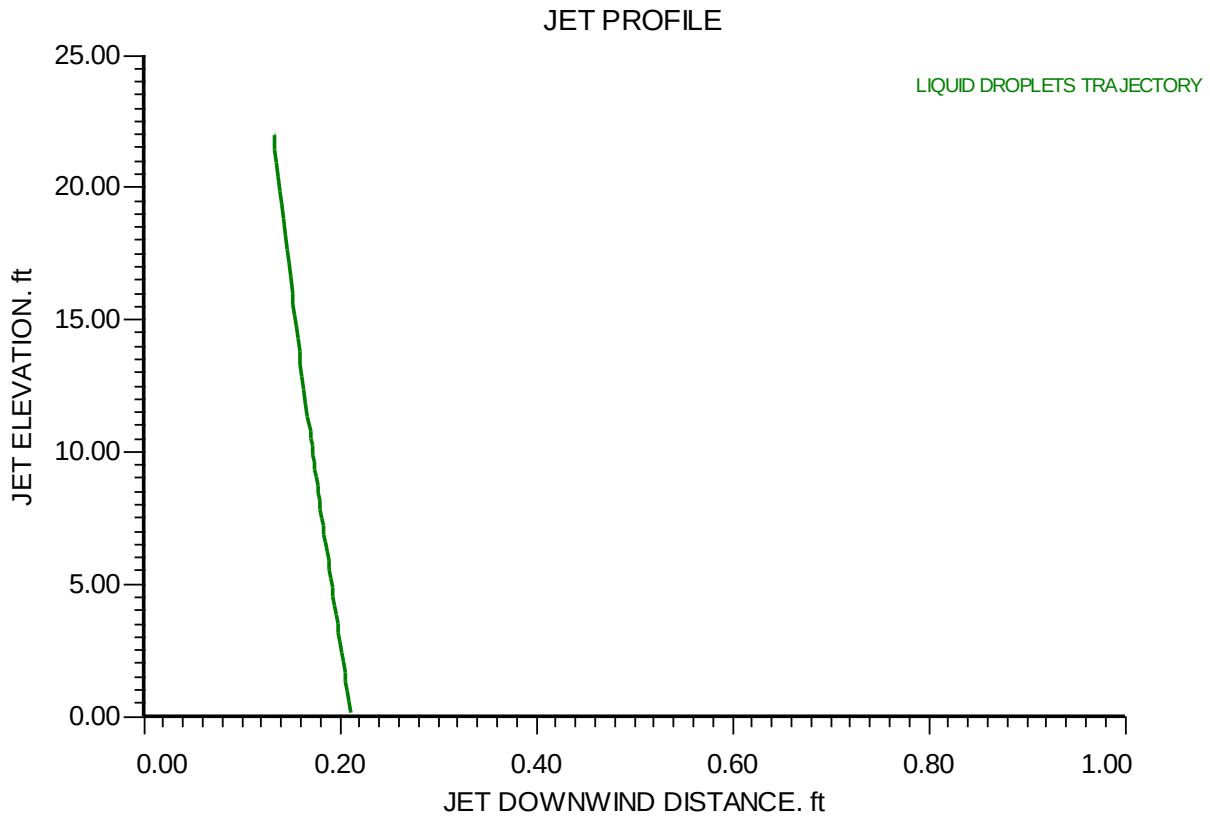


Figure 54: Liquid Release Jet Profile – E-R-15 Layout – 100% Reacted; F2 Stability Class; 20 psig and 205°F

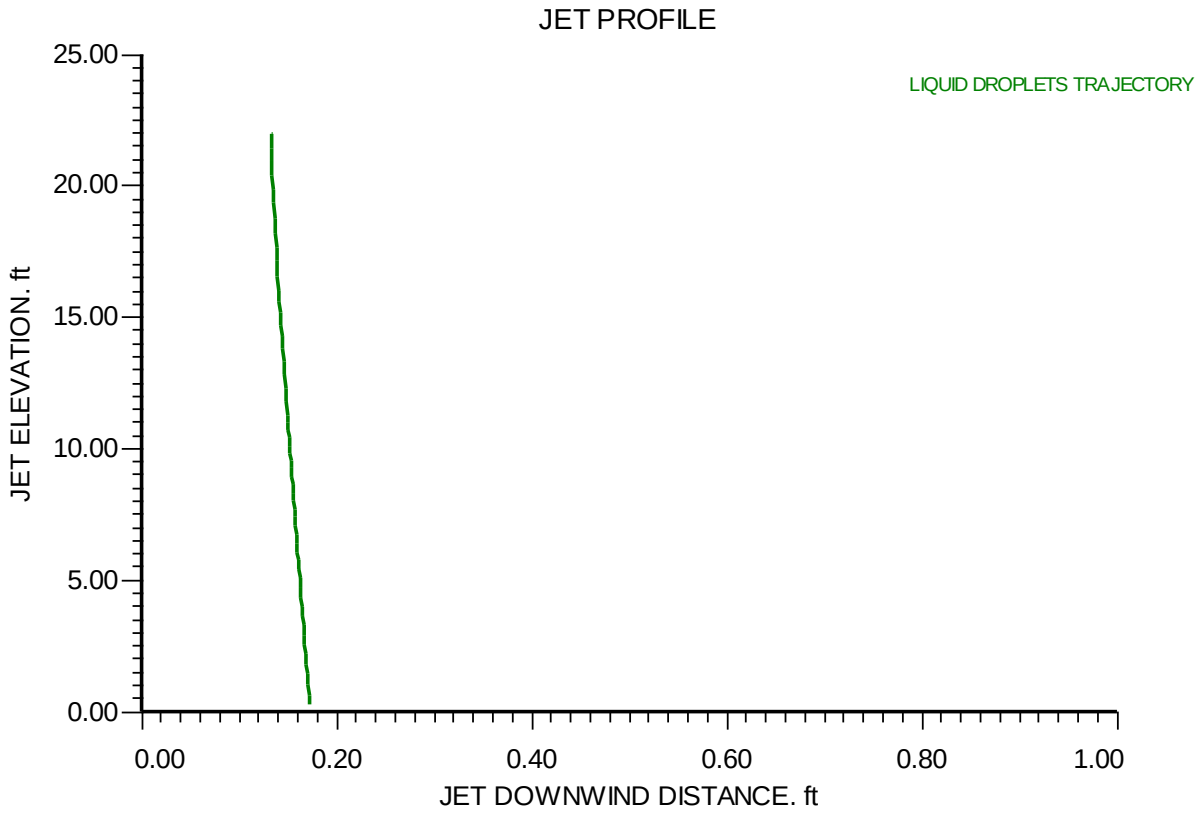


Figure 55: Liquid Release Jet Profile – E-R-15 Layout – 100% Reacted; D5 Stability Class; 5 psig and 210°F

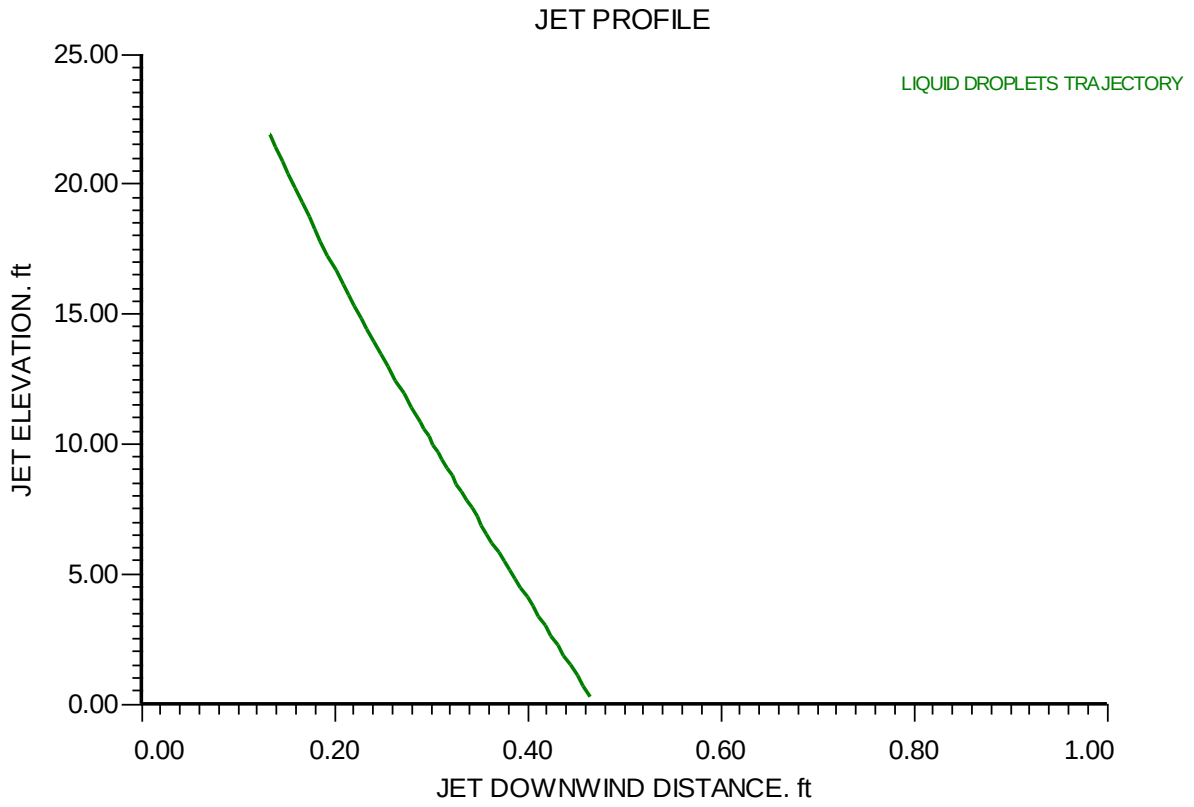
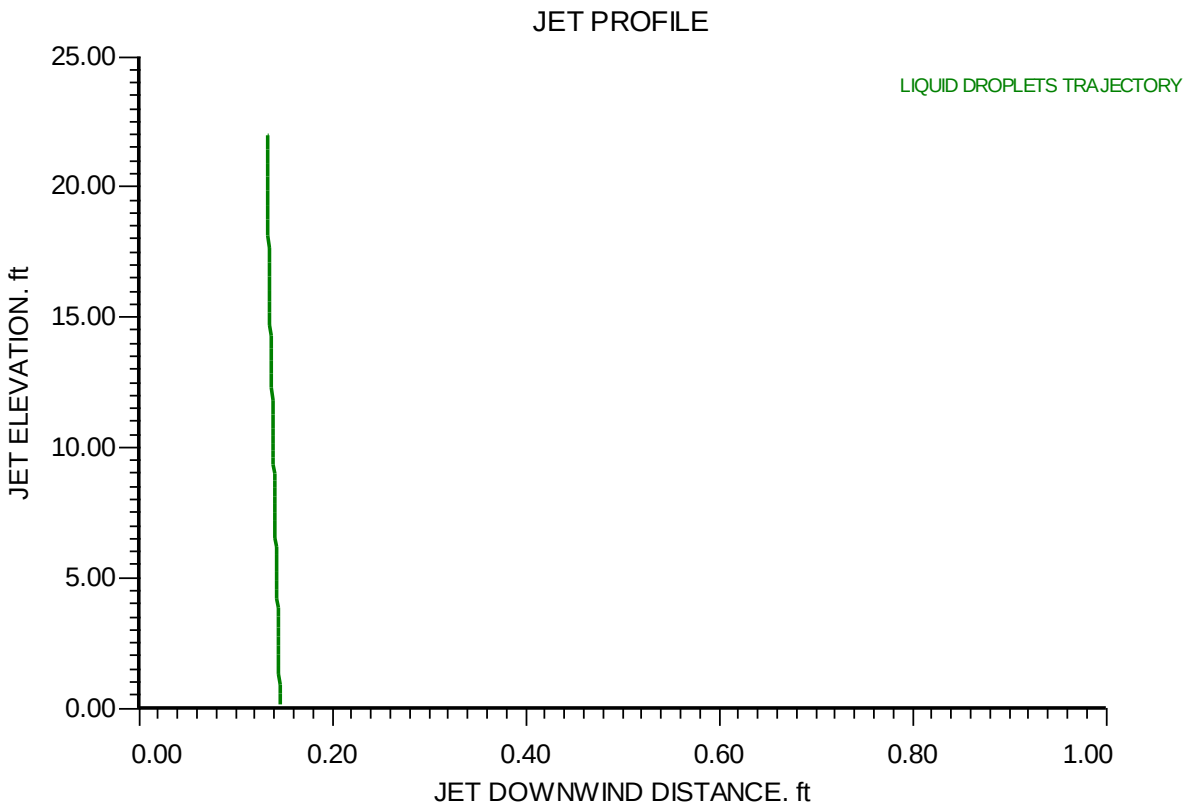


Figure 56: Liquid Release Jet Profile – E-R-15 Layout – 100% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix E: Results – E-R-16 Piping Layout to Pit – Liquid Release Jet Profile

Figure 57: Liquid Release Jet Profile – E-R-16 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

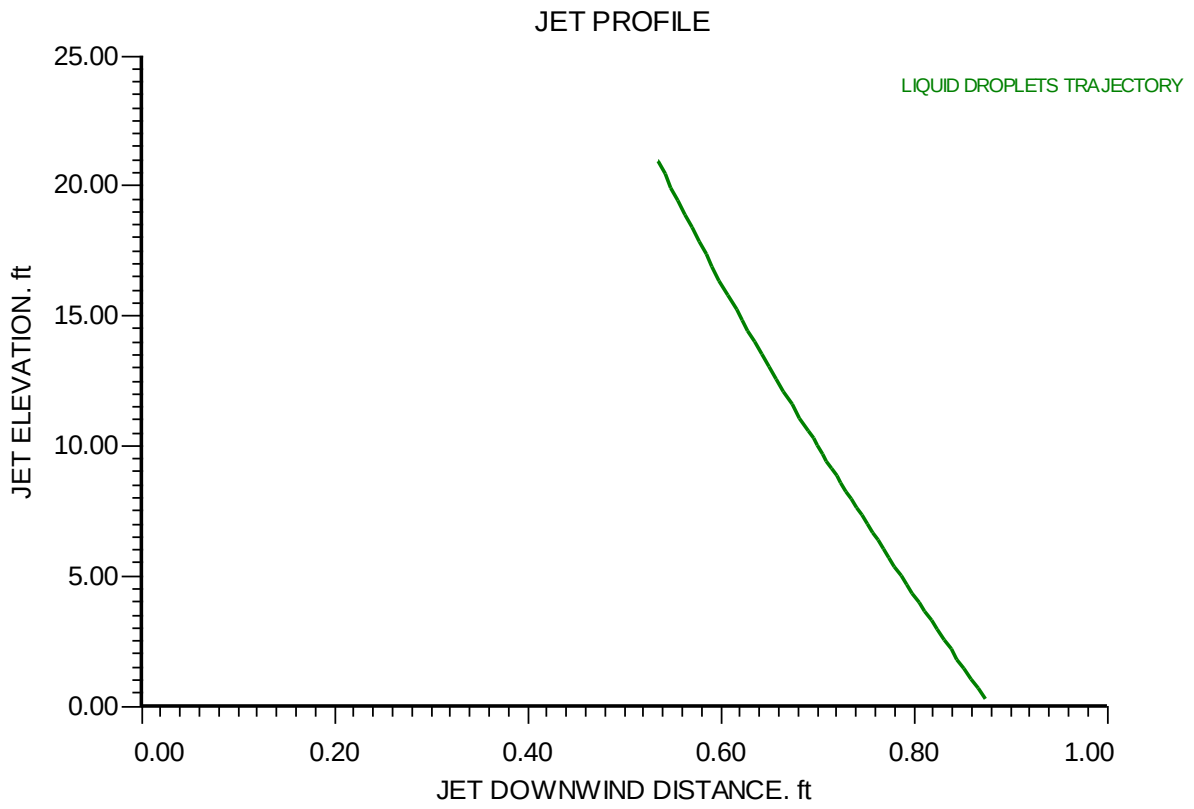


Figure 58: Liquid Release Jet Profile – E-R-16 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

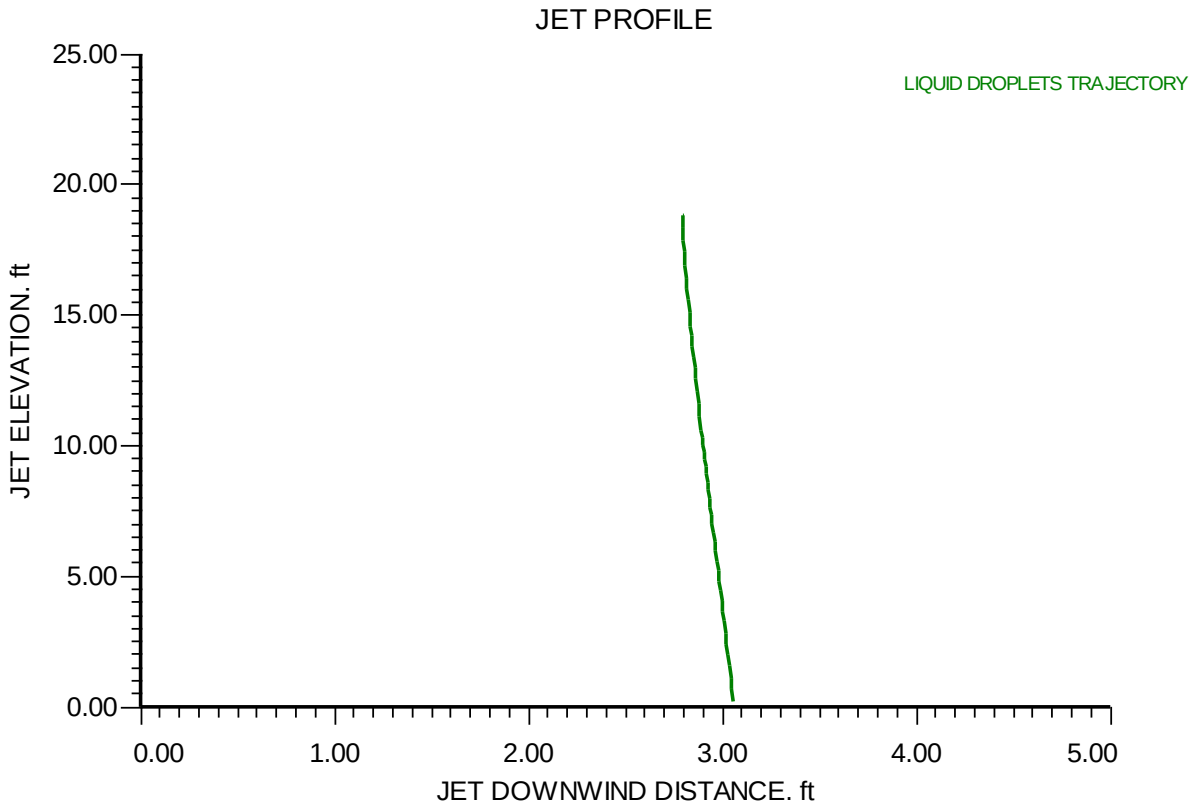


Figure 59: Liquid Release Jet Profile – E-R-16 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

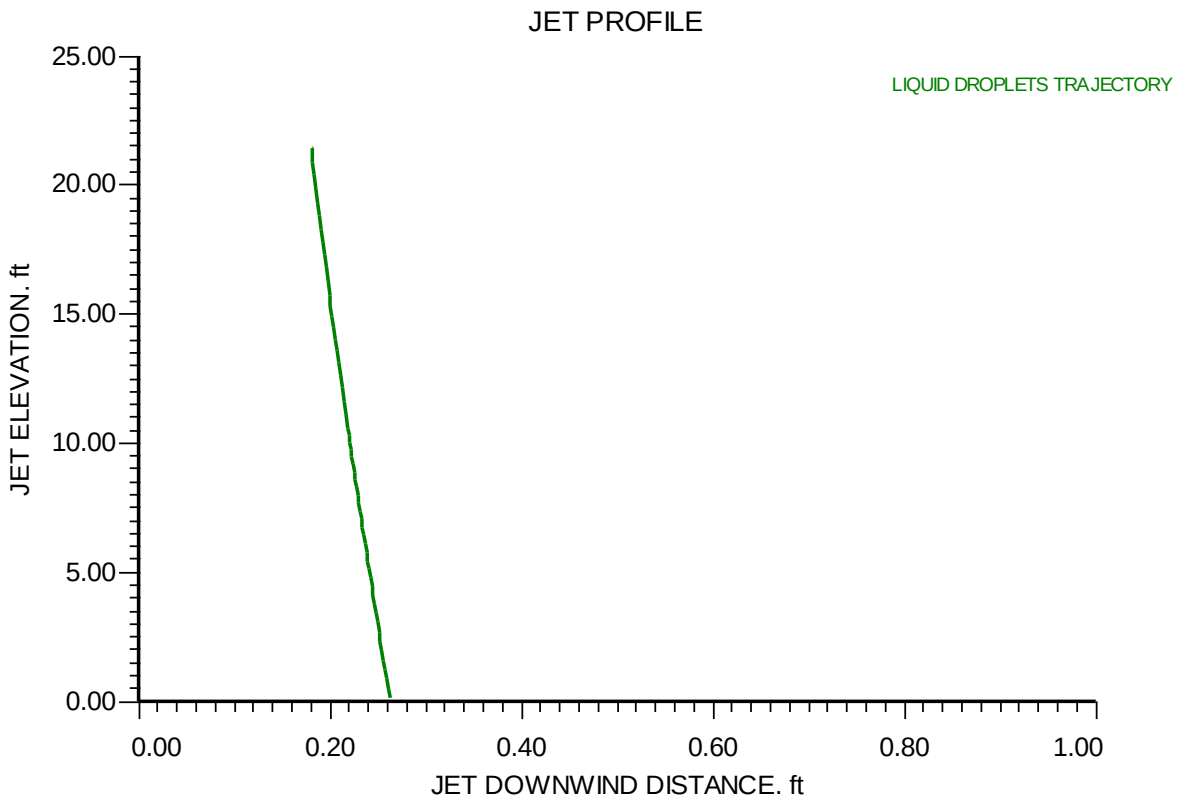


Figure 60: Liquid Release Jet Profile – E-R-16 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

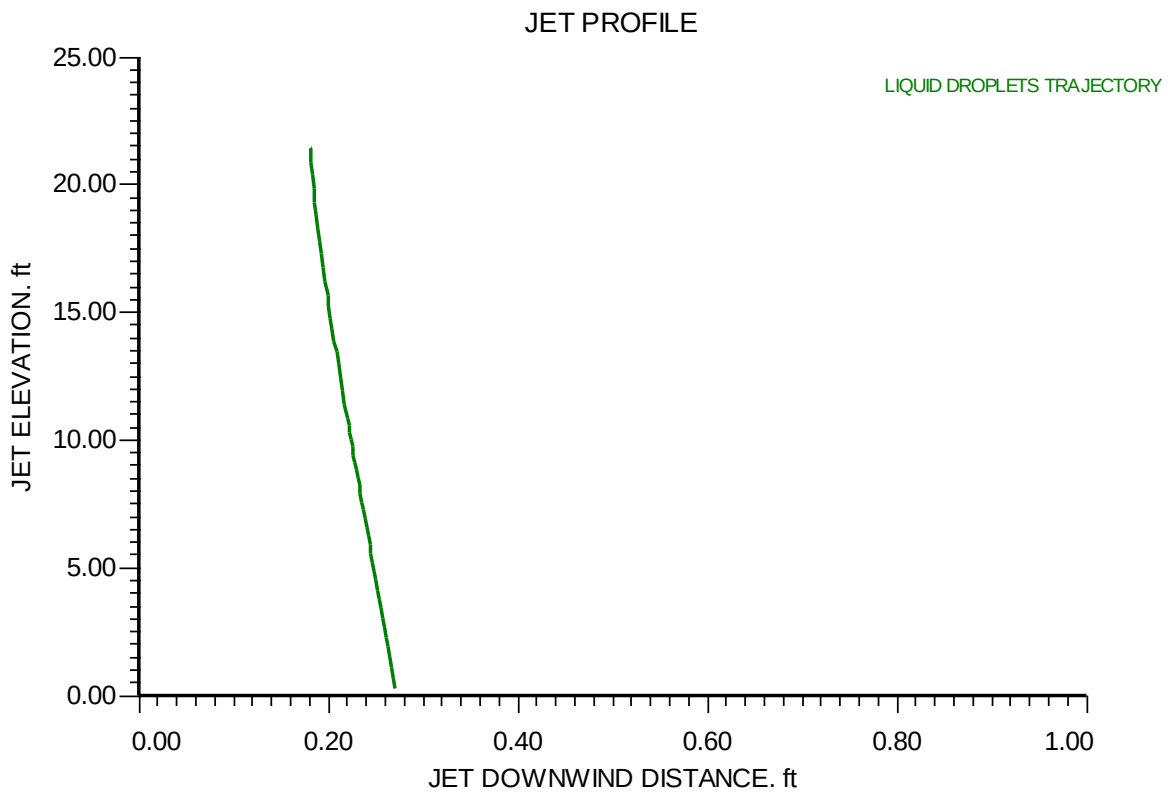


Figure 61: Liquid Release Jet Profile – E-R-16 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

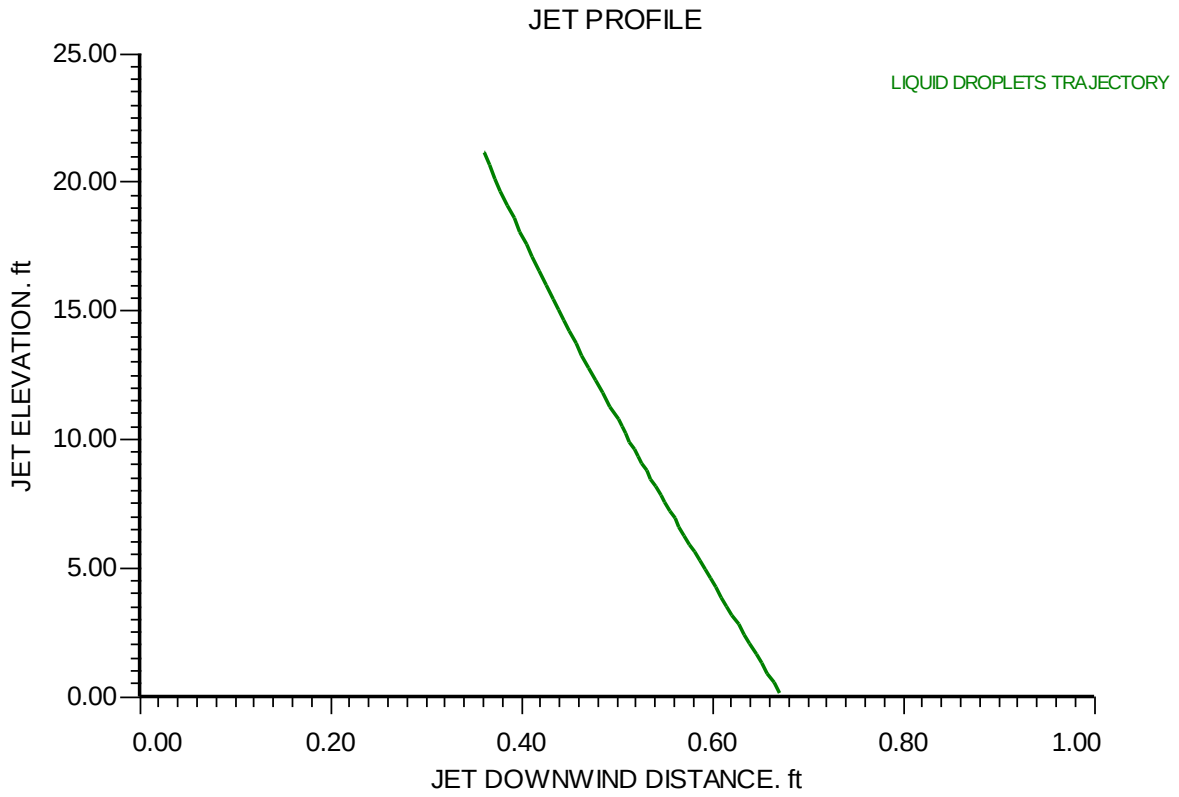


Figure 62: Liquid Release Jet Profile – E-R-16 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

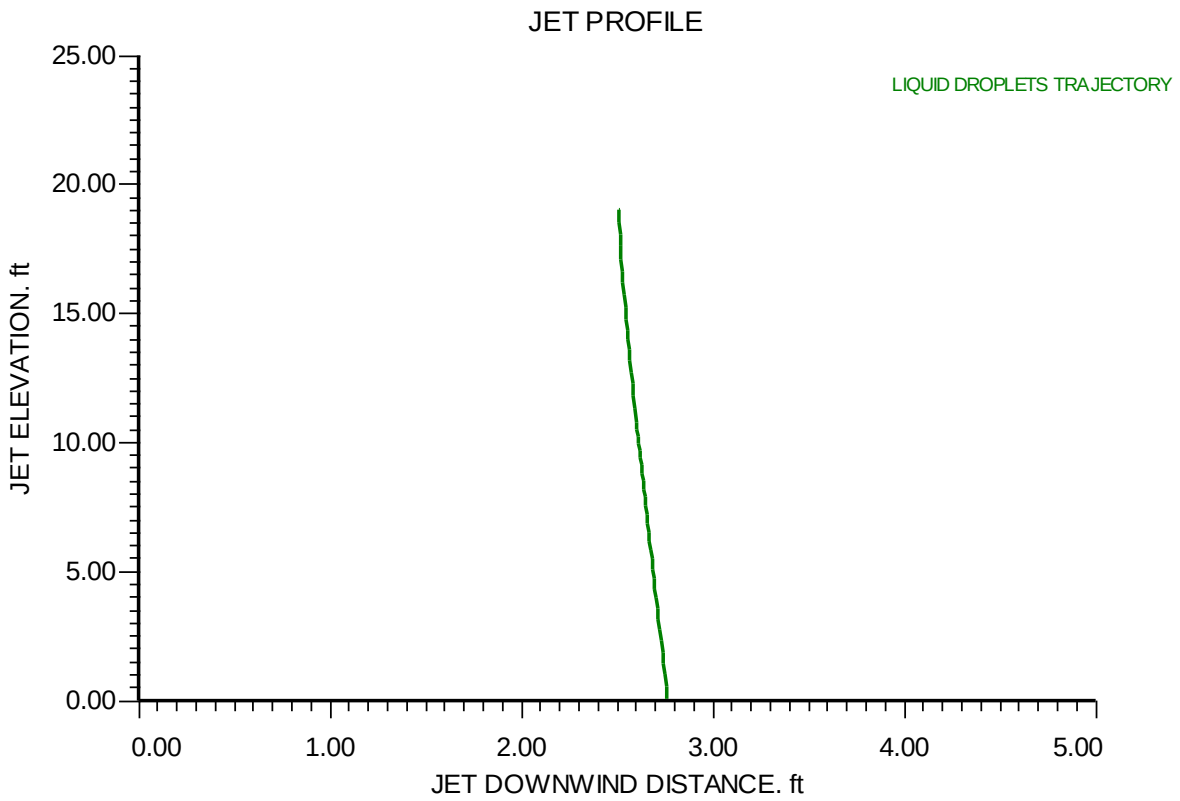


Figure 63: Liquid Release Jet Profile – E-R-16 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

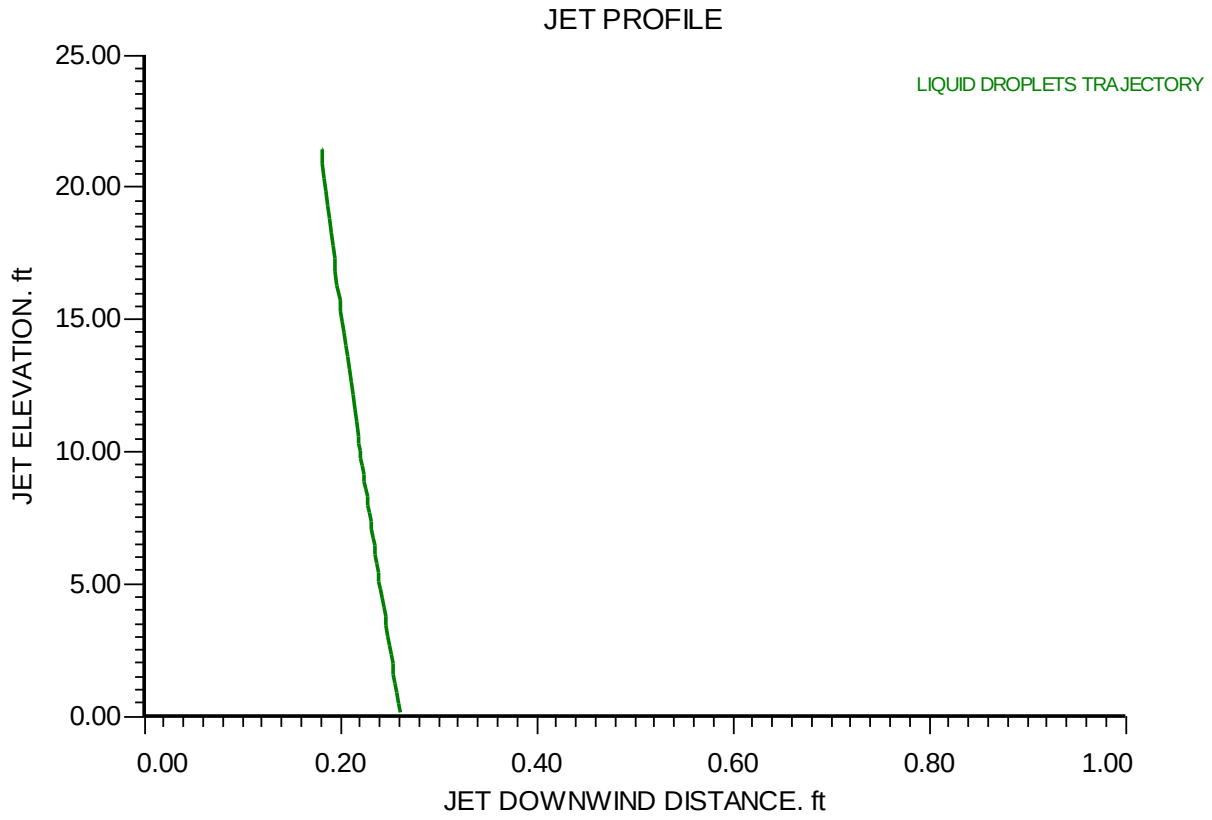


Figure 64: Liquid Release Jet Profile – E-R-16 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F

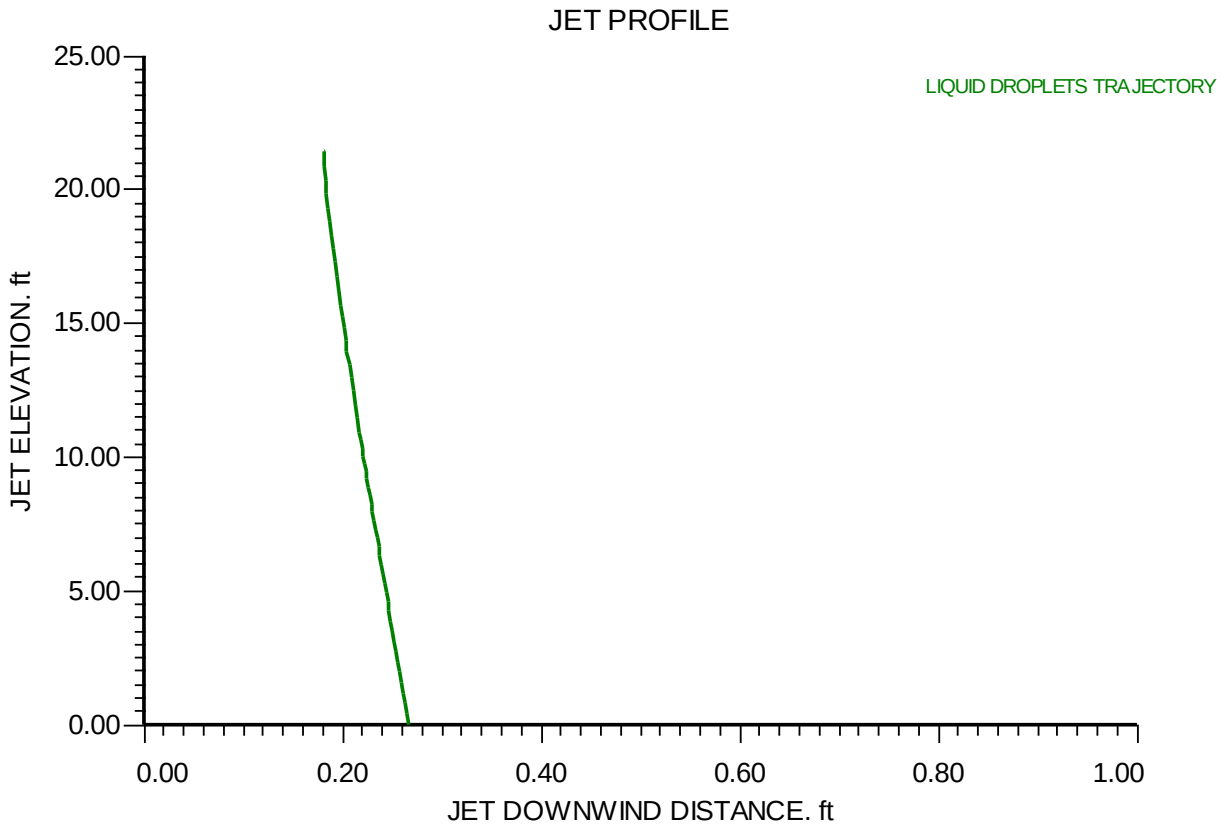


Figure 65: Liquid Release Jet Profile – E-R-16 Layout – 50% Reacted; D5 Stability Class; 20 psig and 205°F

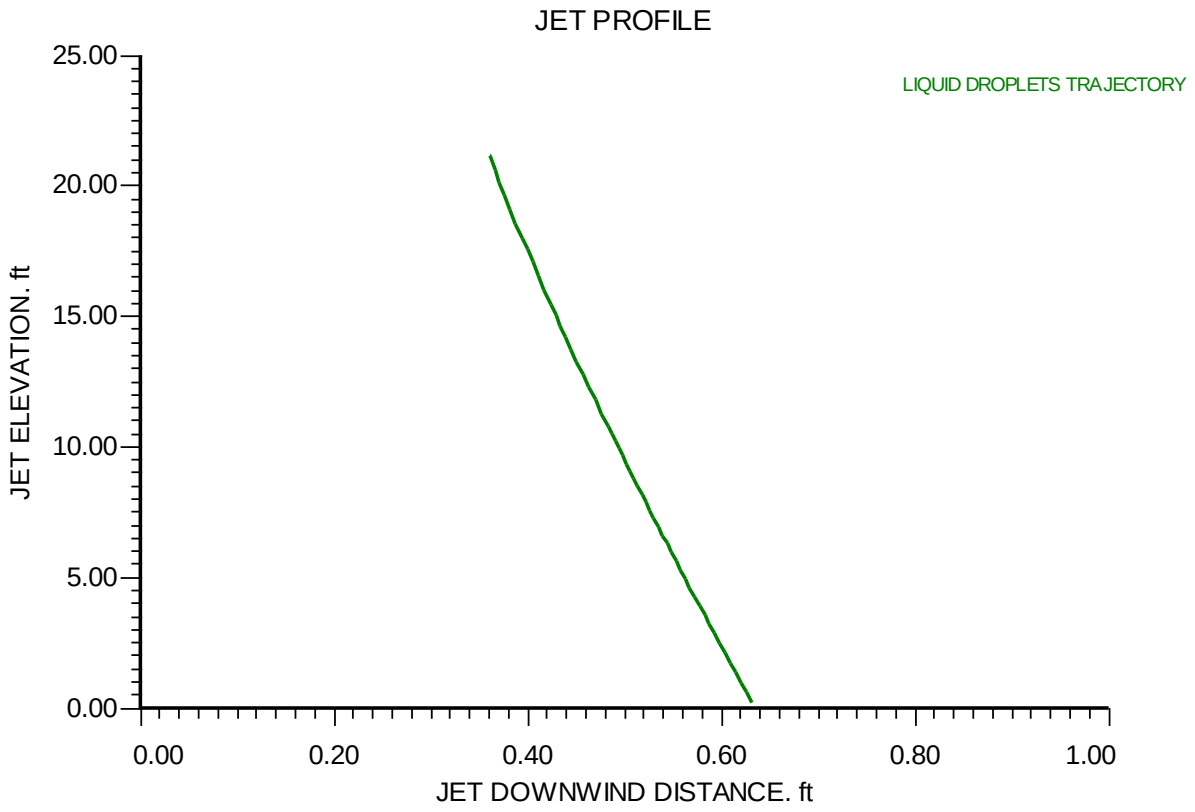


Figure 66: Liquid Release Jet Profile – E-R-16 Layout – 50% Reacted; F2 Stability Class; 20 psig and 205°F

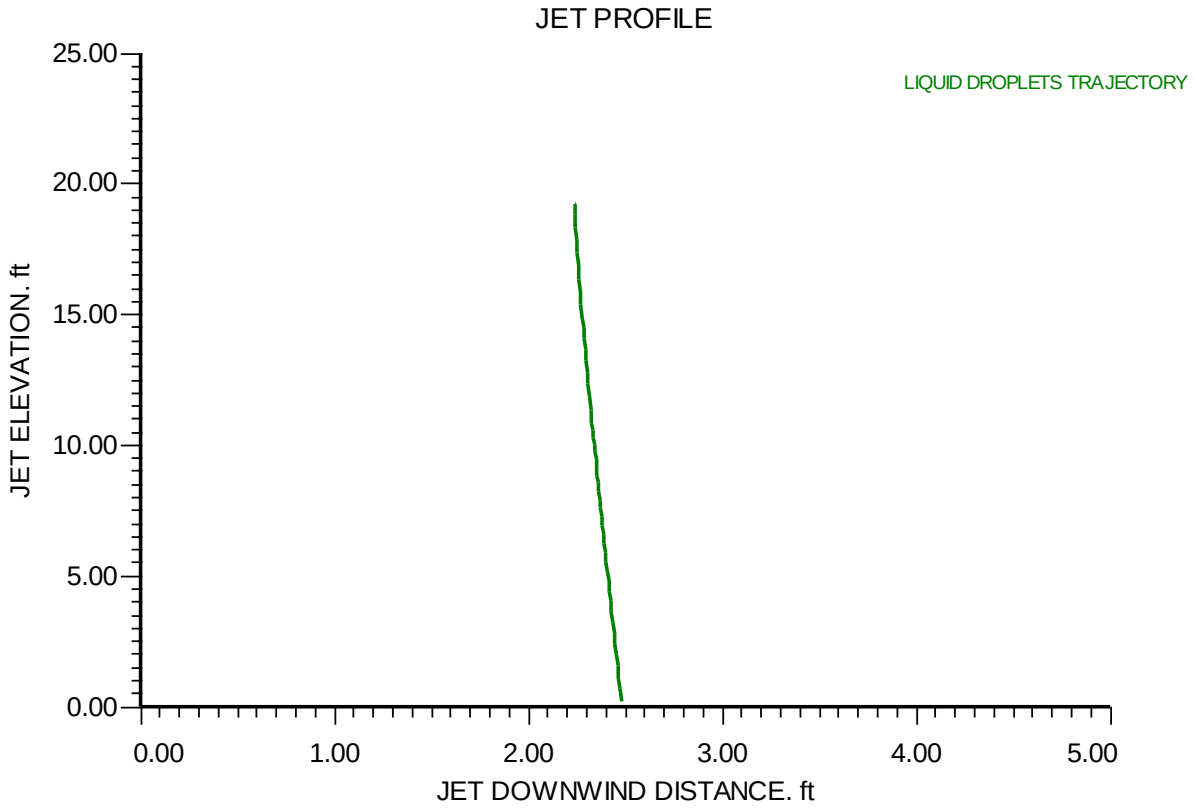


Figure 67: Liquid Release Jet Profile – E-R-16 Layout – 50% Reacted; D5 Stability Class; 5 psig and 210°F

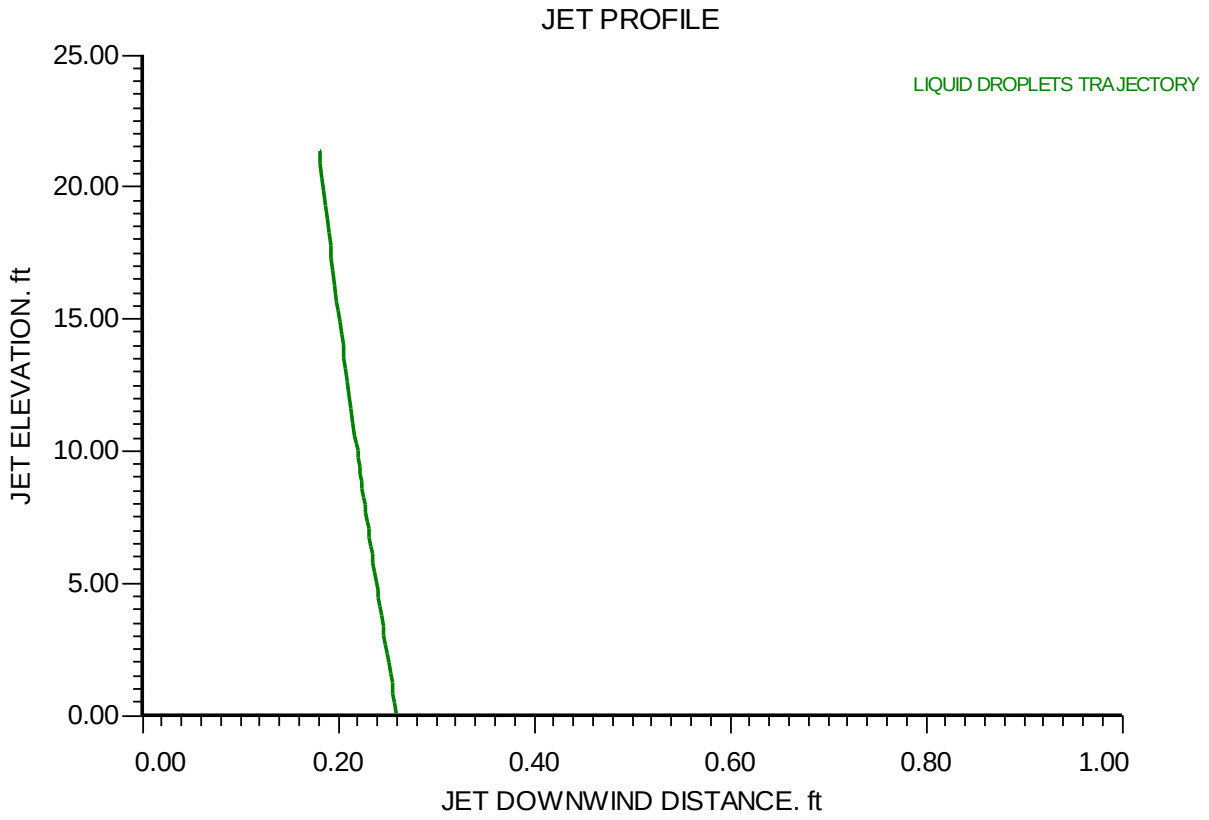


Figure 68: Liquid Release Jet Profile – E-R-16 Layout – 50% Reacted; F2 Stability Class; 5 psig and 210°F

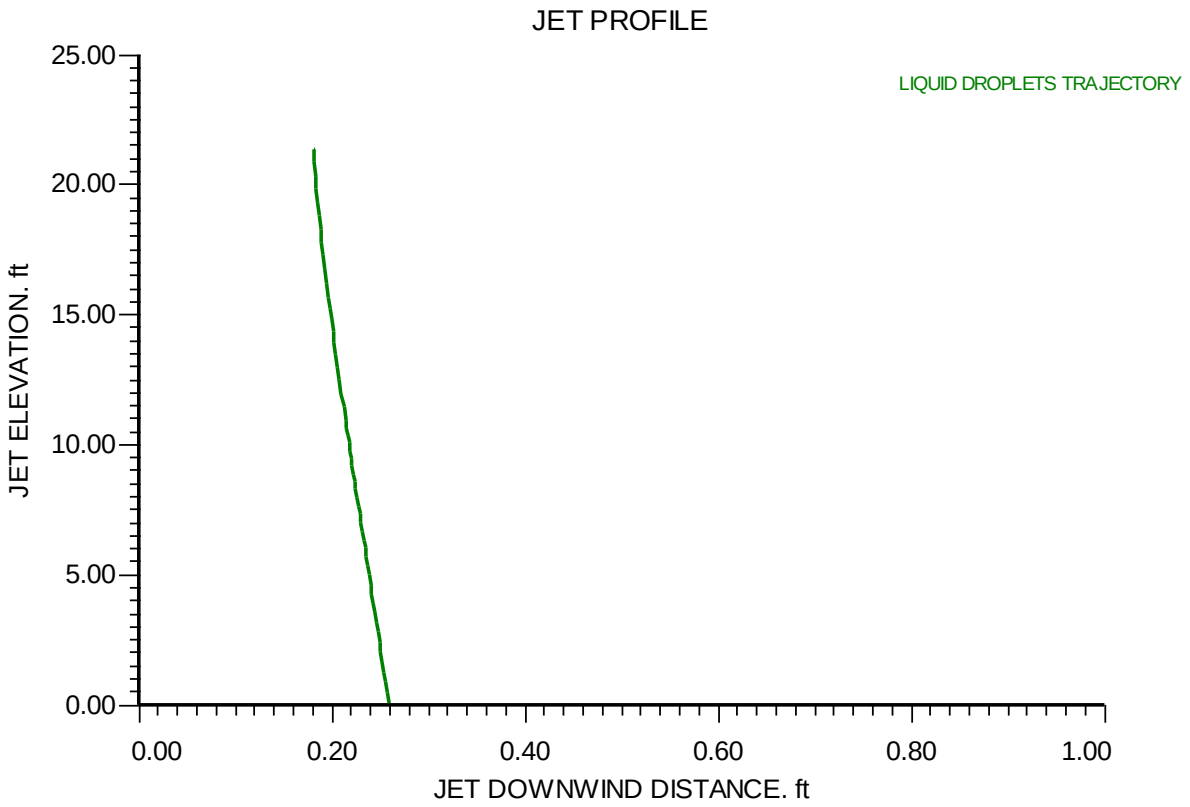


Figure 69: Liquid Release Jet Profile – E-R-16 Layout – 75% Reacted; D5 Stability Class; 20 psig and 205°F

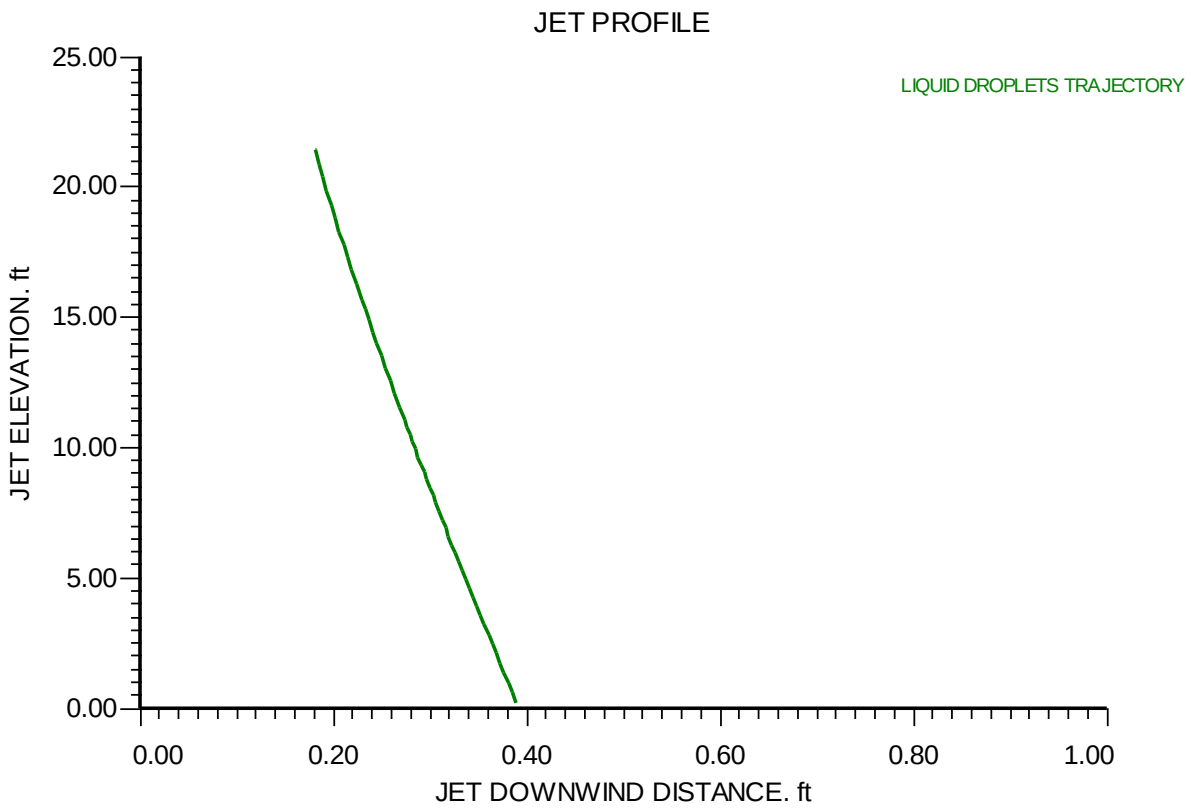


Figure 70: Liquid Release Jet Profile – E-R-16 Layout – 75% Reacted; F2 Stability Class; 20 psig and 205°F

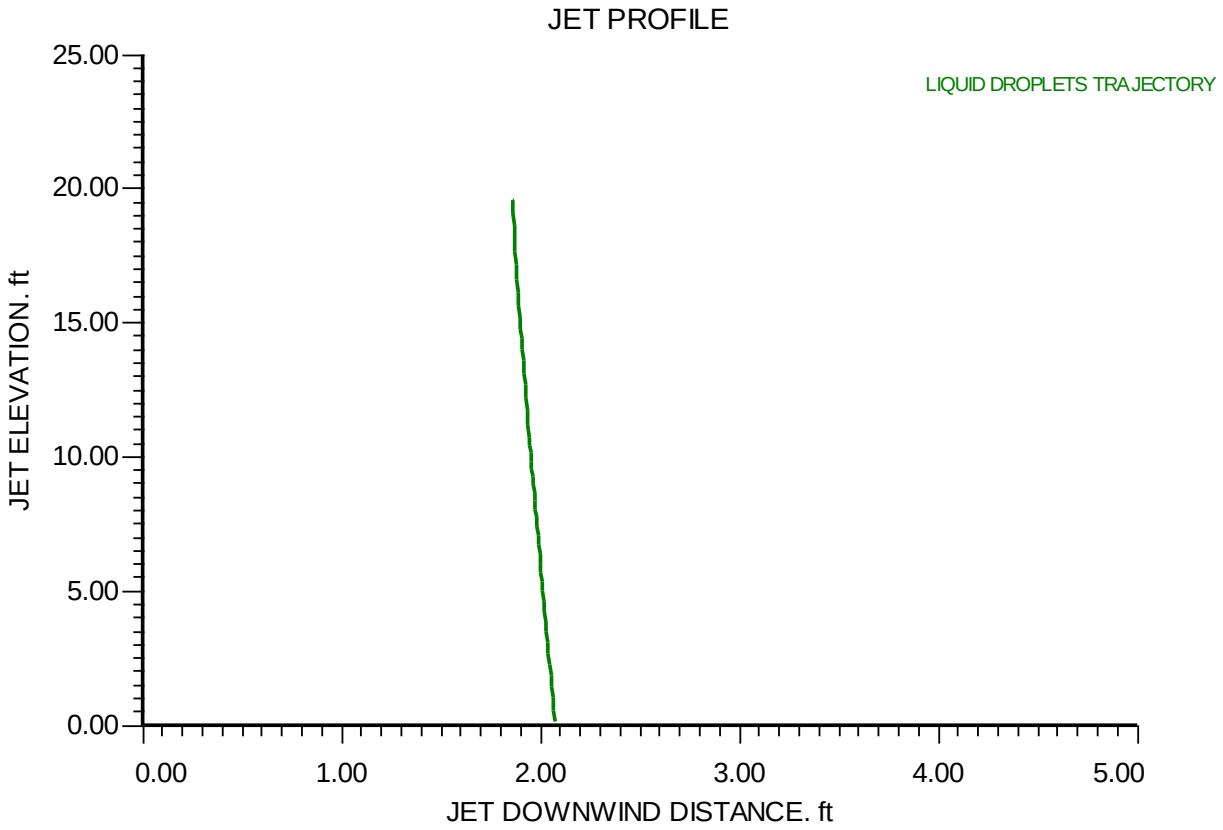


Figure 71: Liquid Release Jet Profile – E-R-16 Layout – 75% Reacted; D5 Stability Class; 5 psig and 210°F

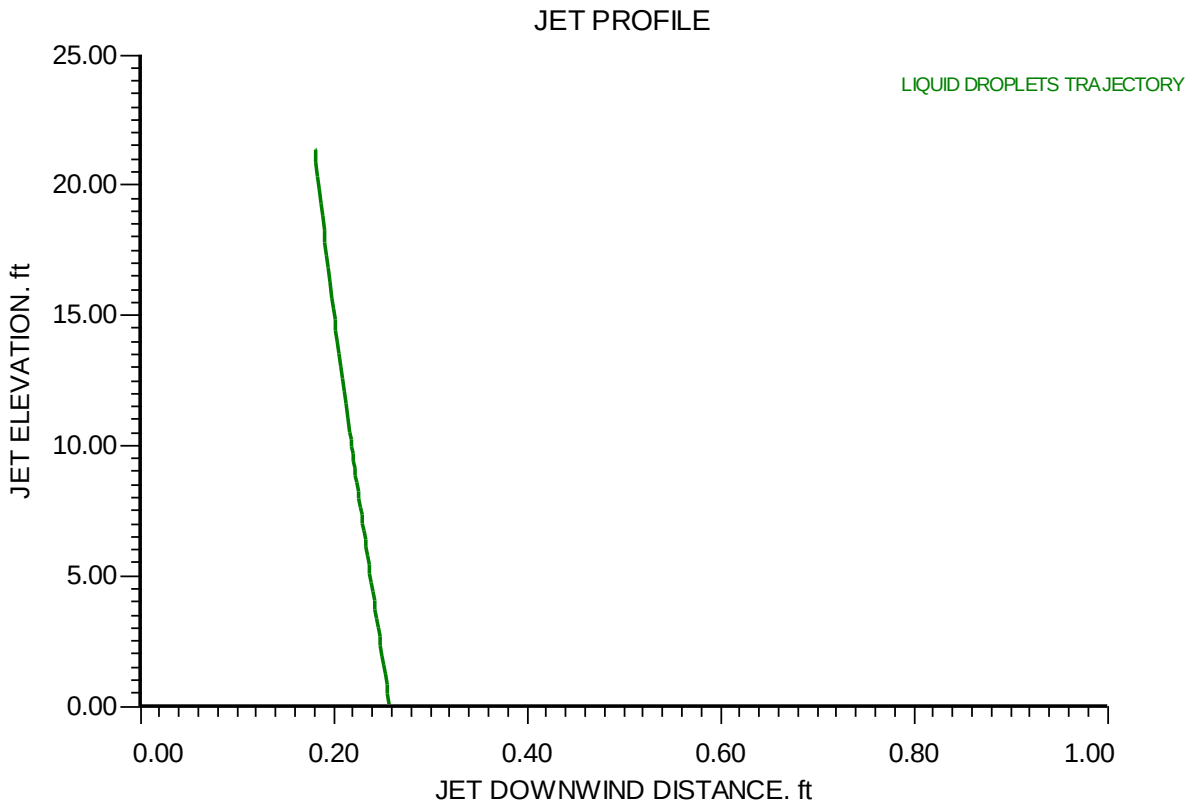


Figure 72: Liquid Release Jet Profile – E-R-16 Layout – 75% Reacted; F2 Stability Class; 5 psig and 210°F

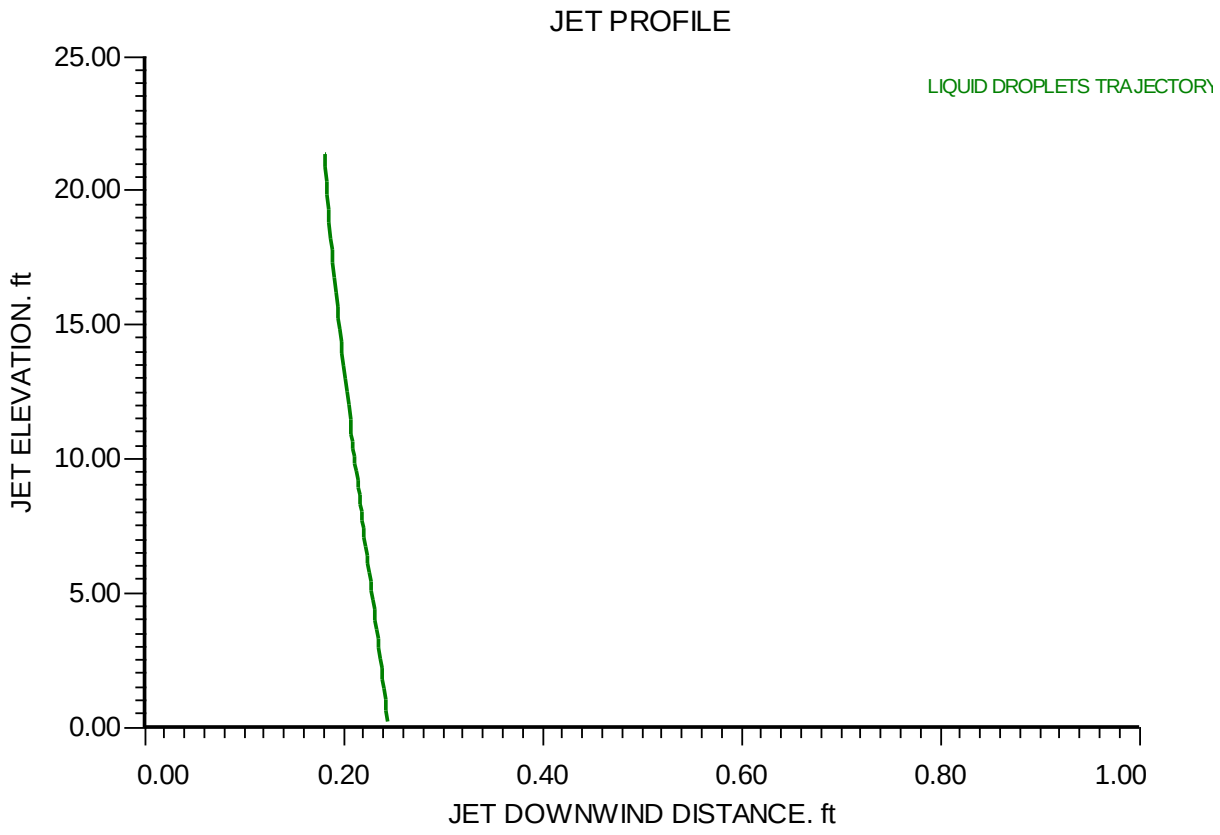


Figure 73: Liquid Release Jet Profile – E-R-16 Layout – 100% Reacted; D5 Stability Class; 20 psig and 205°F

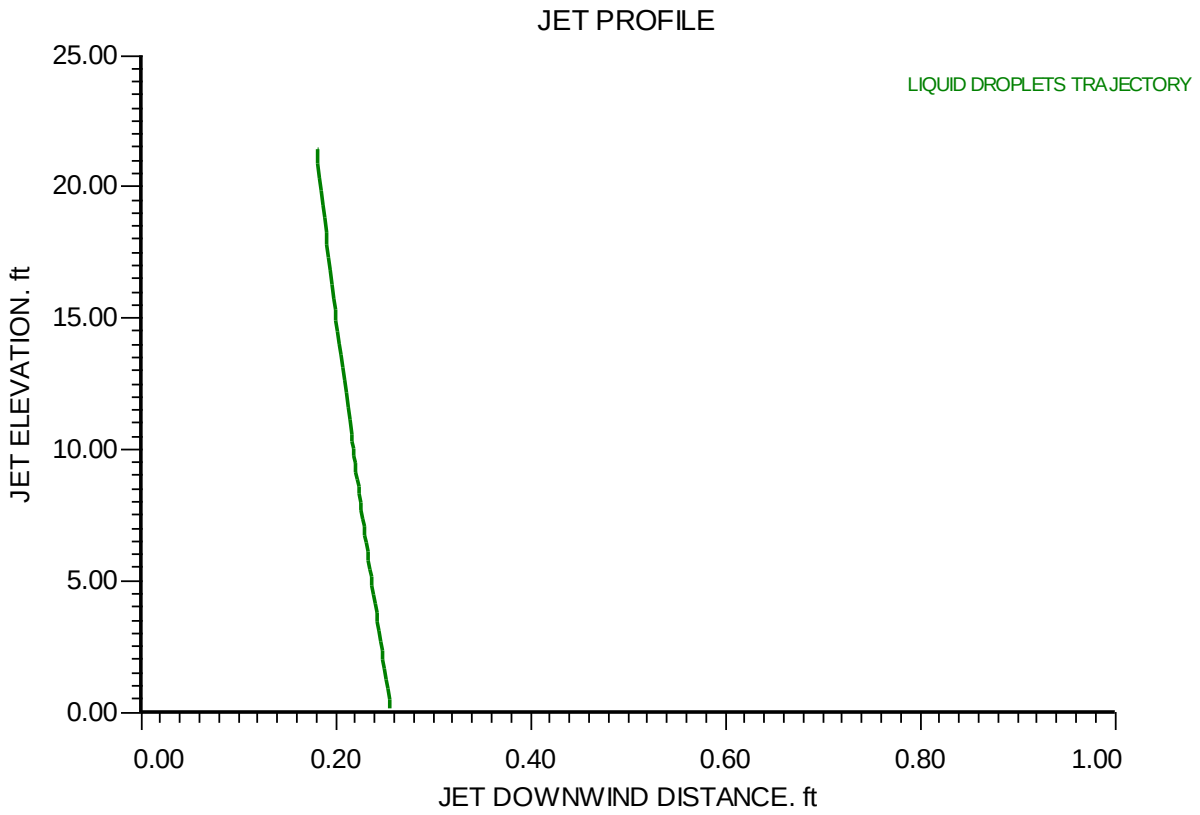


Figure 74: Liquid Release Jet Profile – E-R-16 Layout – 100% Reacted; F2 Stability Class; 20 psig and 205°F

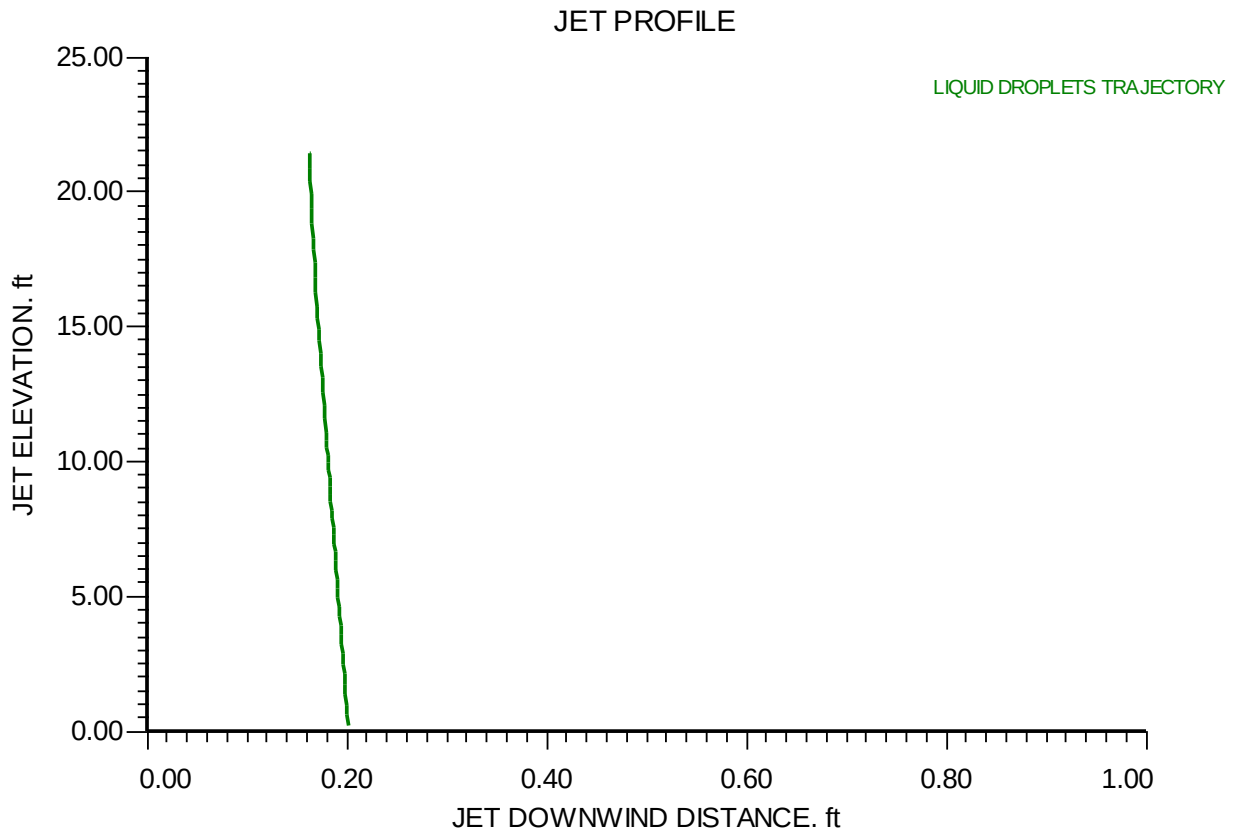


Figure 75: Liquid Release Jet Profile – E-R-16 Layout – 100% Reacted; D5 Stability Class; 5 psig and 210°F

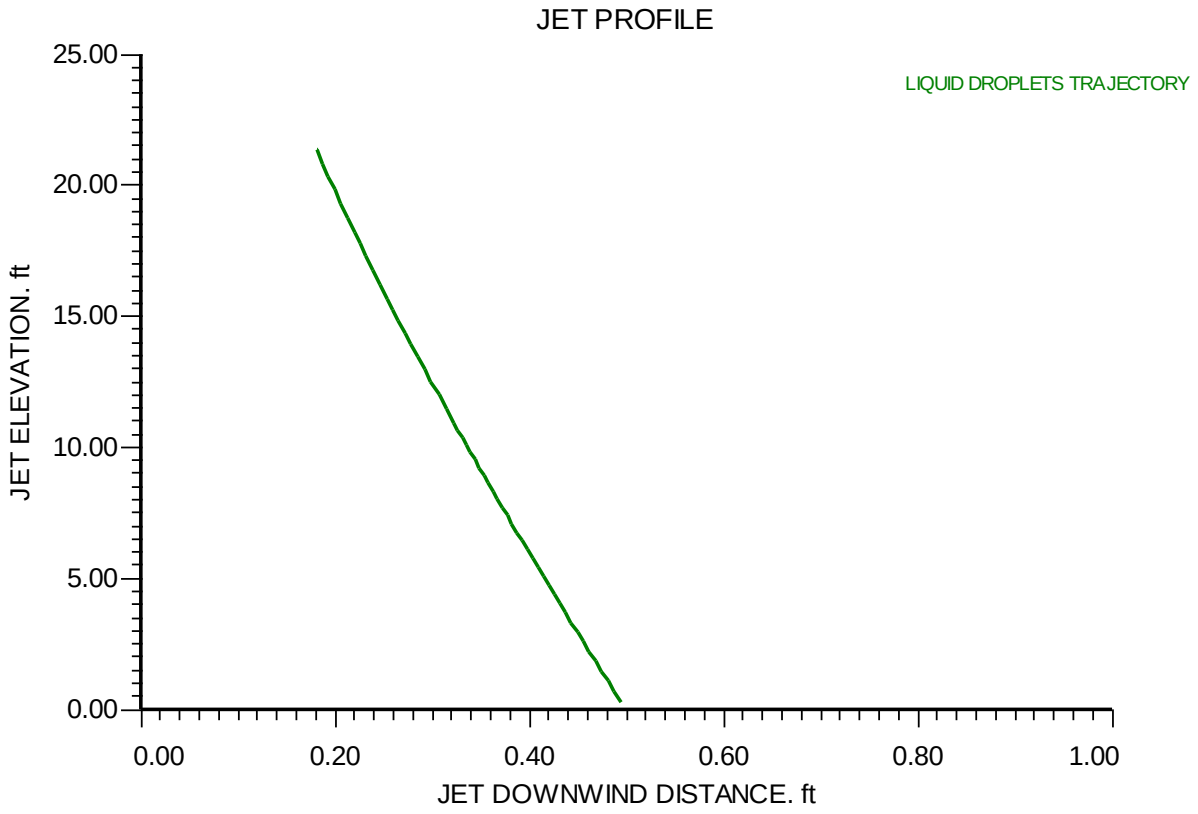
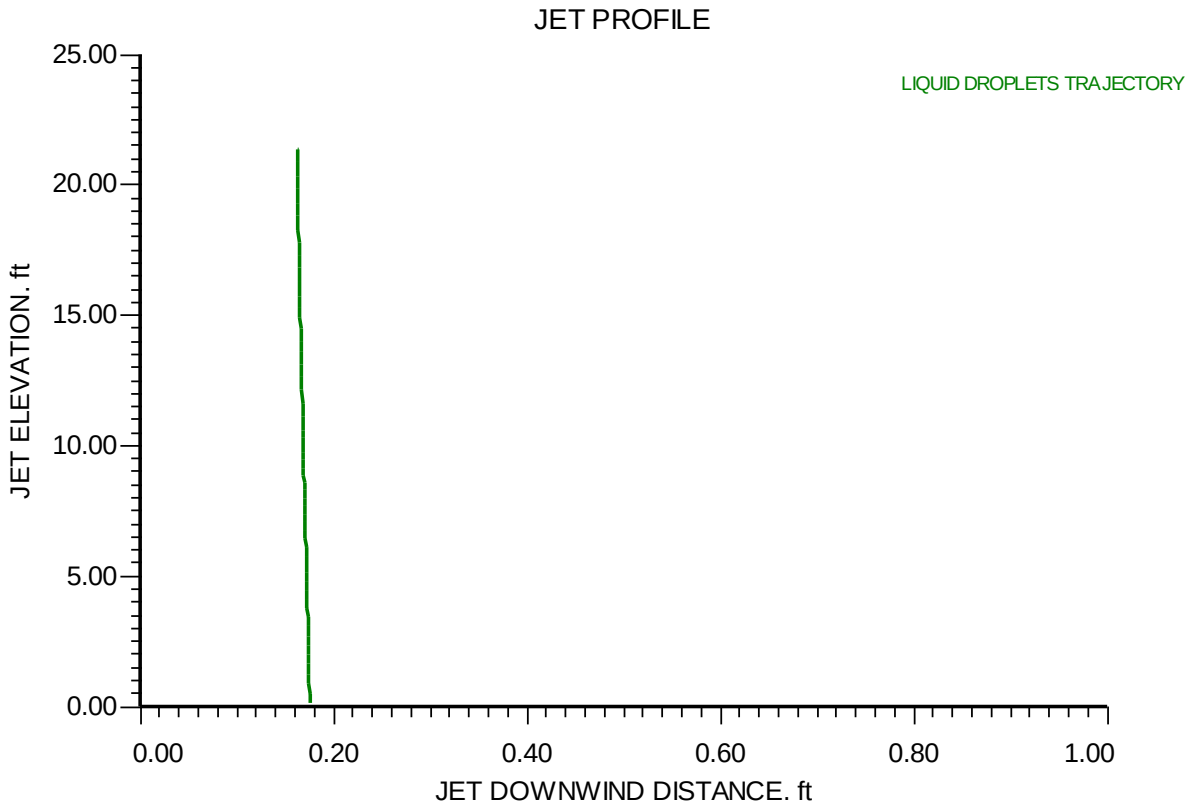


Figure 76: Liquid Release Jet Profile – E-R-16 Layout – 100% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix F: Results – E-R-17 Piping Layout to Pit – Liquid Release Jet Profile

Figure 77: Liquid Release Jet Profile – E-R-17 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

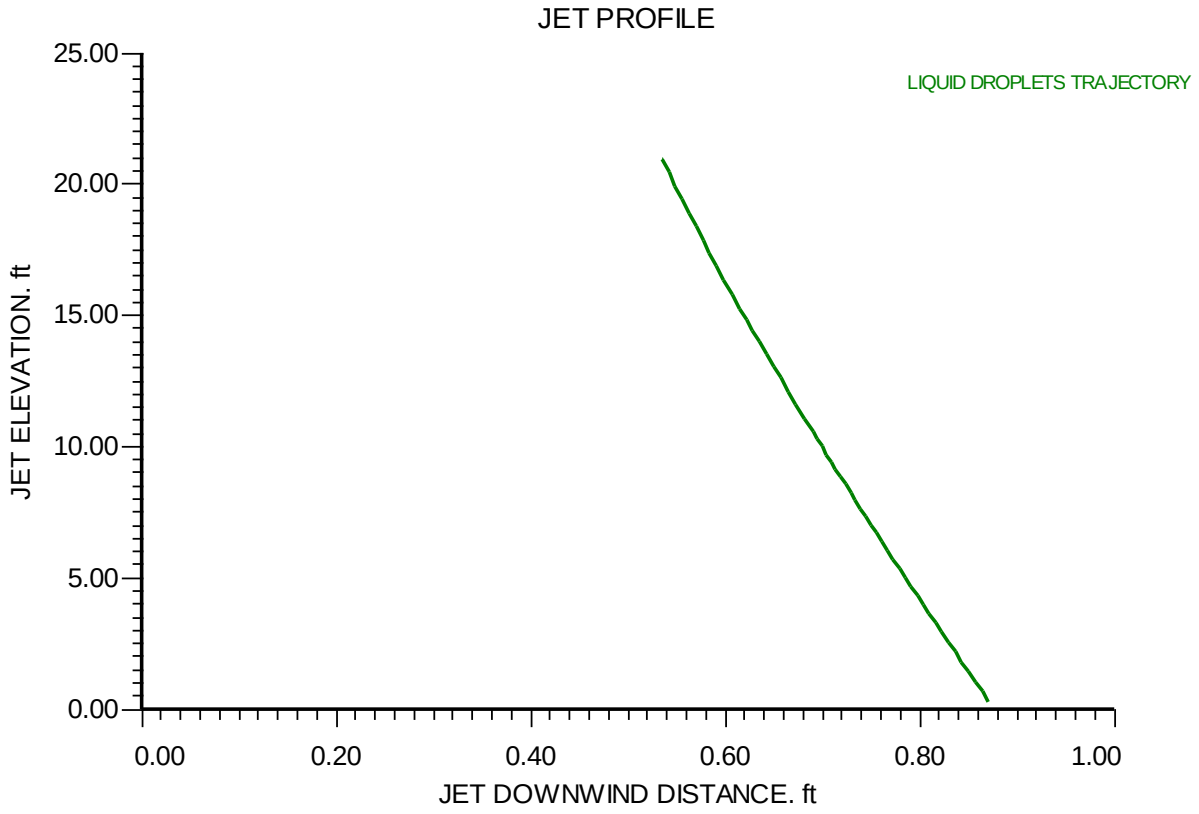


Figure 78: Liquid Release Jet Profile – E-R-17 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

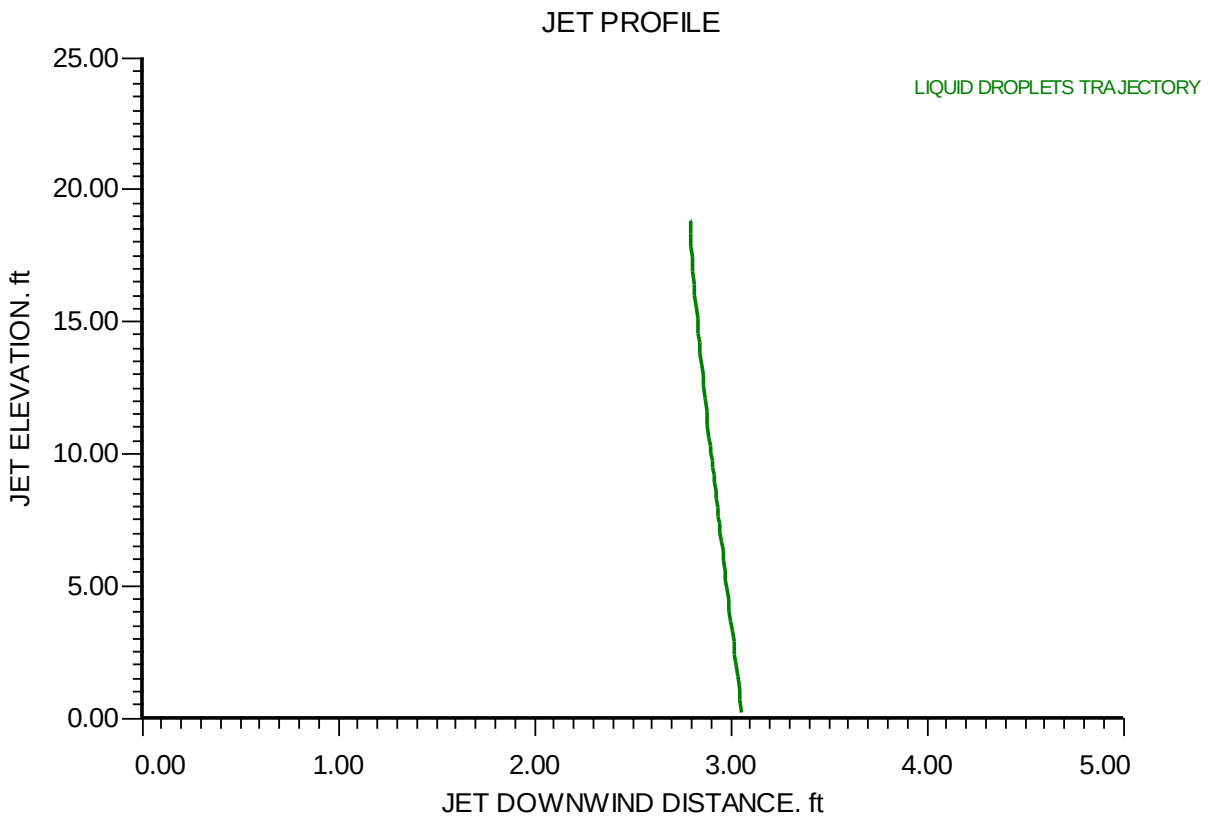


Figure 79: Liquid Release Jet Profile – E-R-17 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

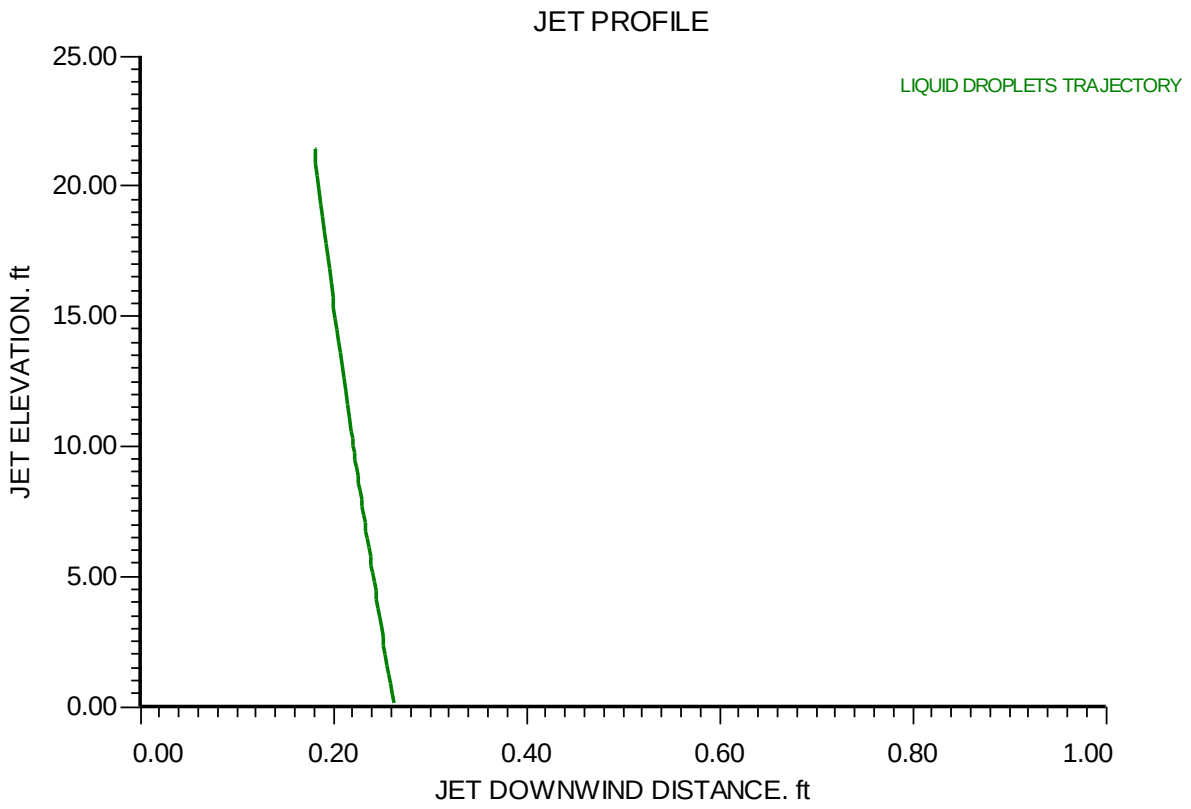


Figure 80: Liquid Release Jet Profile – E-R-17 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

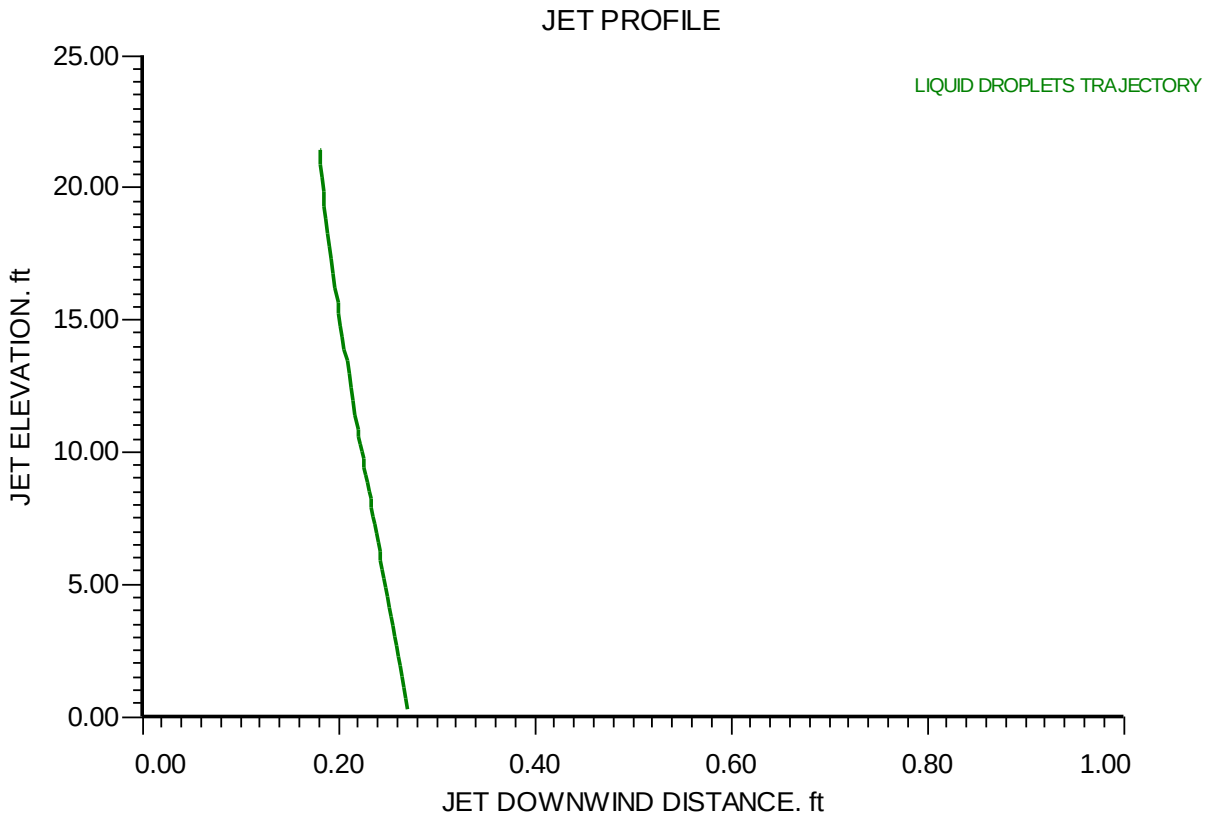


Figure 81: Liquid Release Jet Profile – E-R-17 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

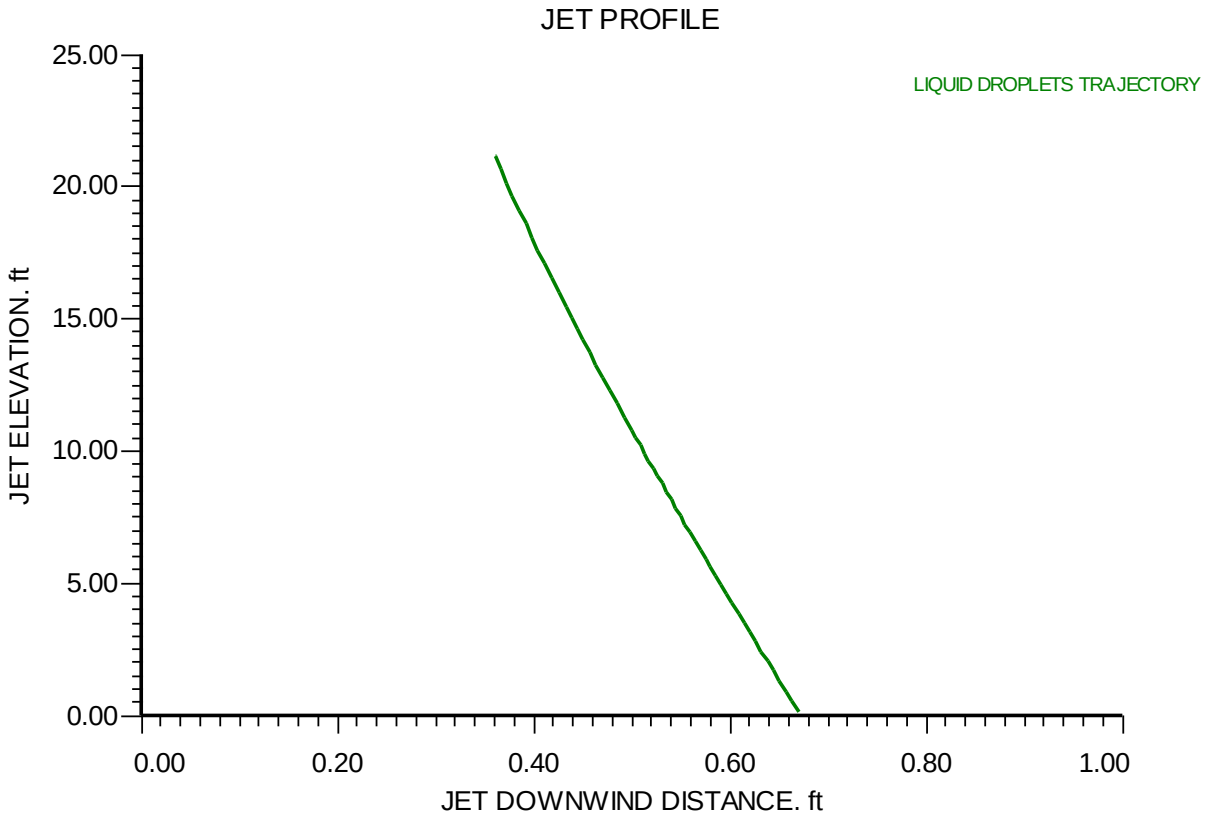


Figure 82: Liquid Release Jet Profile – E-R-17 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

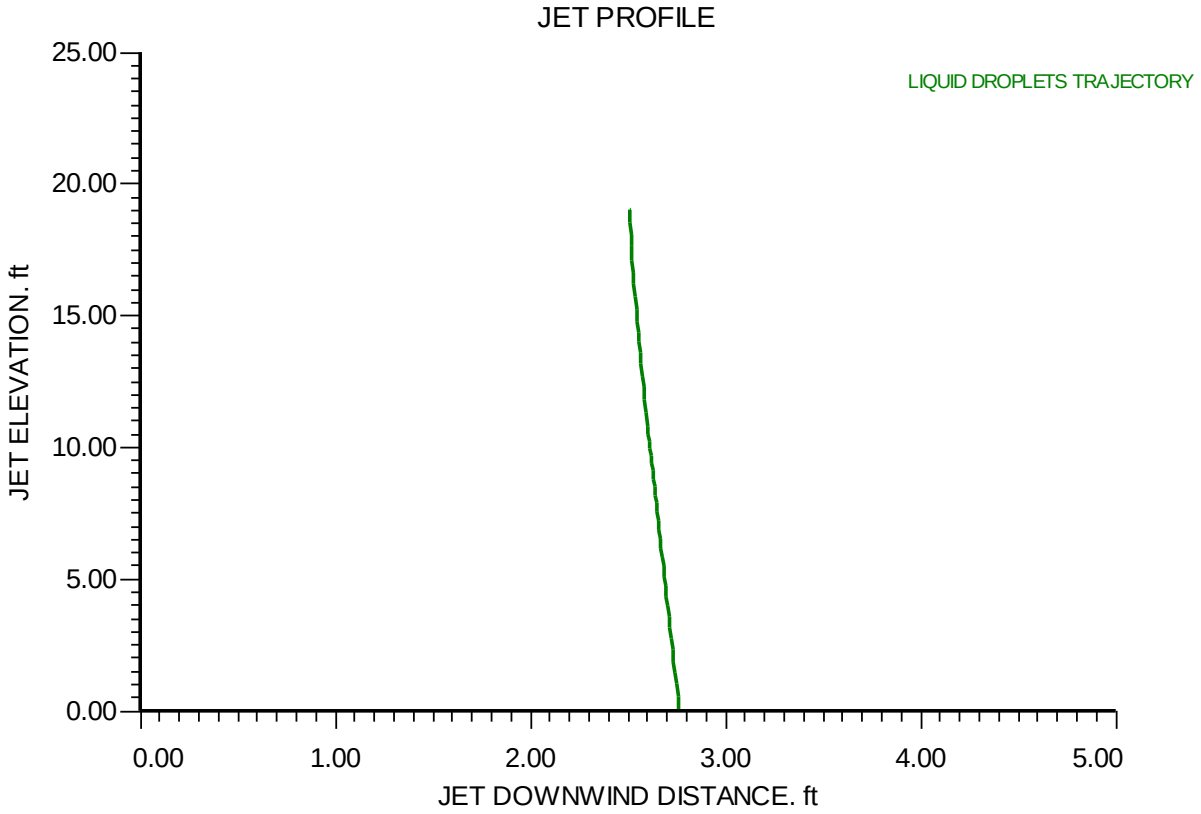


Figure 83: Liquid Release Jet Profile – E-R-17 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

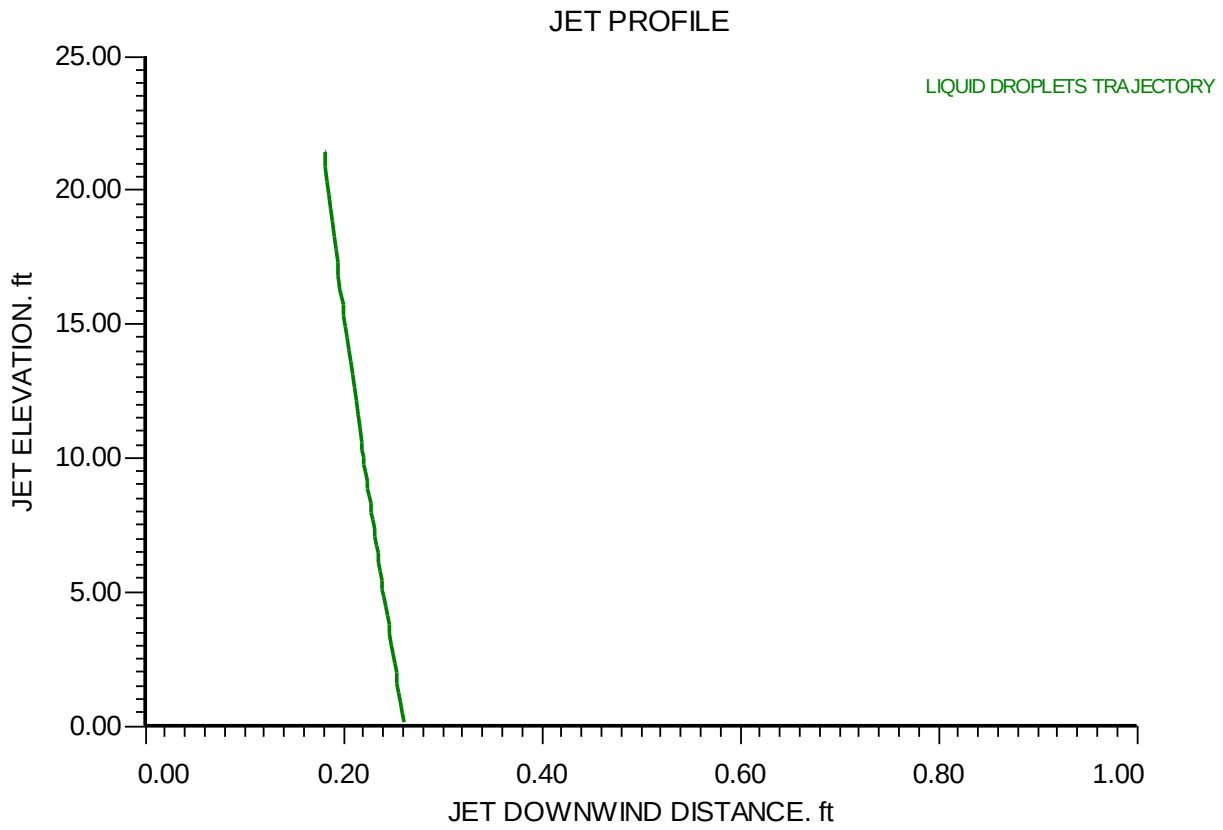


Figure 84: Liquid Release Jet Profile – E-R-17 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F

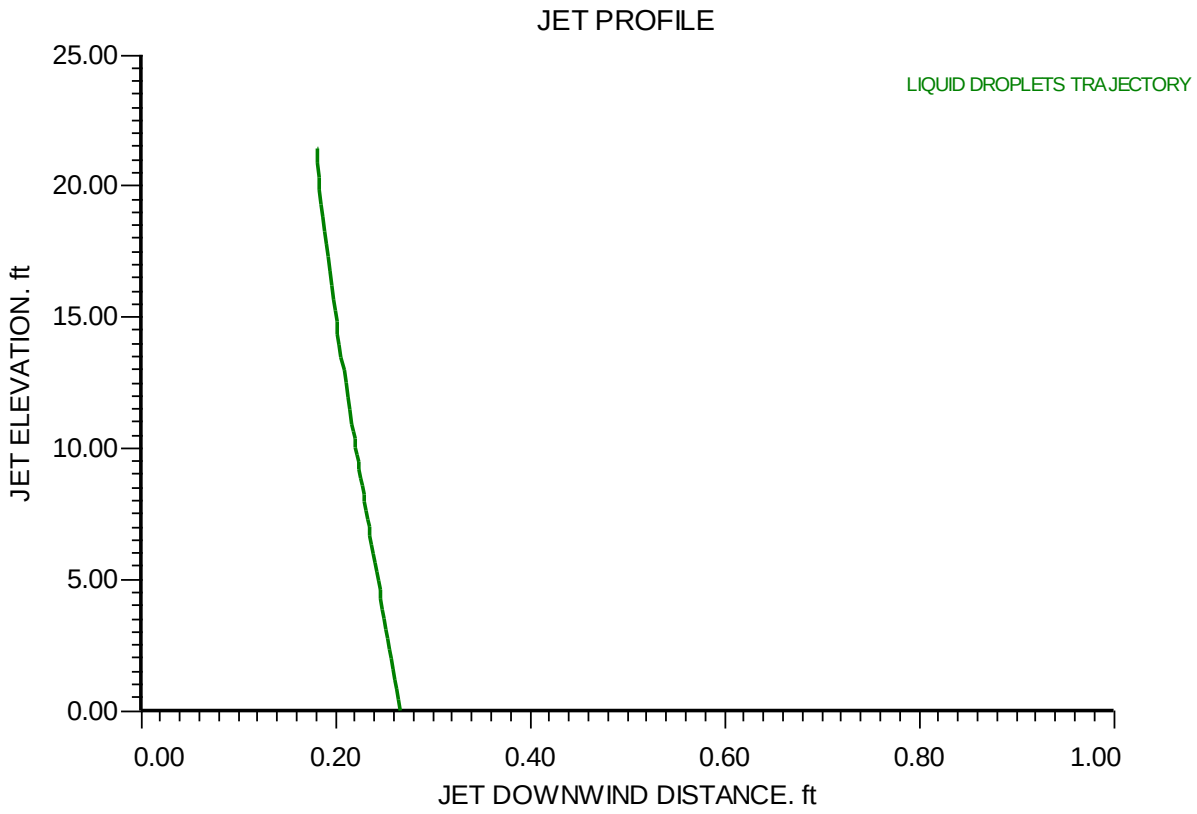


Figure 85: Liquid Release Jet Profile – E-R-17 Layout – 50% Reacted; D5 Stability Class; 20 psig and 205°F

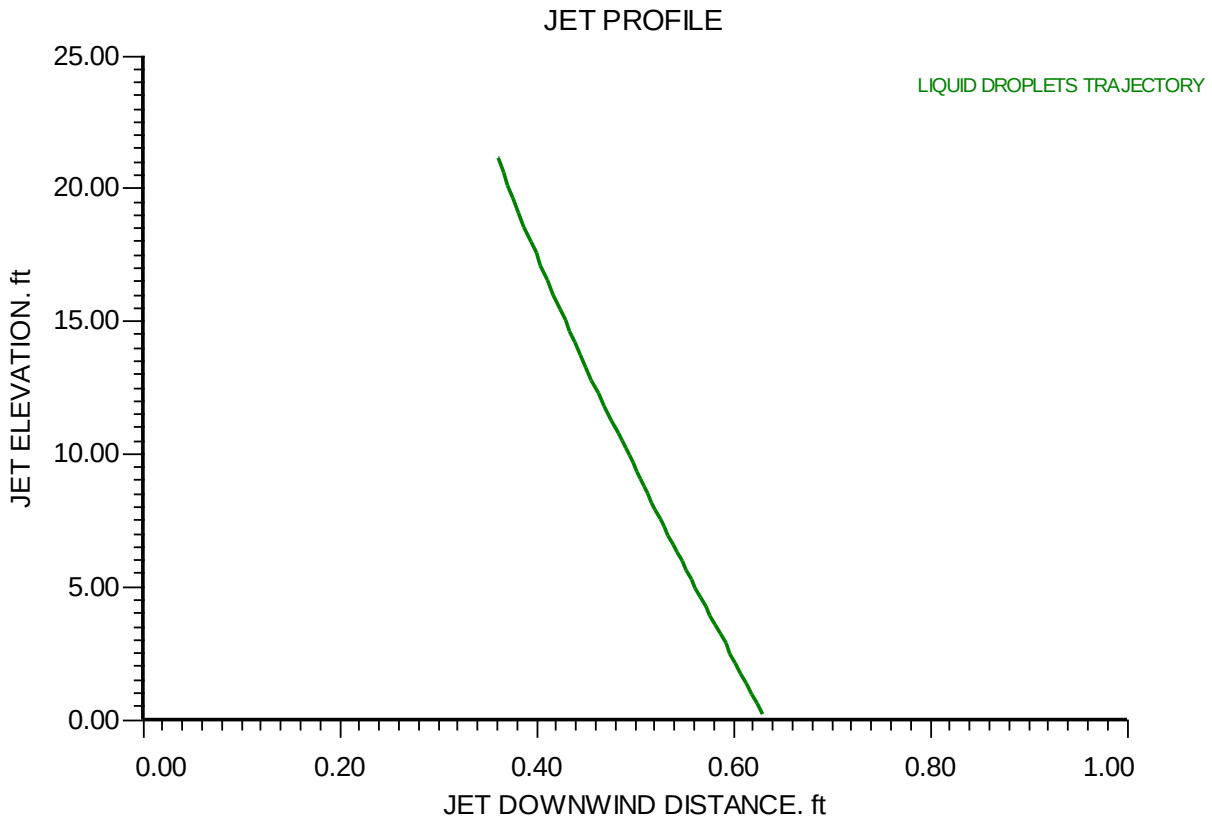


Figure 86: Liquid Release Jet Profile – E-R-17 Layout – 50% Reacted; F2 Stability Class; 20 psig and 205°F

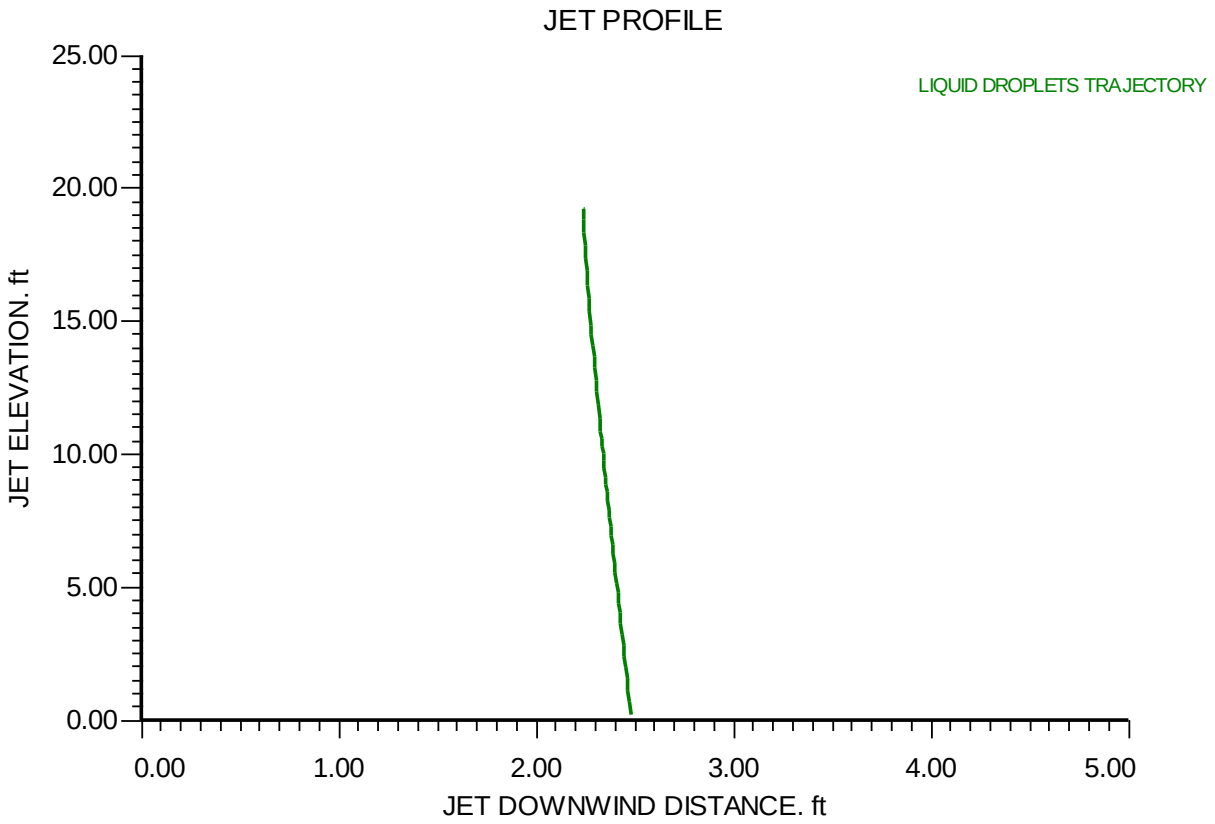


Figure 87: Liquid Release Jet Profile – E-R-17 Layout – 50% Reacted; D5 Stability Class; 5 psig and 210°F

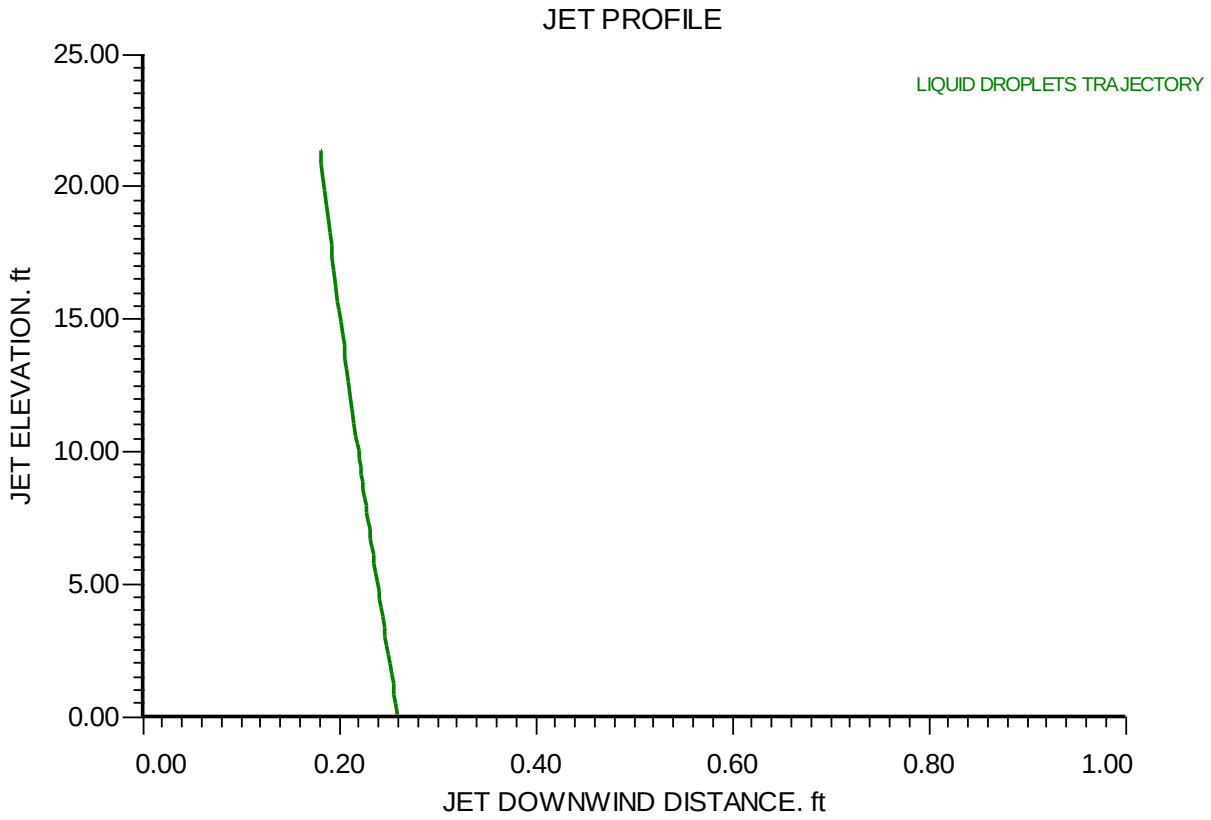


Figure 88: Liquid Release Jet Profile – E-R-17 Layout – 50% Reacted; F2 Stability Class; 5 psig and 210°F

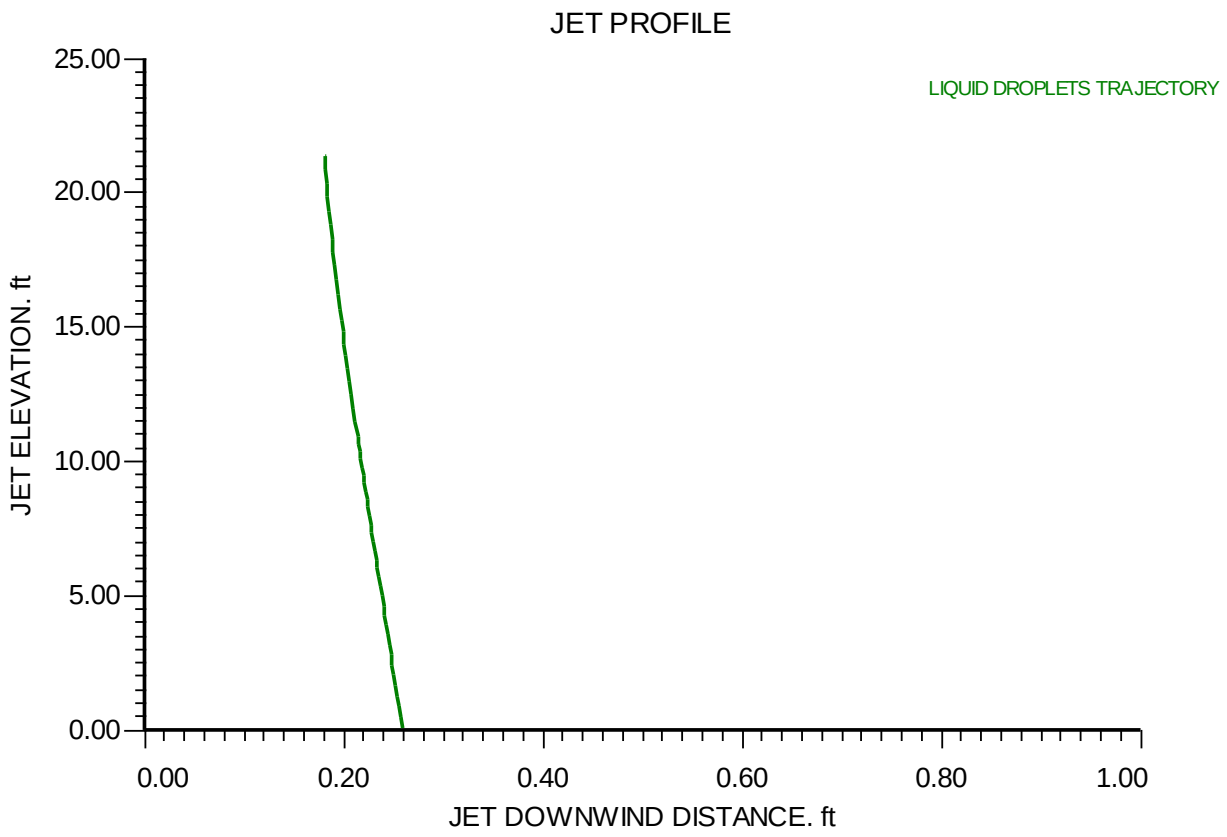


Figure 89: Liquid Release Jet Profile – E-R-17 Layout – 75% Reacted; D5 Stability Class; 20 psig and 205°F

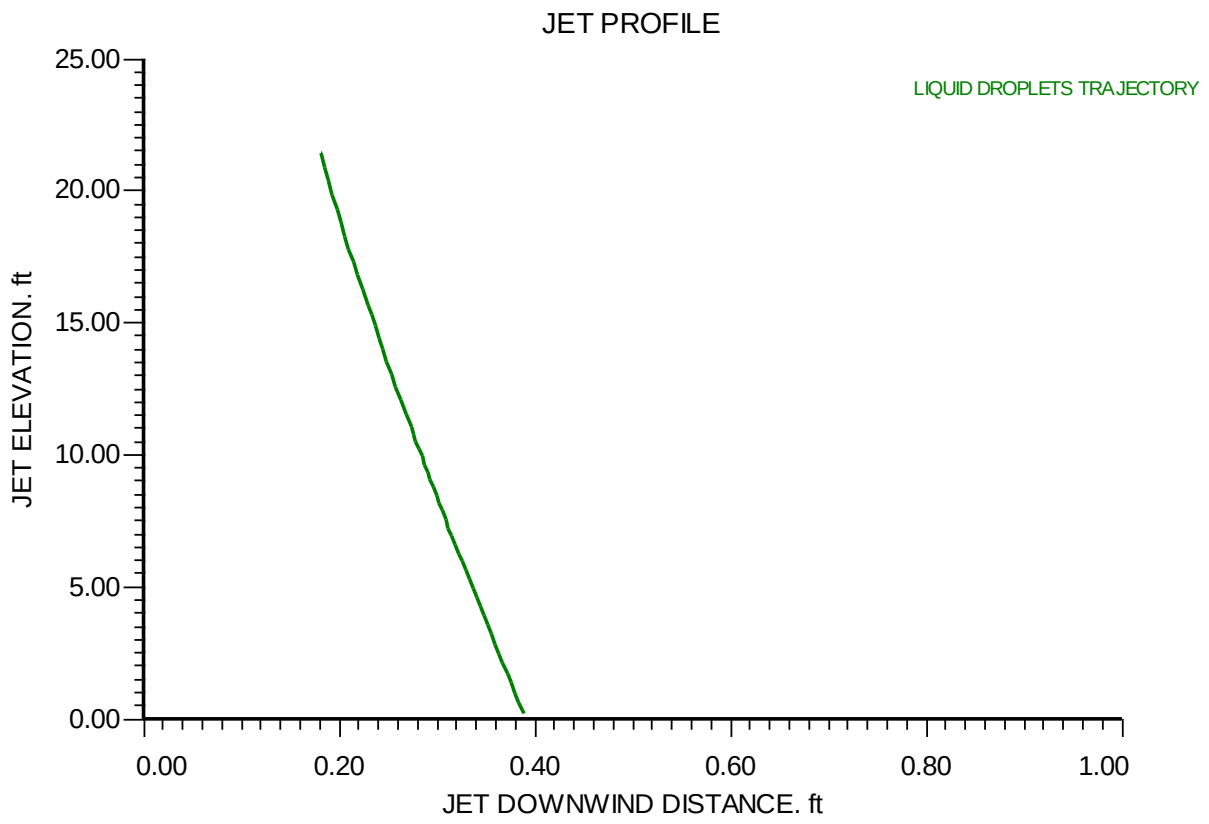


Figure 90: Liquid Release Jet Profile – E-R-17 Layout – 75% Reacted; F2 Stability Class; 20 psig and 205°F

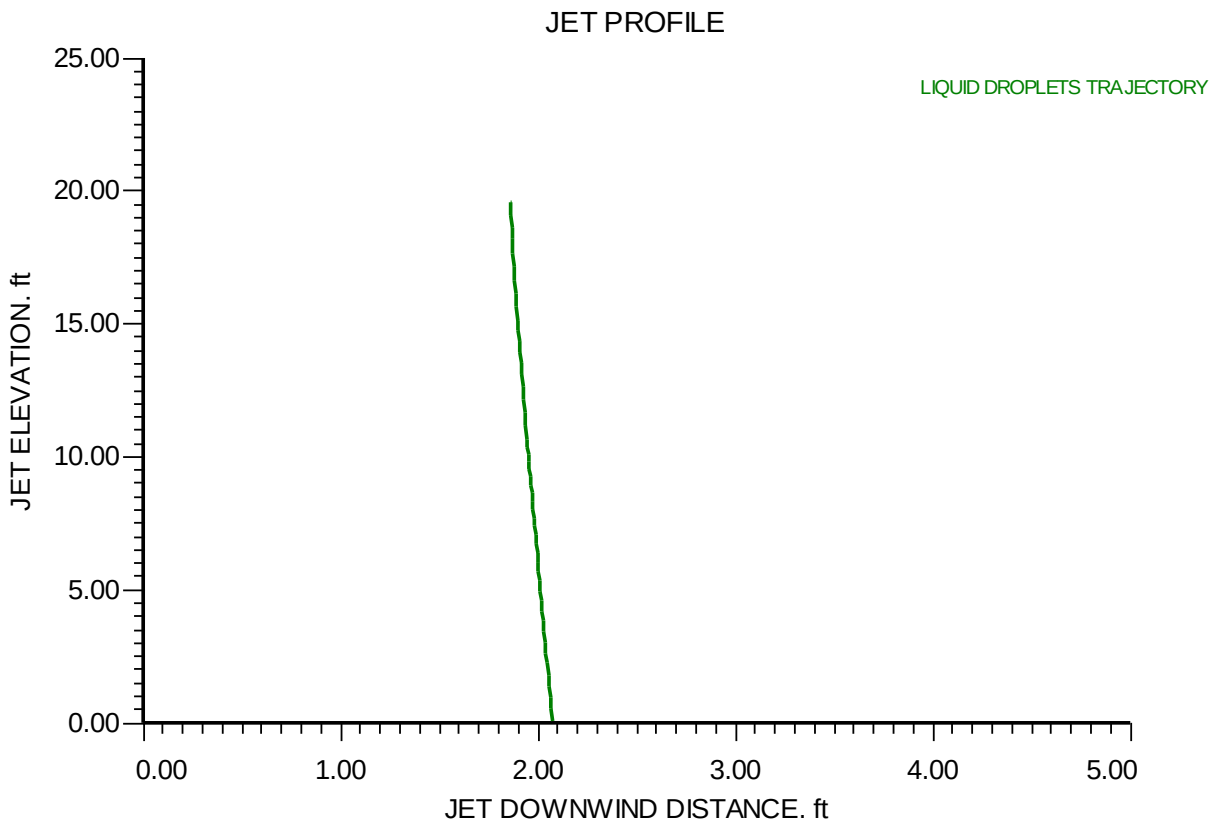


Figure 91: Liquid Release Jet Profile – E-R-17 Layout – 75% Reacted; D5 Stability Class; 5 psig and 210°F

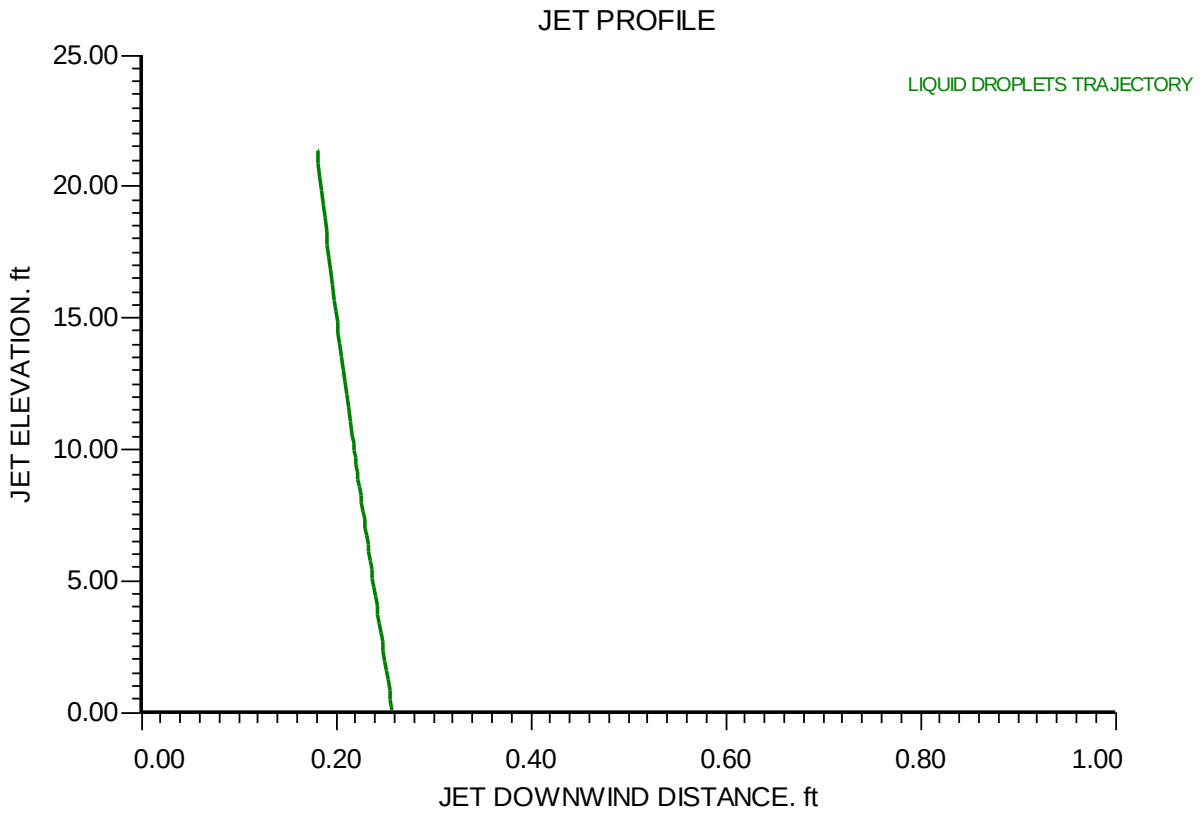


Figure 92: Liquid Release Jet Profile – E-R-17 Layout – 75% Reacted; F2 Stability Class; 5 psig and 210°F

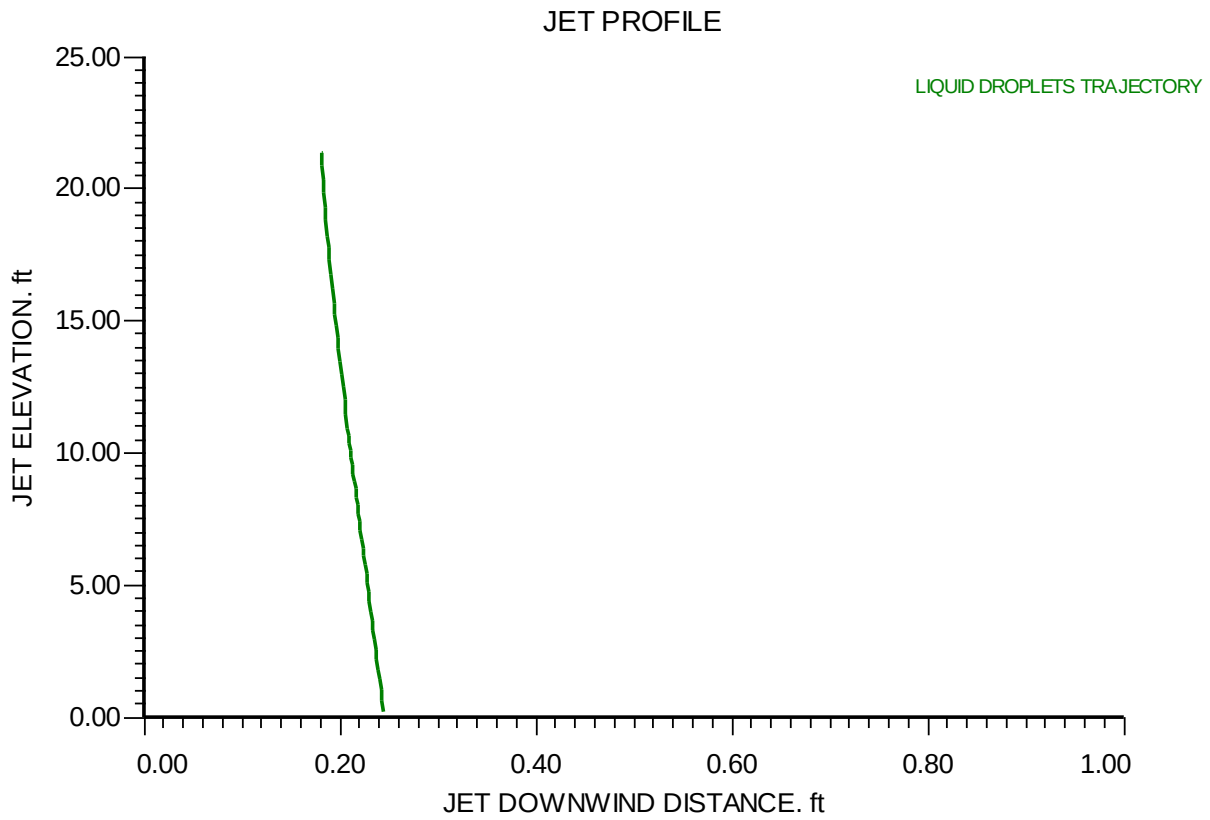


Figure 93: Liquid Release Jet Profile – E-R-17 Layout – 100% Reacted; D5 Stability Class; 20 psig and 205°F

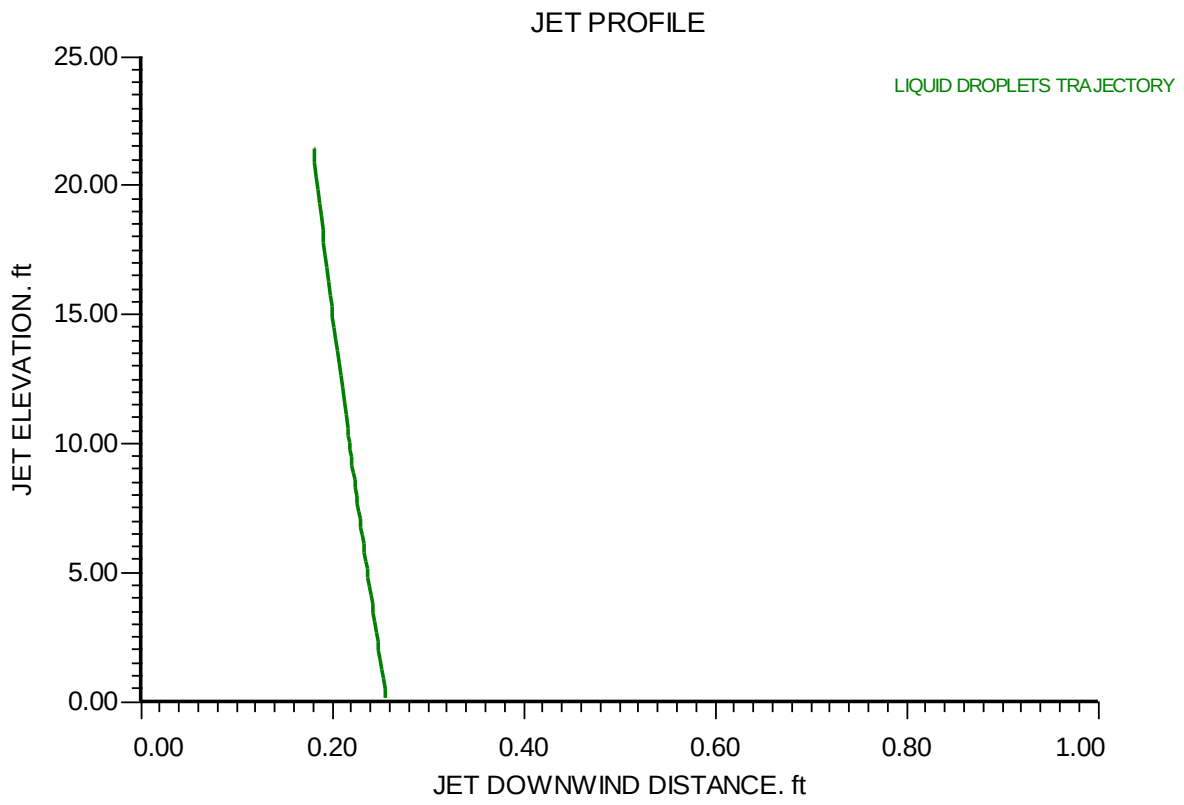


Figure 94: Liquid Release Jet Profile – E-R-17 Layout – 100% Reacted; F2 Stability Class; 20 psig and 205°F

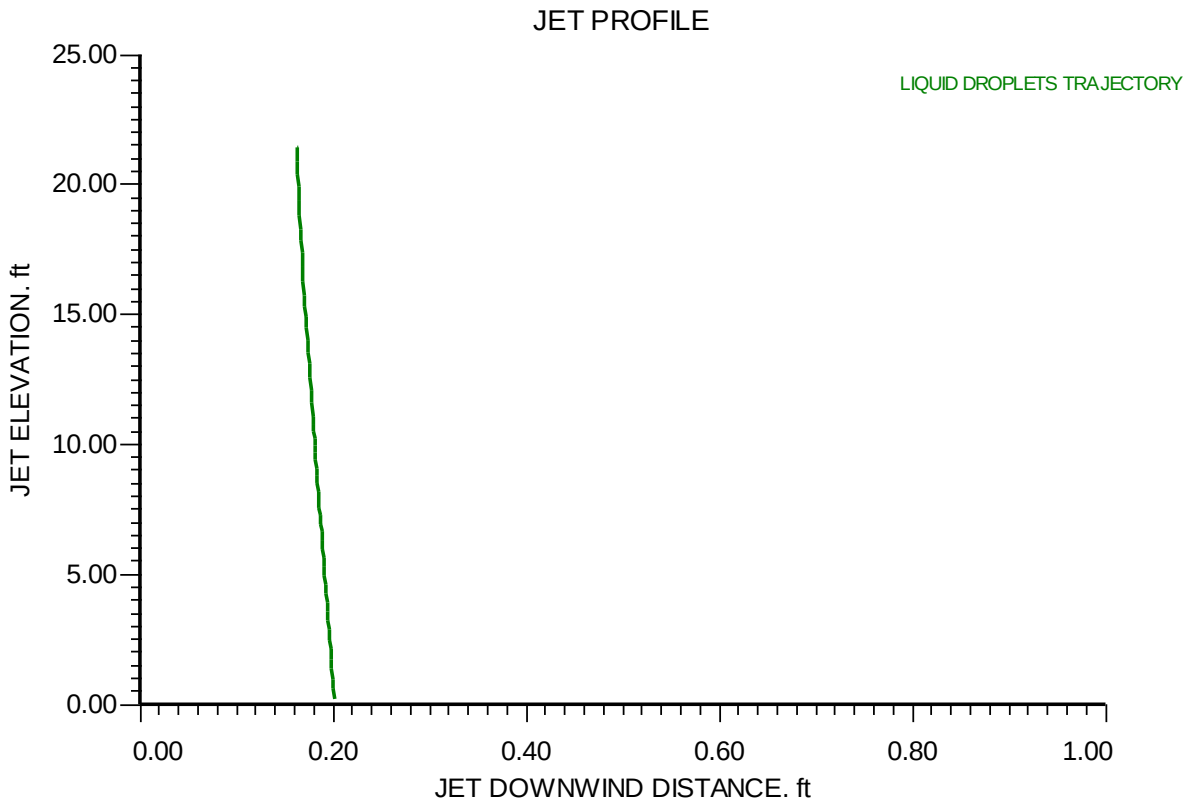


Figure 95: Liquid Release Jet Profile – E-R-17 Layout – 100% Reacted; D5 Stability Class; 5 psig and 210°F

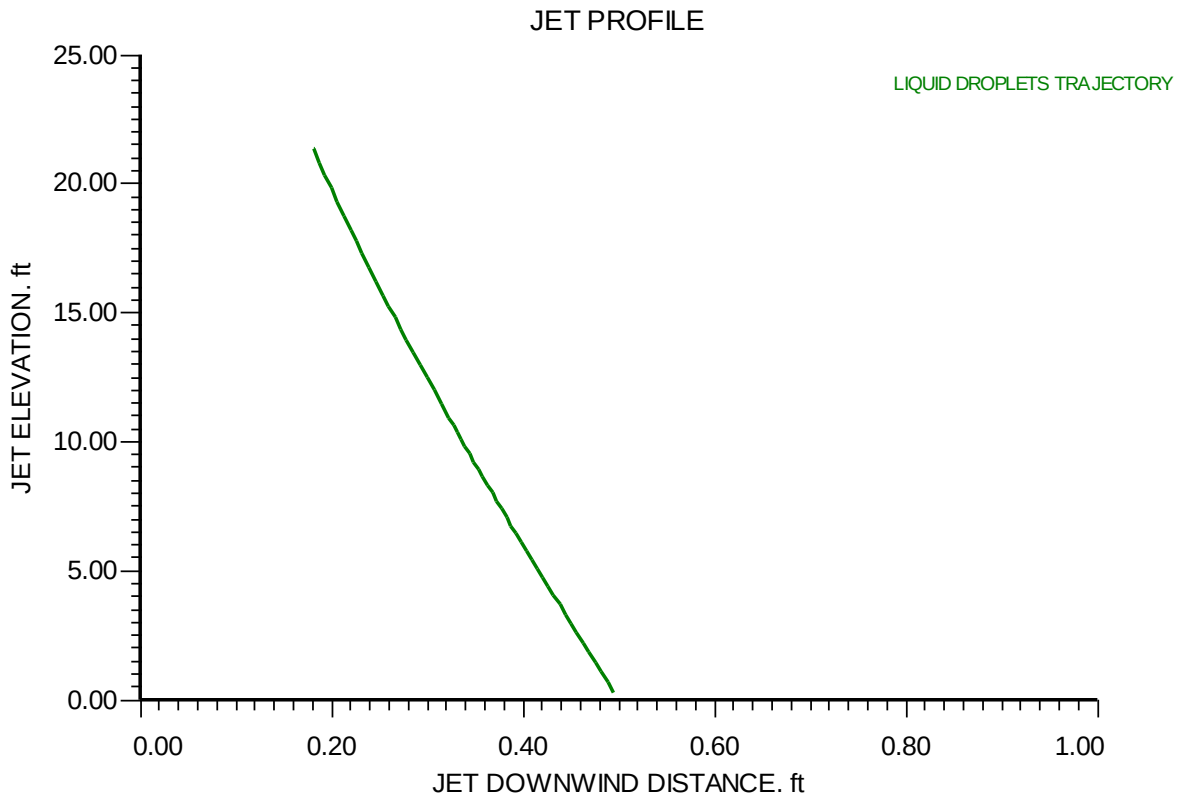
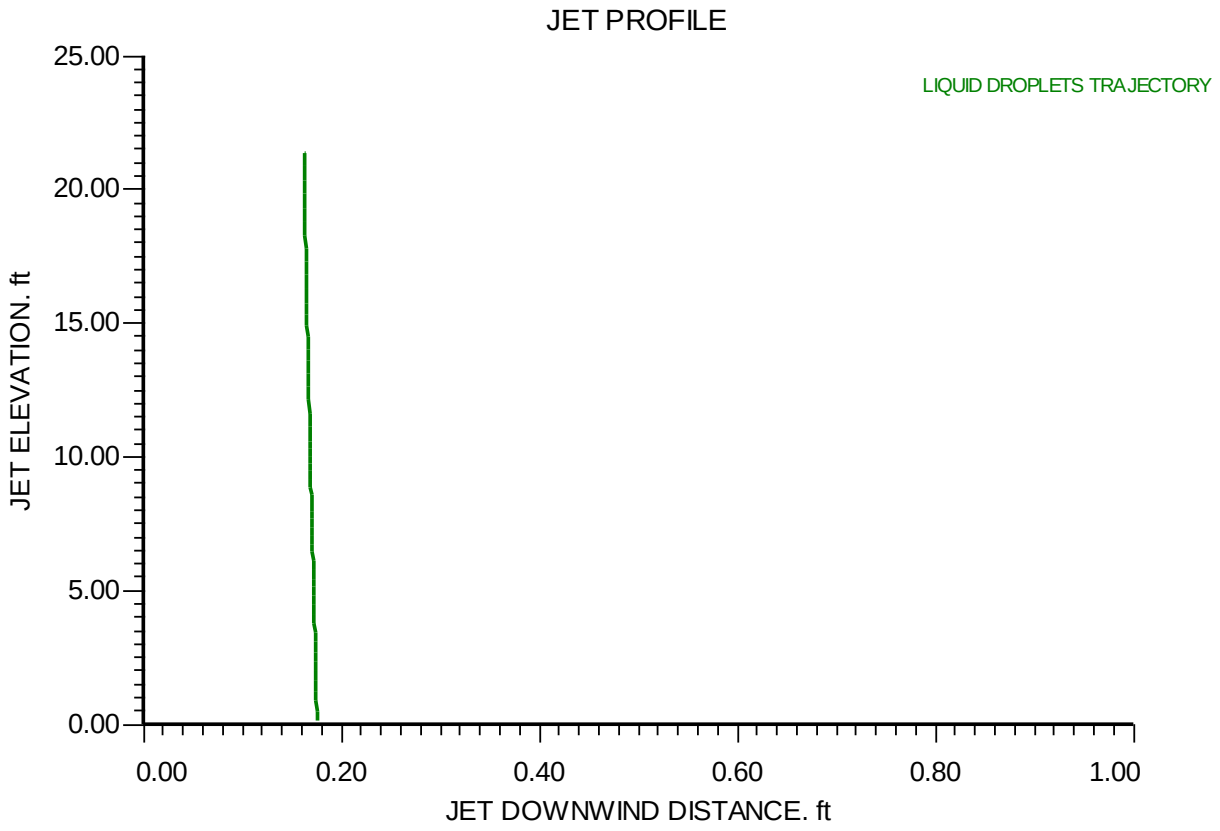


Figure 96: Liquid Release Jet Profile – E-R-17 Layout – 100% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix G: Results – E-R-18 Piping Layout to Pit – Liquid Release Jet Profile

Figure 97: Liquid Release Jet Profile – E-R-18 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

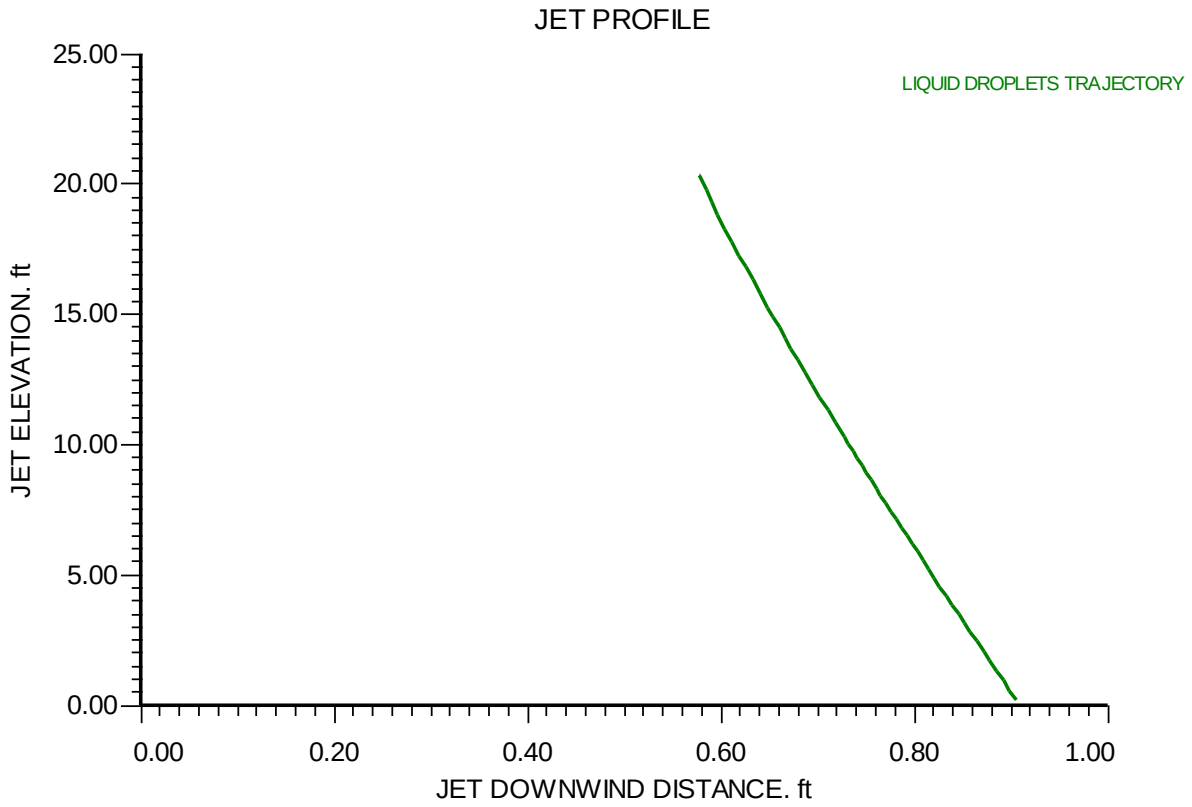


Figure 98: Liquid Release Jet Profile – E-R-18 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

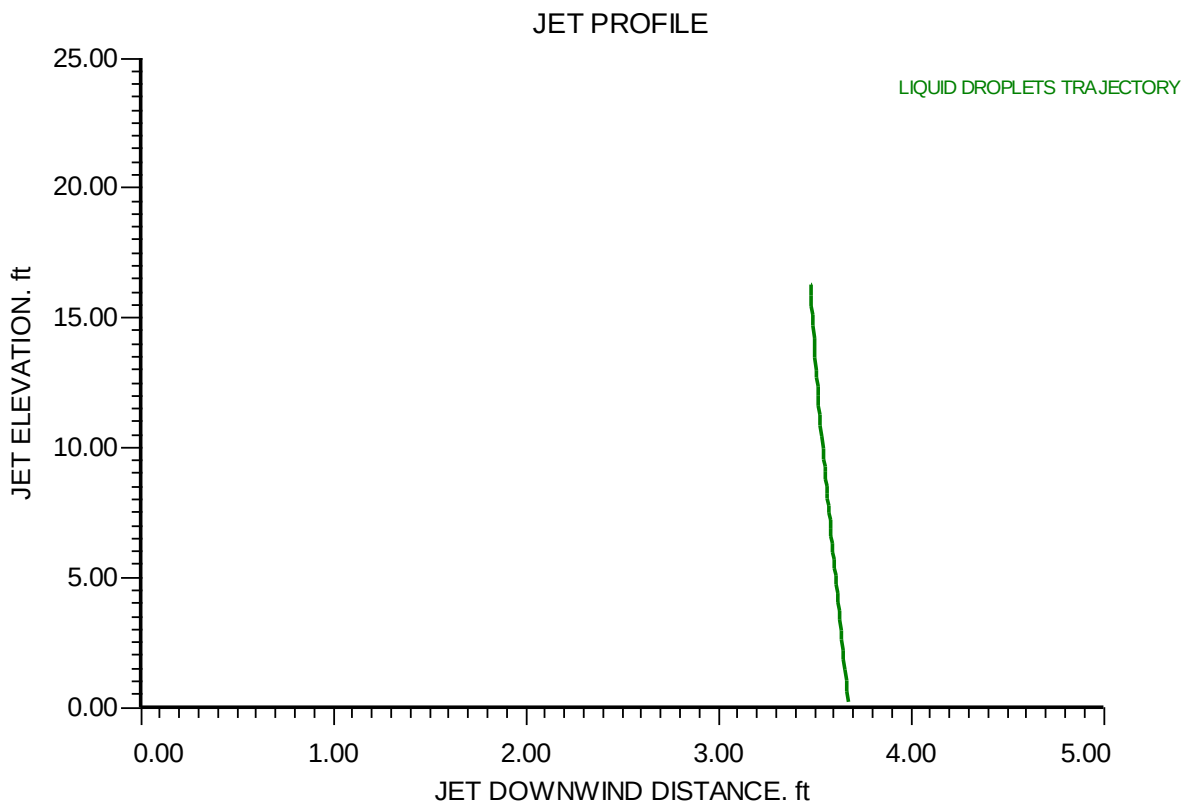


Figure 99: Liquid Release Jet Profile – E-R-18 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

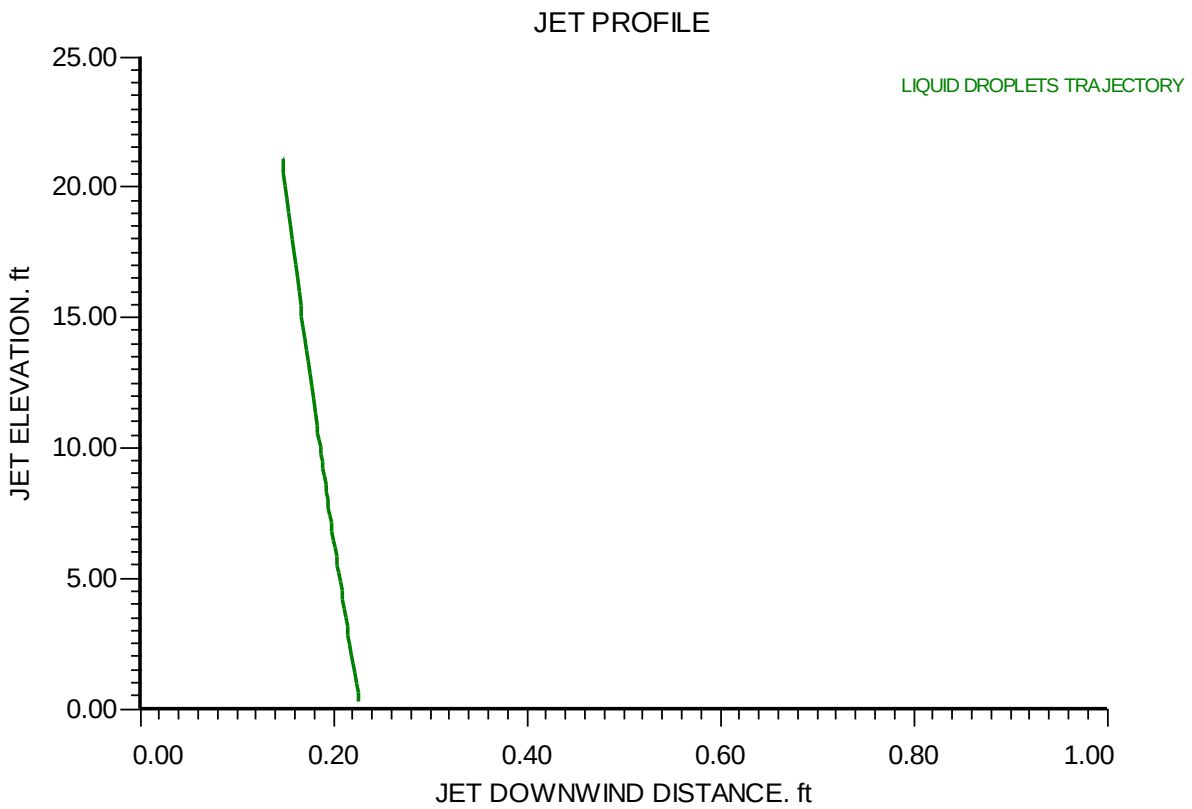


Figure 100: Liquid Release Jet Profile – E-R-18 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

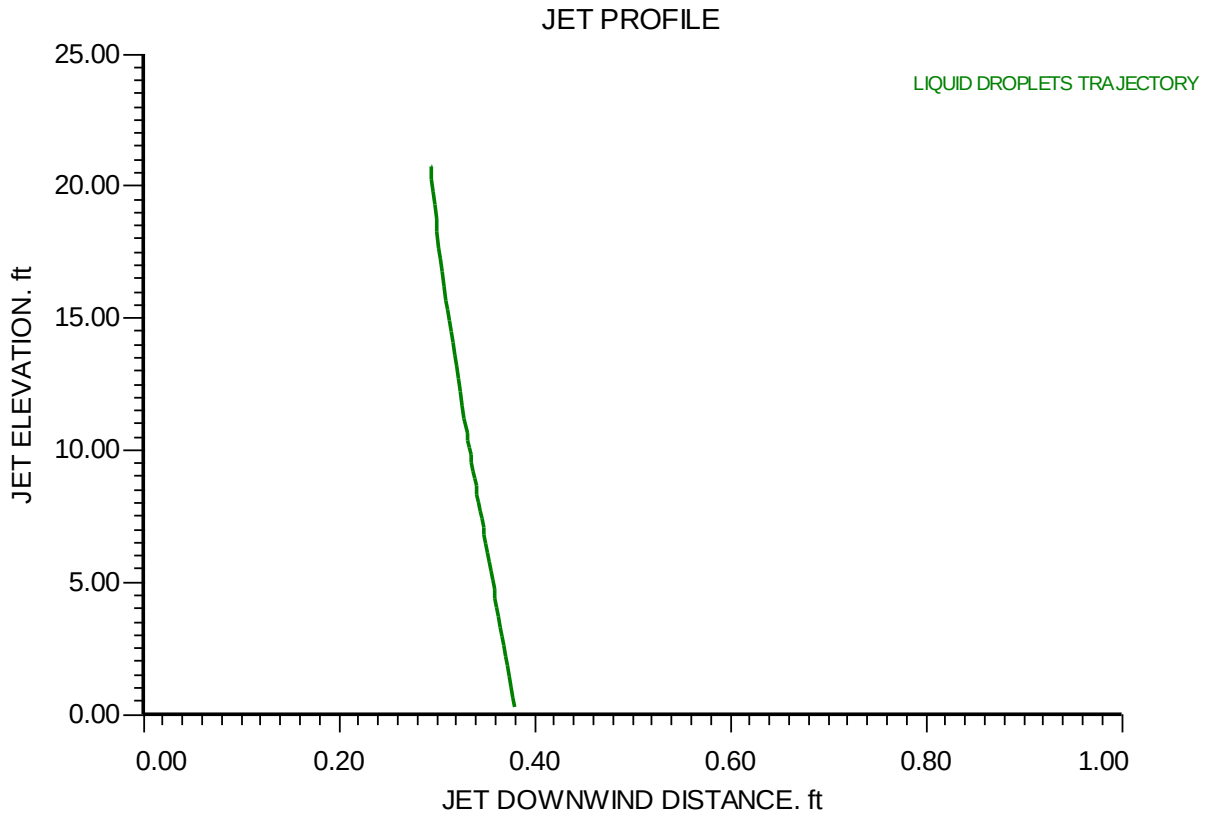


Figure 101: Liquid Release Jet Profile – E-R-18 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

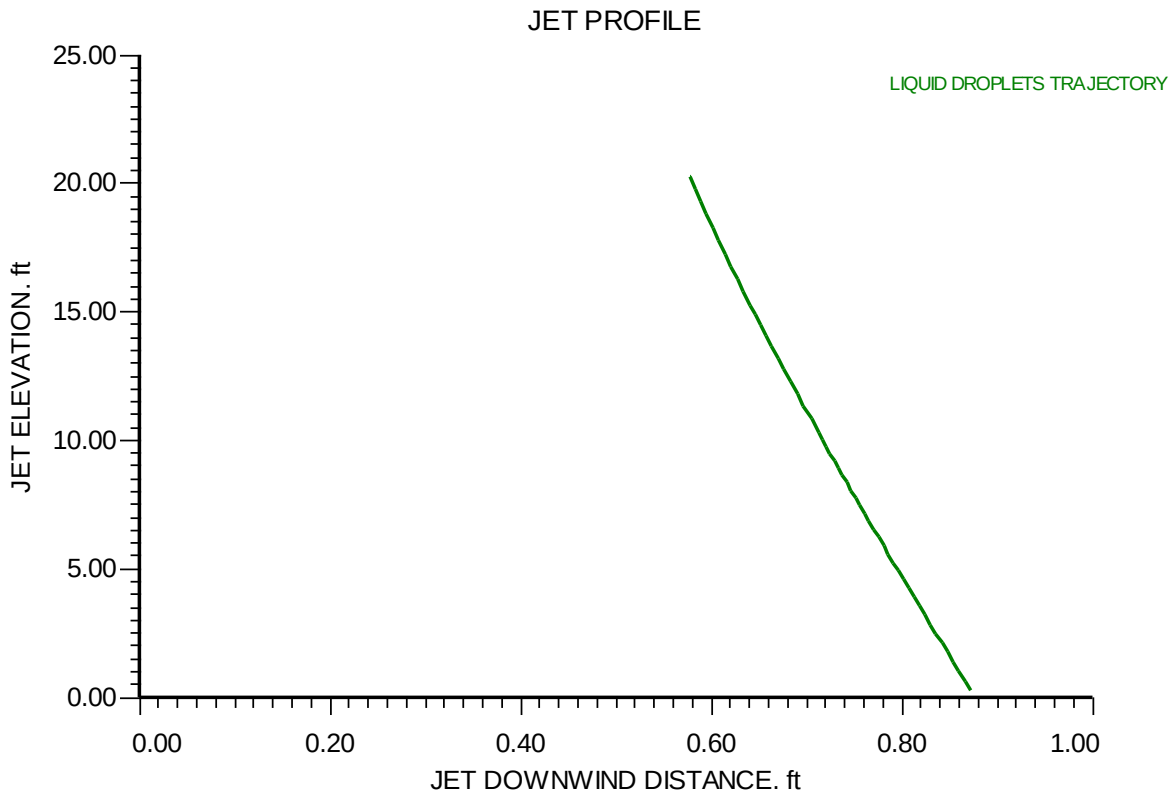


Figure 102: Liquid Release Jet Profile – E-R-18 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

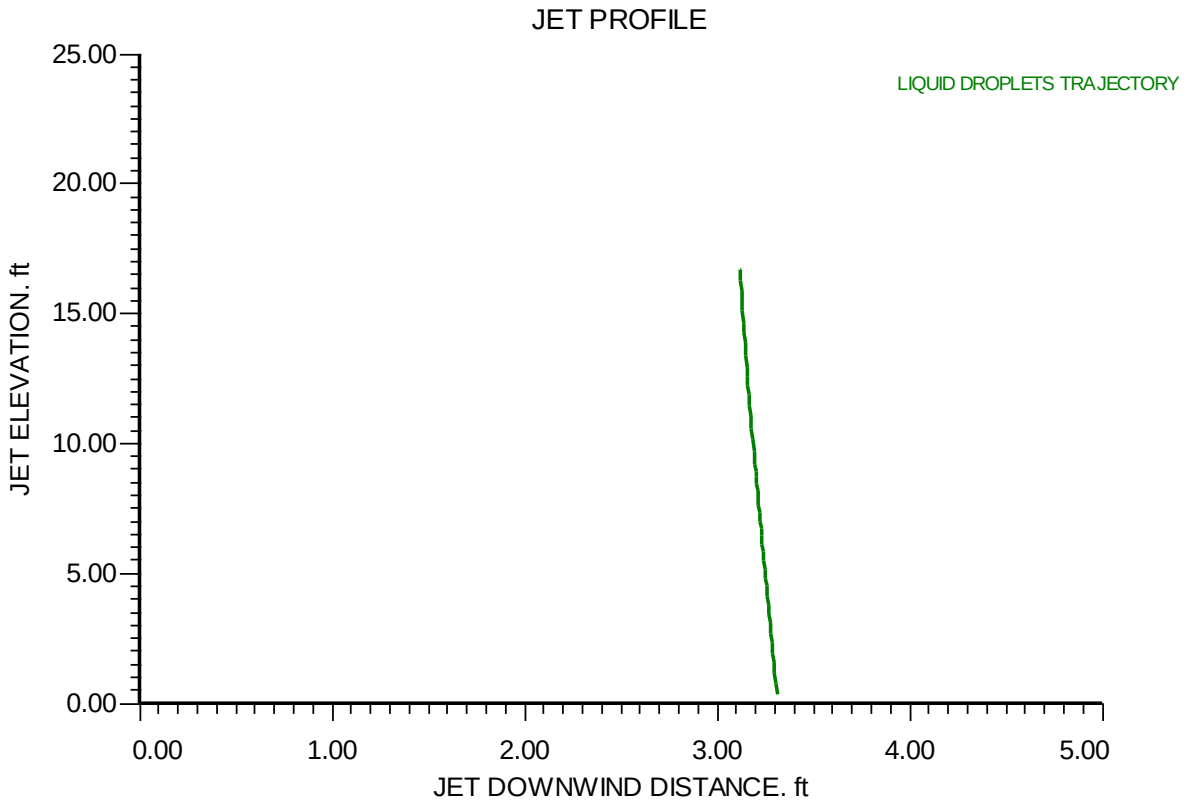


Figure 103: Liquid Release Jet Profile – E-R-18 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

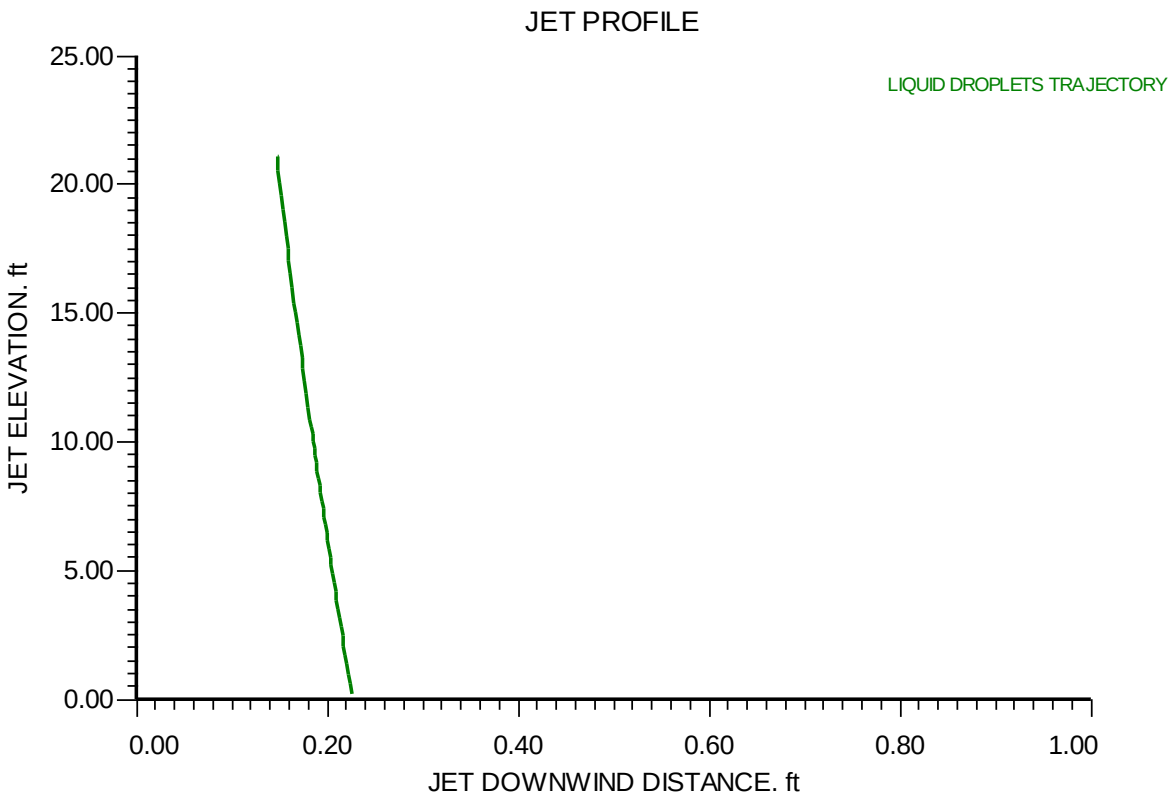


Figure 104: Liquid Release Jet Profile – E-R-18 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F

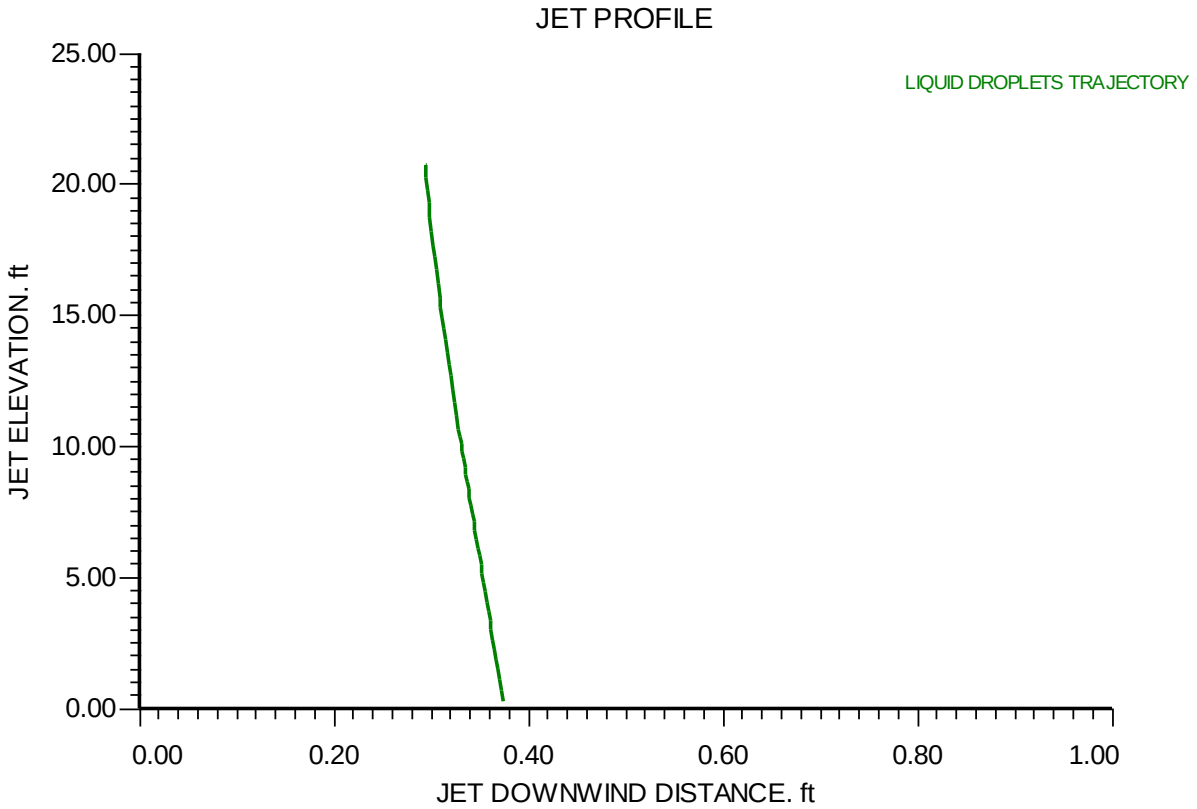


Figure 105: Liquid Release Jet Profile – E-R-18 Layout – 50% Reacted; D5 Stability Class; 20 psig and 205°F

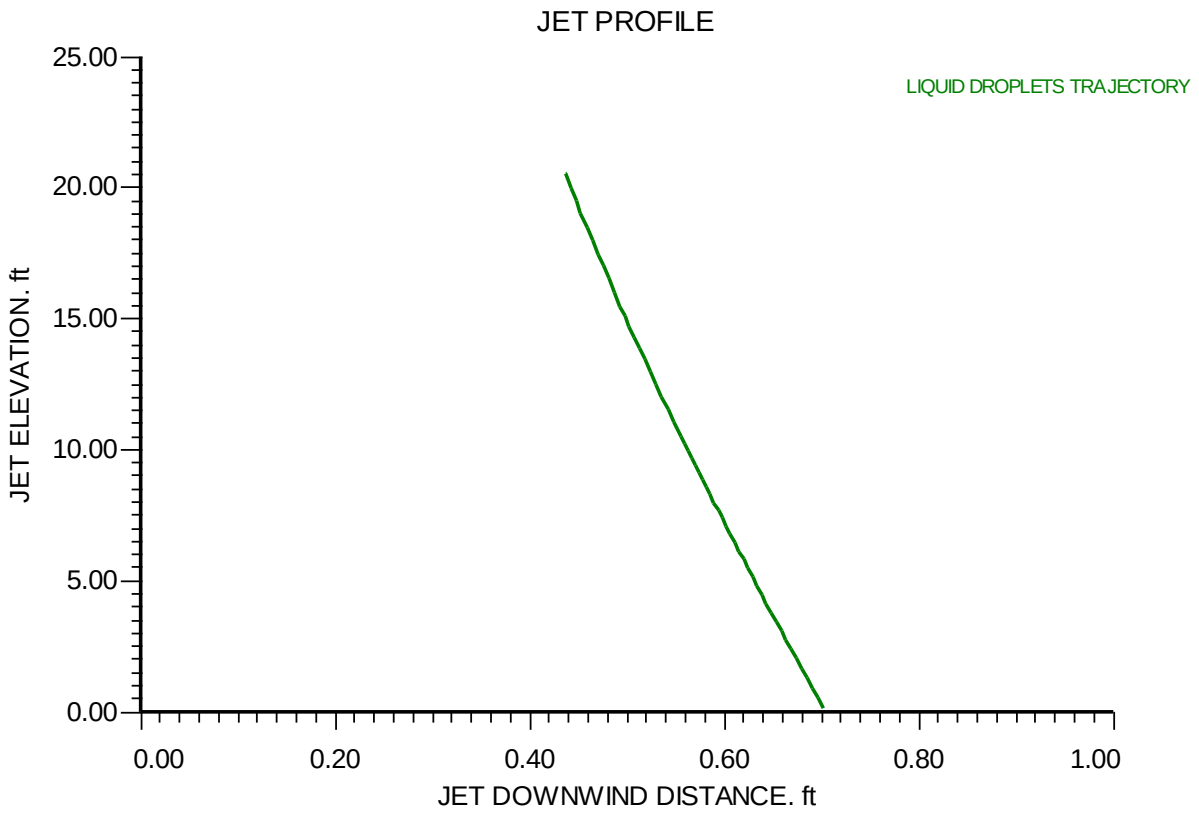


Figure 106: Liquid Release Jet Profile – E-R-18 Layout – 50% Reacted; F2 Stability Class; 20 psig and 205°F

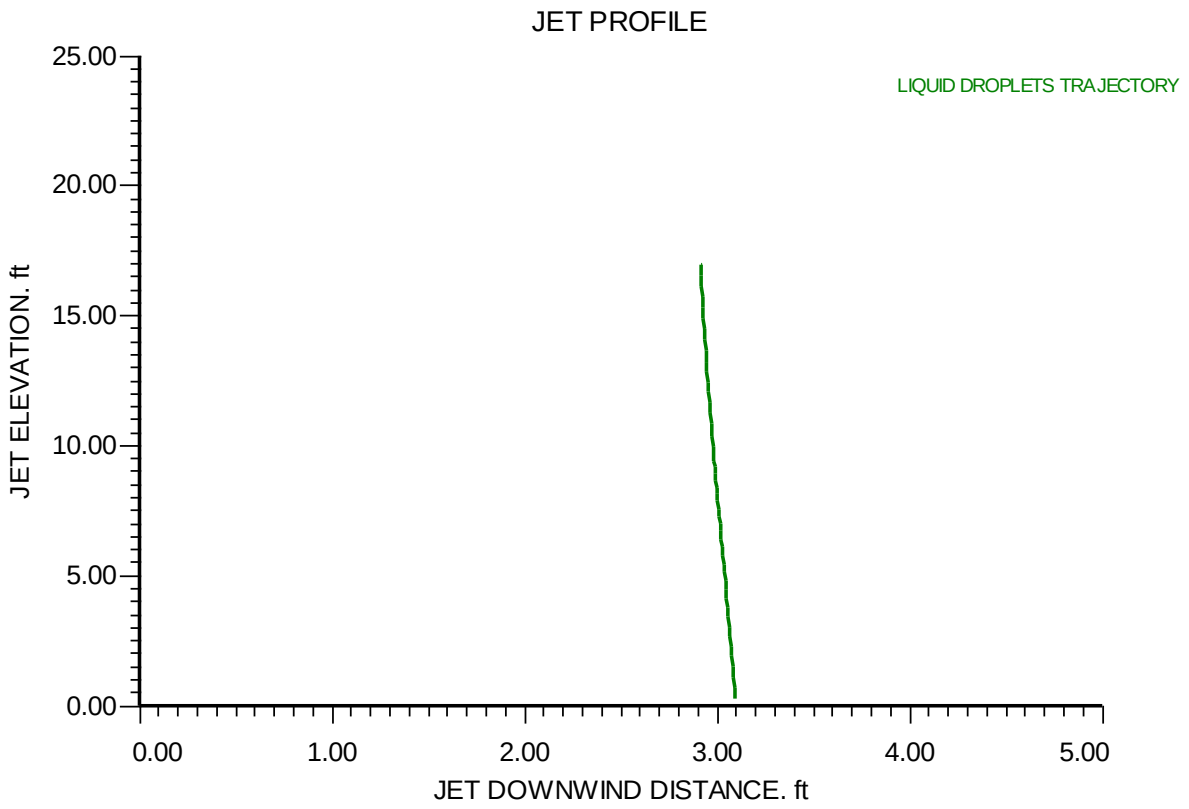


Figure 107: Liquid Release Jet Profile – E-R-18 Layout – 50% Reacted; D5 Stability Class; 5 psig and 210°F

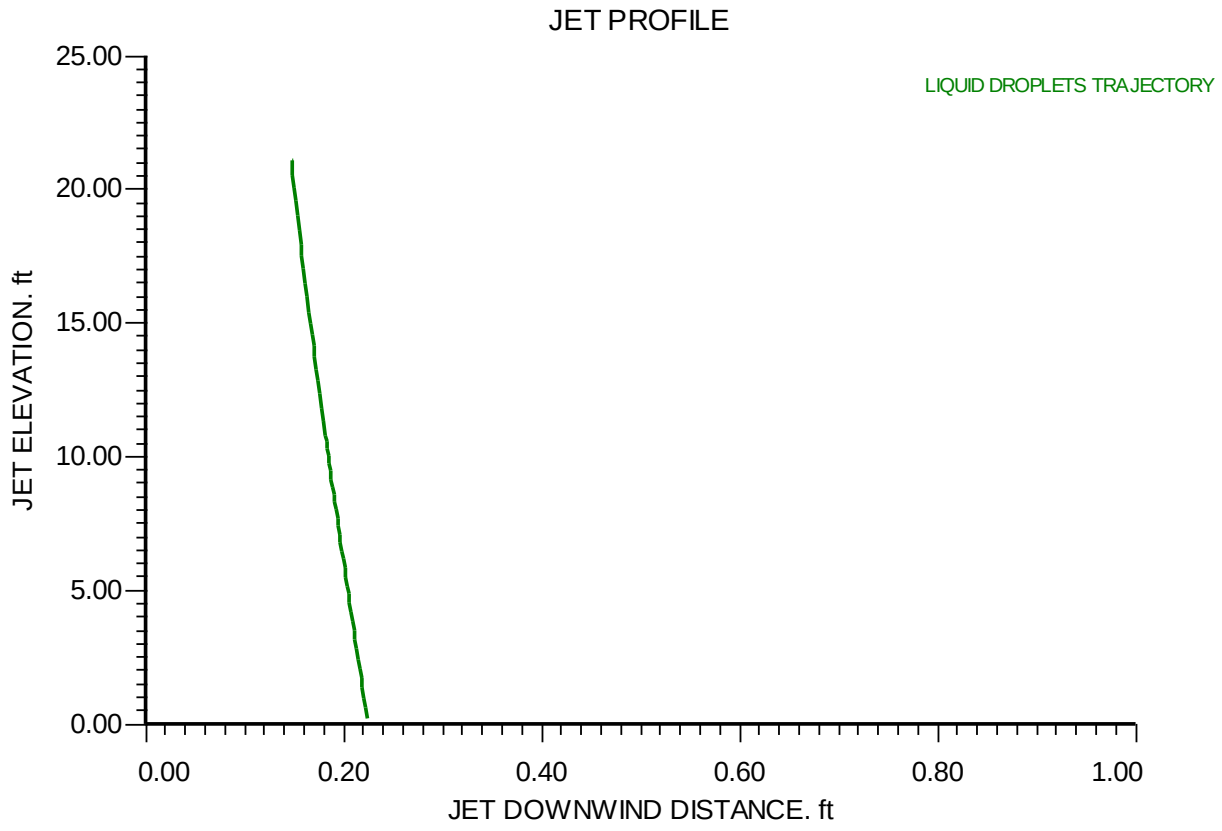


Figure 108: Liquid Release Jet Profile – E-R-18 Layout – 50% Reacted; F2 Stability Class; 5 psig and 210°F

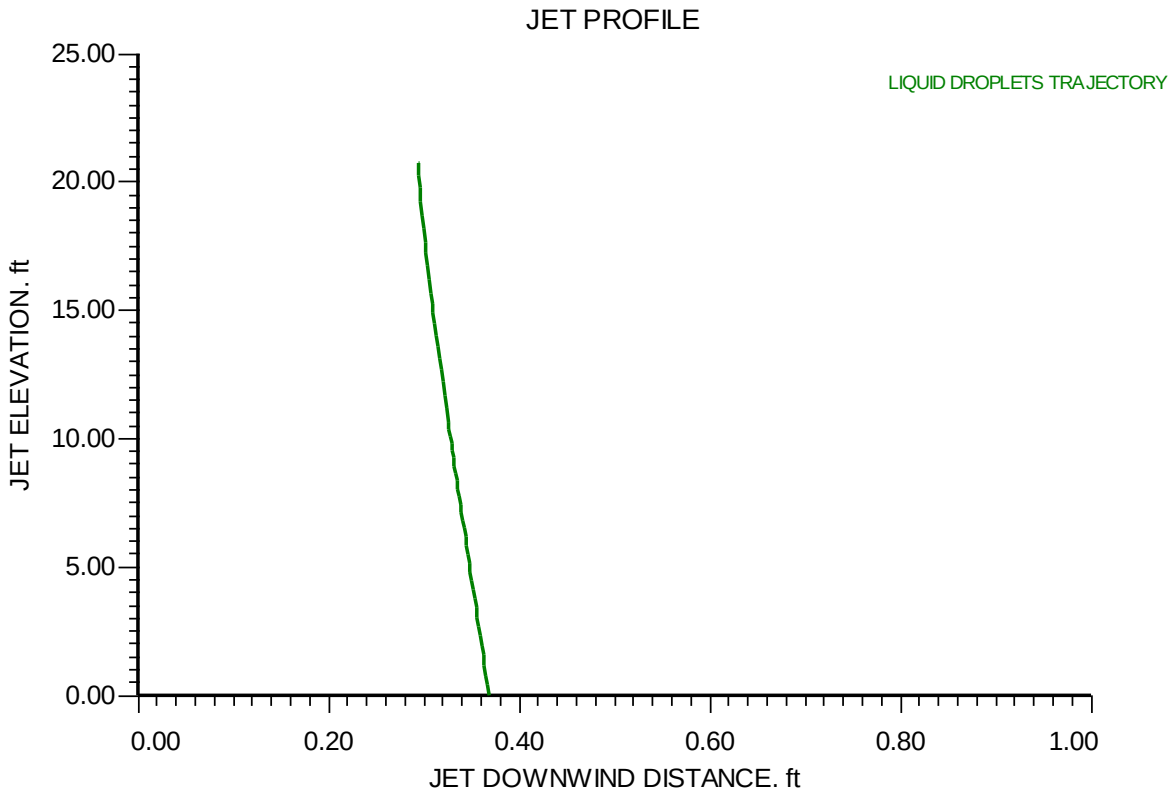


Figure 109: Liquid Release Jet Profile – E-R-18 Layout – 75% Reacted; D5 Stability Class; 20 psig and 205°F

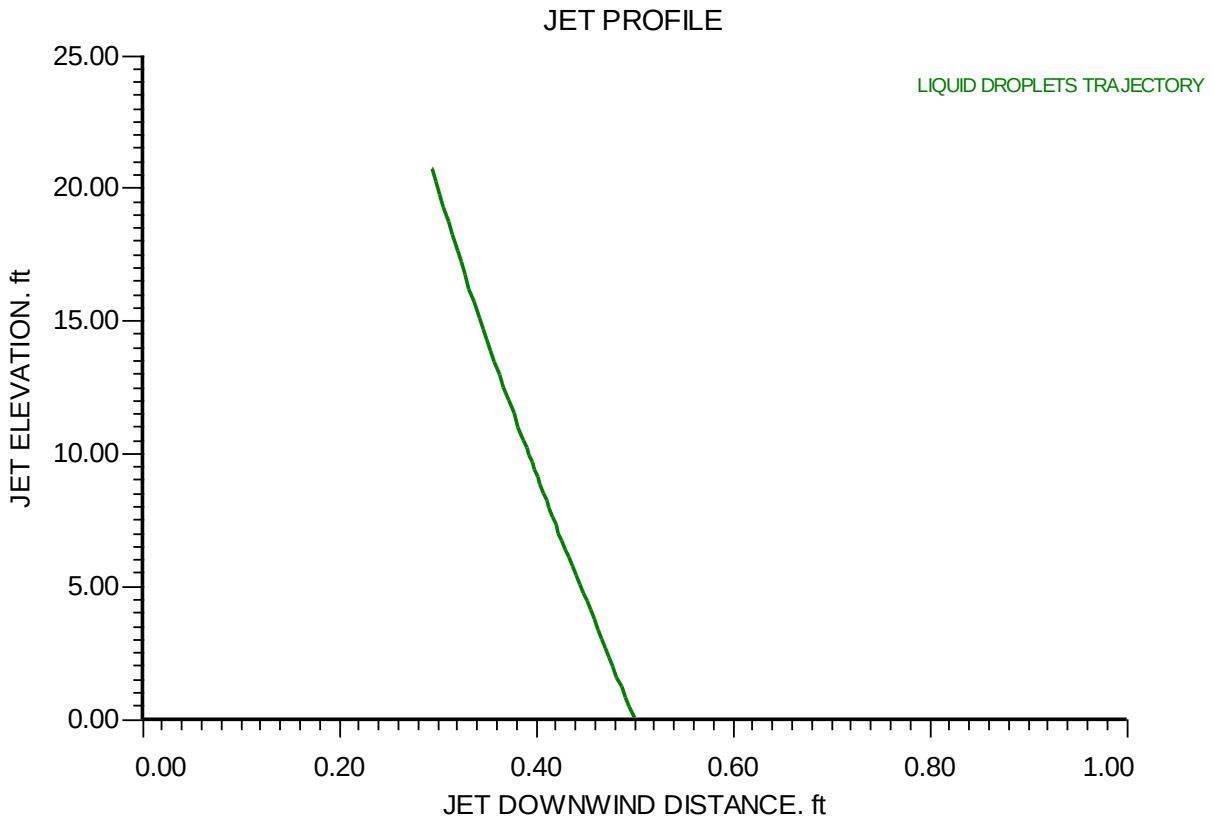


Figure 110: Liquid Release Jet Profile – E-R-18 Layout – 75% Reacted; F2 Stability Class; 20 psig and 205°F

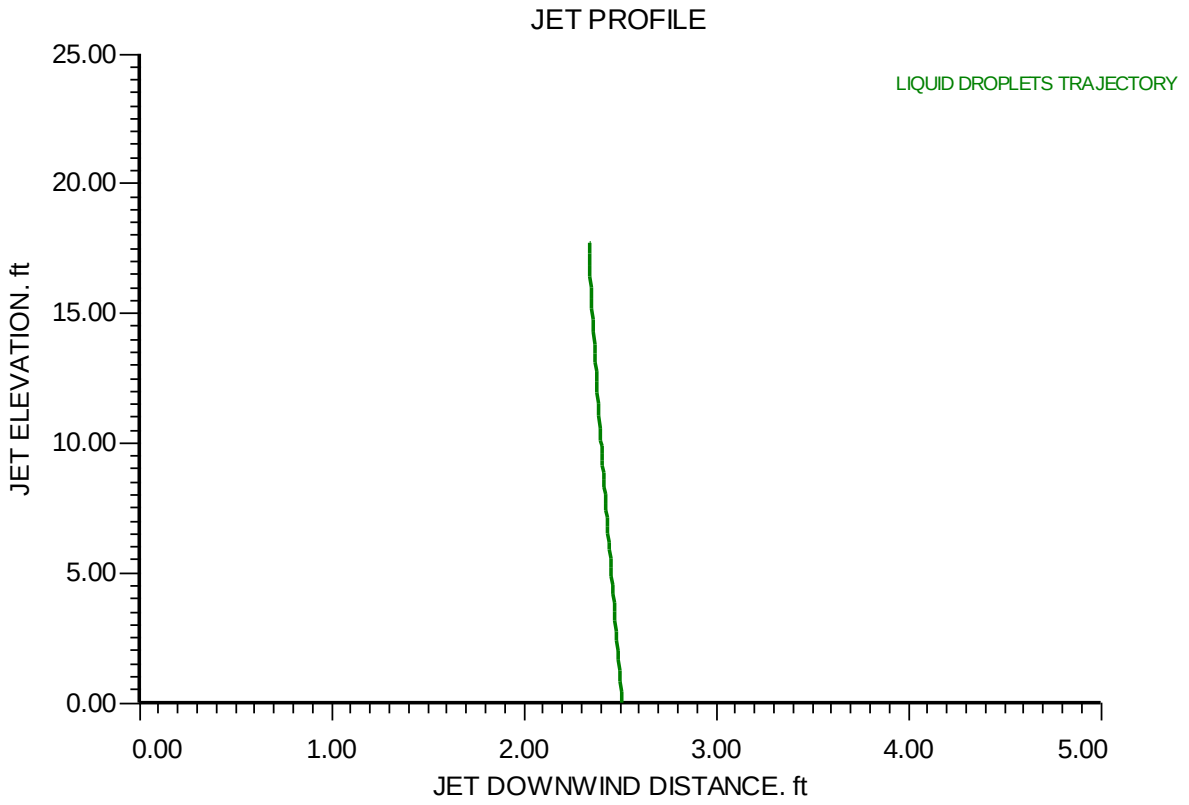


Figure 111: Liquid Release Jet Profile – E-R-18 Layout – 75% Reacted; D5 Stability Class; 5 psig and 210°F

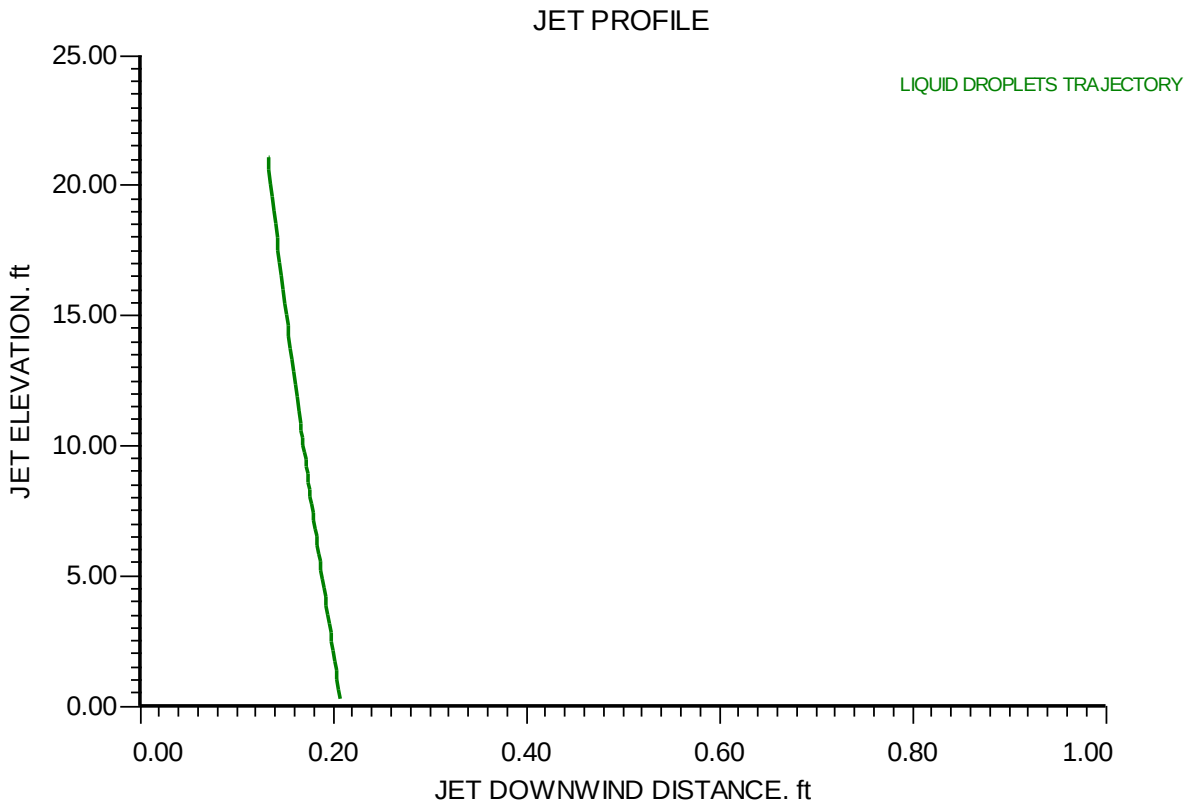


Figure 112: Liquid Release Jet Profile – E-R-18 Layout – 75% Reacted; F2 Stability Class; 5 psig and 210°F

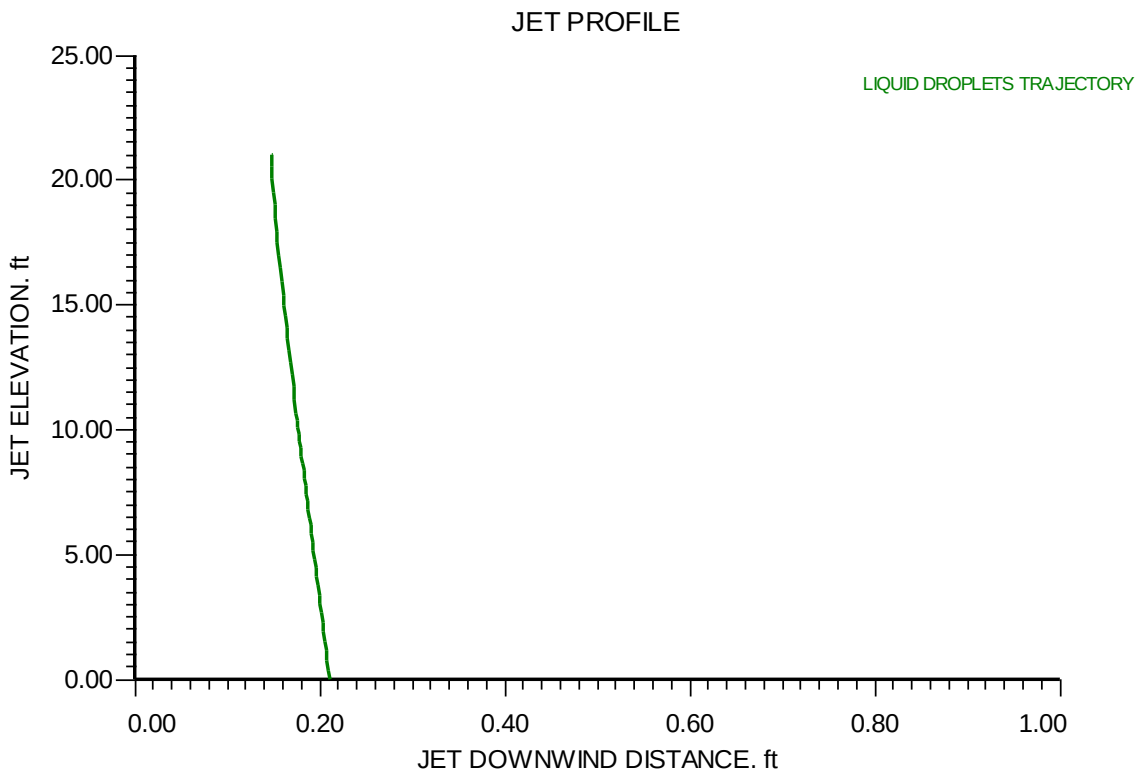


Figure 113: Liquid Release Jet Profile – E-R-18 Layout – 100% Reacted; D5 Stability Class; 20 psig and 205°F

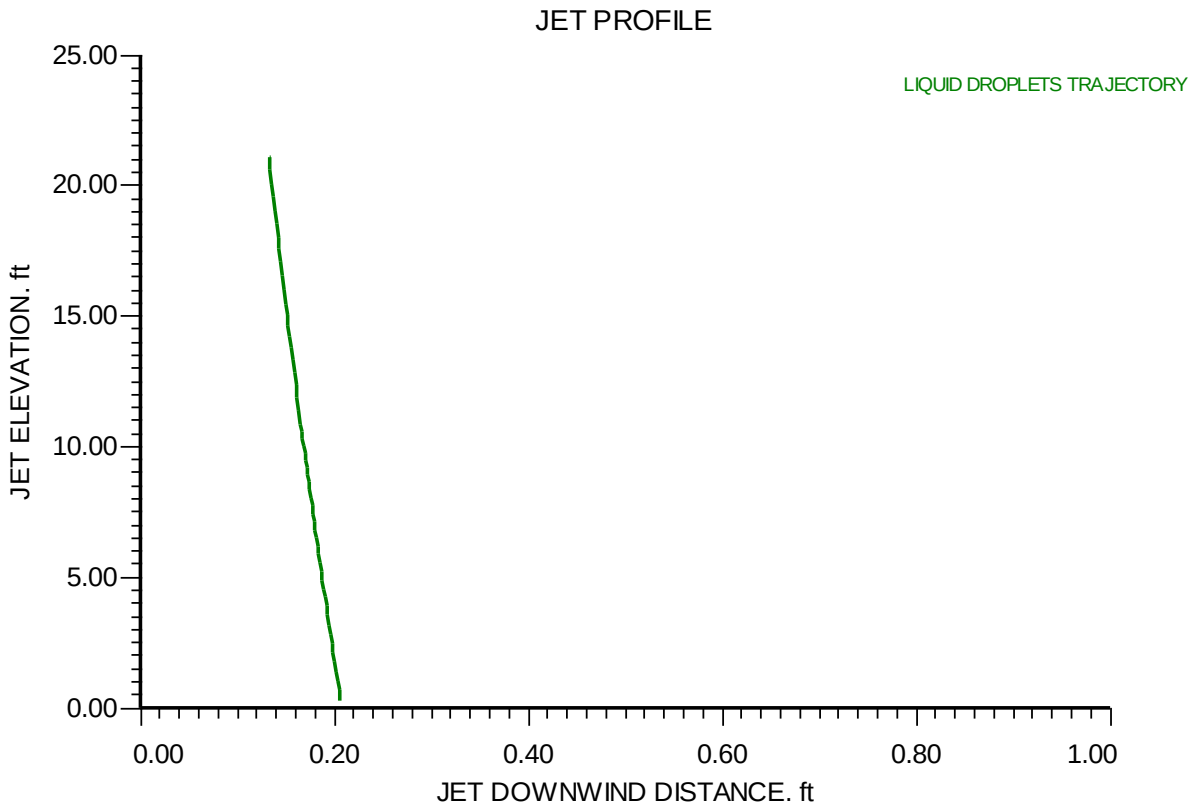


Figure 114: Liquid Release Jet Profile – E-R-18 Layout – 100% Reacted; F2 Stability Class; 20 psig and 205°F

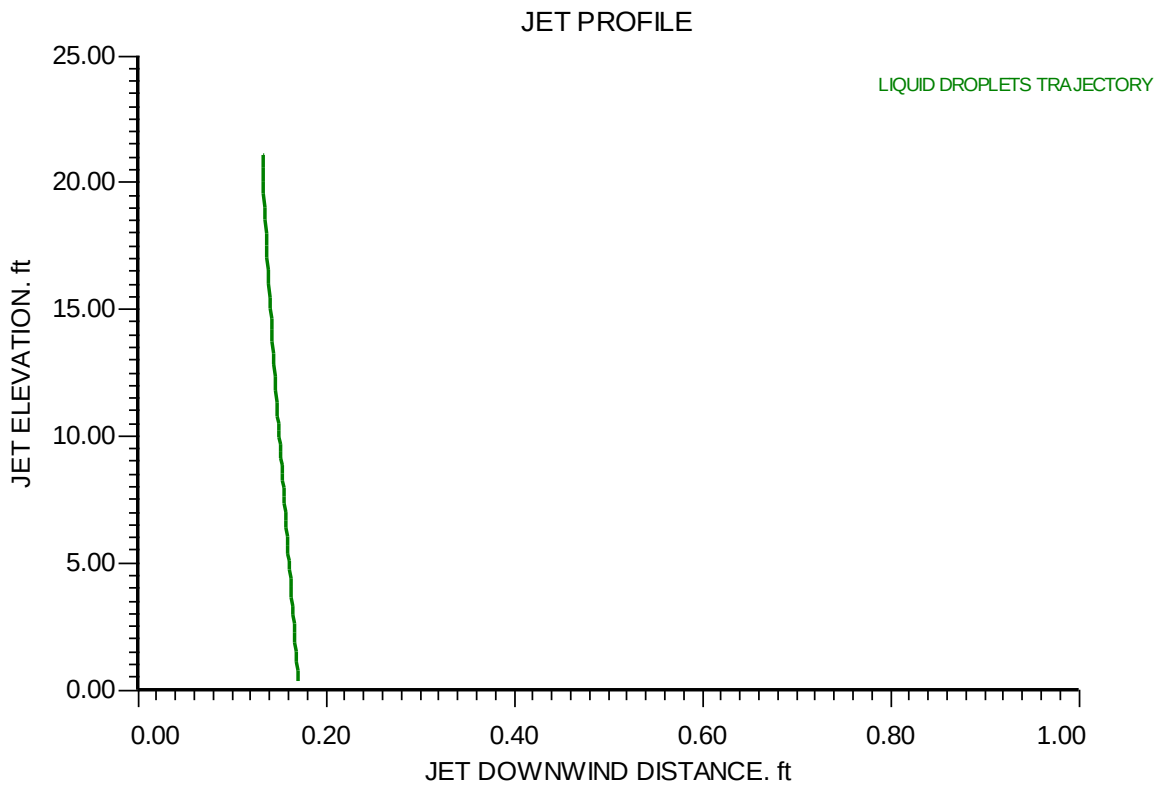


Figure 115: Liquid Release Jet Profile – E-R-18 Layout – 100% Reacted; D5 Stability Class; 5 psig and 210°F

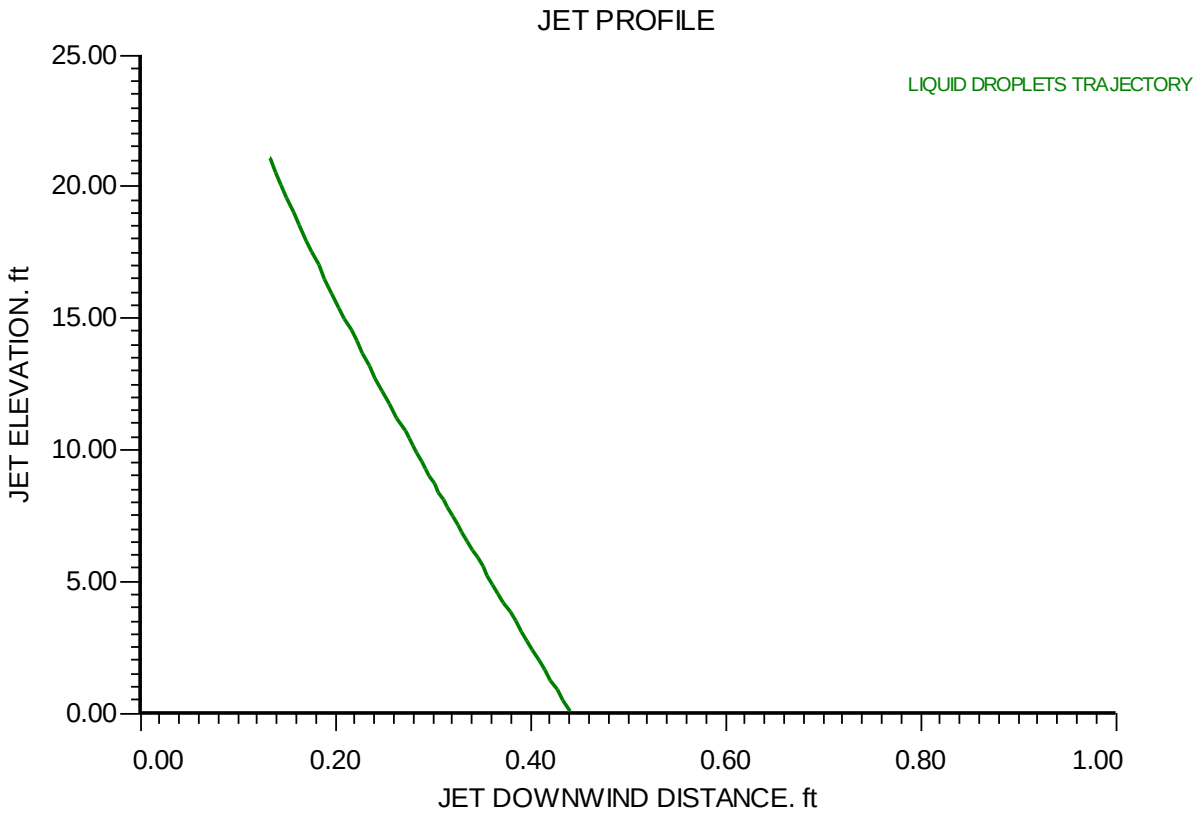
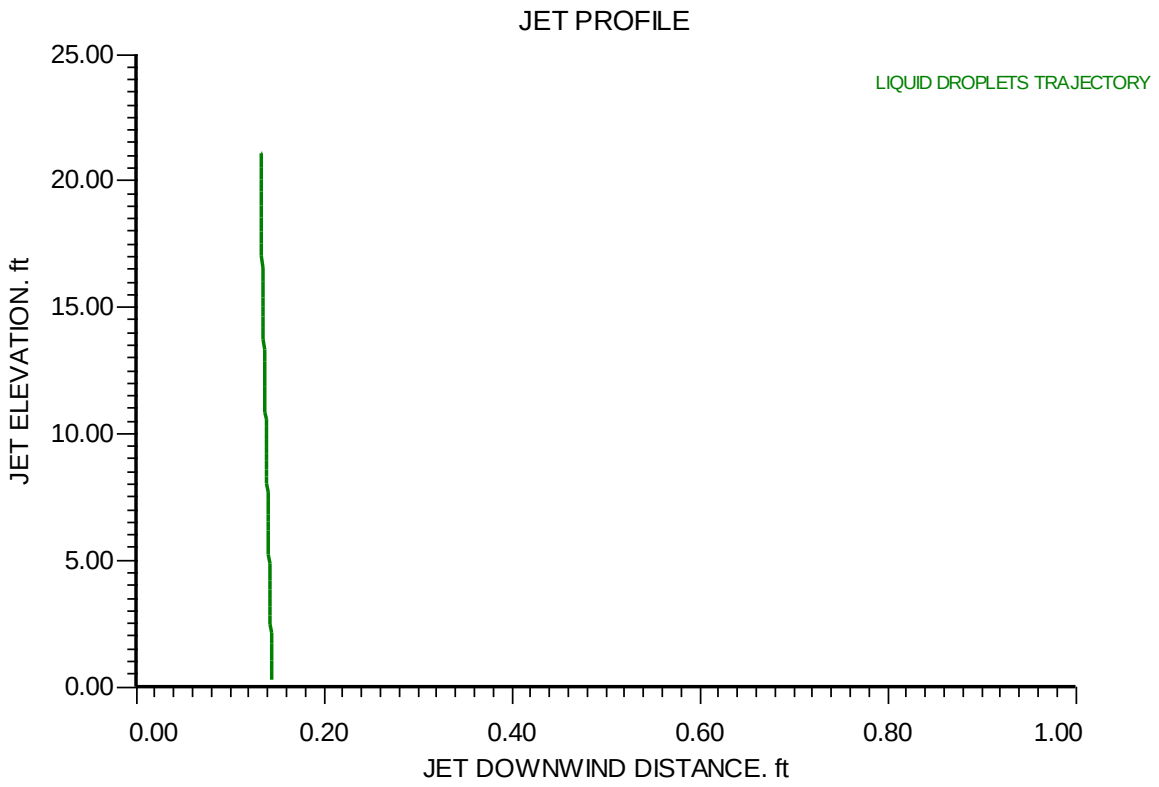


Figure 116: Liquid Release Jet Profile – E-R-18 Layout – 100% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix H: Results – PROPOSED Piping Layout to Pit - Liquid Pool Depth

Figure 117: Liquid Pool Depth – Proposed Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

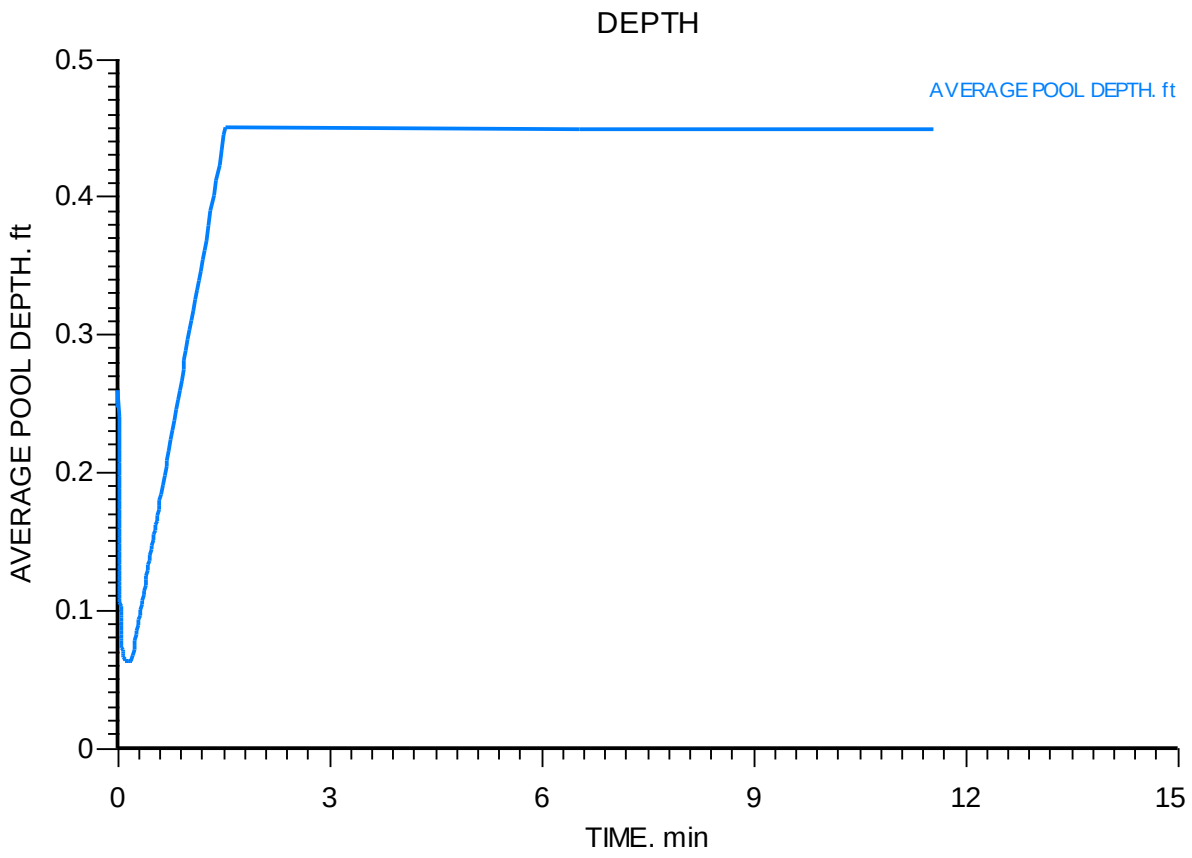


Figure 118: Liquid Pool Depth – Proposed Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

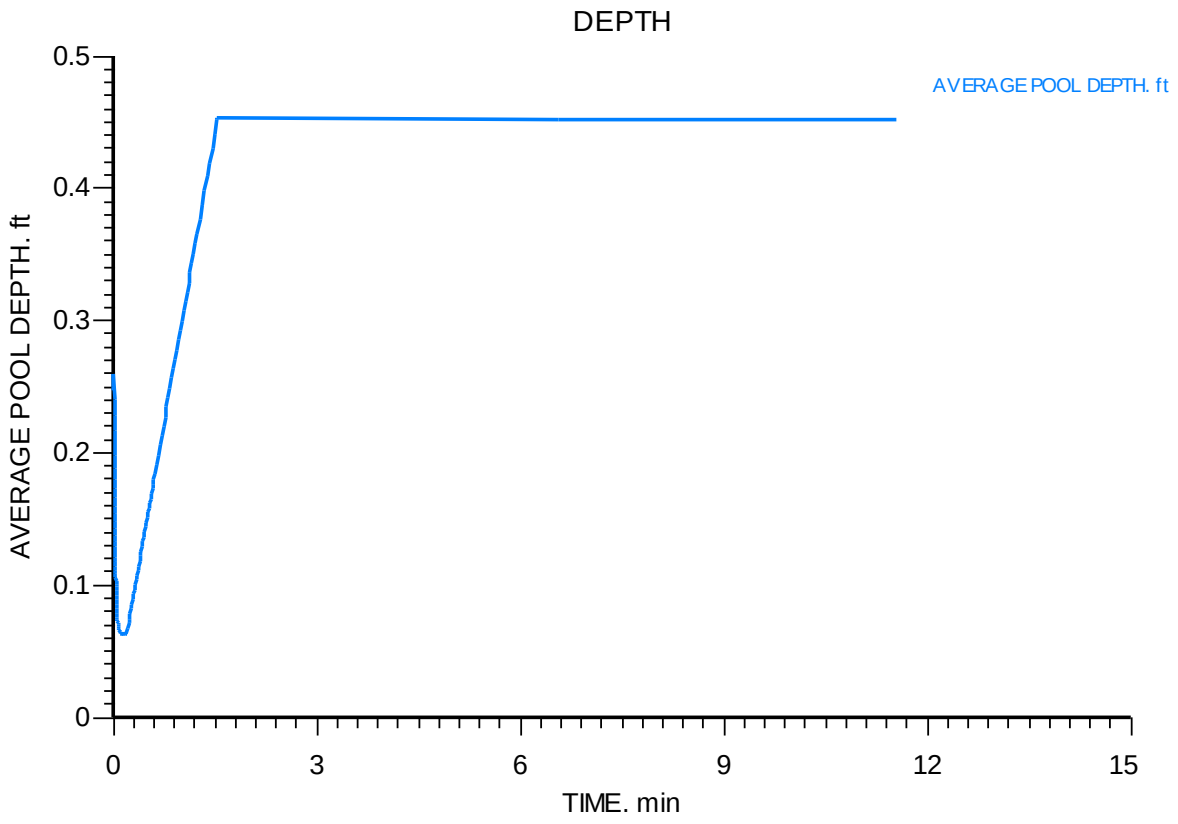


Figure 119: Liquid Pool Depth – Proposed Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

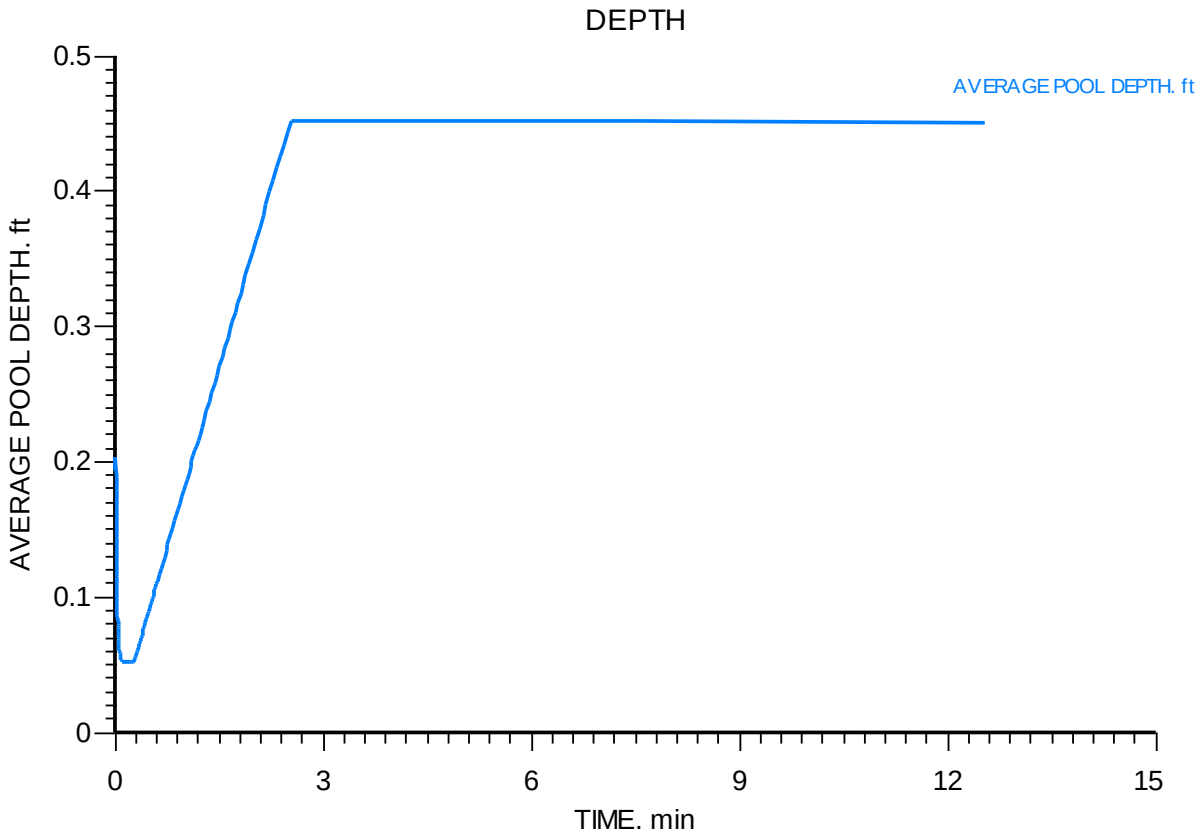


Figure 120: Liquid Pool Depth – Proposed Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

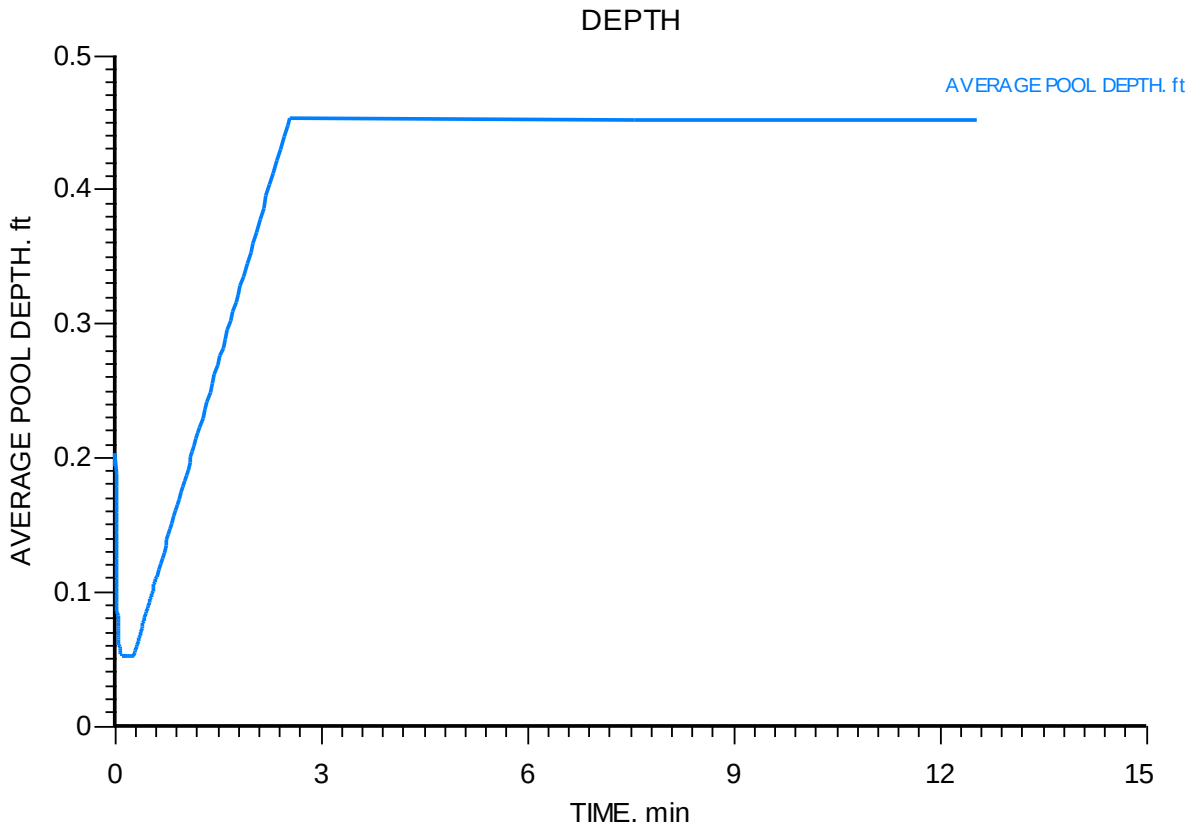


Figure 121: Liquid Pool Depth – Proposed Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

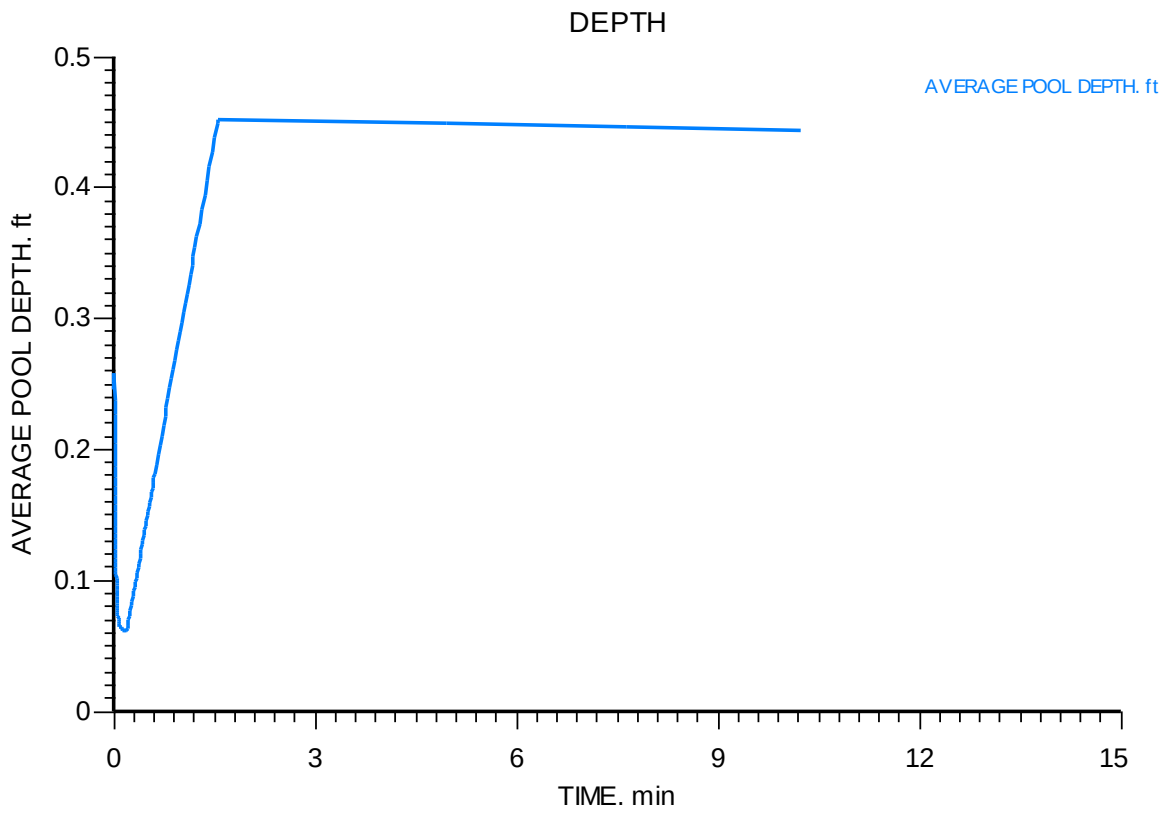


Figure 122: Liquid Pool Depth – Proposed Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

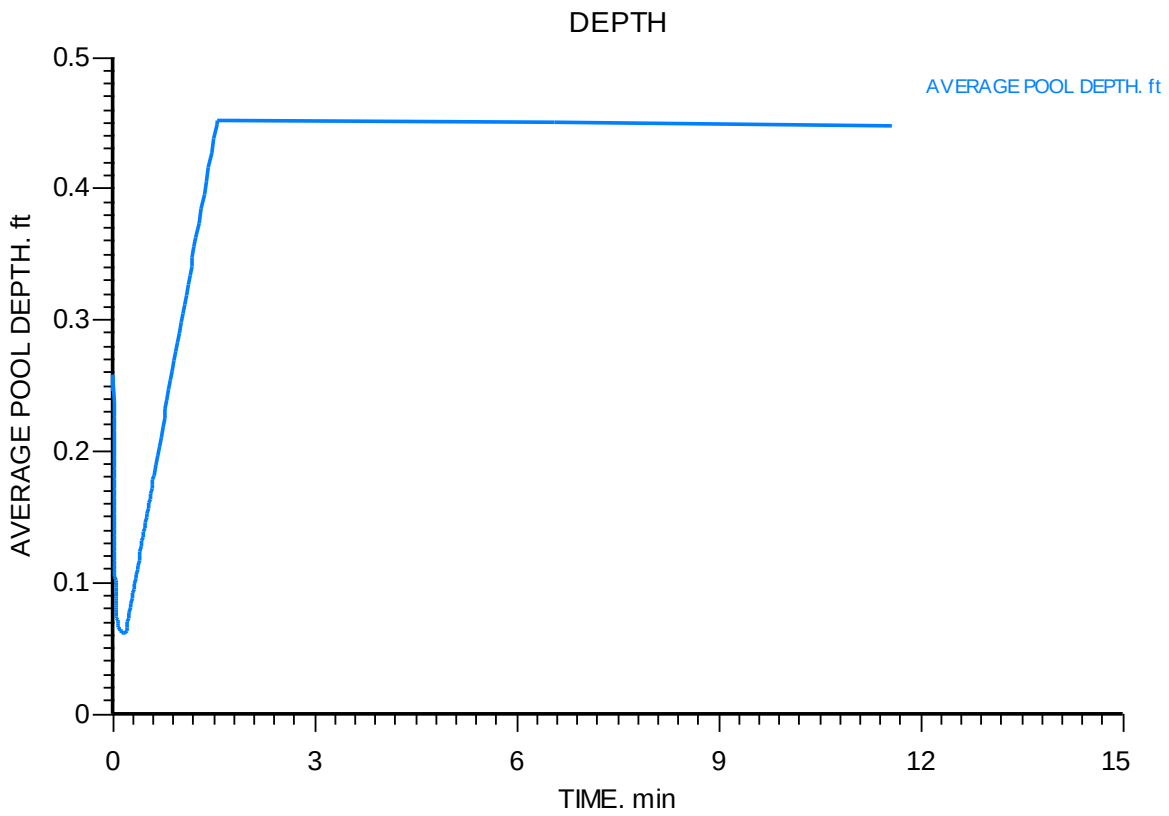


Figure 123: Liquid Pool Depth – Proposed Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

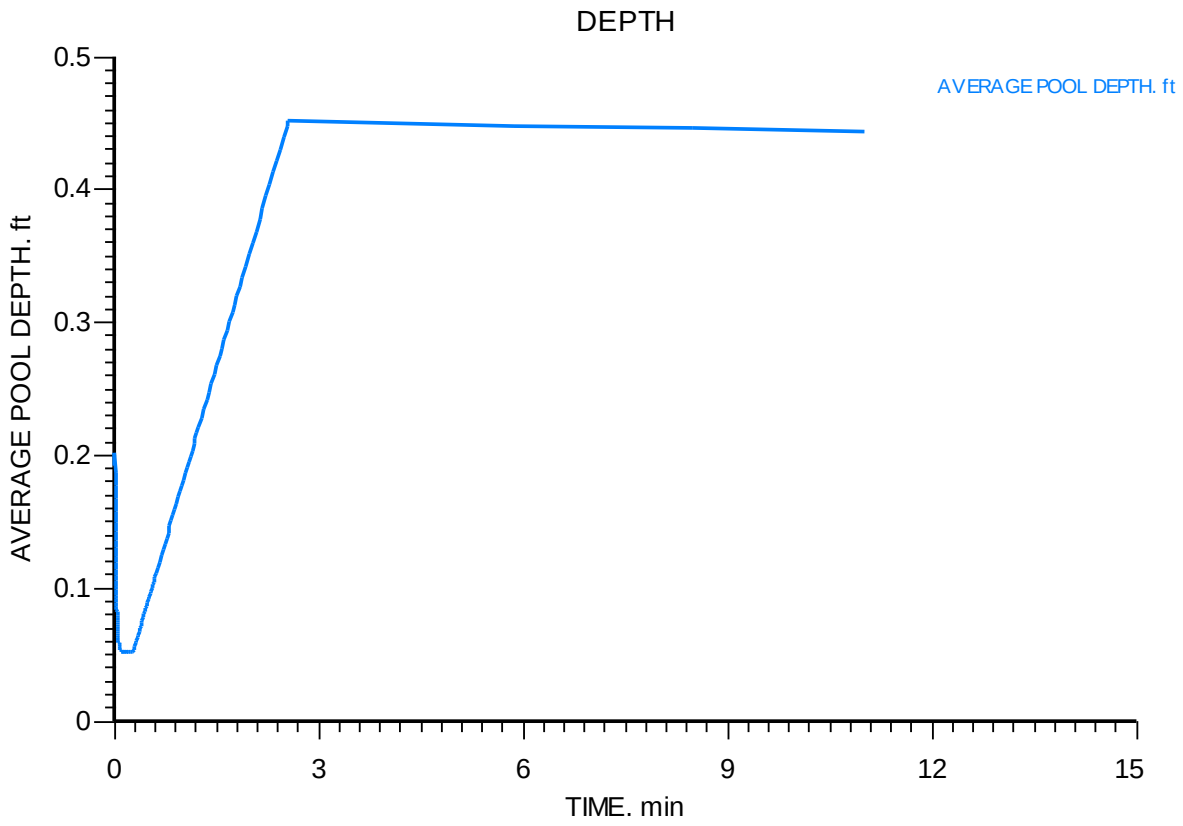
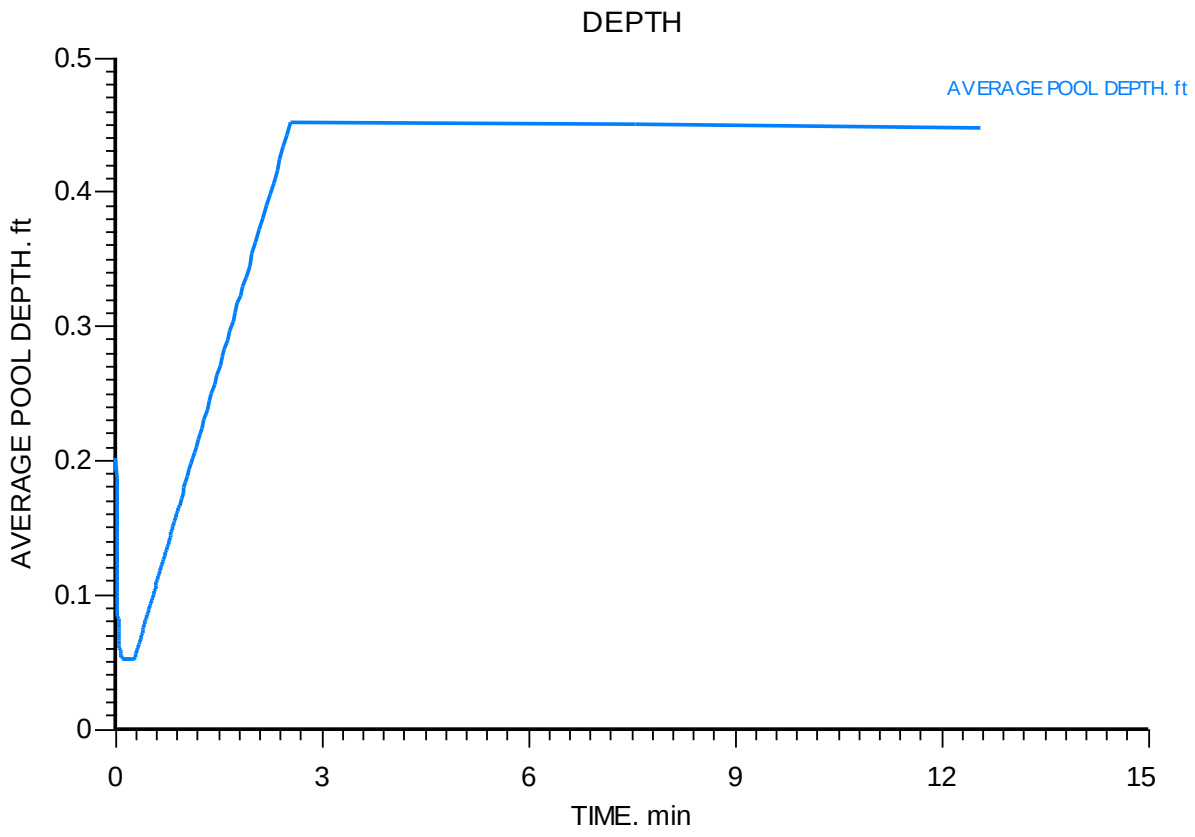


Figure 124: Liquid Pool Depth – Proposed Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix I: Results – E-R-14 Piping Layout to Pit - Liquid Pool Depth

Figure 125: Liquid Pool Depth – E-R-14 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

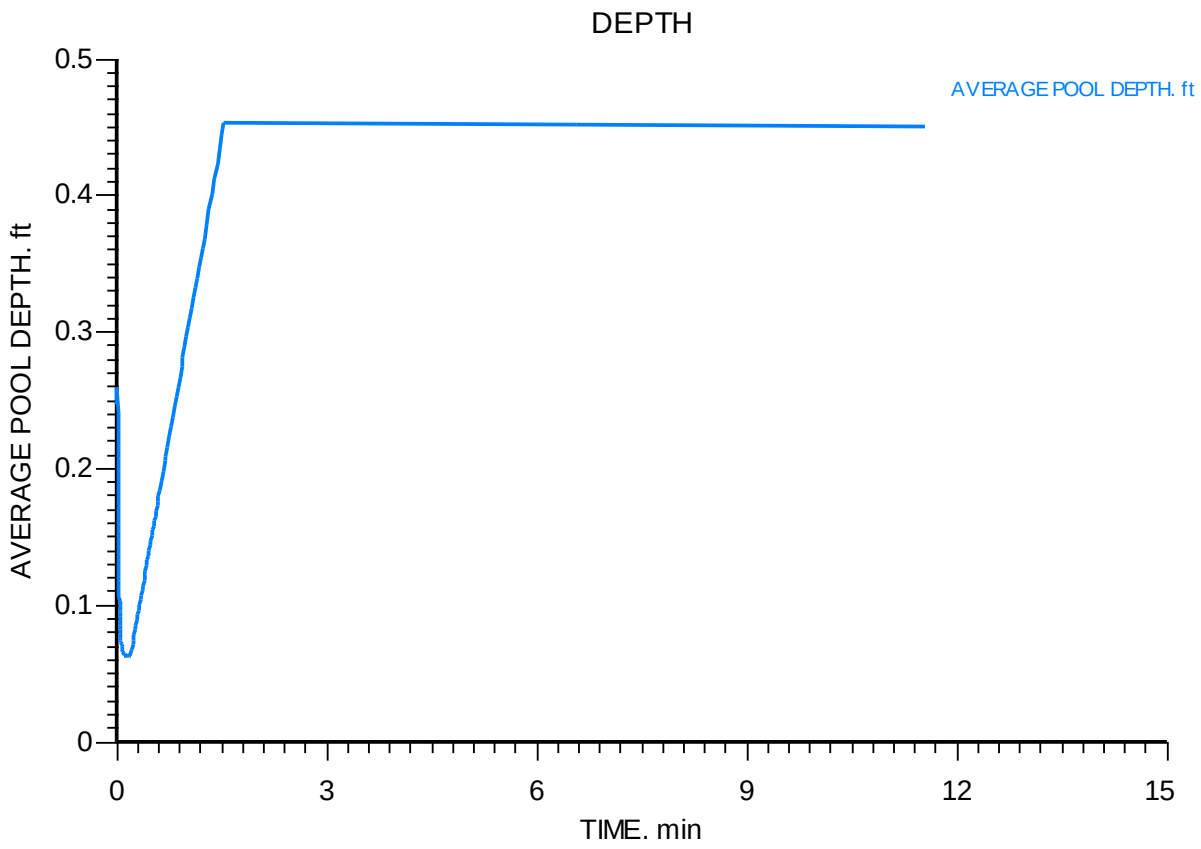


Figure 126: Liquid Pool Depth – E-R-14 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

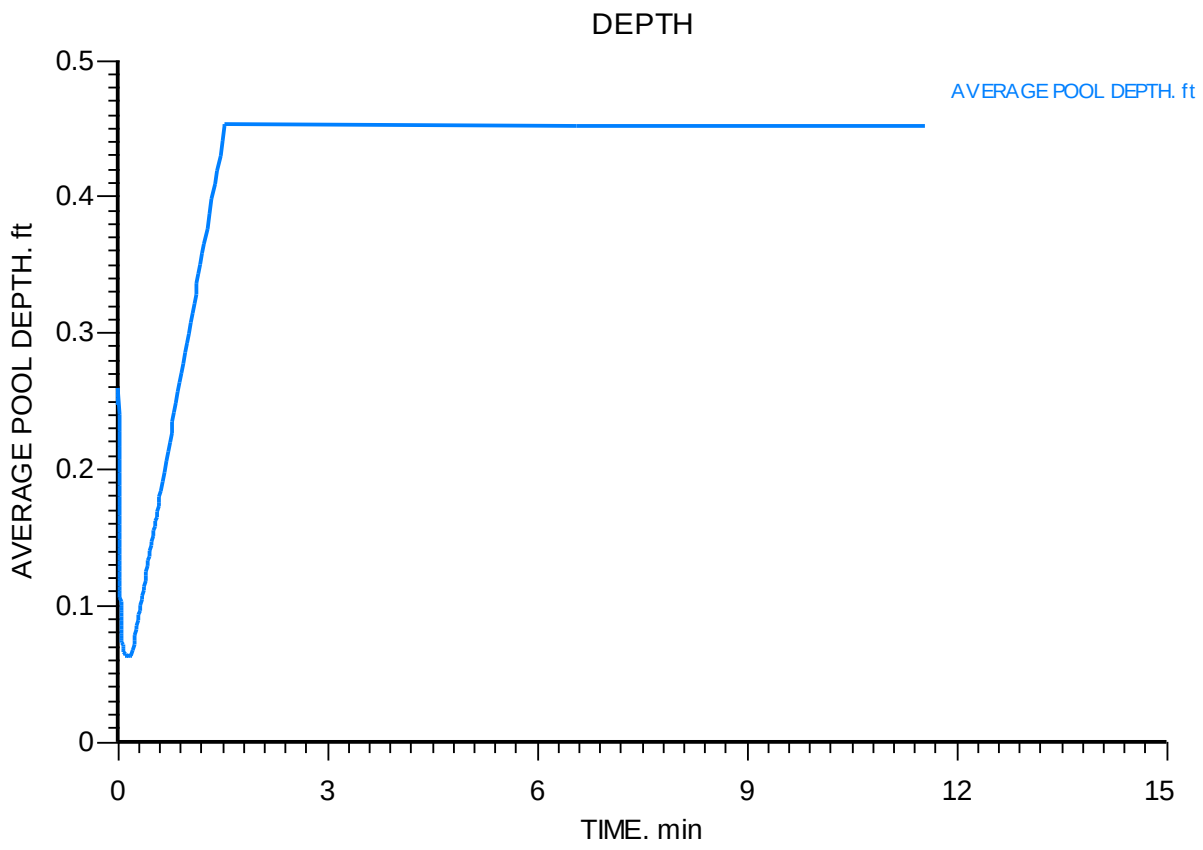


Figure 127: Liquid Pool Depth – E-R-14 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

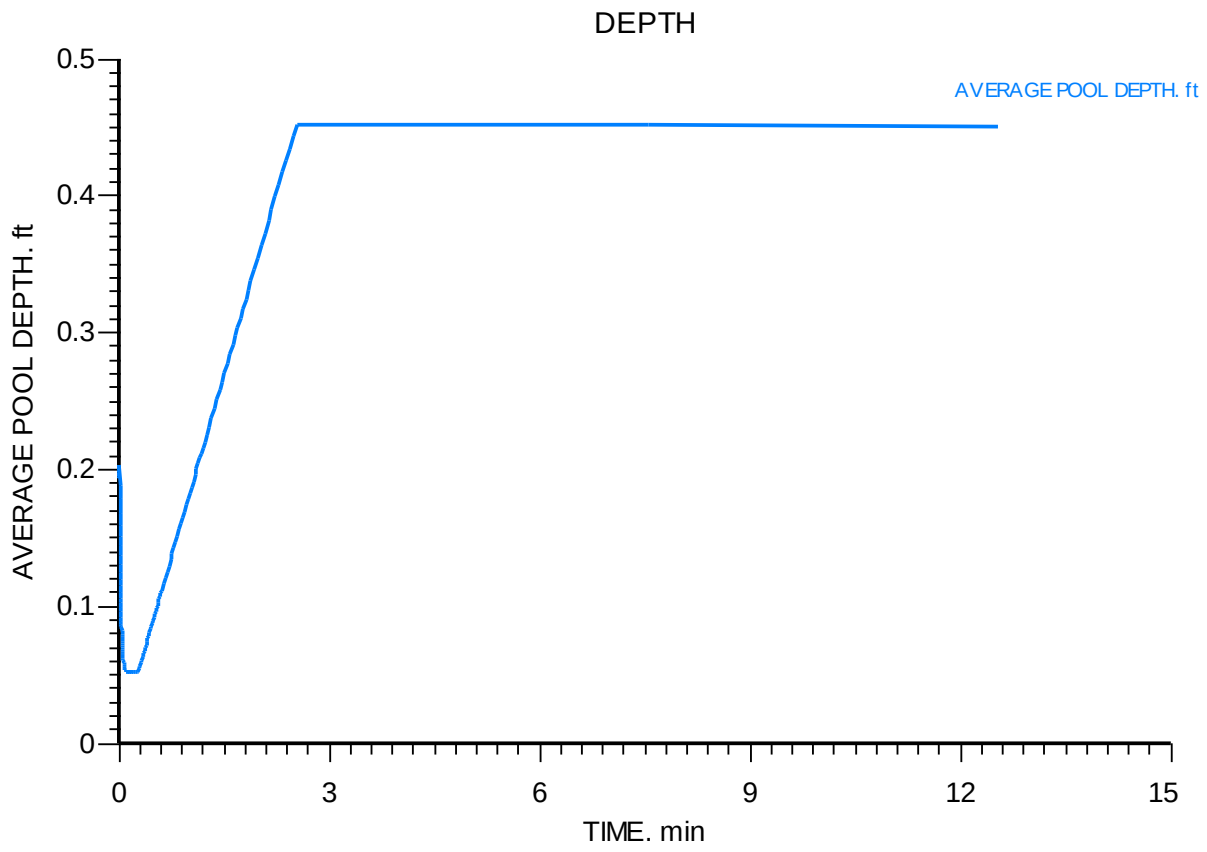


Figure 128: Liquid Pool Depth – E-R-14 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

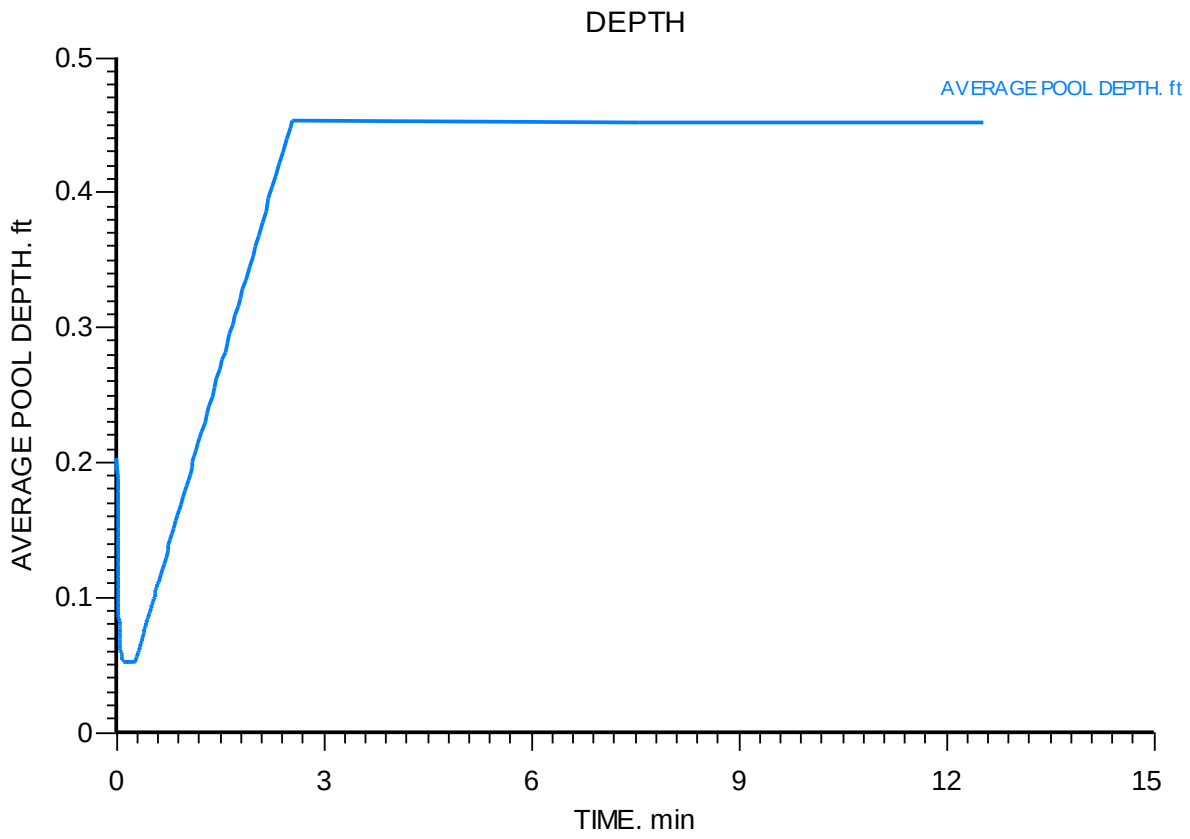


Figure 129: Liquid Pool Depth – E-R-14 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

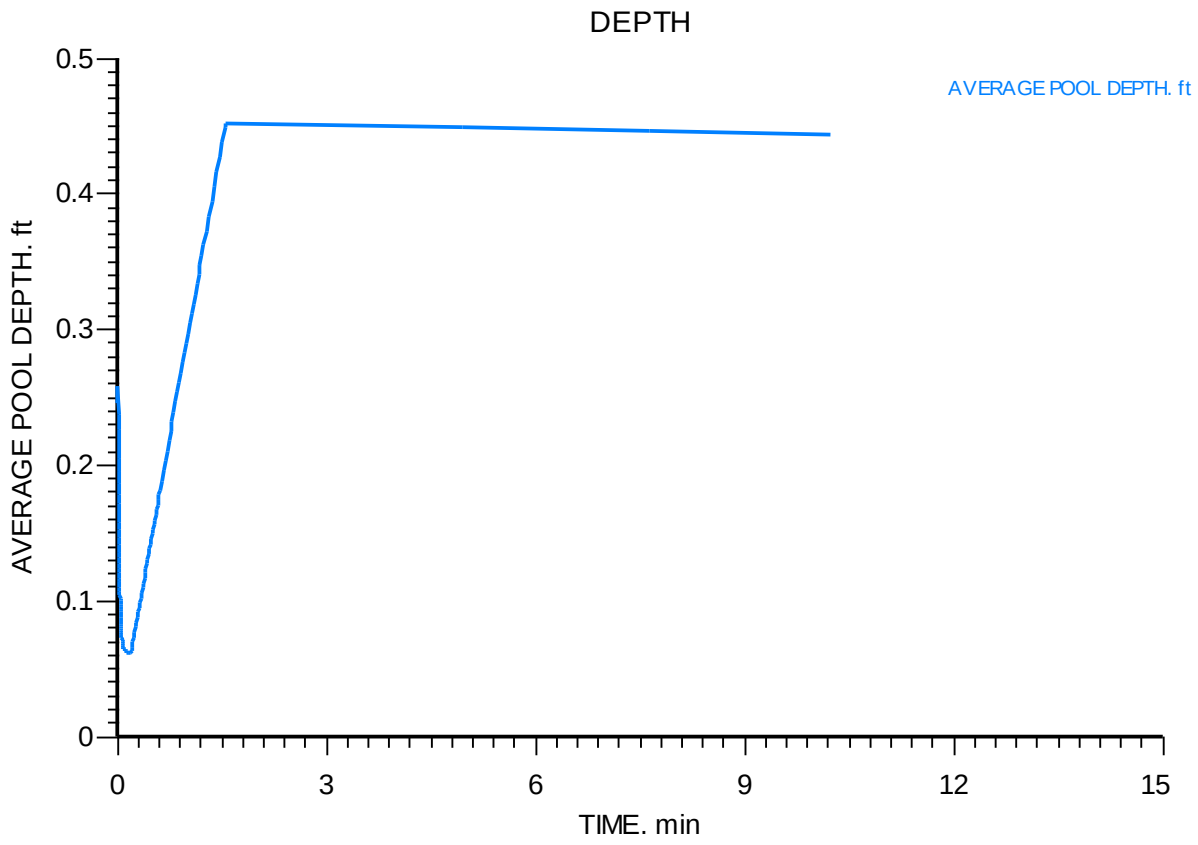


Figure 130: Liquid Pool Depth – E-R-14 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

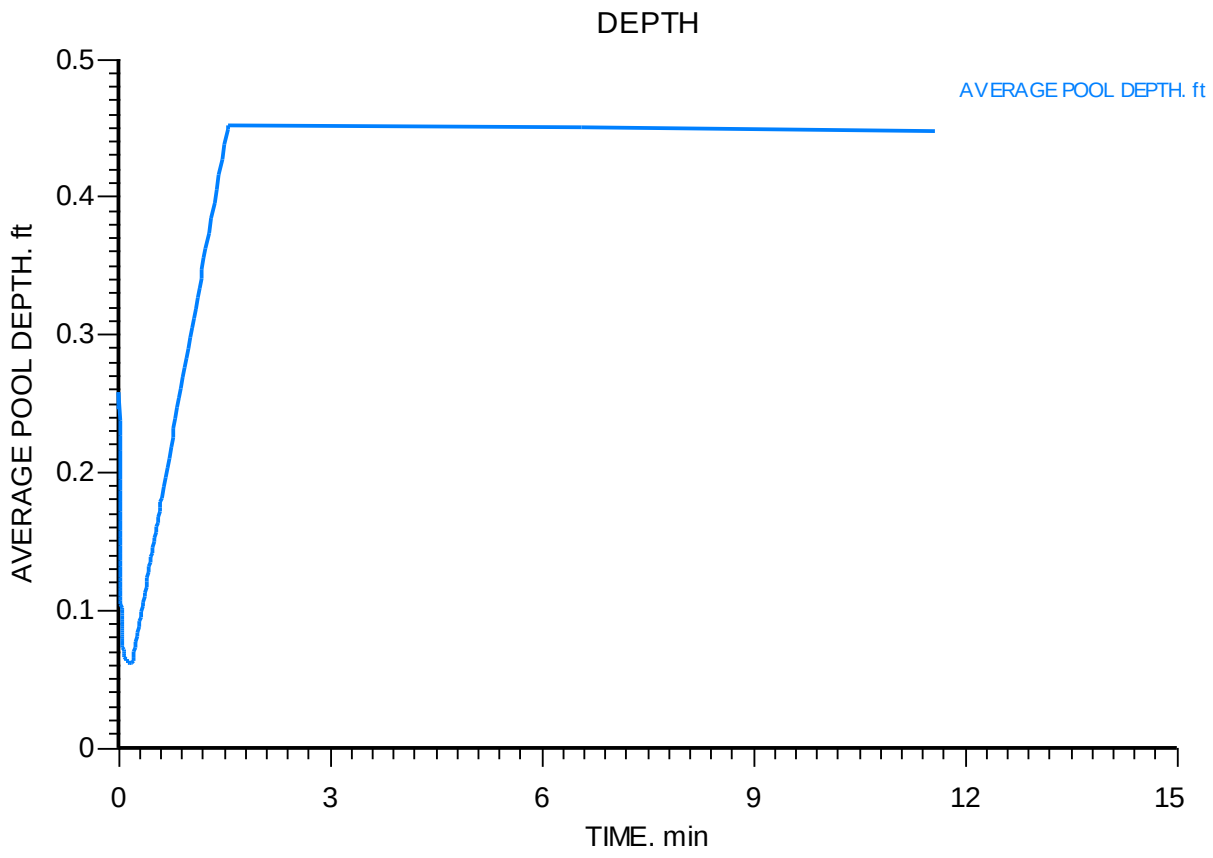


Figure 131: Liquid Pool Depth – E-R-14 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

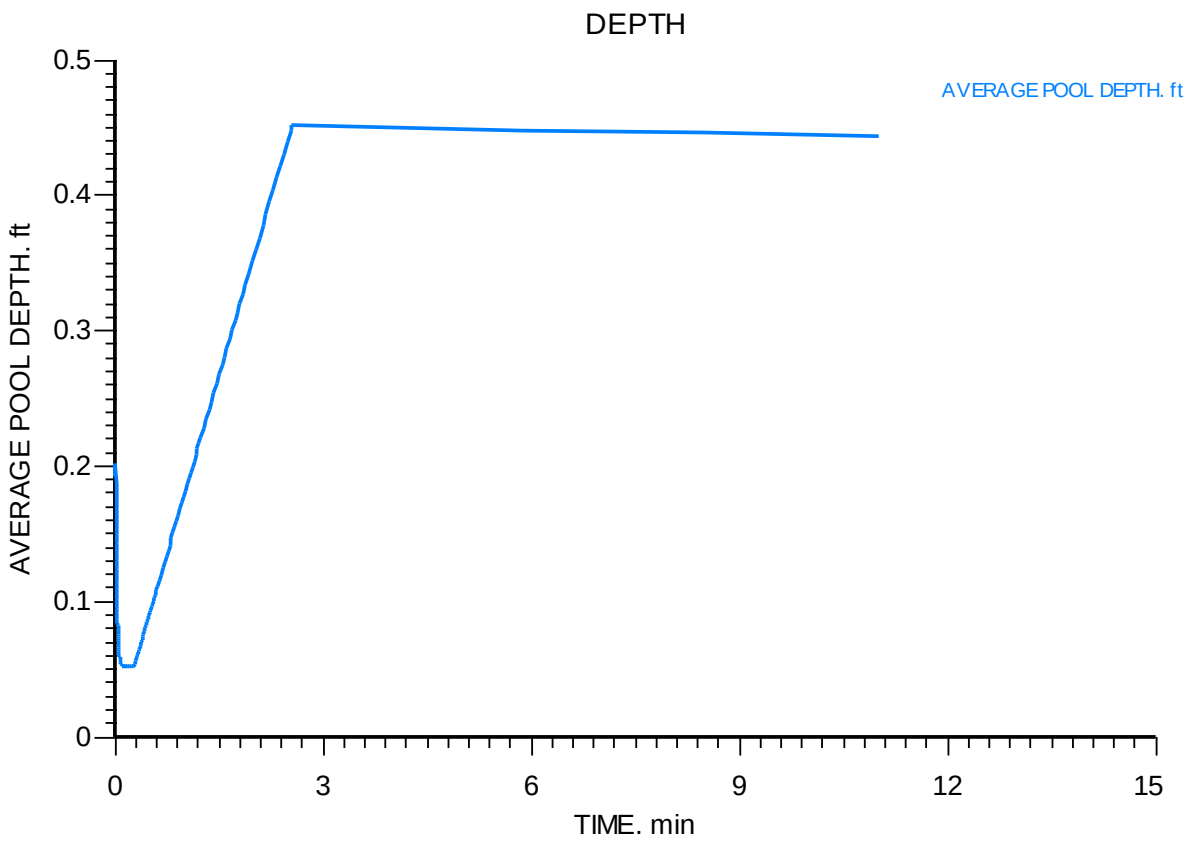
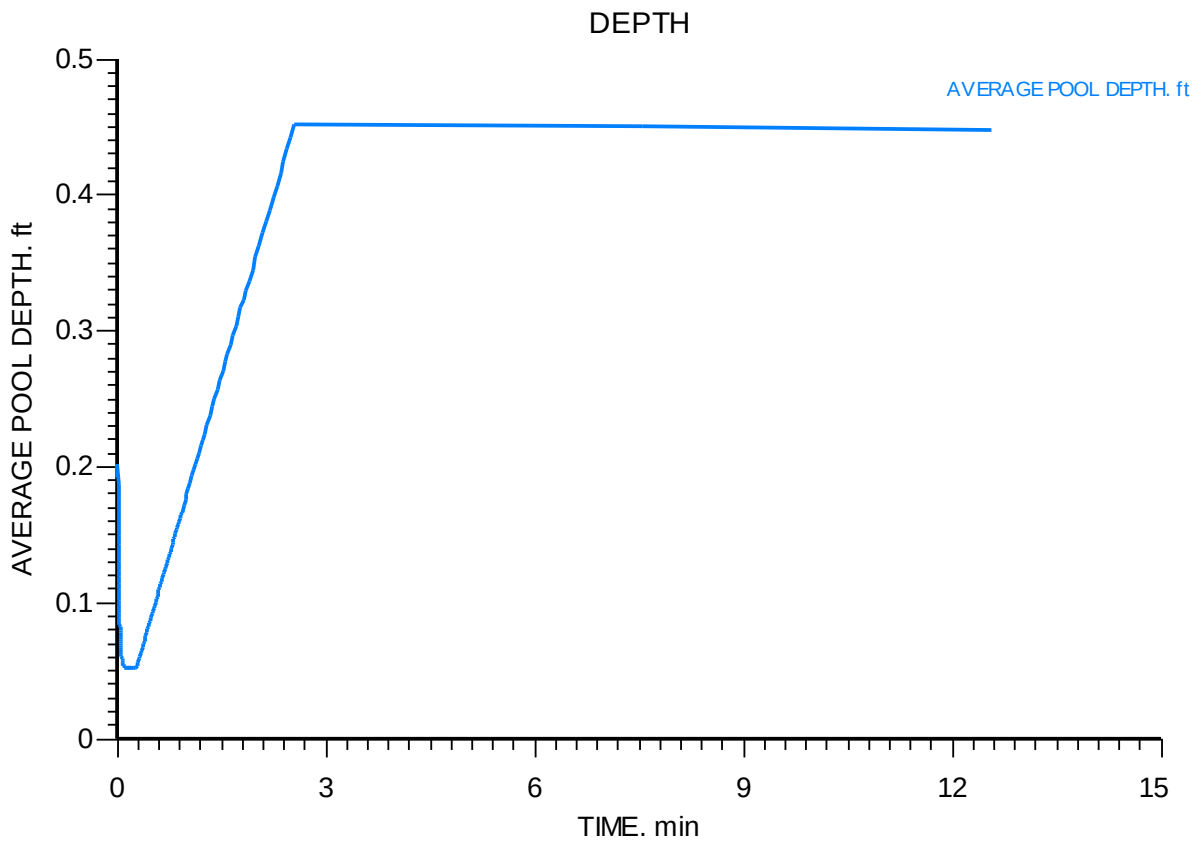


Figure 132: Liquid Pool Depth – E-R-14 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix J: Results – E-R-15 Piping Layout to Pit - Liquid Pool Depth

Figure 133: Liquid Pool Depth – E-R-15 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

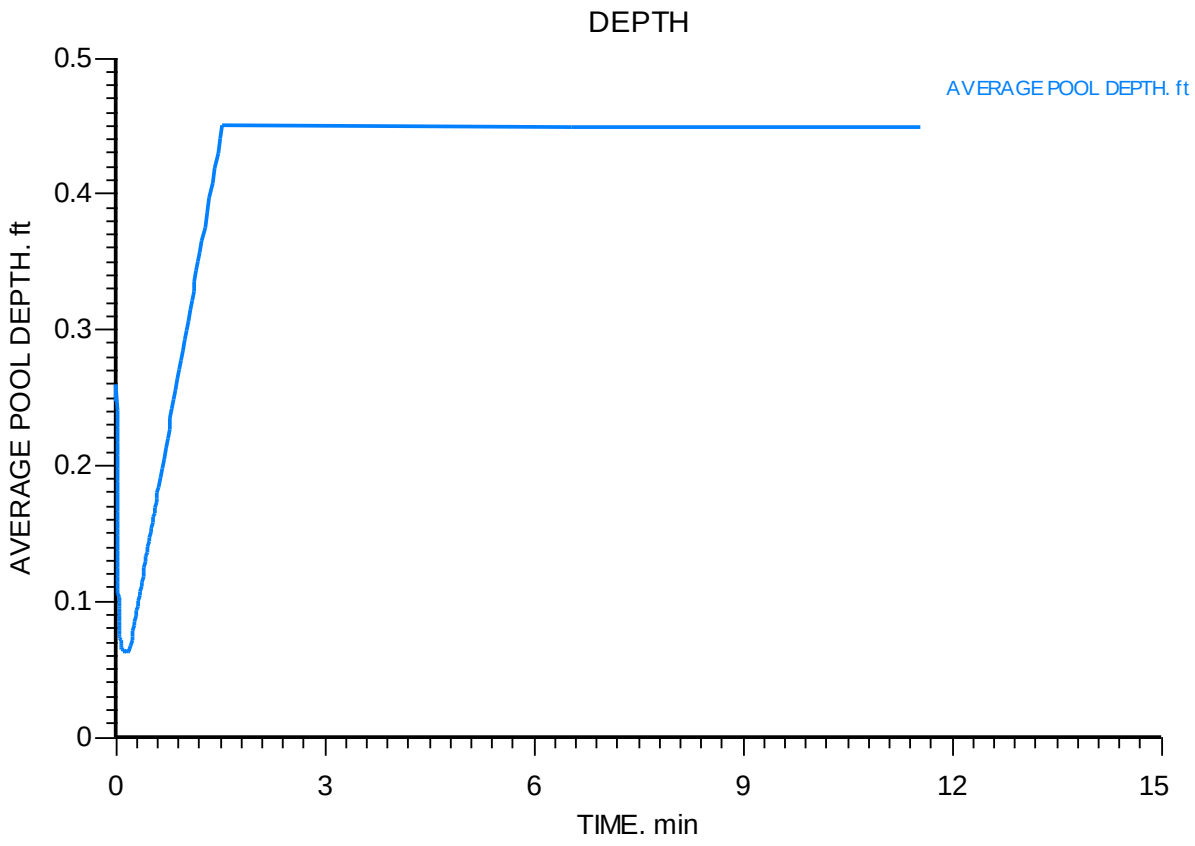


Figure 134: Liquid Pool Depth – E-R-15 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

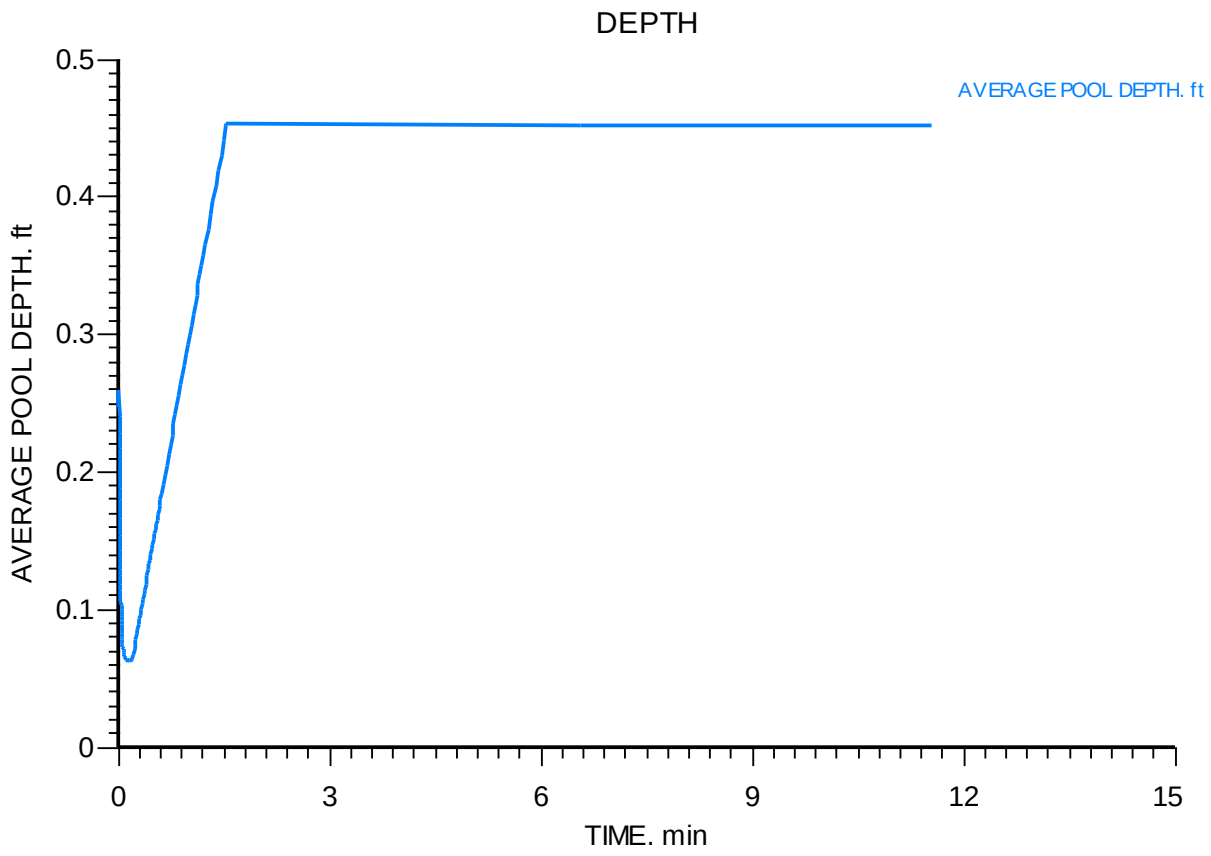


Figure 135: Liquid Pool Depth – E-R-15 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

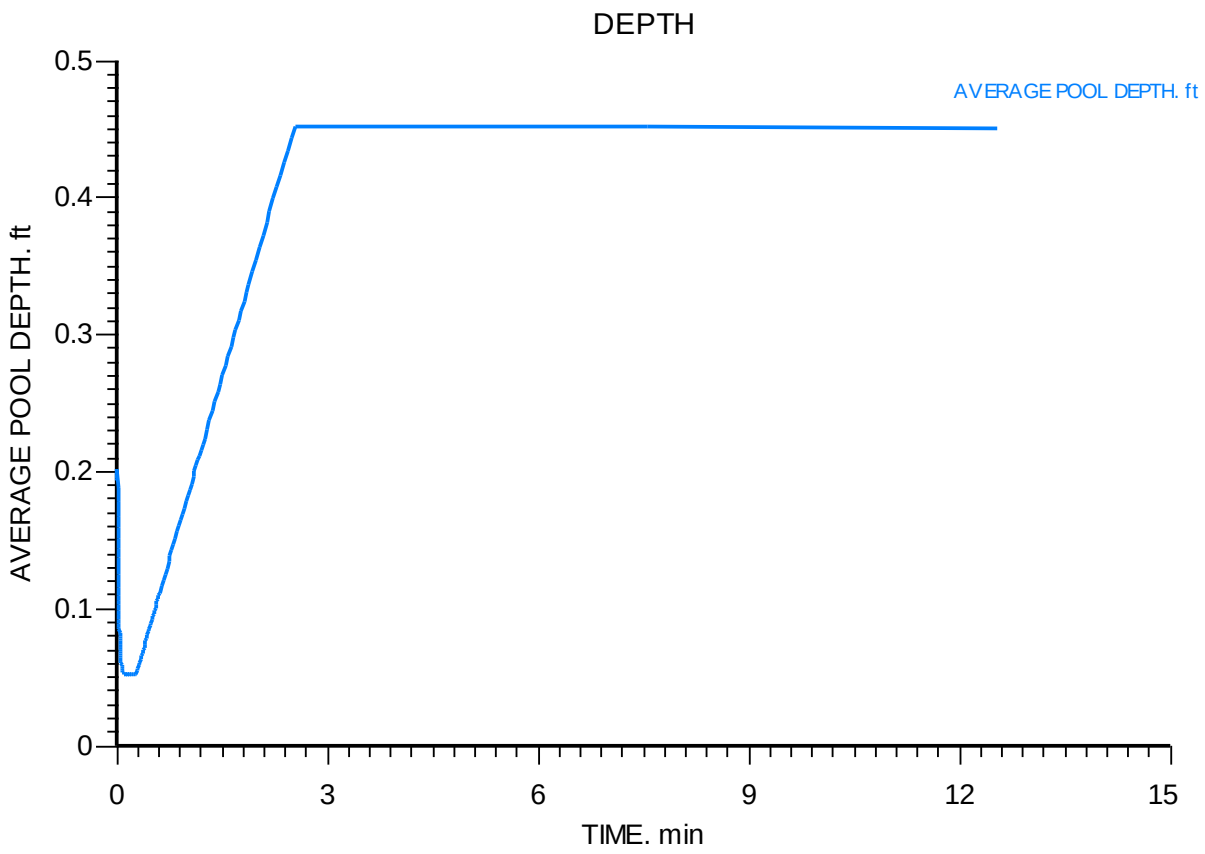


Figure 136: Liquid Pool Depth – E-R-15 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

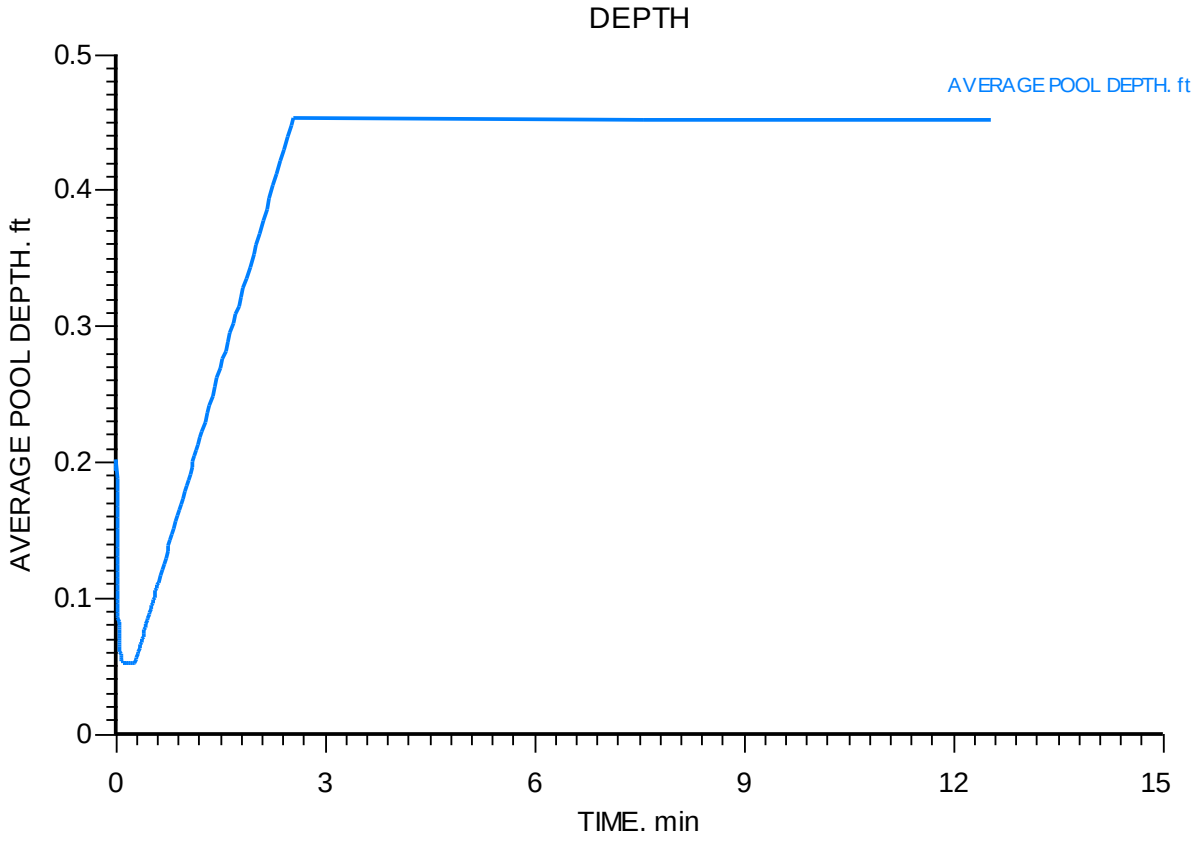


Figure 137: Liquid Pool Depth – E-R-15 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

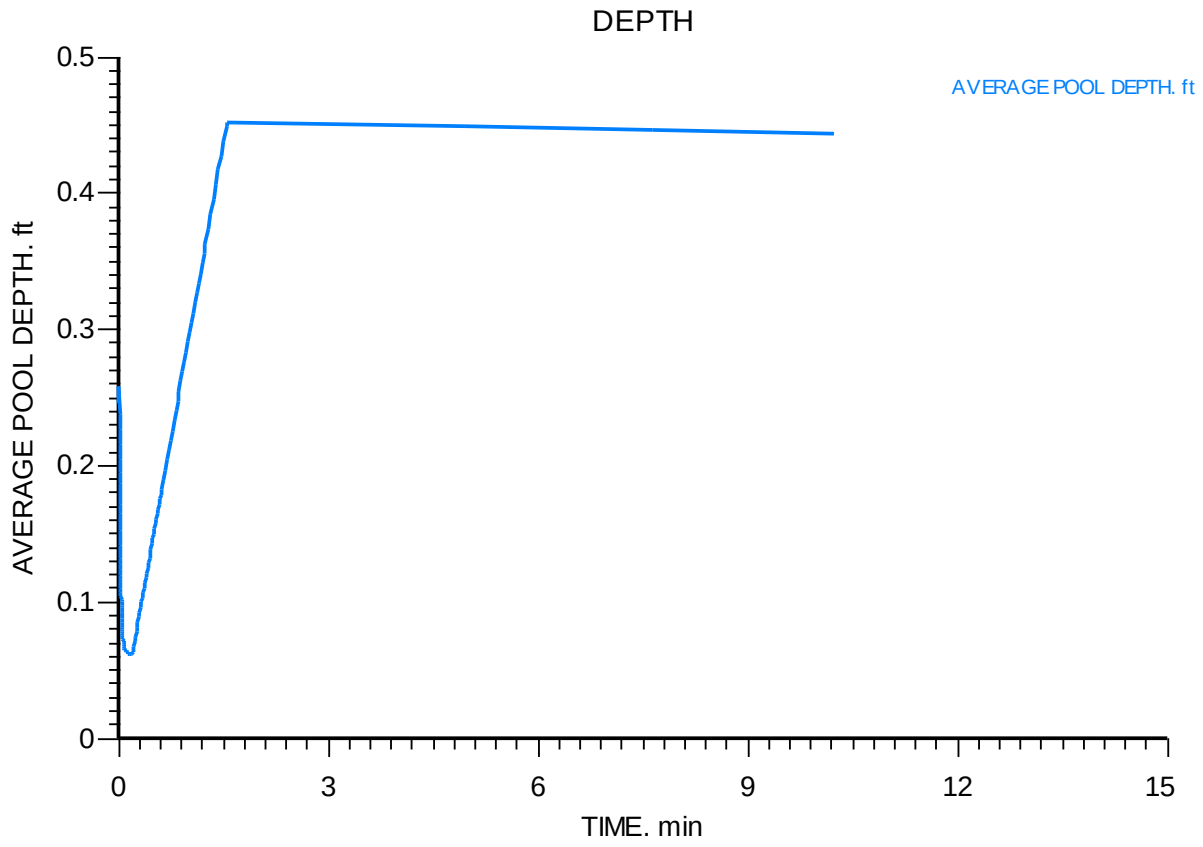


Figure 138: Liquid Pool Depth – E-R-15 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

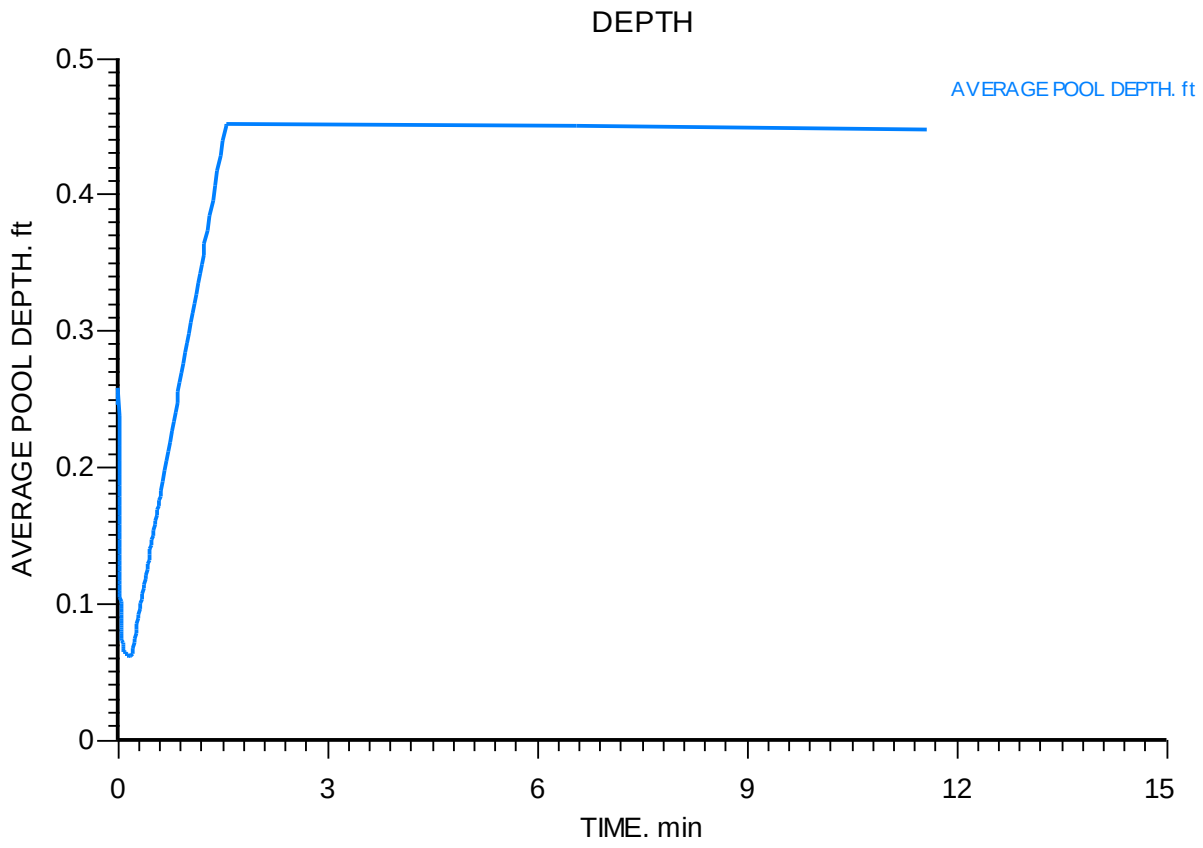


Figure 139: Liquid Pool Depth – E-R-15 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

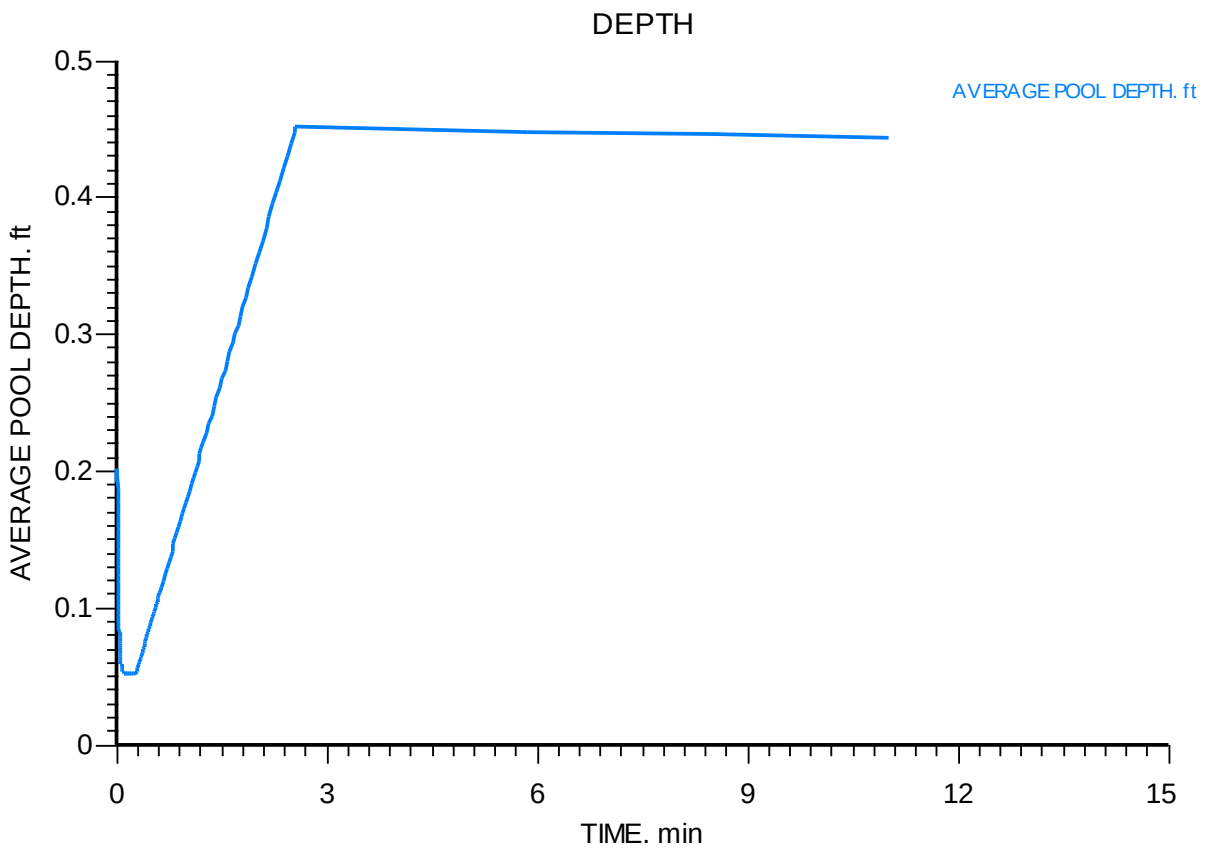
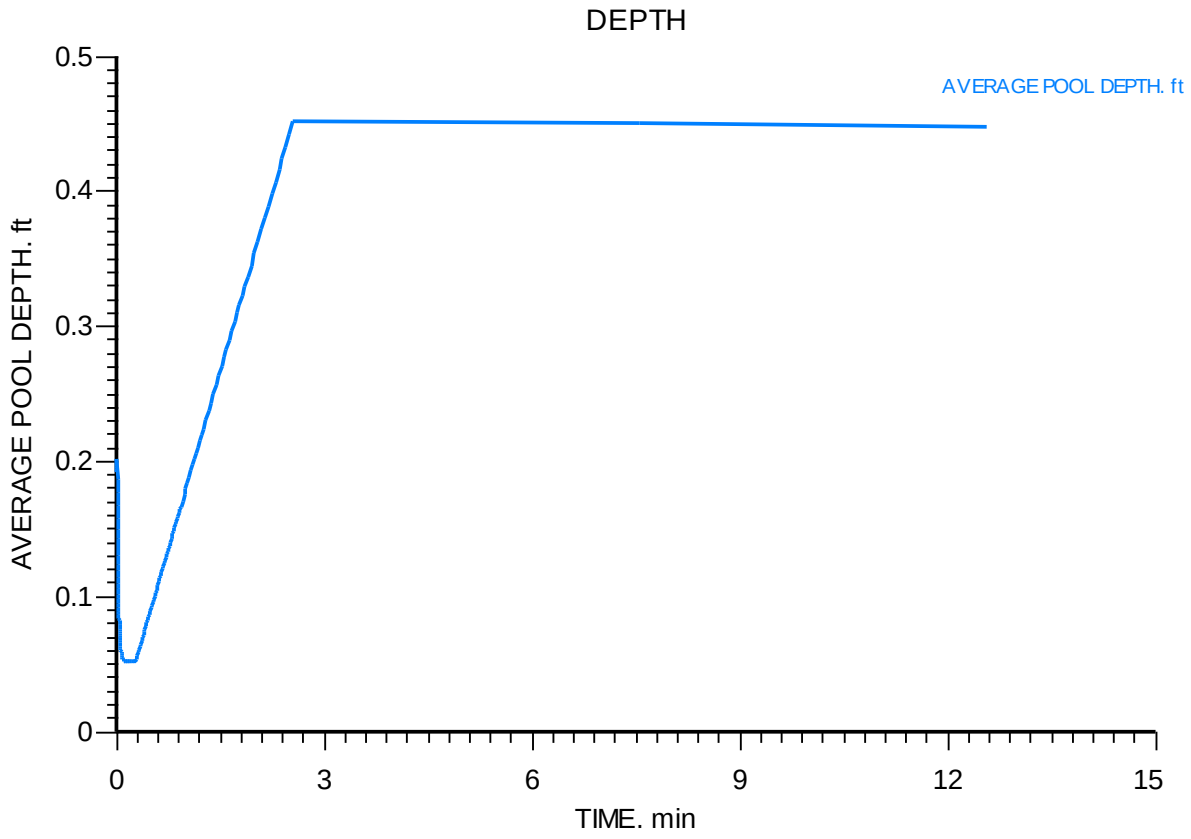


Figure 140: Liquid Pool Depth – E-R-15 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix K: Results – E-R-16 Piping Layout to Pit - Liquid Pool Depth

Figure 141: Liquid Pool Depth – E-R-16 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

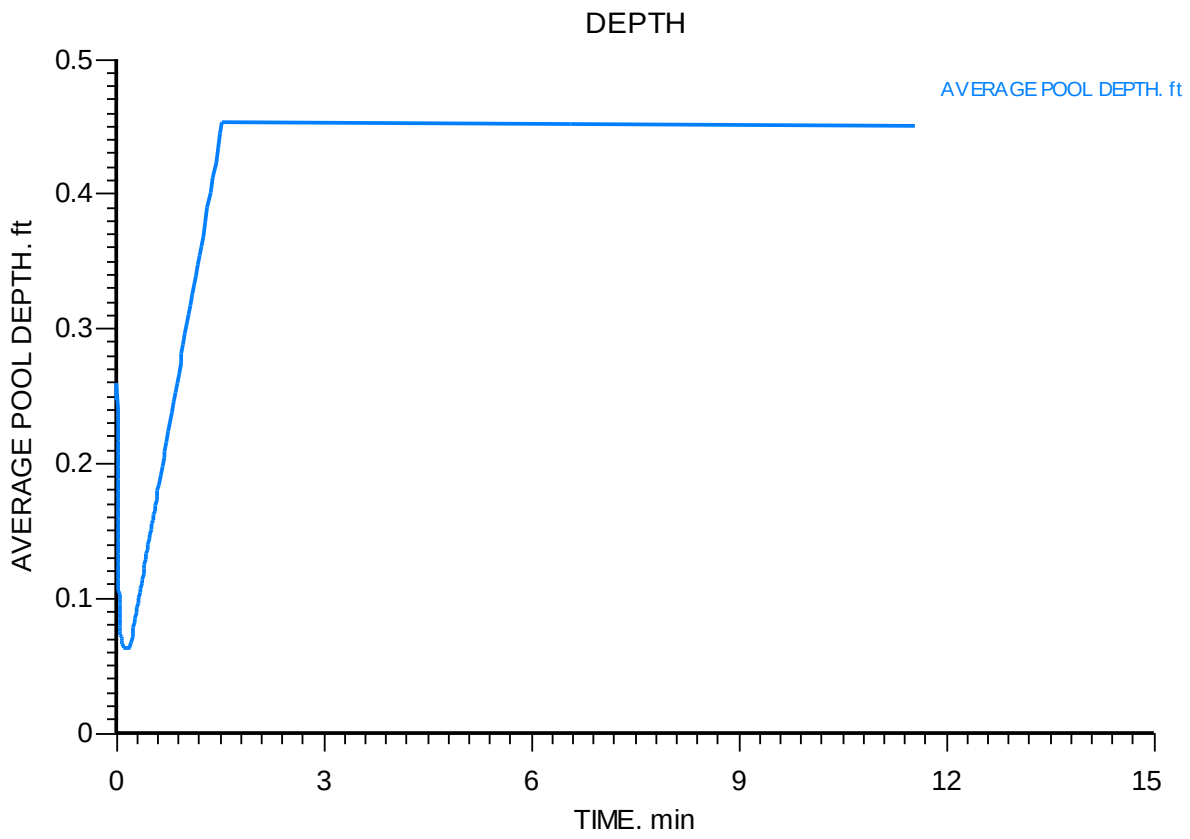


Figure 142: Liquid Pool Depth – E-R-16 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

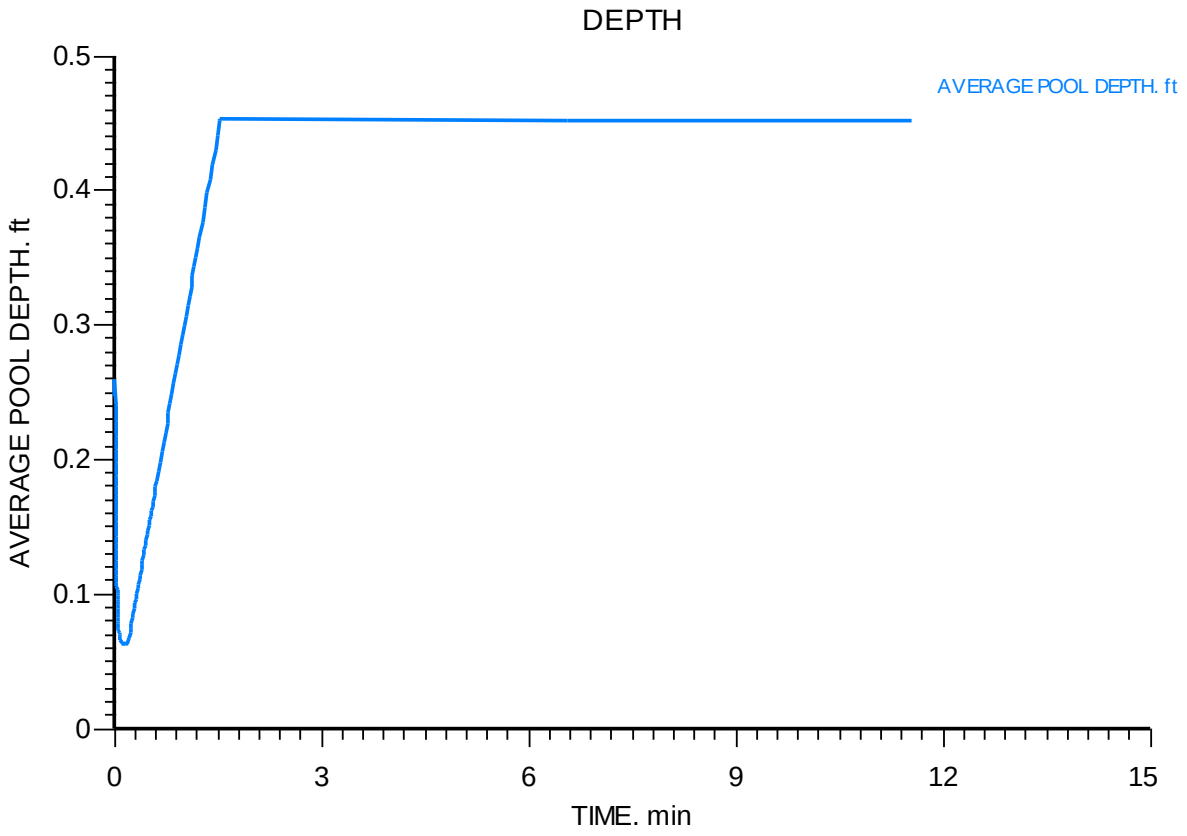


Figure 143: Liquid Pool Depth – E-R-16 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

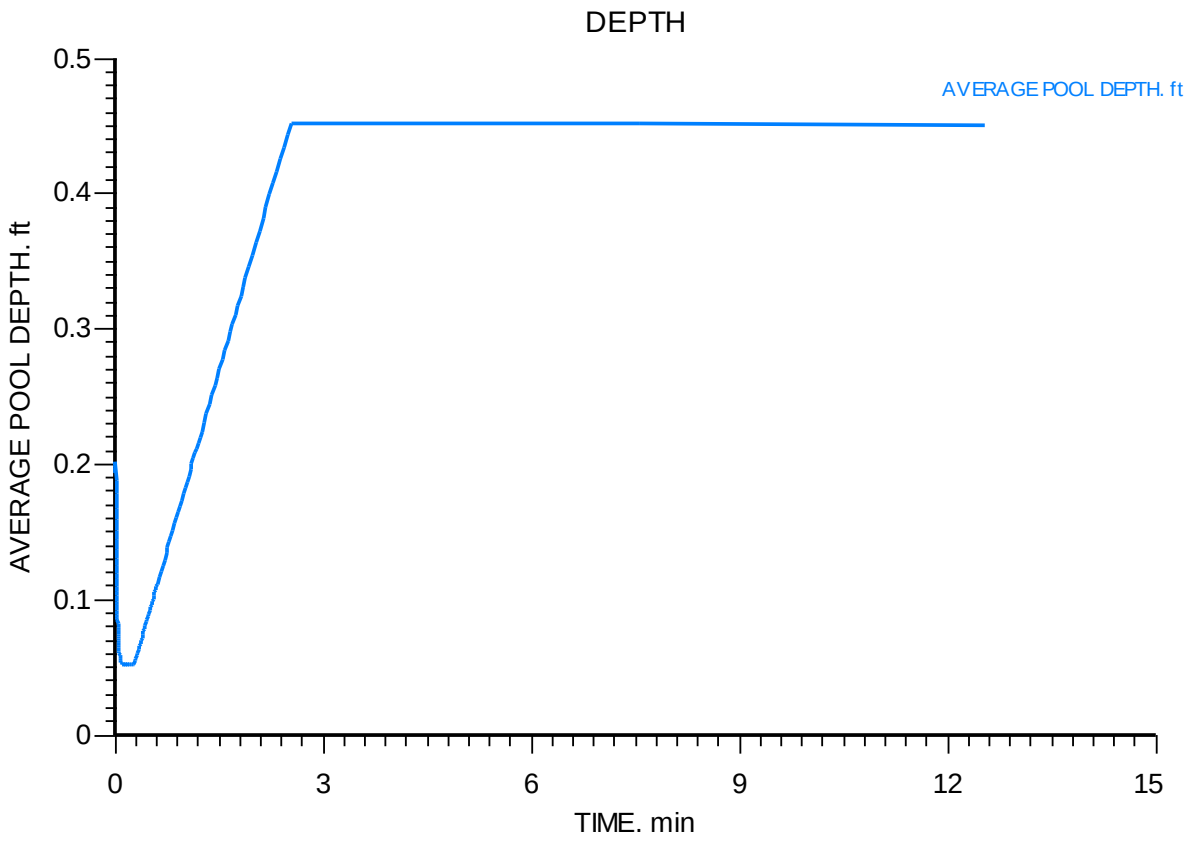


Figure 144: Liquid Pool Depth – E-R-16 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

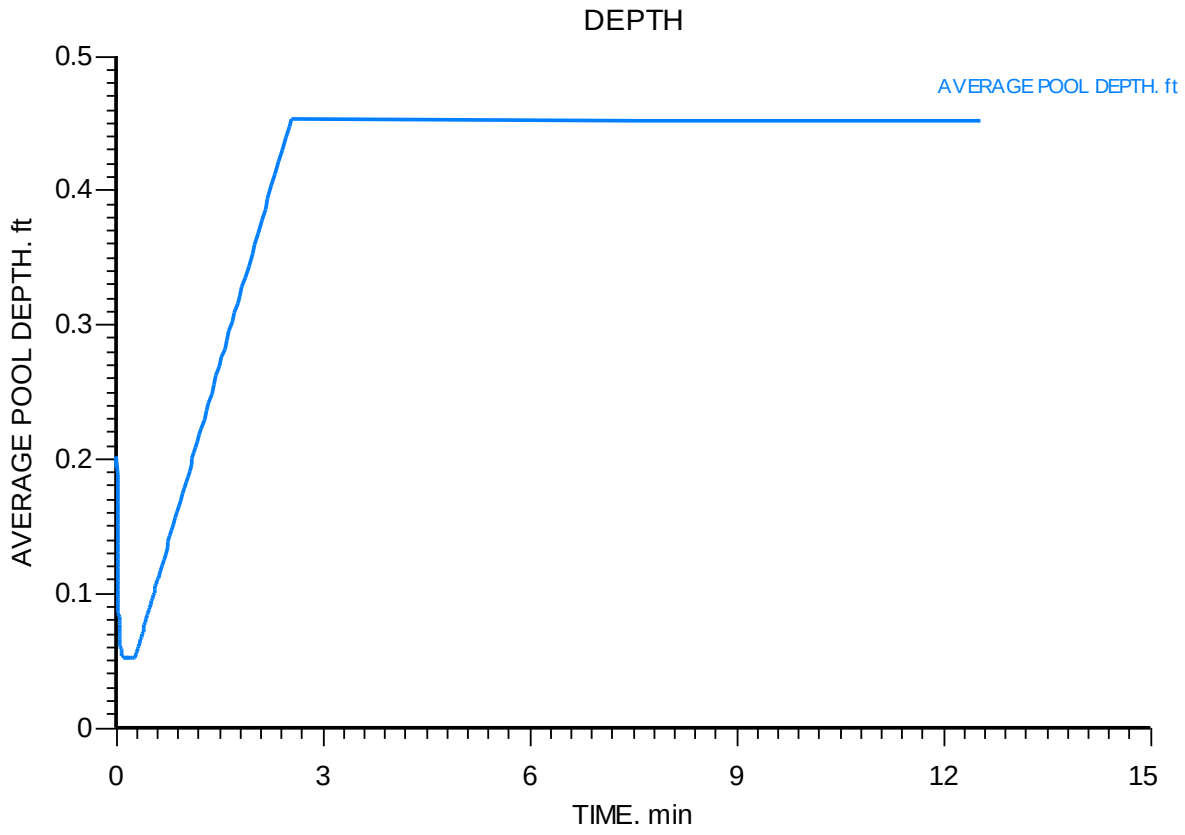


Figure 145: Liquid Pool Depth – E-R-16 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

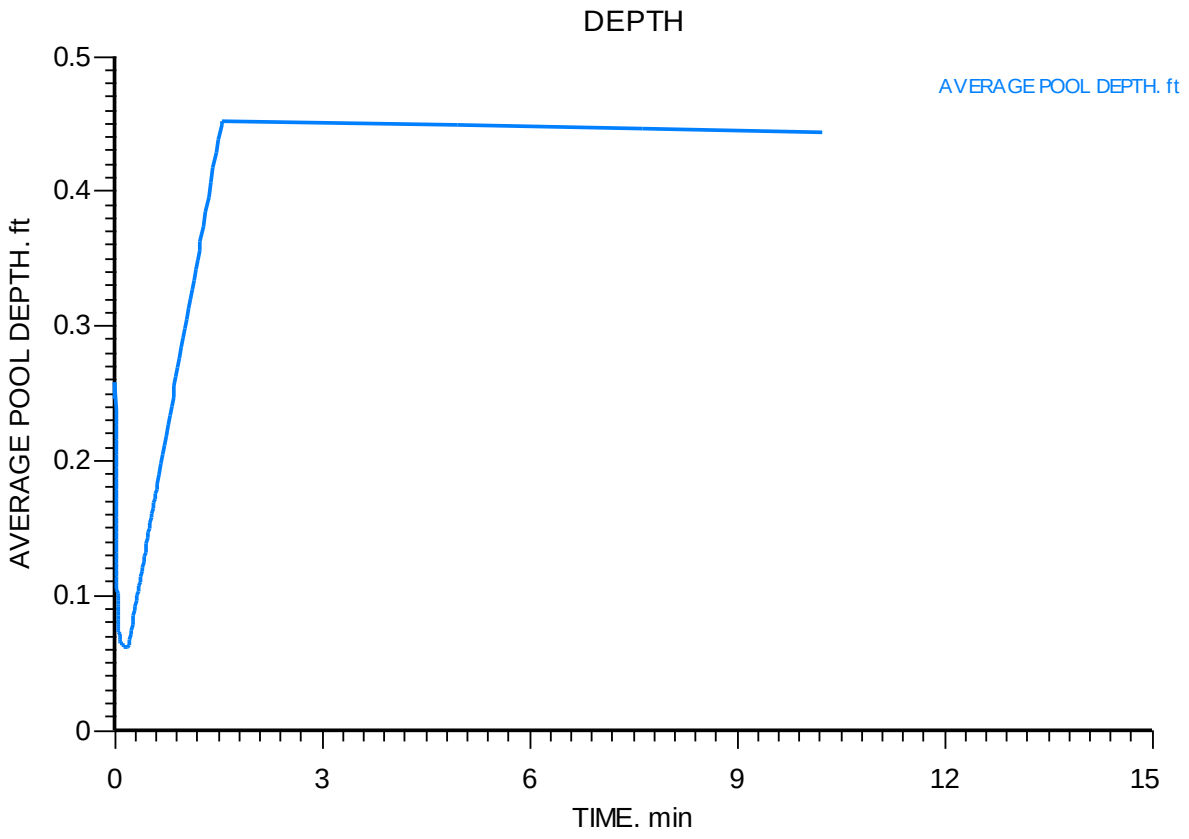


Figure 146: Liquid Pool Depth – E-R-16 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

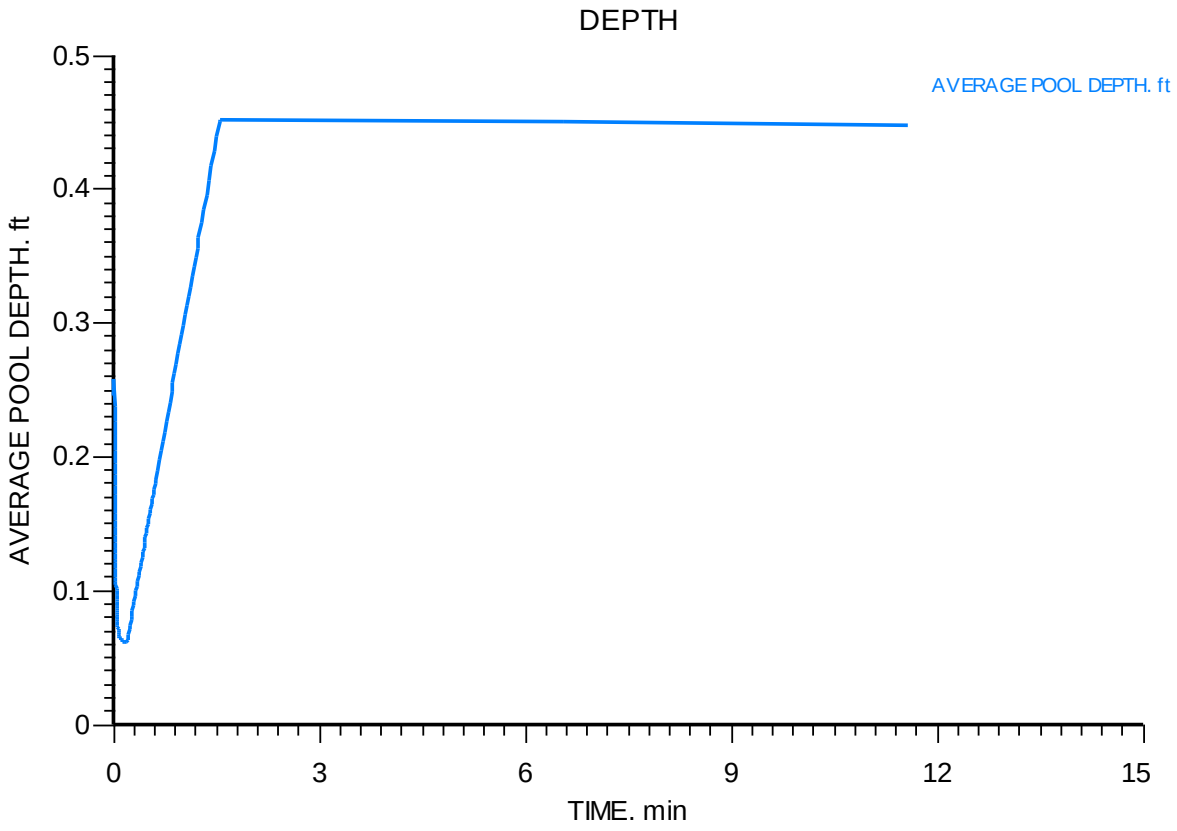


Figure 147: Liquid Pool Depth – E-R-16 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

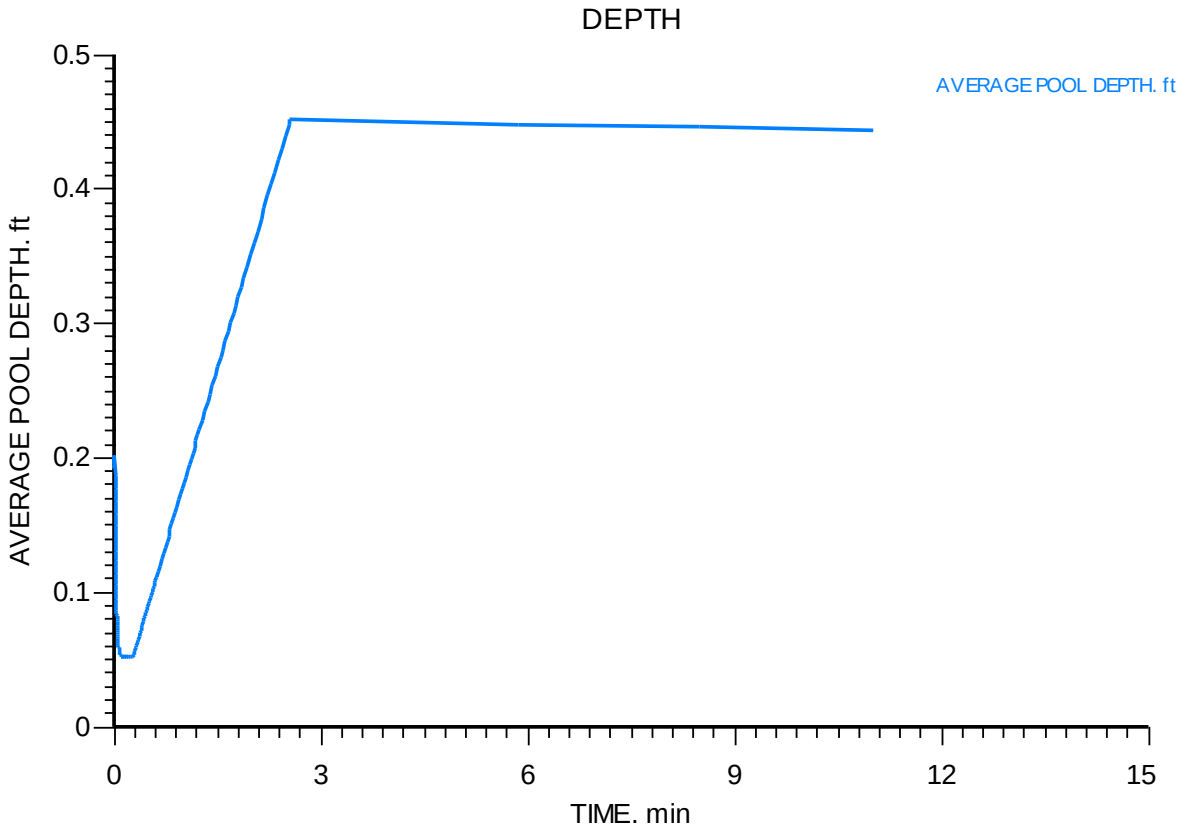
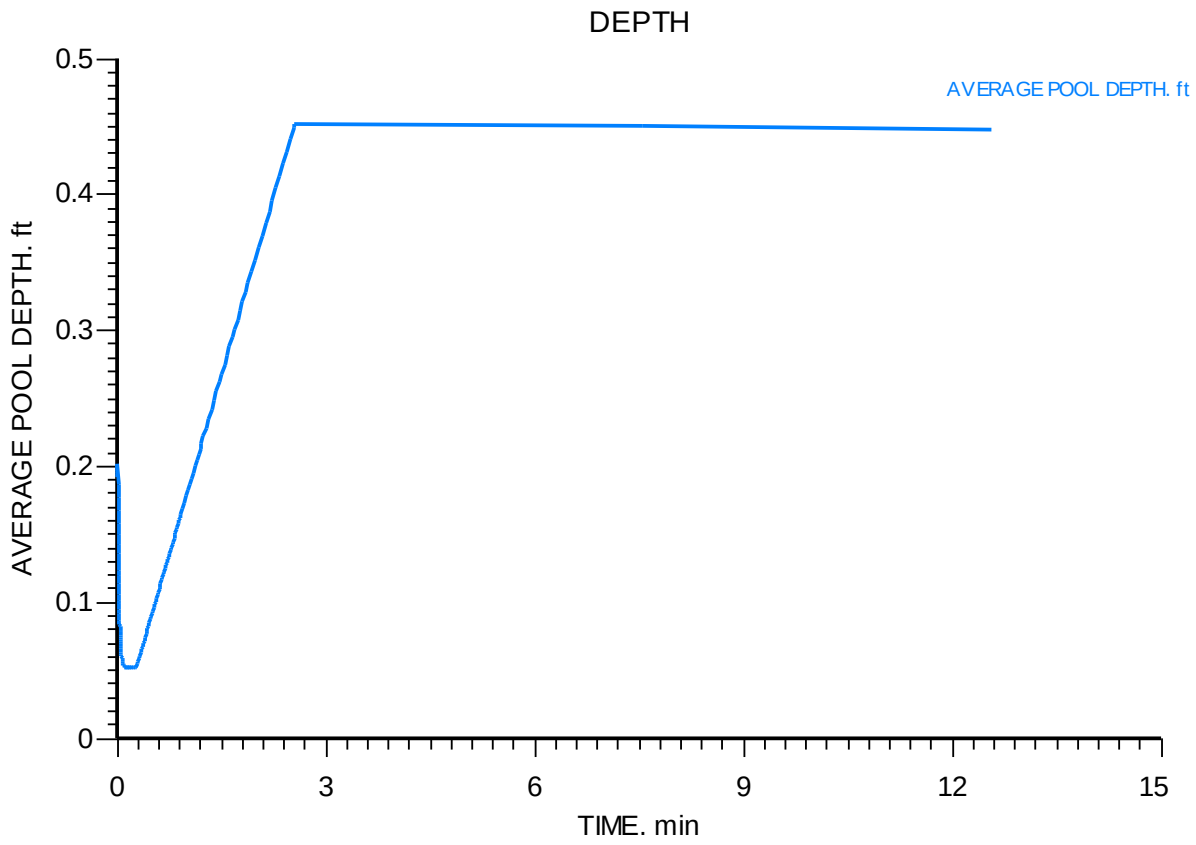


Figure 148: Liquid Pool Depth – E-R-16 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix L: Results – E-R-17 Piping Layout to Pit - Liquid Pool Depth

Figure 149: Liquid Pool Depth – E-R-17 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

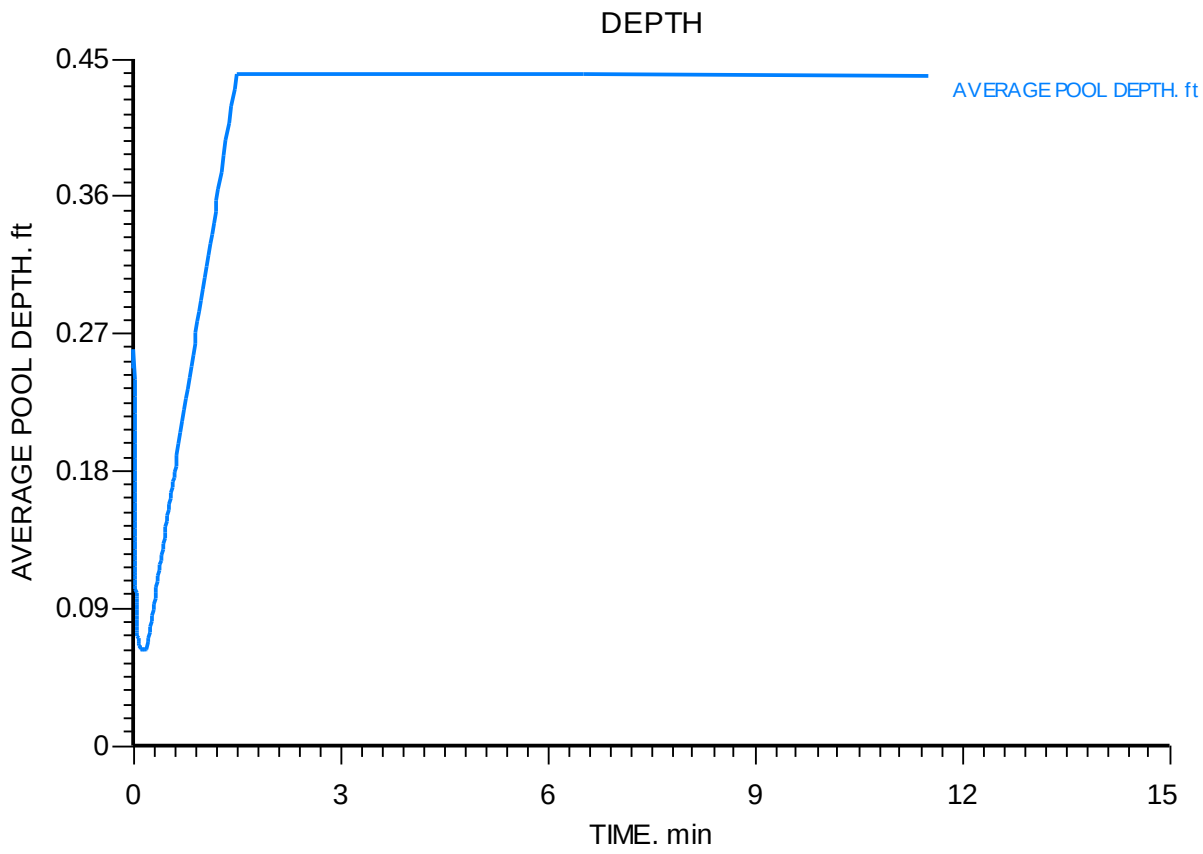


Figure 150: Liquid Pool Depth – E-R-17 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

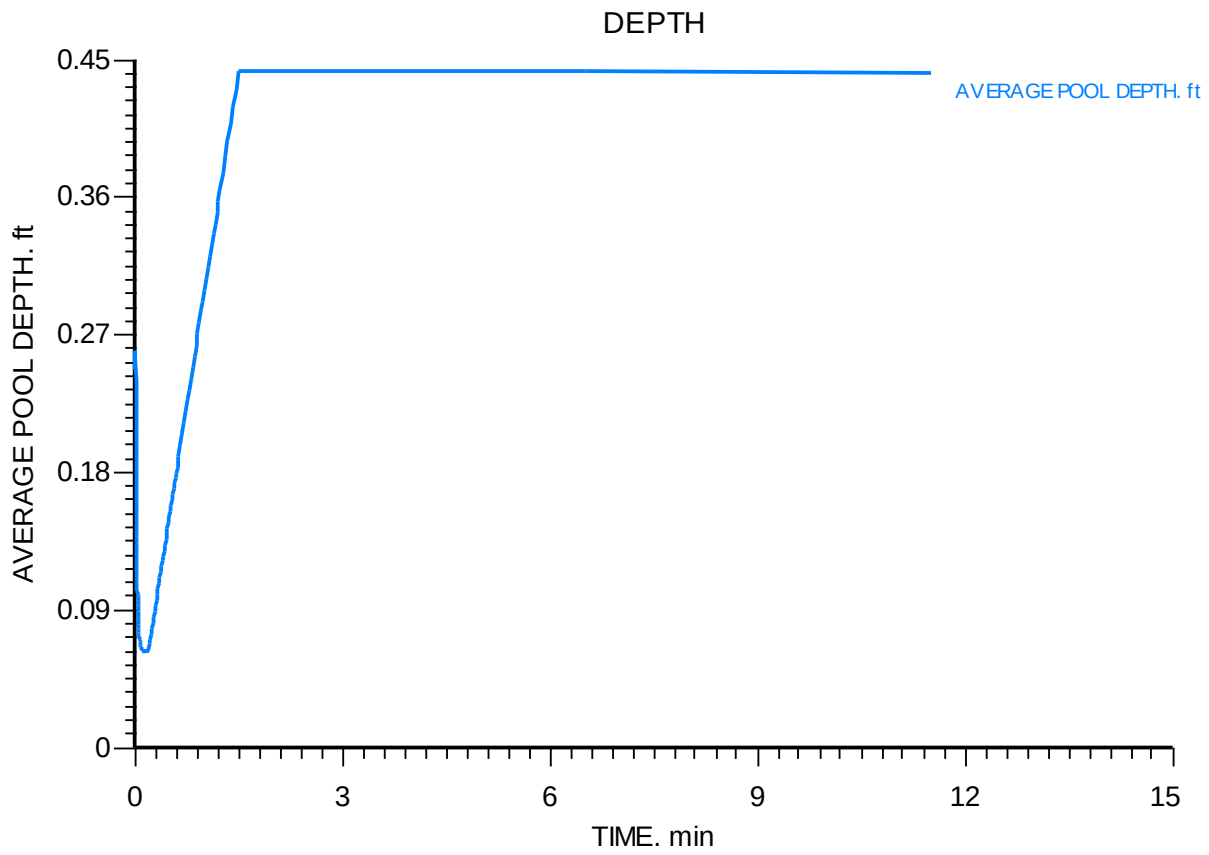


Figure 151: Liquid Pool Depth – E-R-17 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

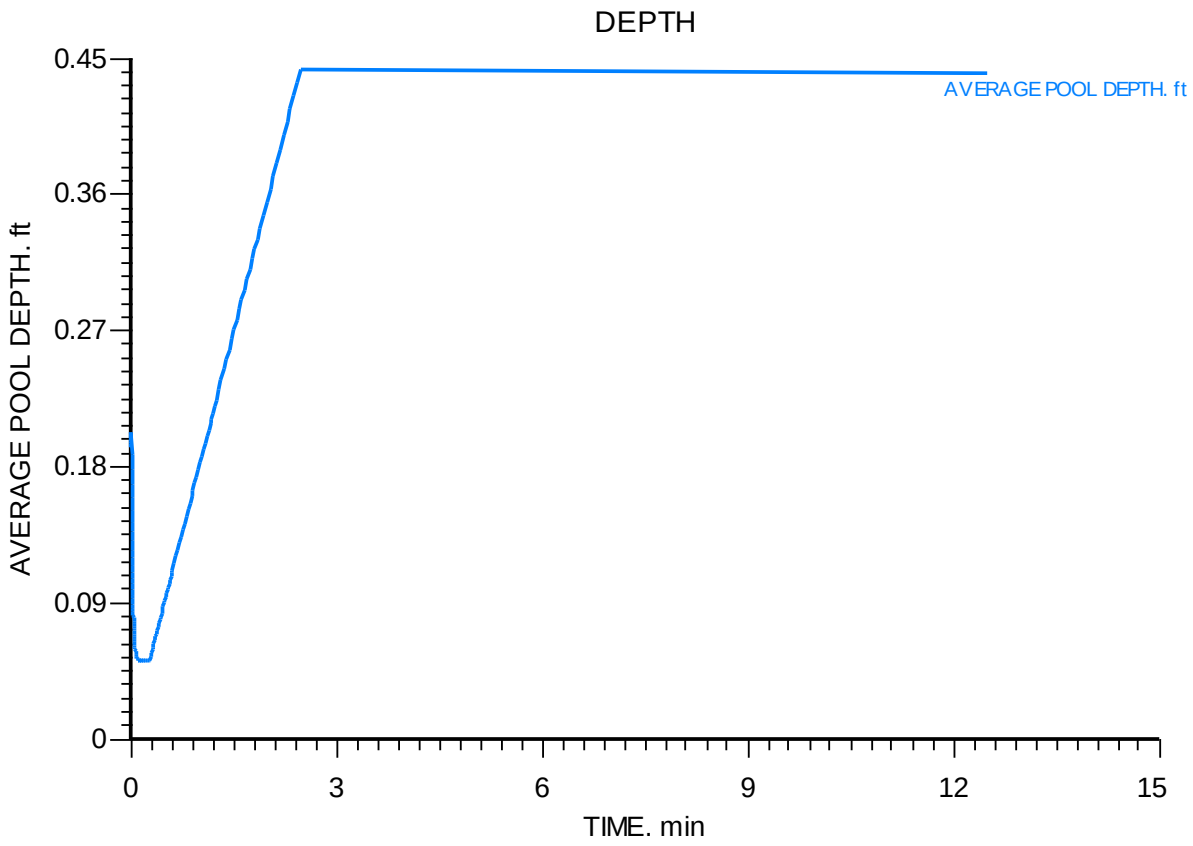


Figure 152: Liquid Pool Depth – E-R-17 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

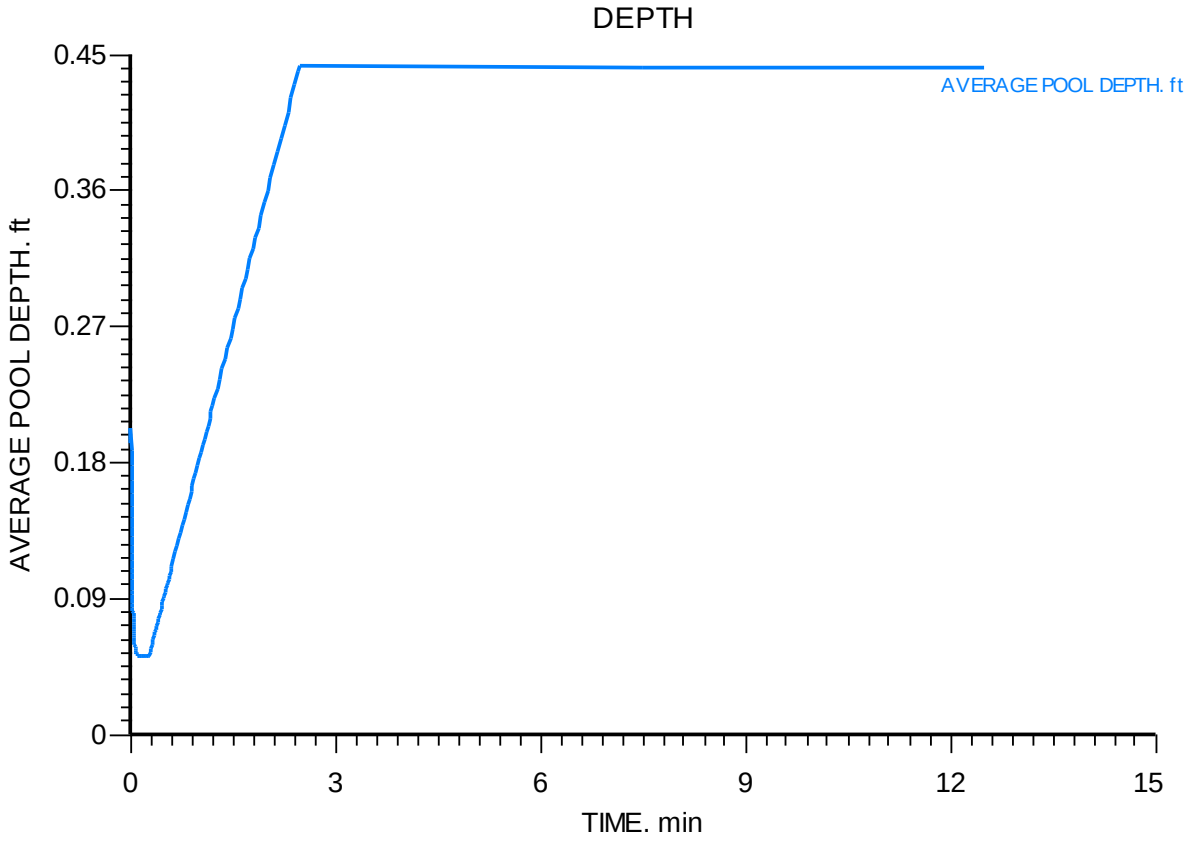


Figure 153: Liquid Pool Depth – E-R-17 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

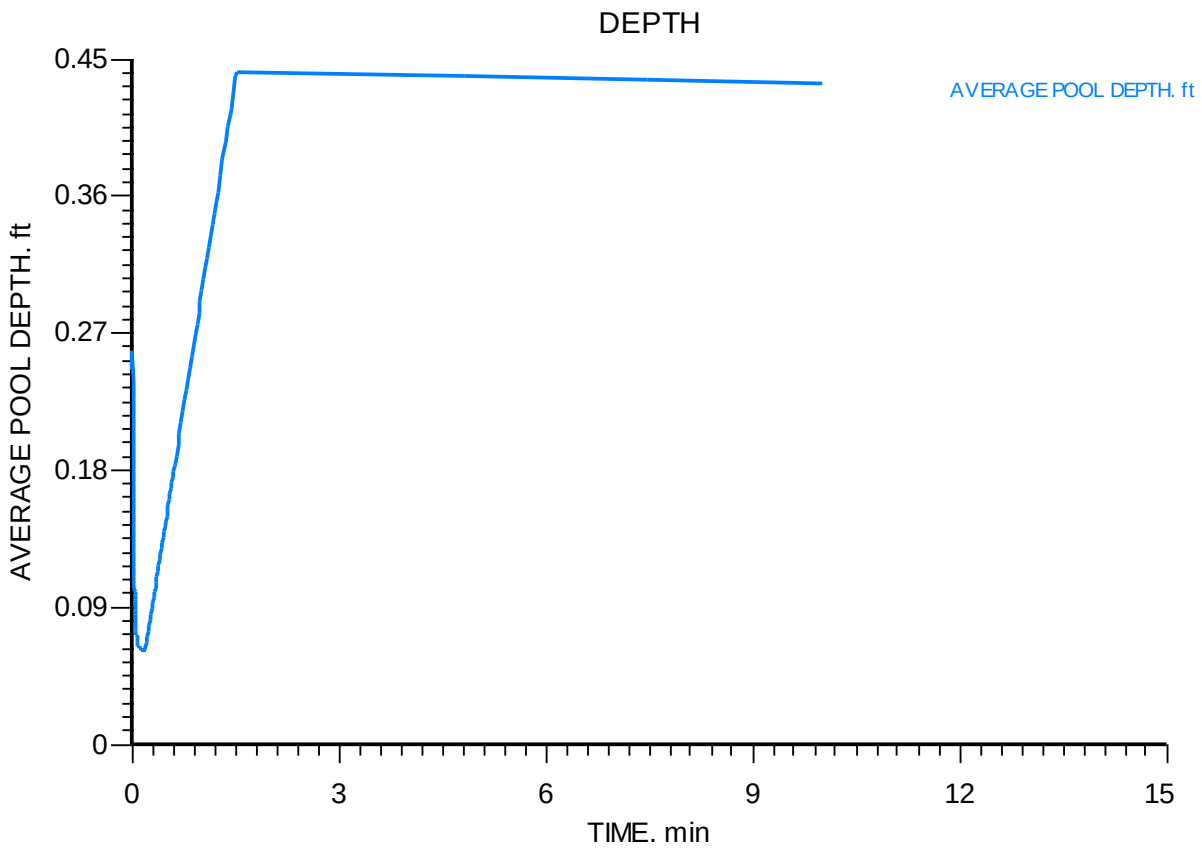


Figure 154: Liquid Pool Depth – E-R-17 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

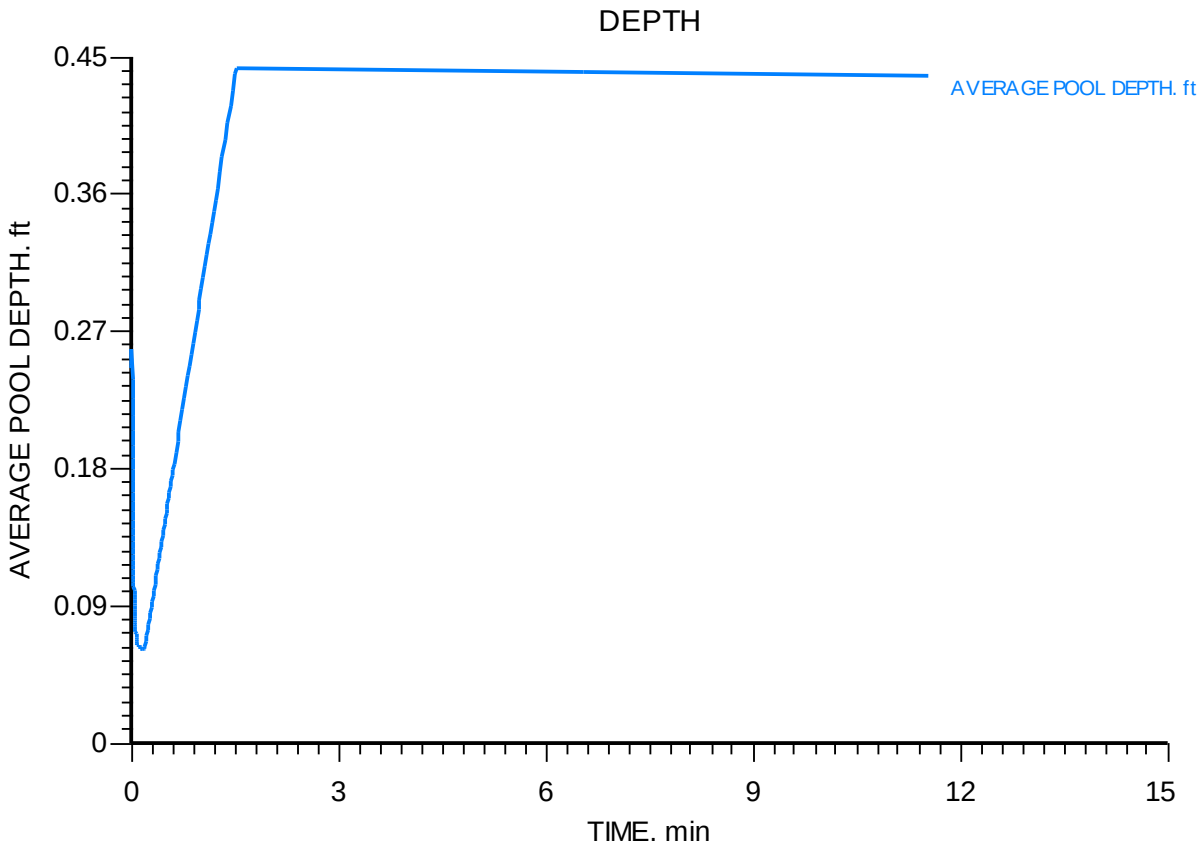


Figure 155: Liquid Pool Depth – E-R-17 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

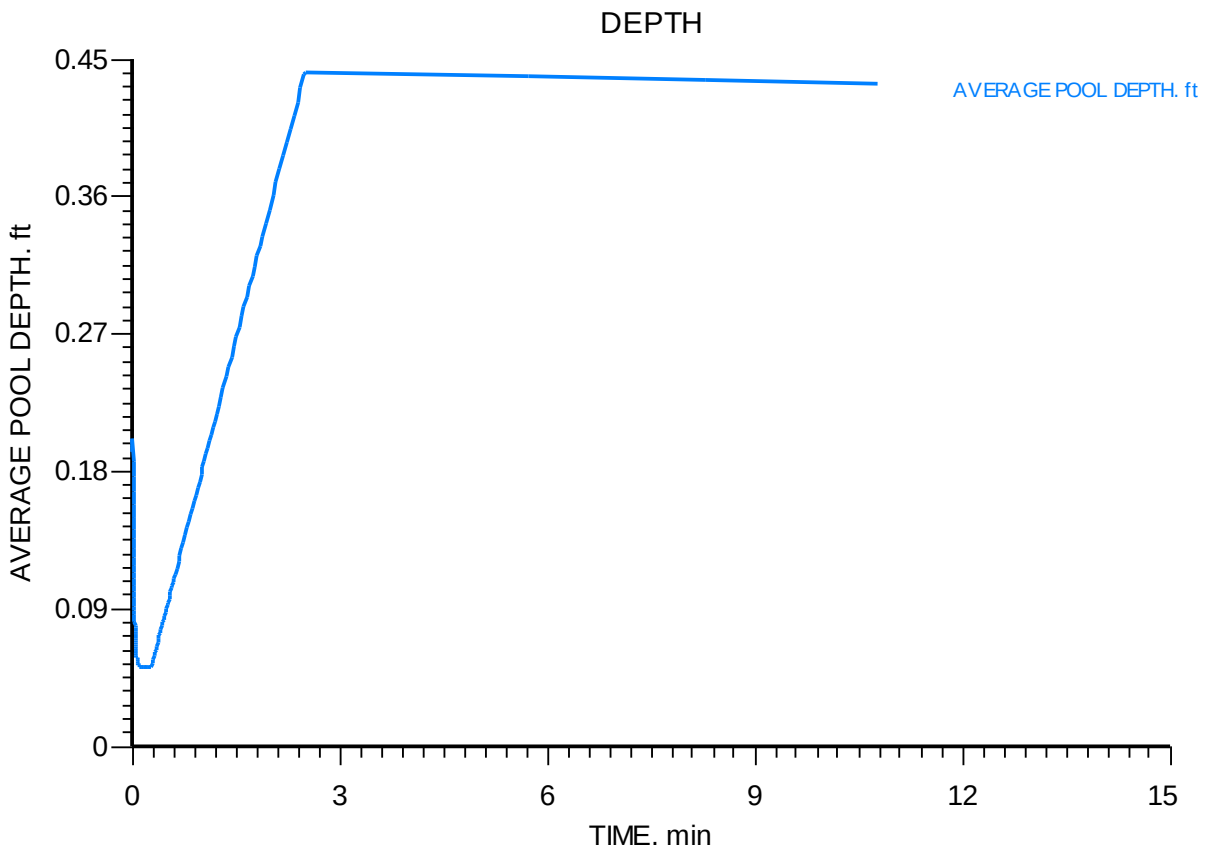
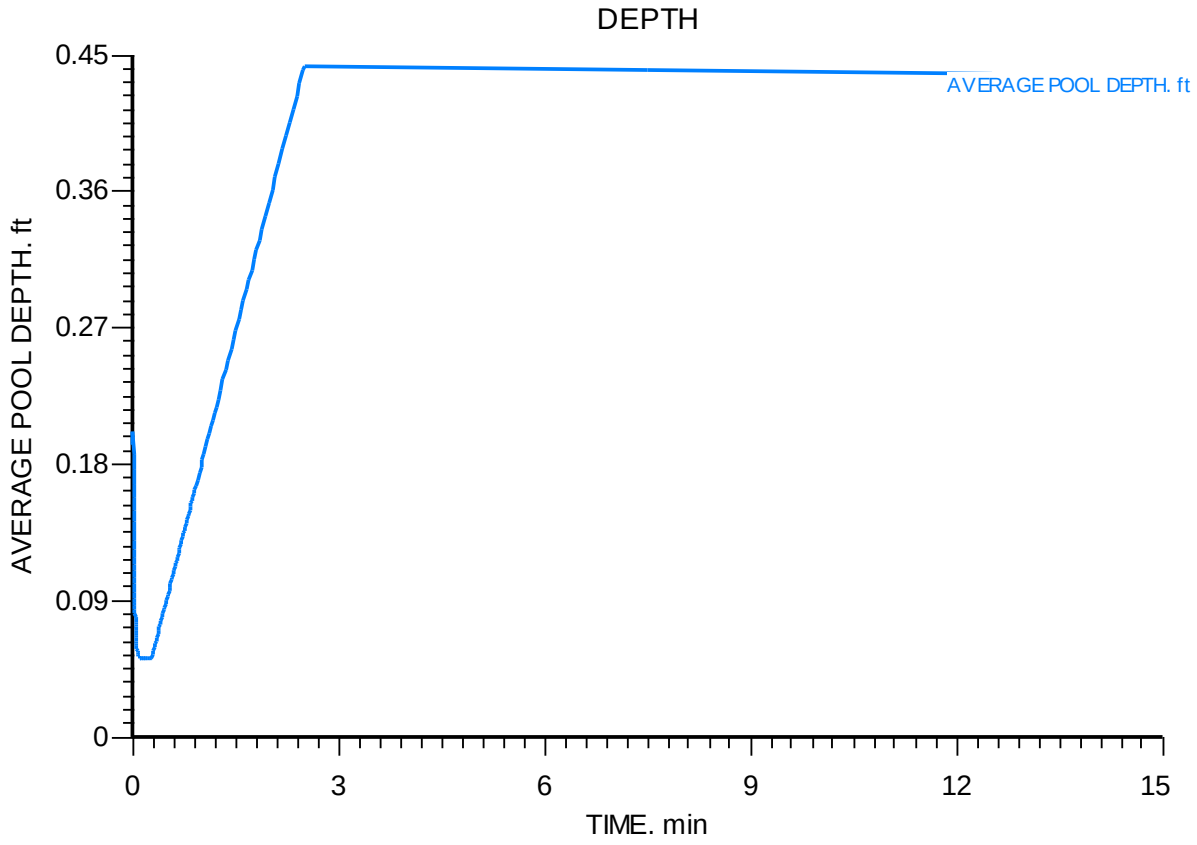


Figure 156: Liquid Pool Depth – E-R-17 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix M: Results – E-R-18 Piping Layout to Pit - Liquid Pool Depth

Figure 157: Liquid Pool Depth – E-R-18 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

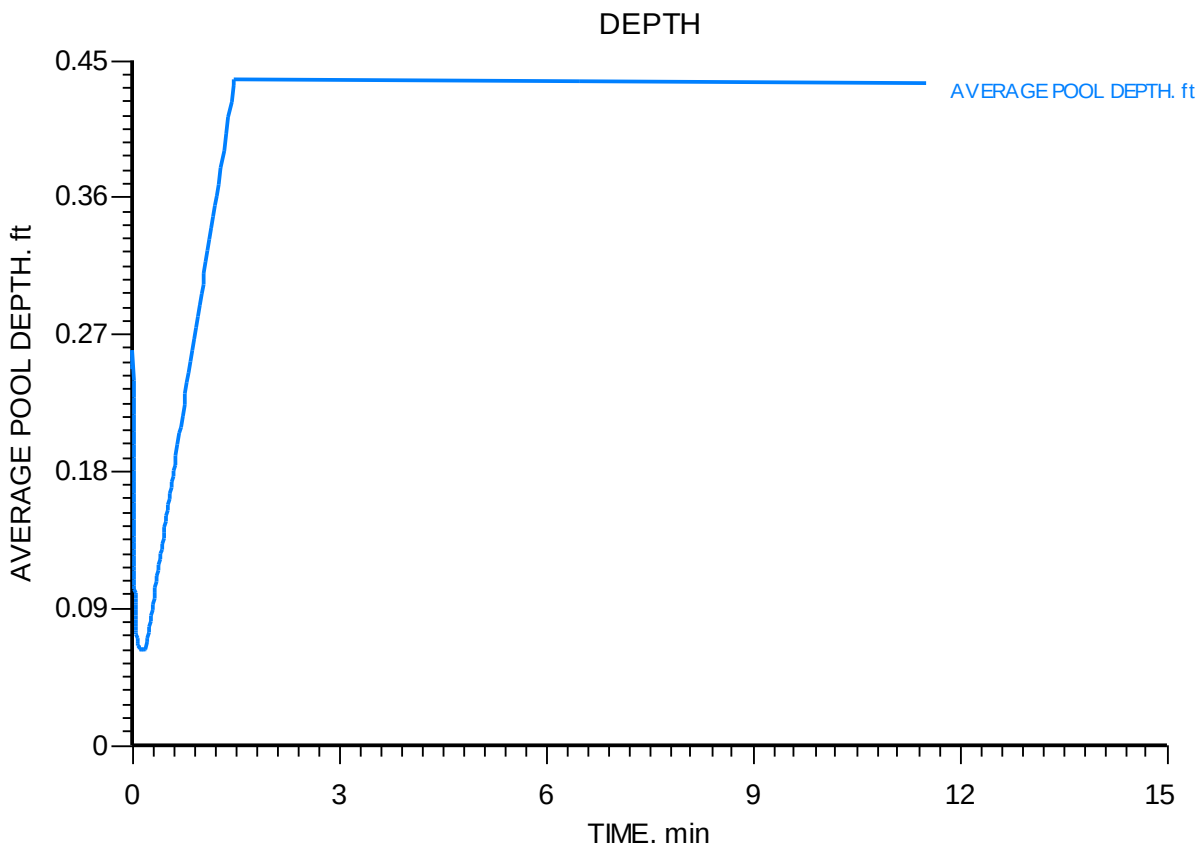


Figure 158: Liquid Pool Depth – E-R-18 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

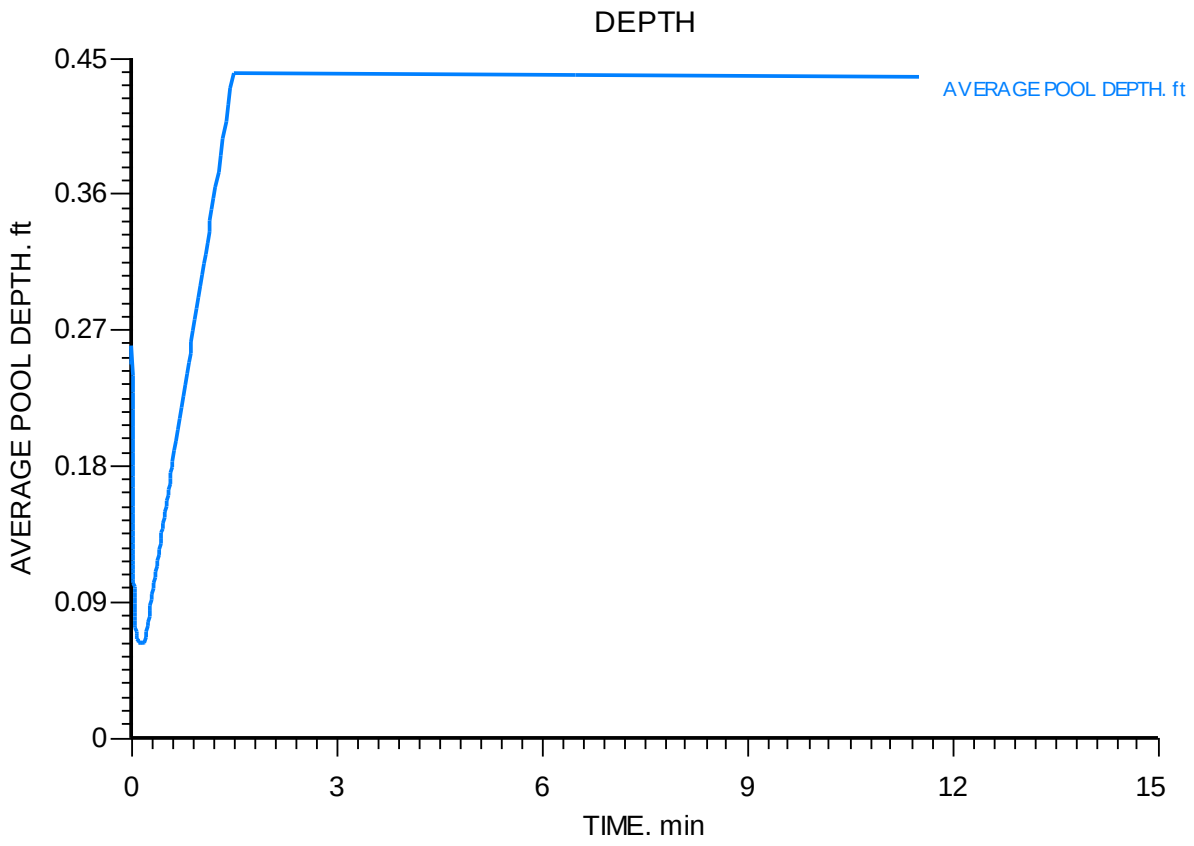


Figure 159: Liquid Pool Depth – E-R-18 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

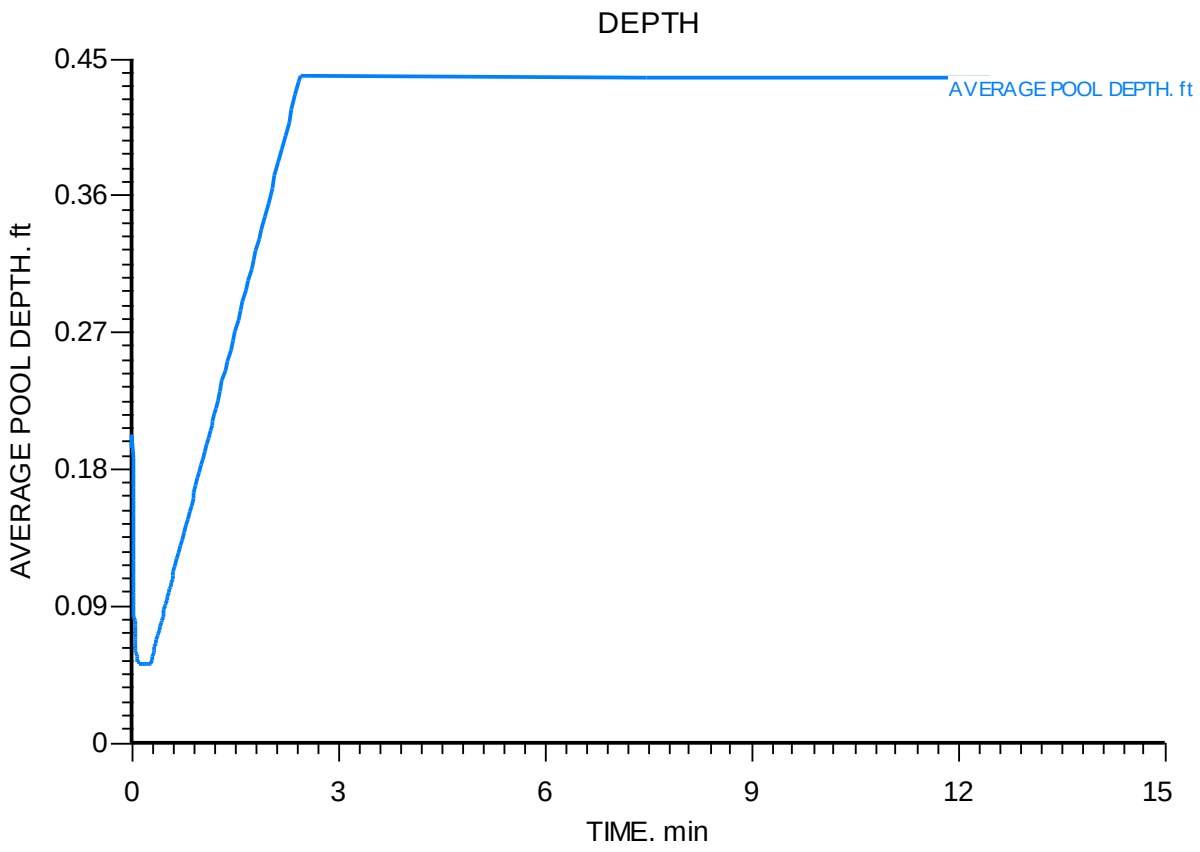


Figure 160: Liquid Pool Depth – E-R-18 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

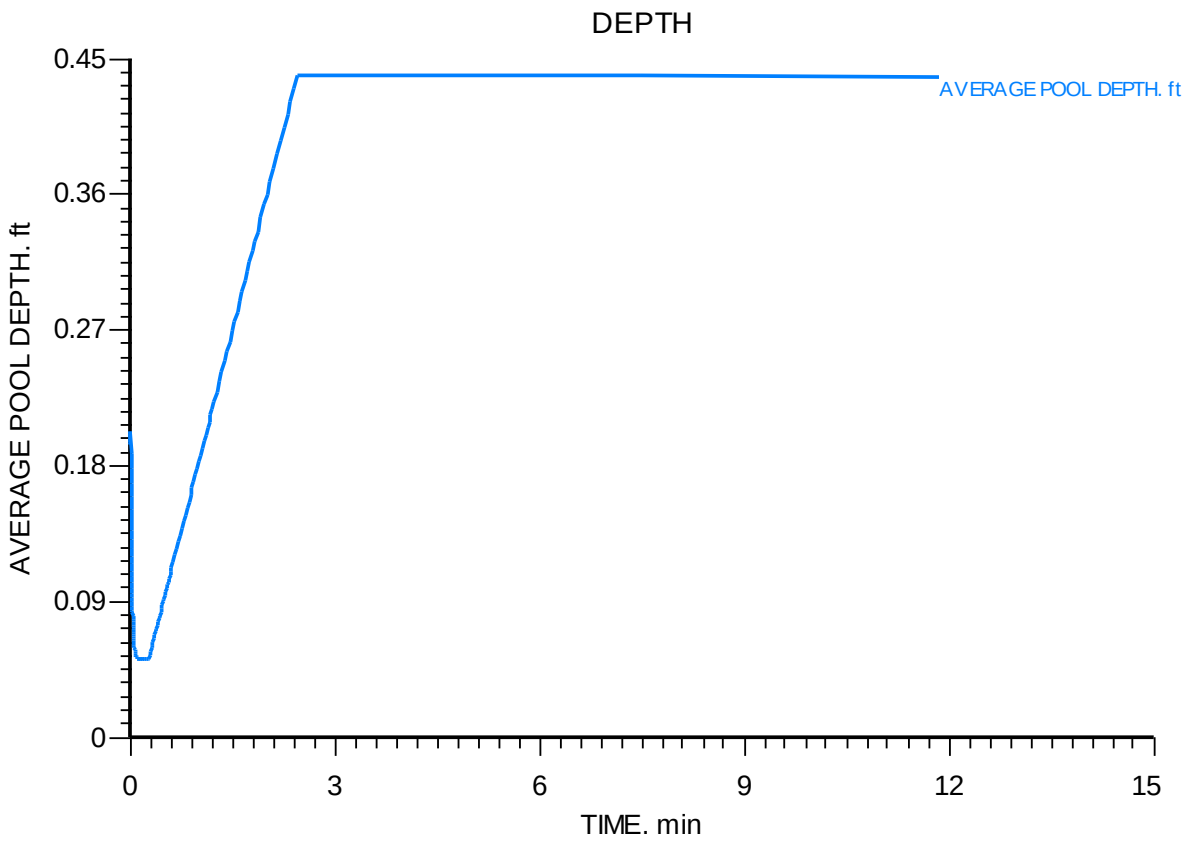


Figure 161: Liquid Pool Depth – E-R-18 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

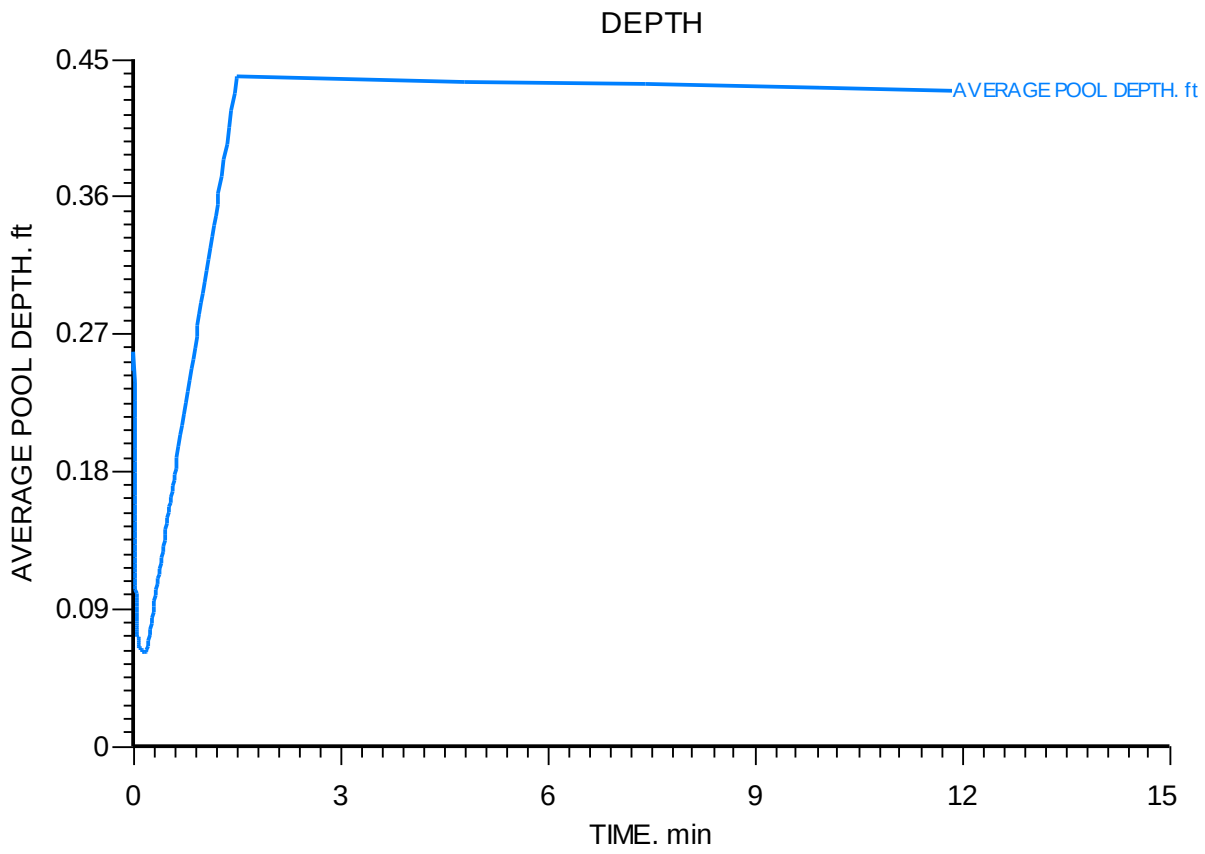


Figure 162: Liquid Pool Depth – E-R-18 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

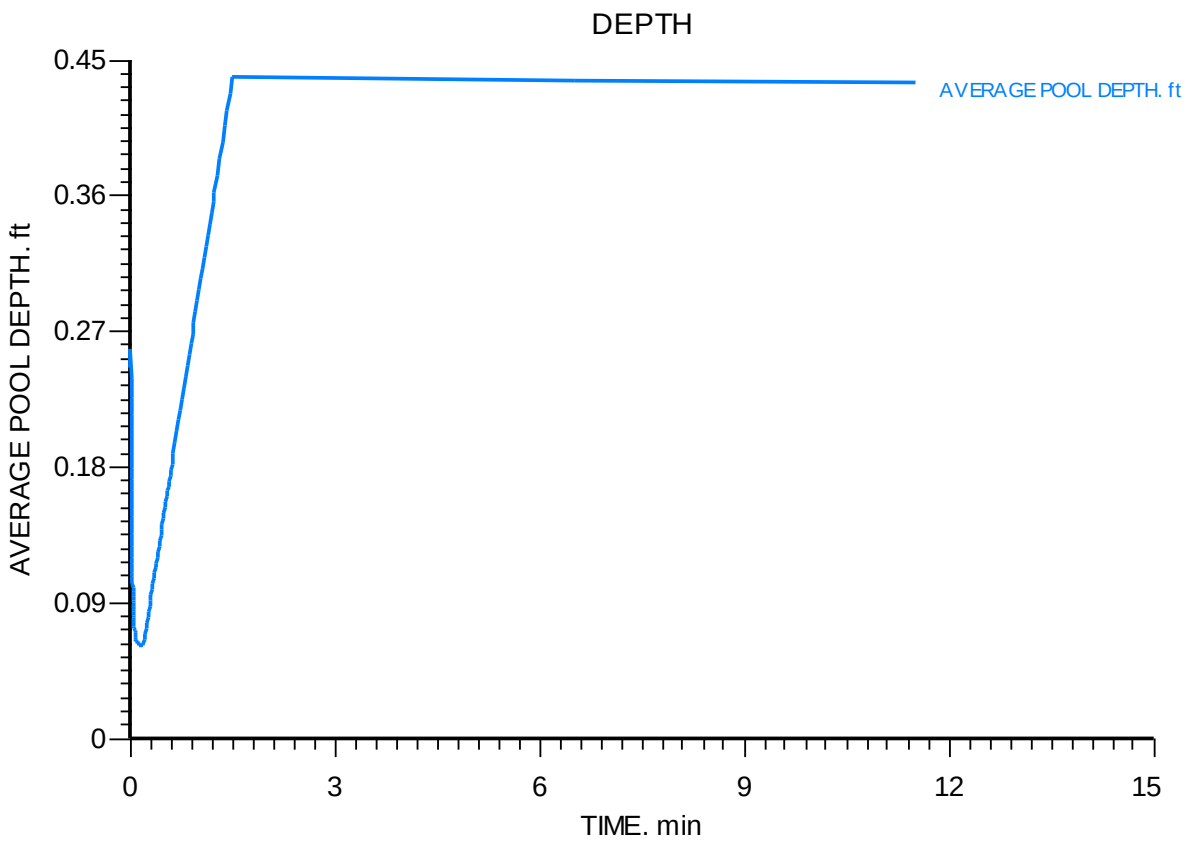


Figure 163: Liquid Pool Depth – E-R-18 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

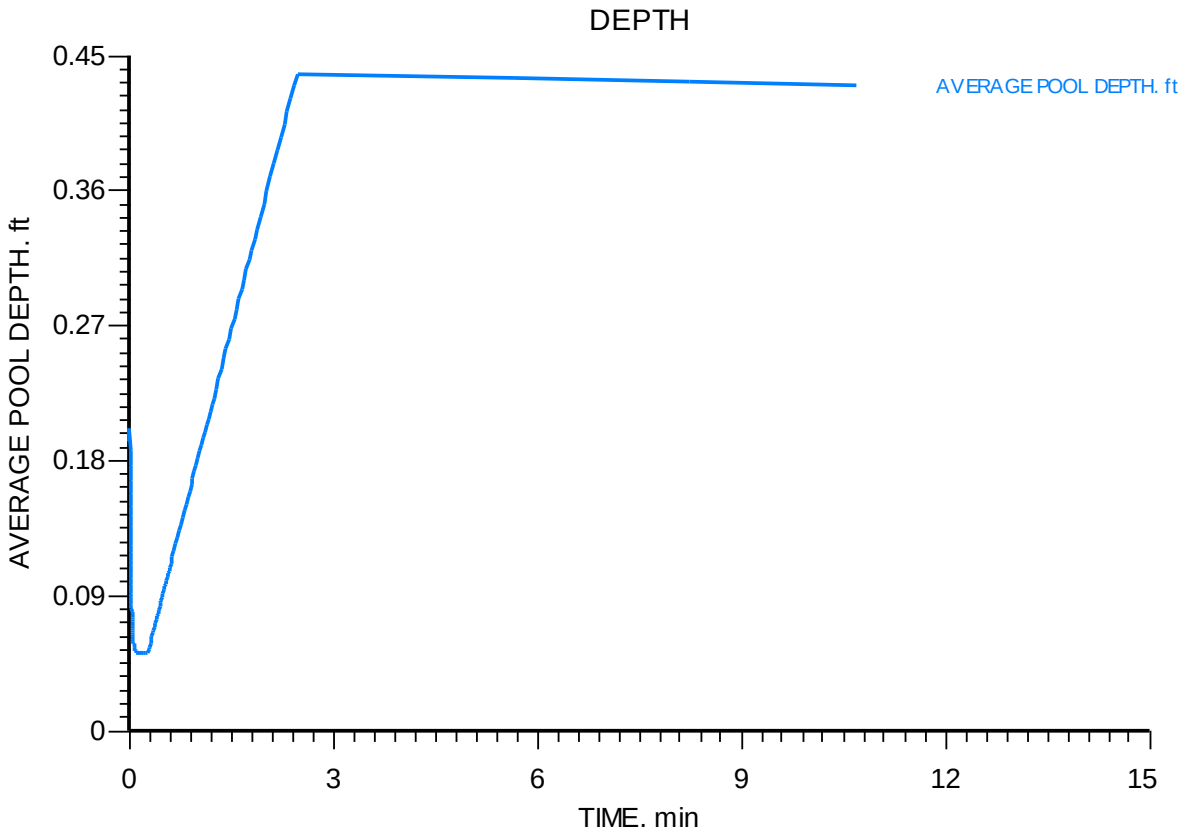
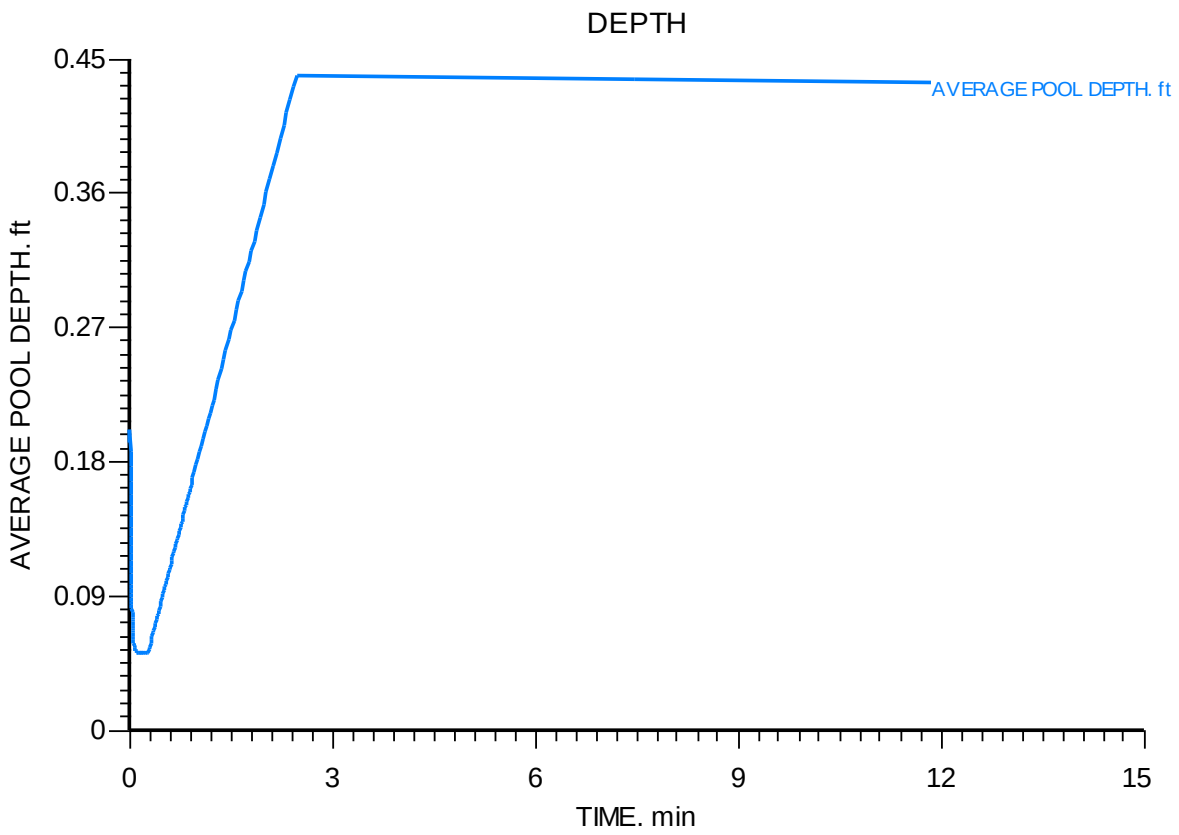


Figure 164: Liquid Pool Depth – E-R-18 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix N: Results – PROPOSED Piping Layout to Pit – Styrene Evaporation Rate

Figure 165: Styrene Evaporation Rate – PROPOSED Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

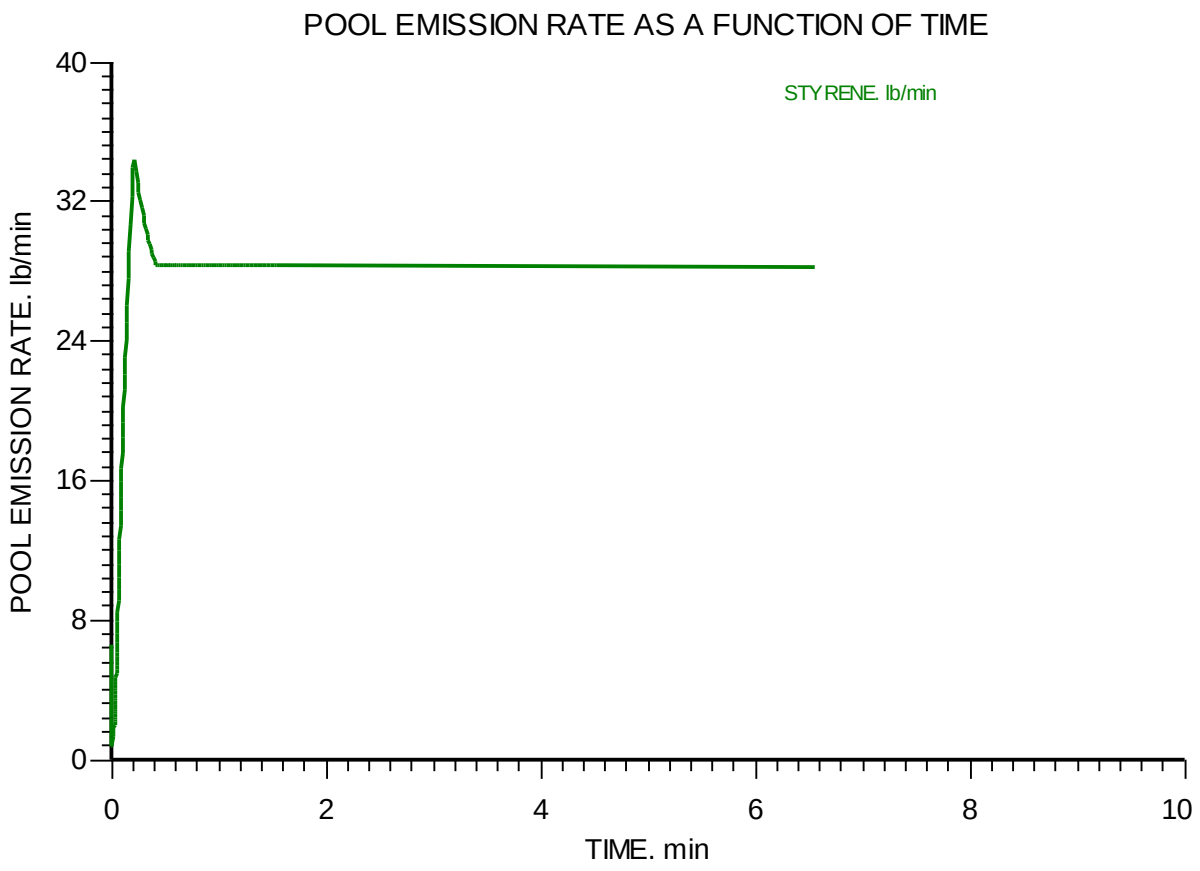


Figure 166: Styrene Evaporation Rate – PROPOSED Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

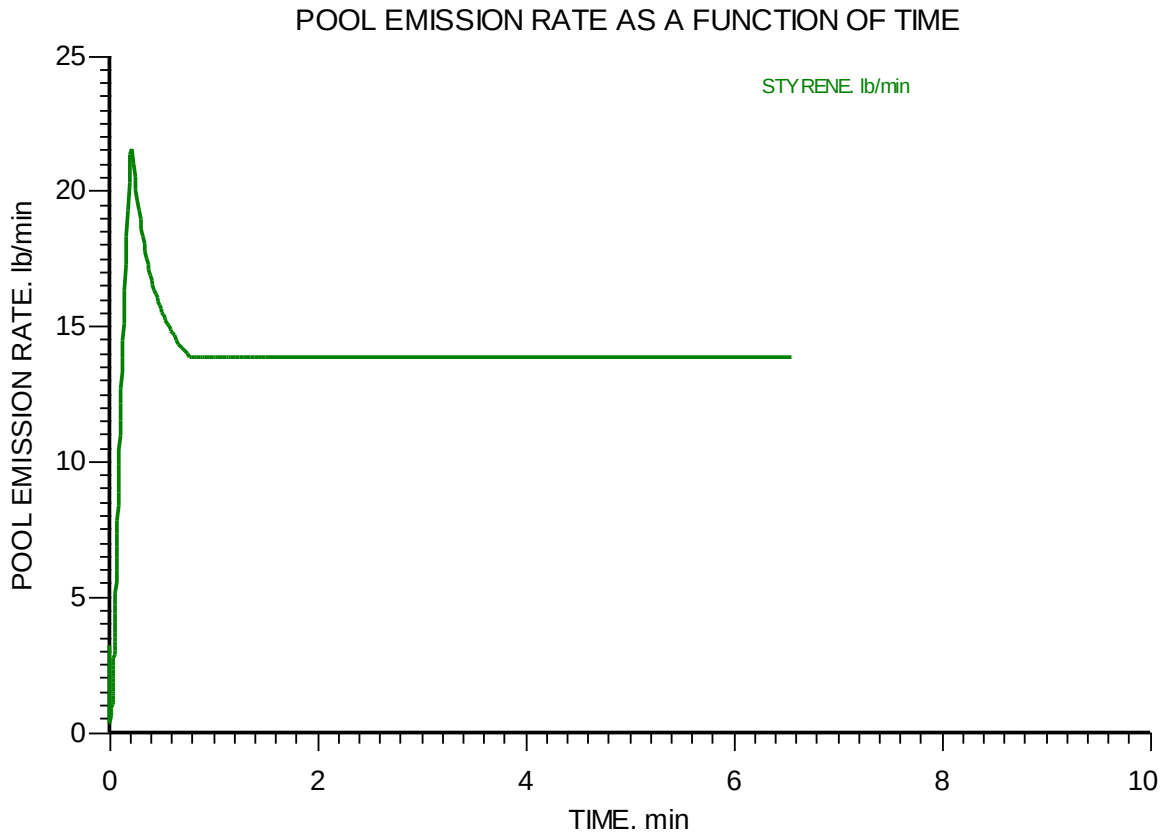


Figure 167: Styrene Evaporation Rate – PROPOSED Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

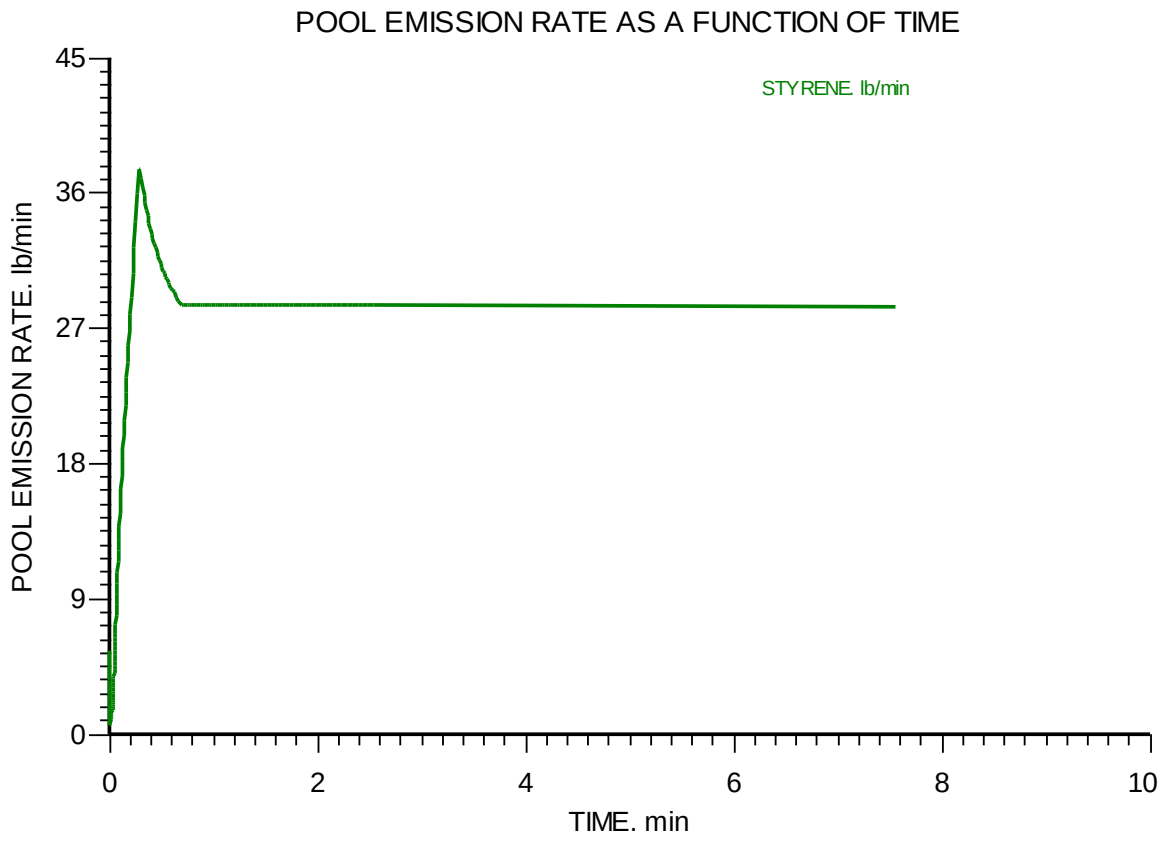


Figure 168: Styrene Evaporation Rate – PROPOSED Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

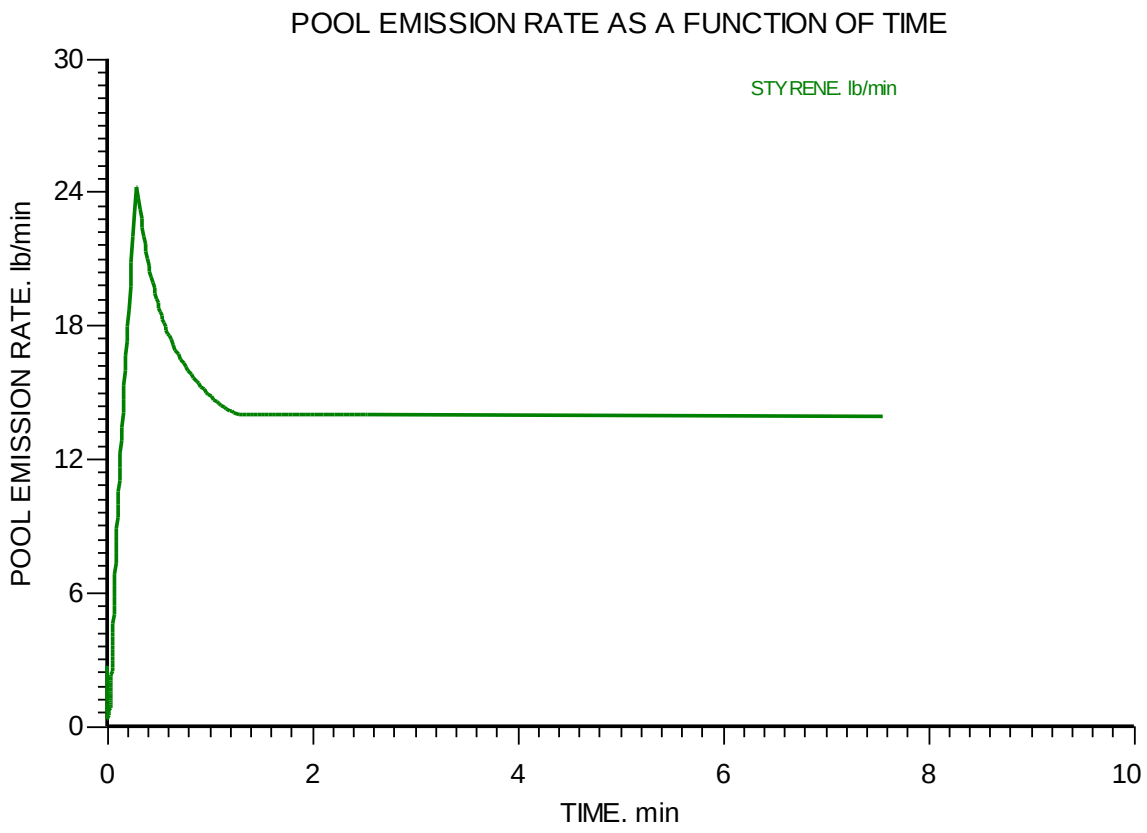


Figure 169: Styrene Evaporation Rate – PROPOSED Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

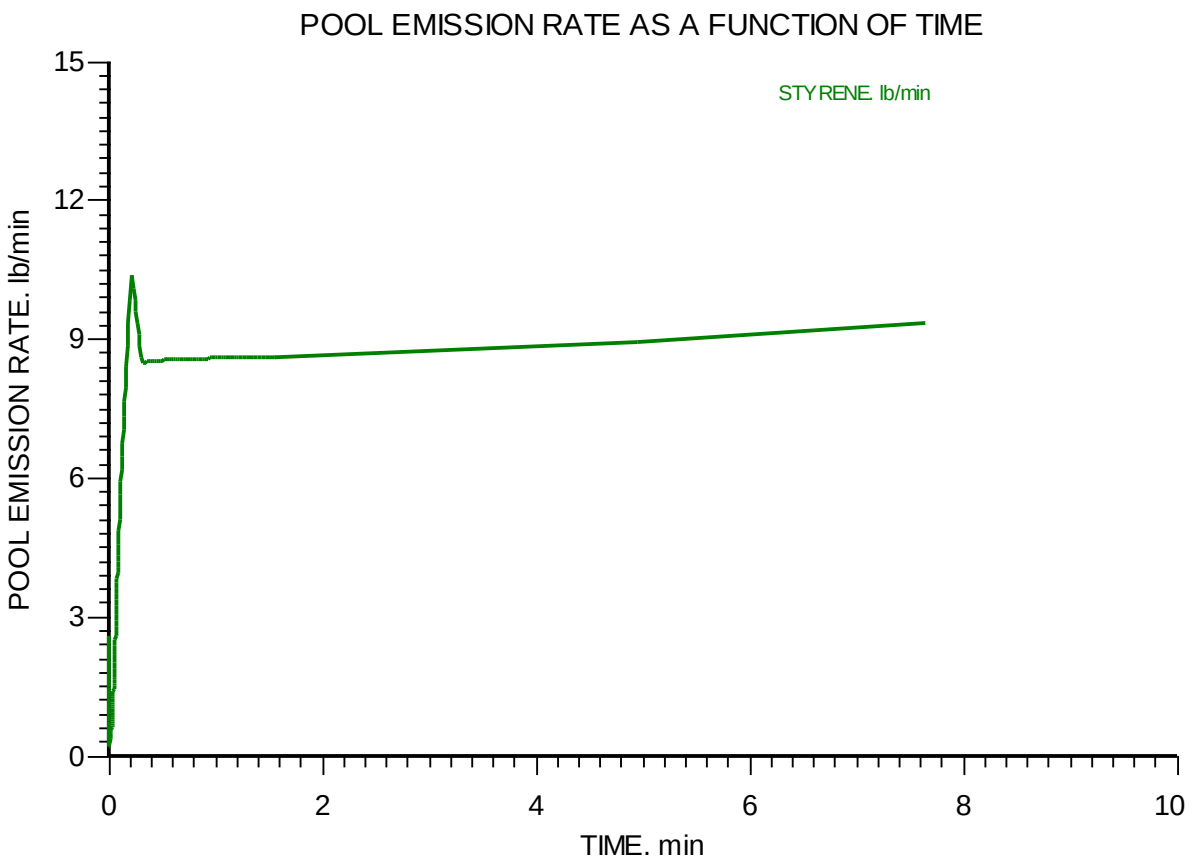


Figure 170: Styrene Evaporation Rate – PROPOSED Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

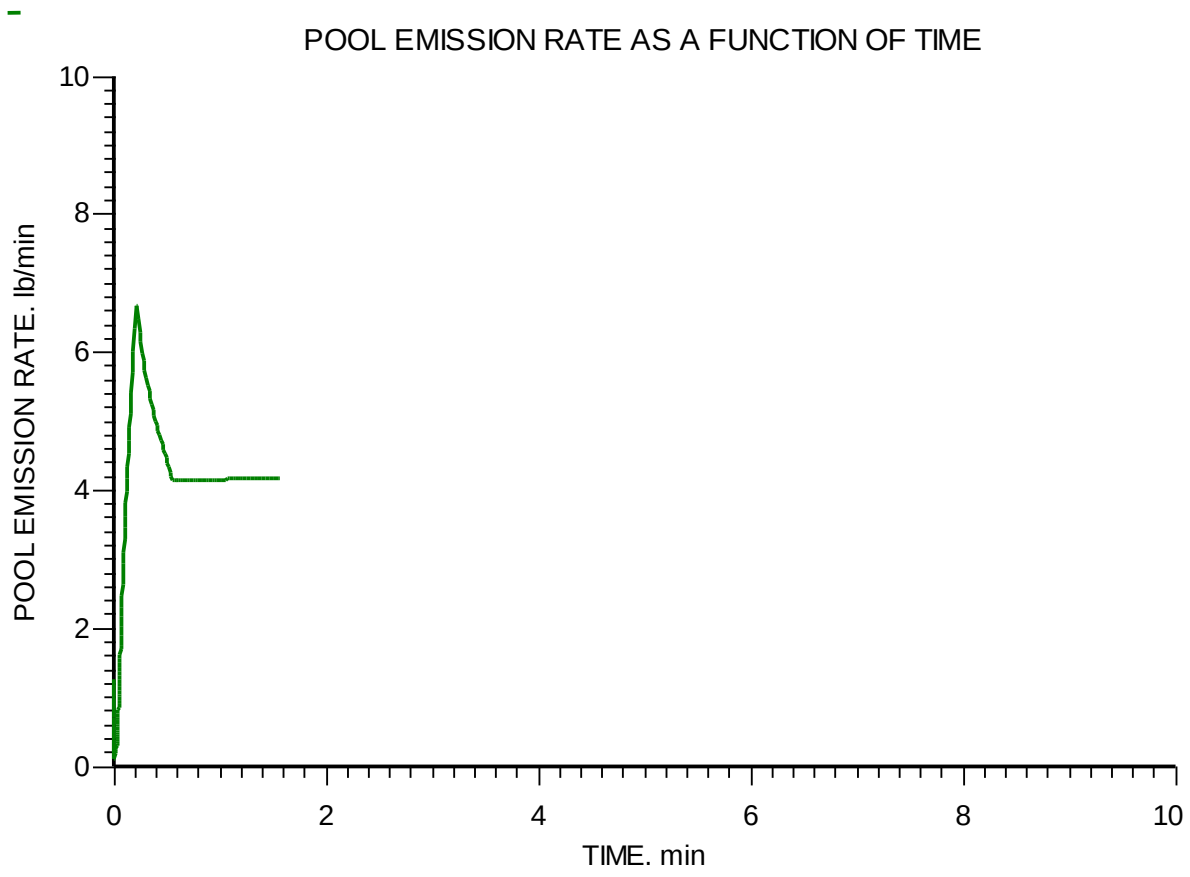


Figure 171: Styrene Evaporation Rate – PROPOSED Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

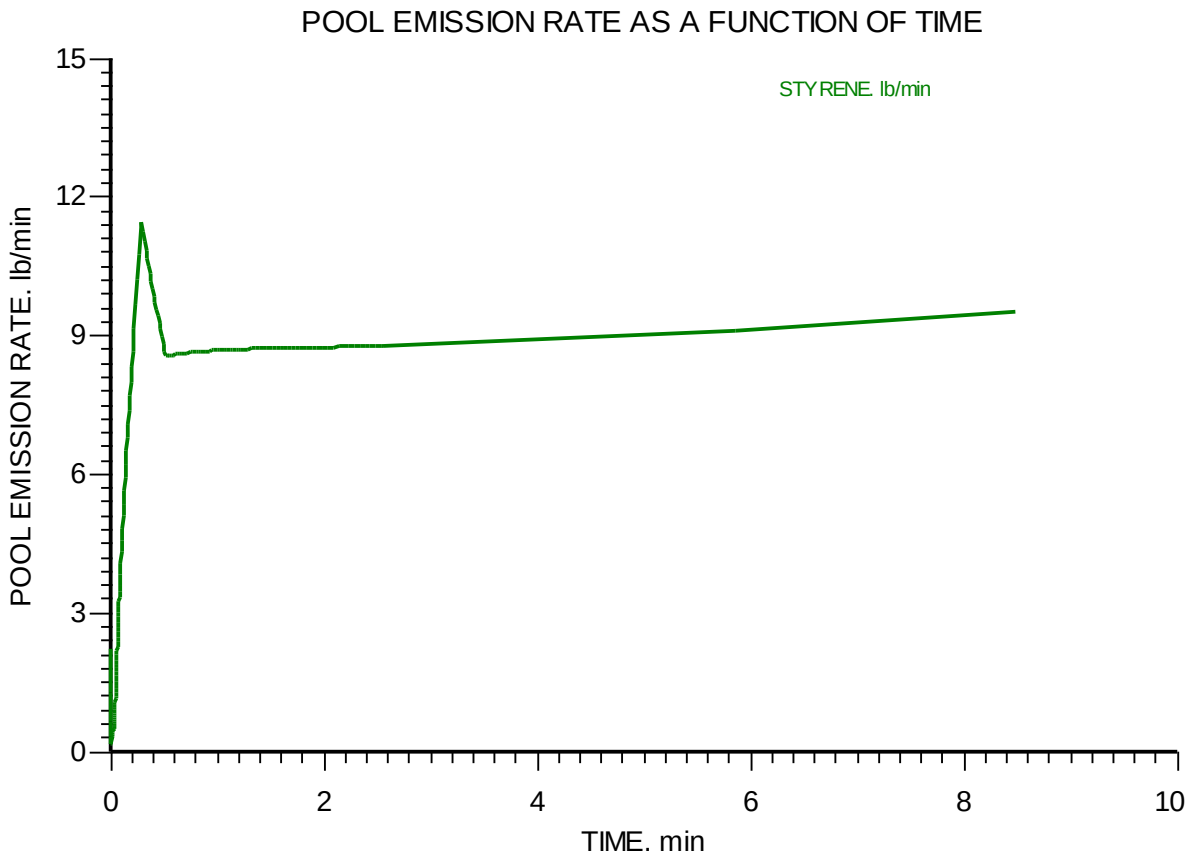
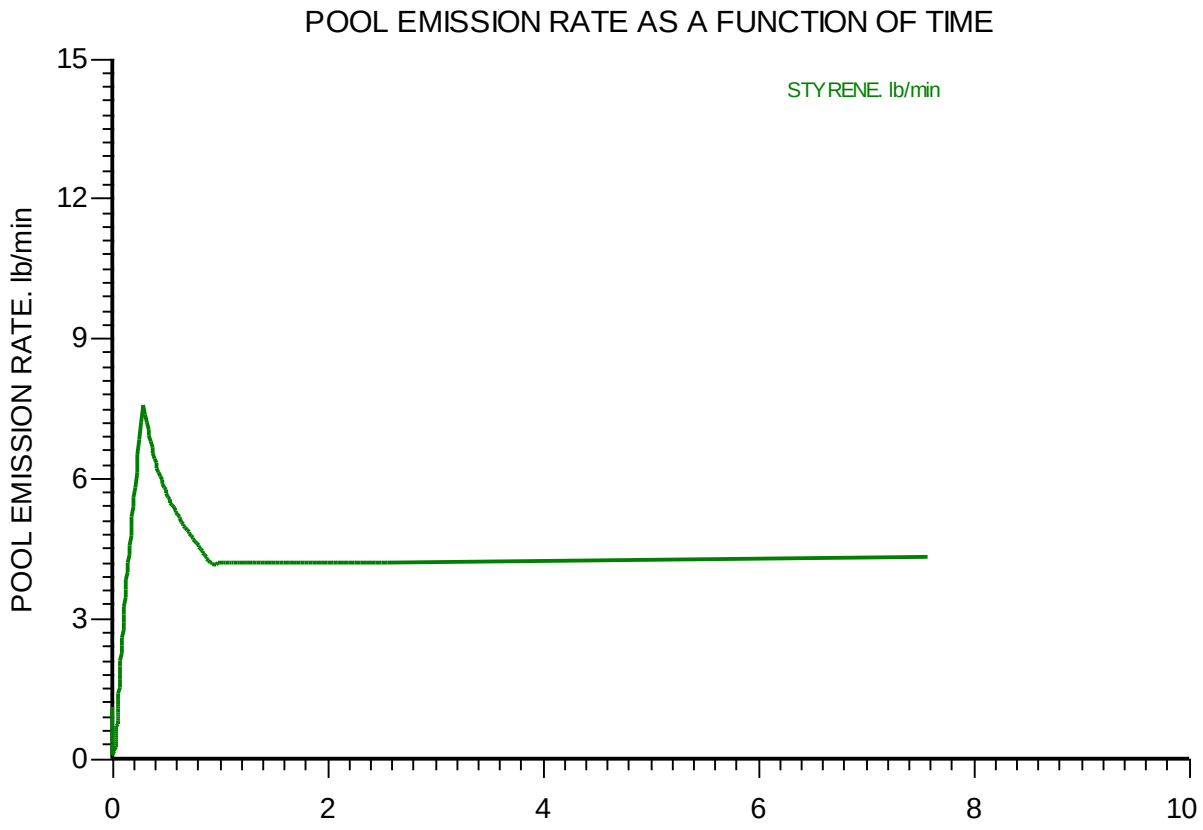


Figure 172: Styrene Evaporation Rate – PROPOSED Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix O: Results – E-R-14 Piping Layout to Pit – Styrene Evaporation Rate

Figure 173: Styrene Evaporation Rate – E-R-14 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

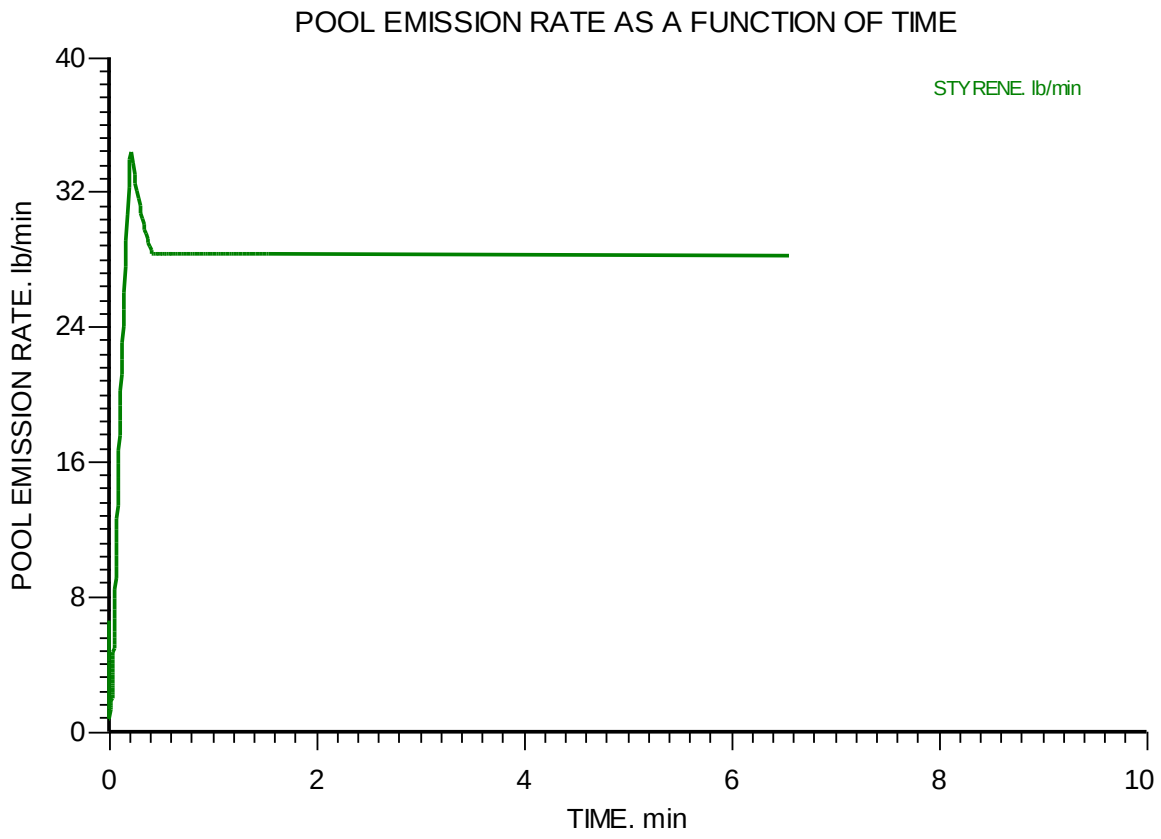


Figure 174: Styrene Evaporation Rate – E-R-14 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

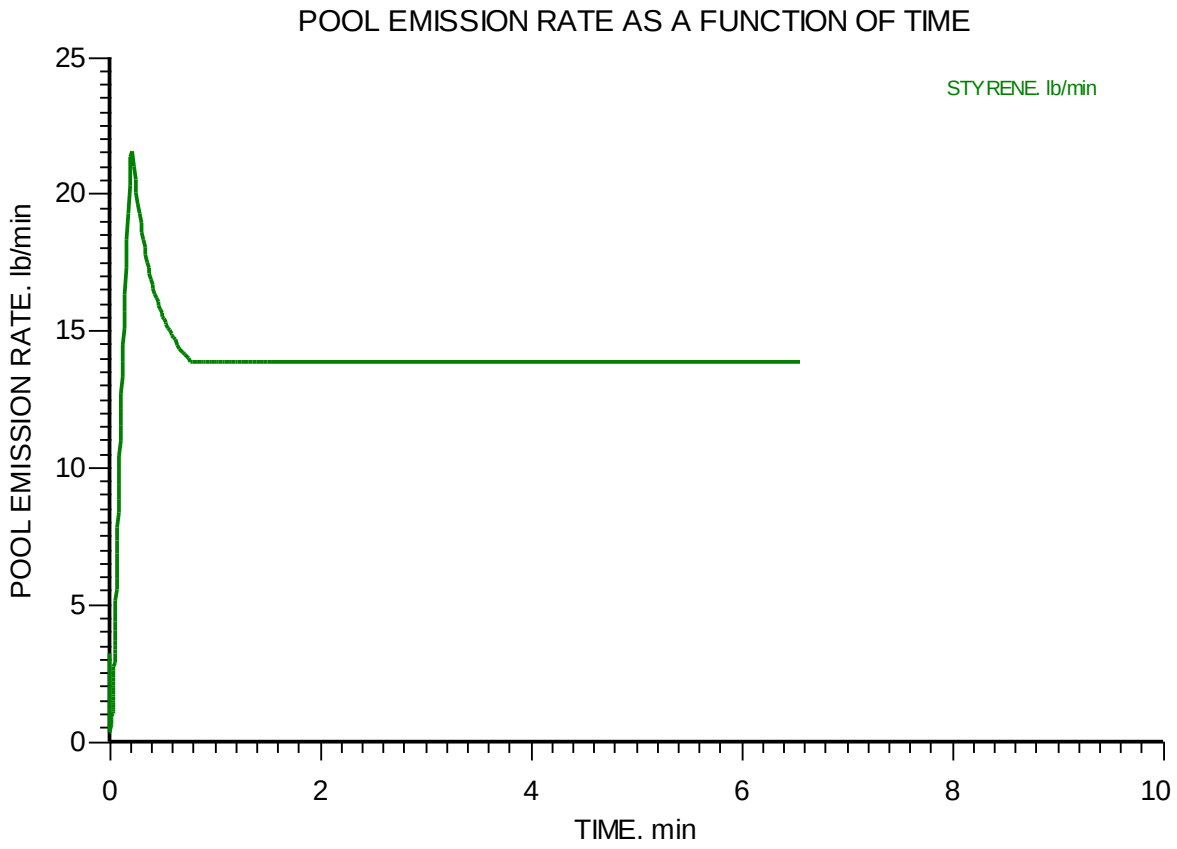


Figure 175: Styrene Evaporation Rate – E-R-14 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

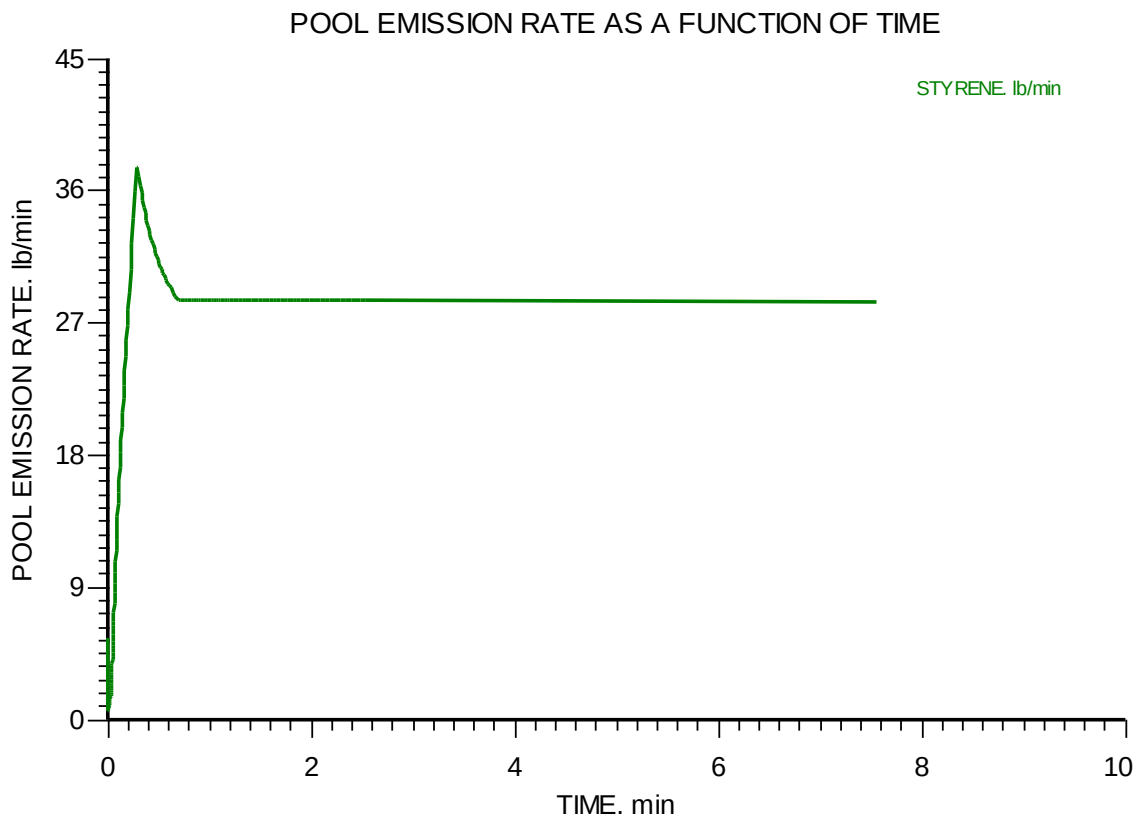


Figure 176: Styrene Evaporation Rate – E-R-14 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

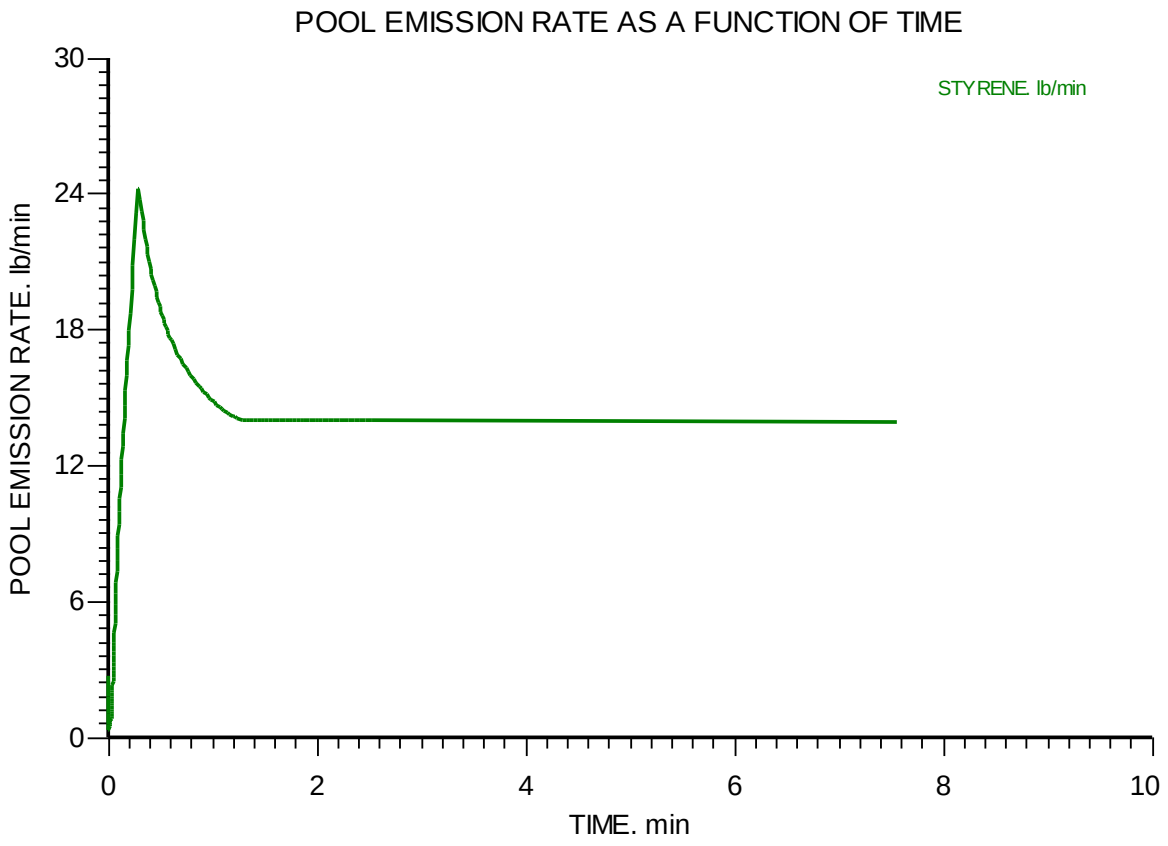


Figure 177: Styrene Evaporation Rate – E-R-14 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

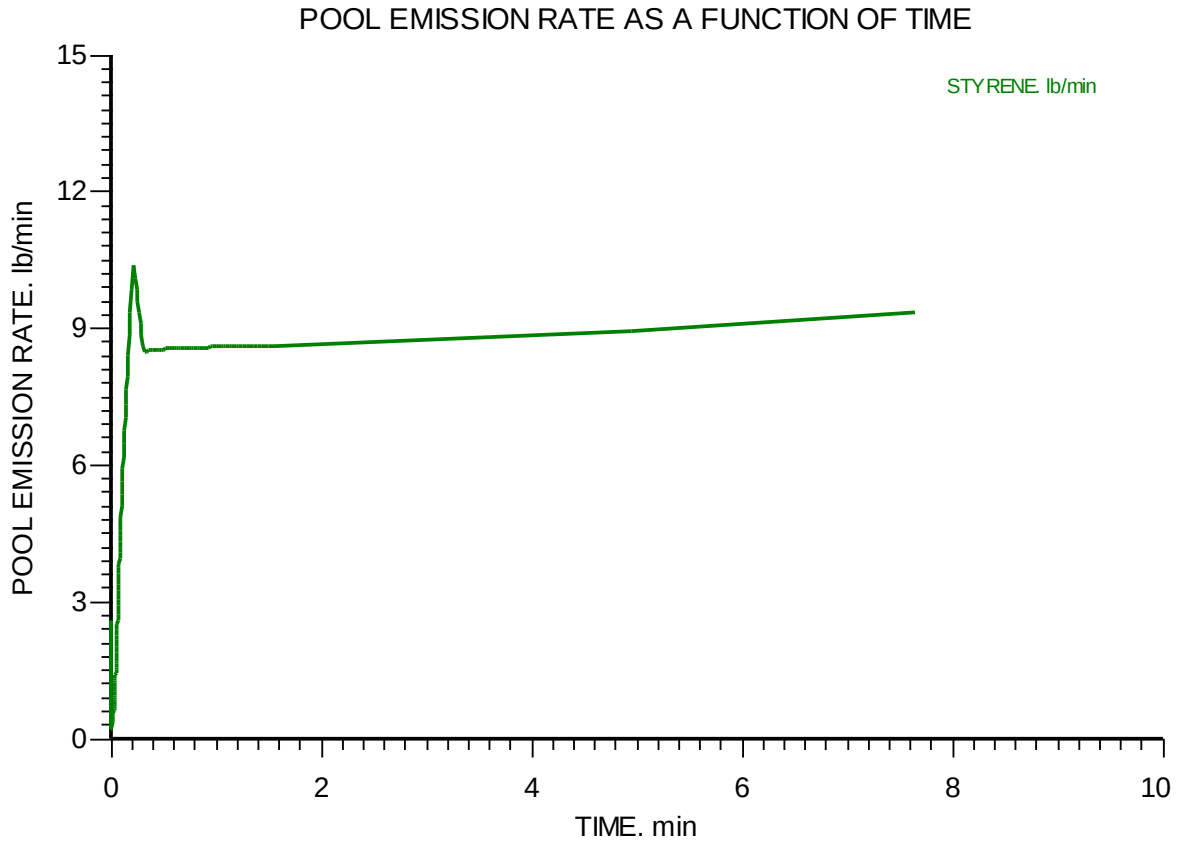


Figure 178: Styrene Evaporation Rate – E-R-14 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

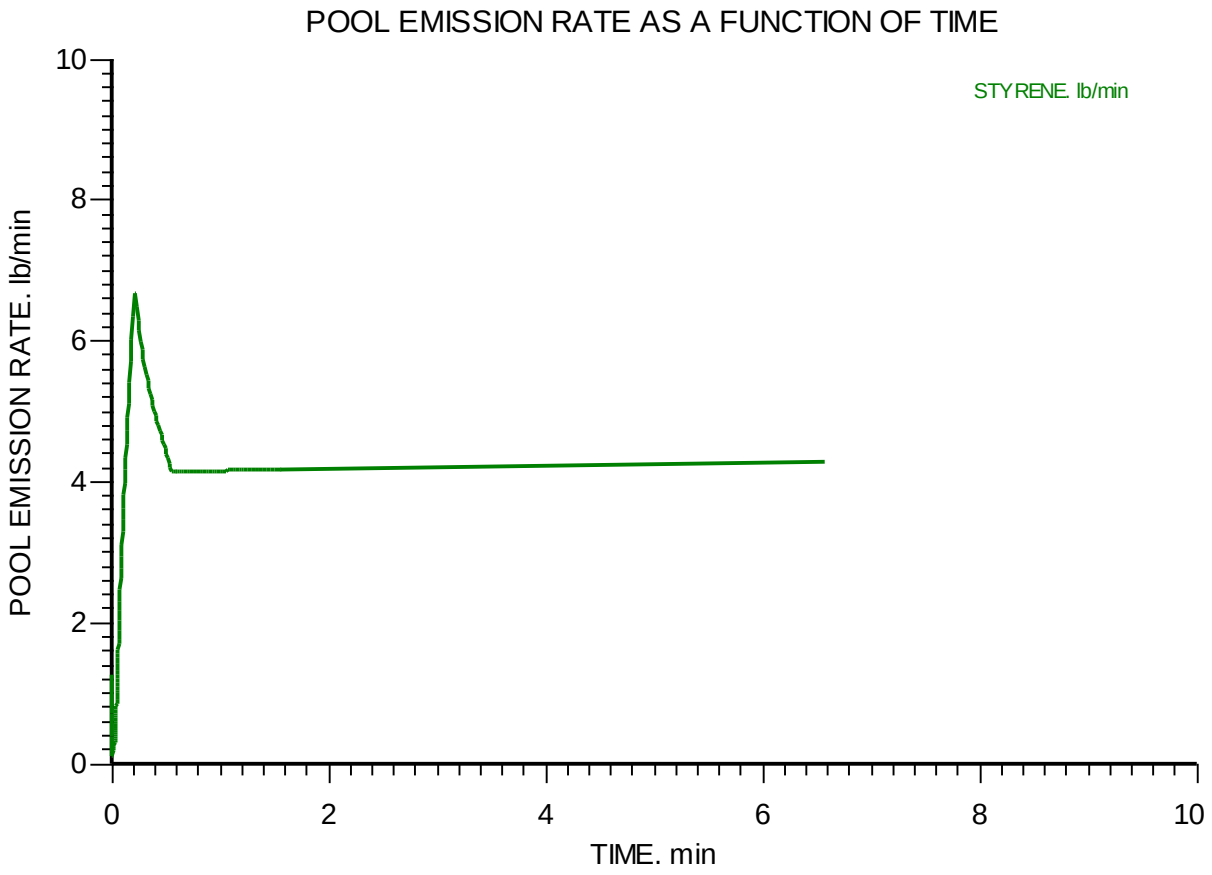


Figure 179: Styrene Evaporation Rate – E-R-14 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

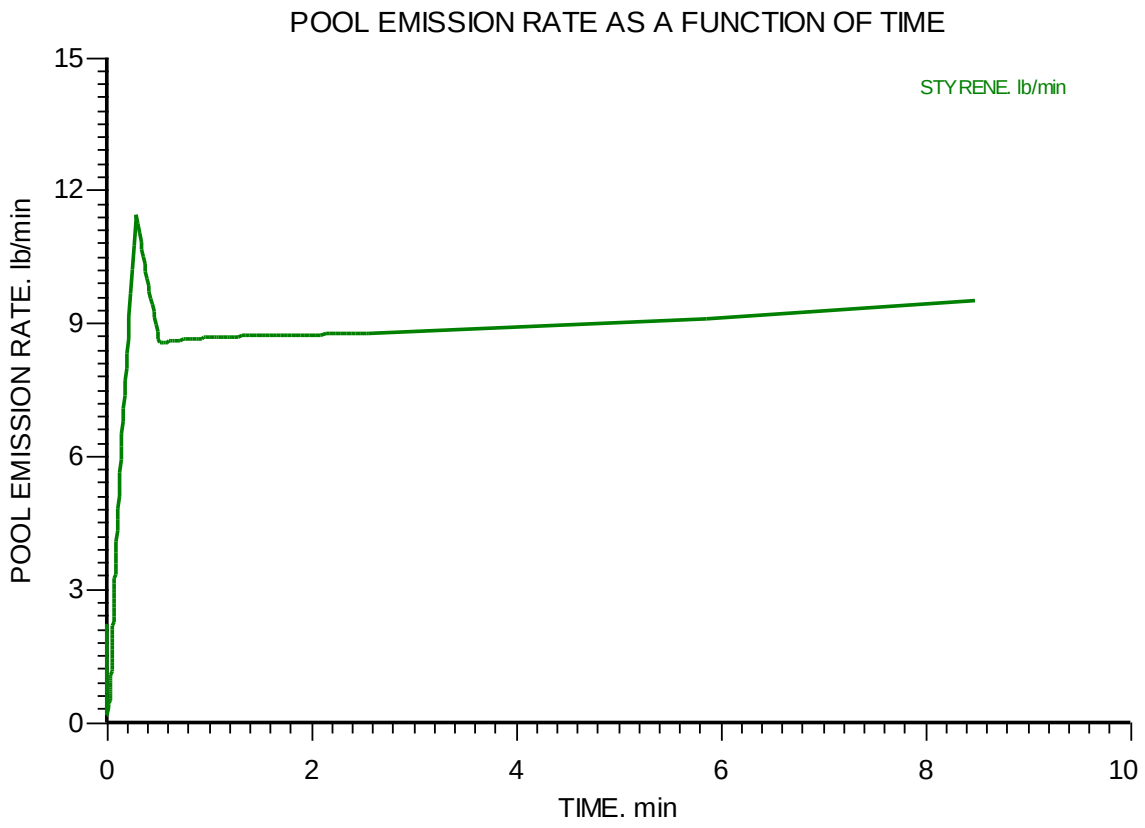
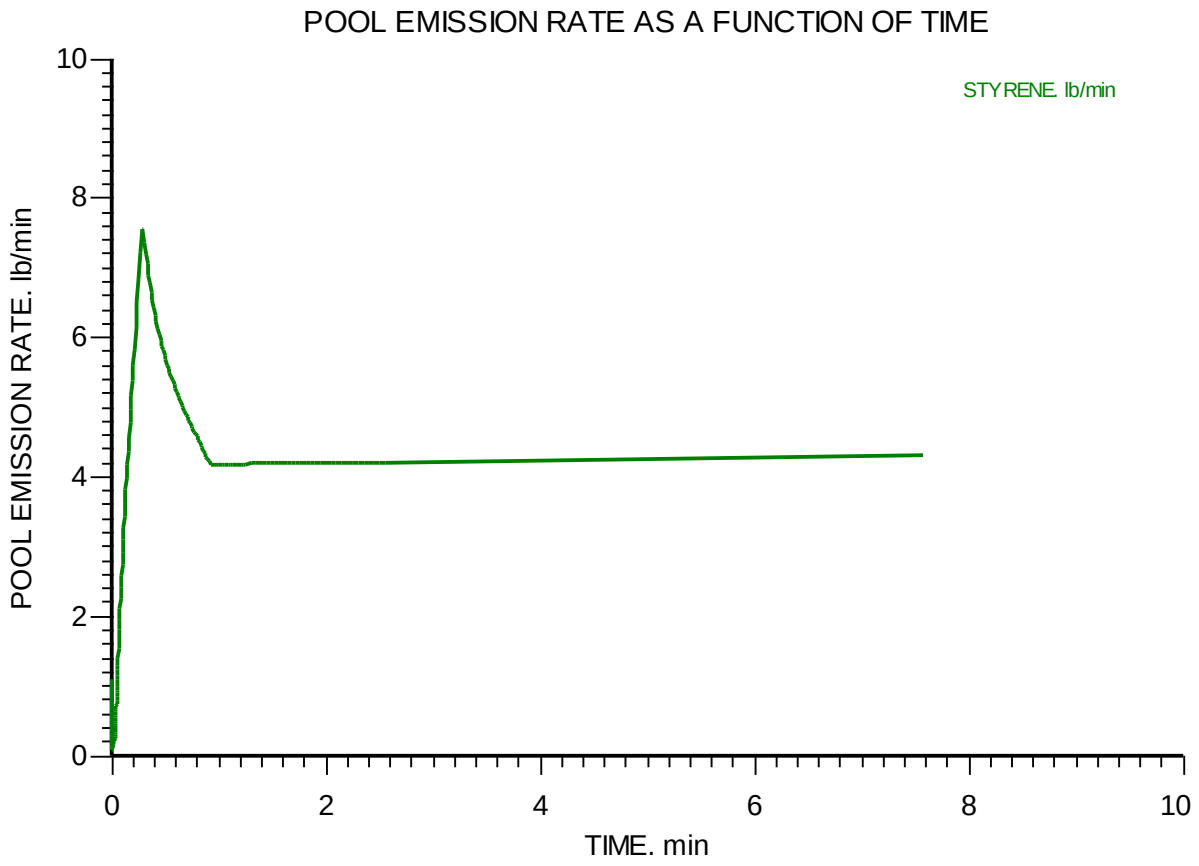


Figure 180: Styrene Evaporation Rate – E-R-14 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix P: Results – E-R-15 Piping Layout to Pit – Styrene Evaporation Rate

Figure 181: Styrene Evaporation Rate – E-R-15 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

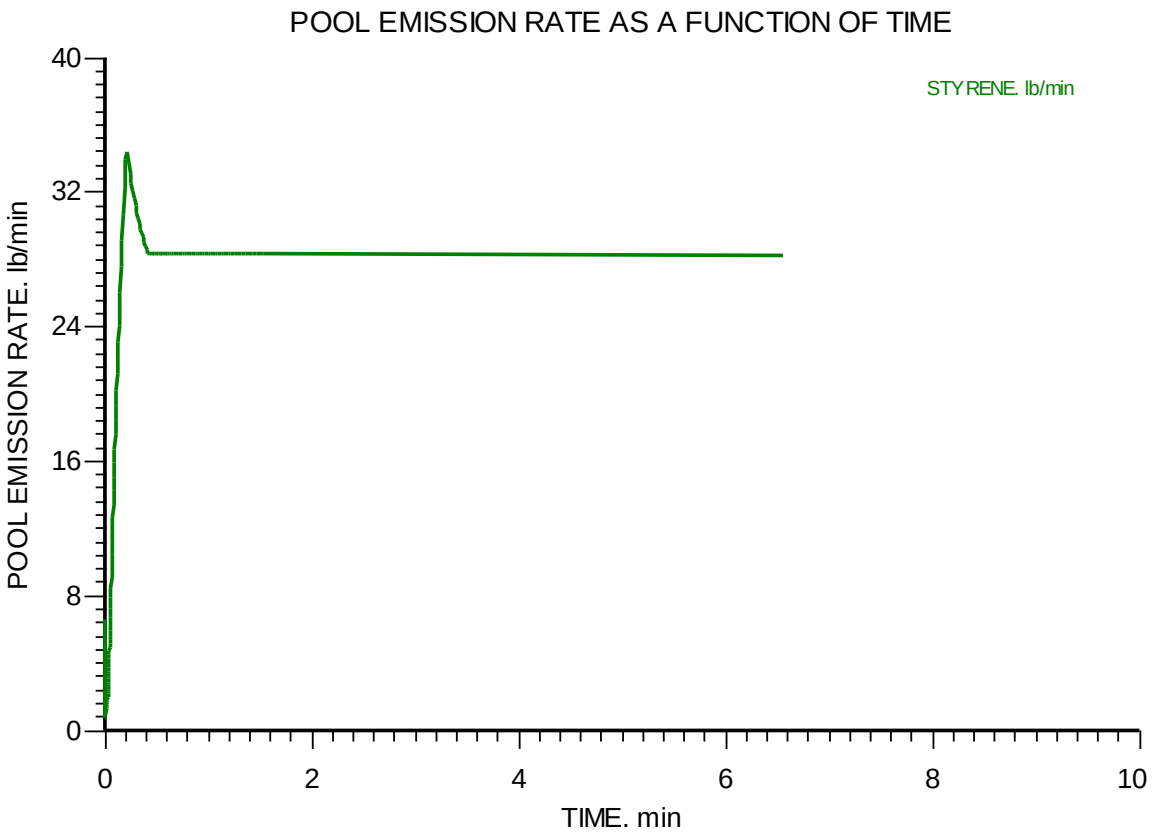


Figure 182: Styrene Evaporation Rate – E-R-15 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

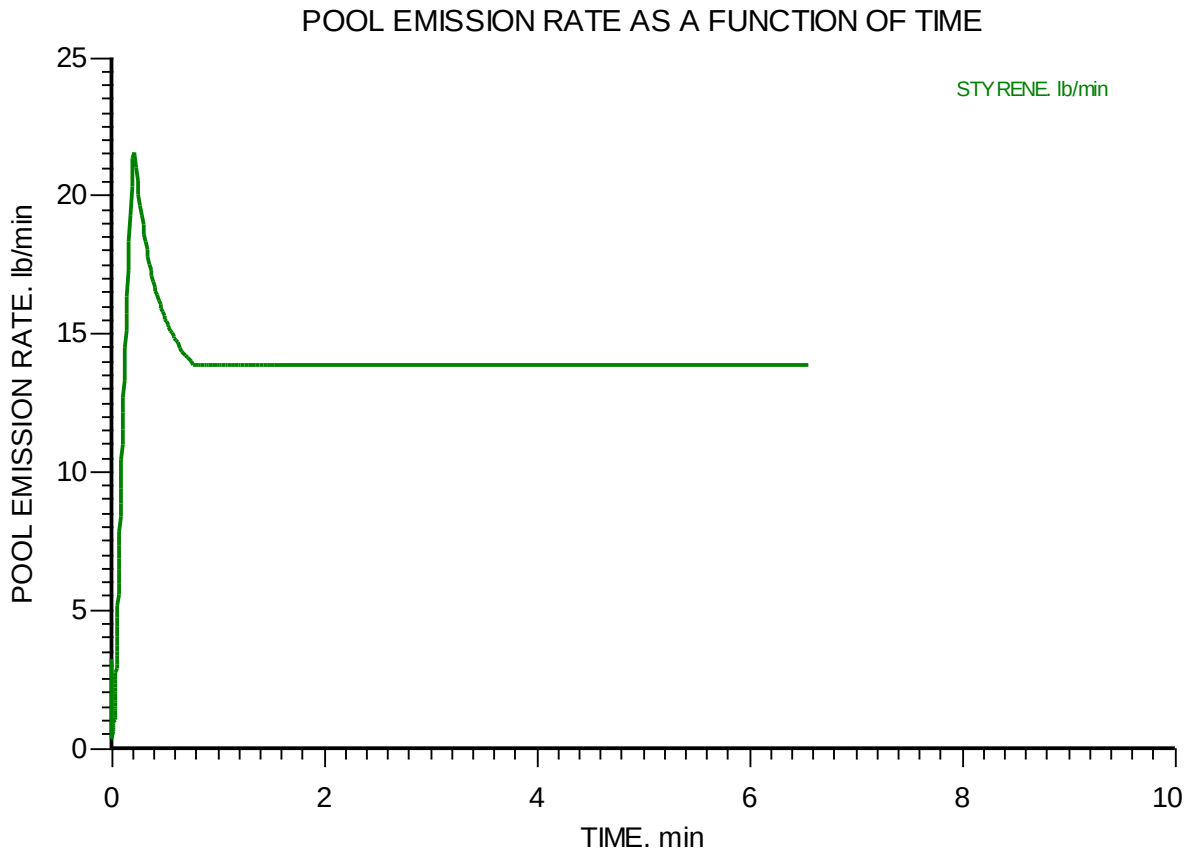


Figure 183: Styrene Evaporation Rate – E-R-15 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

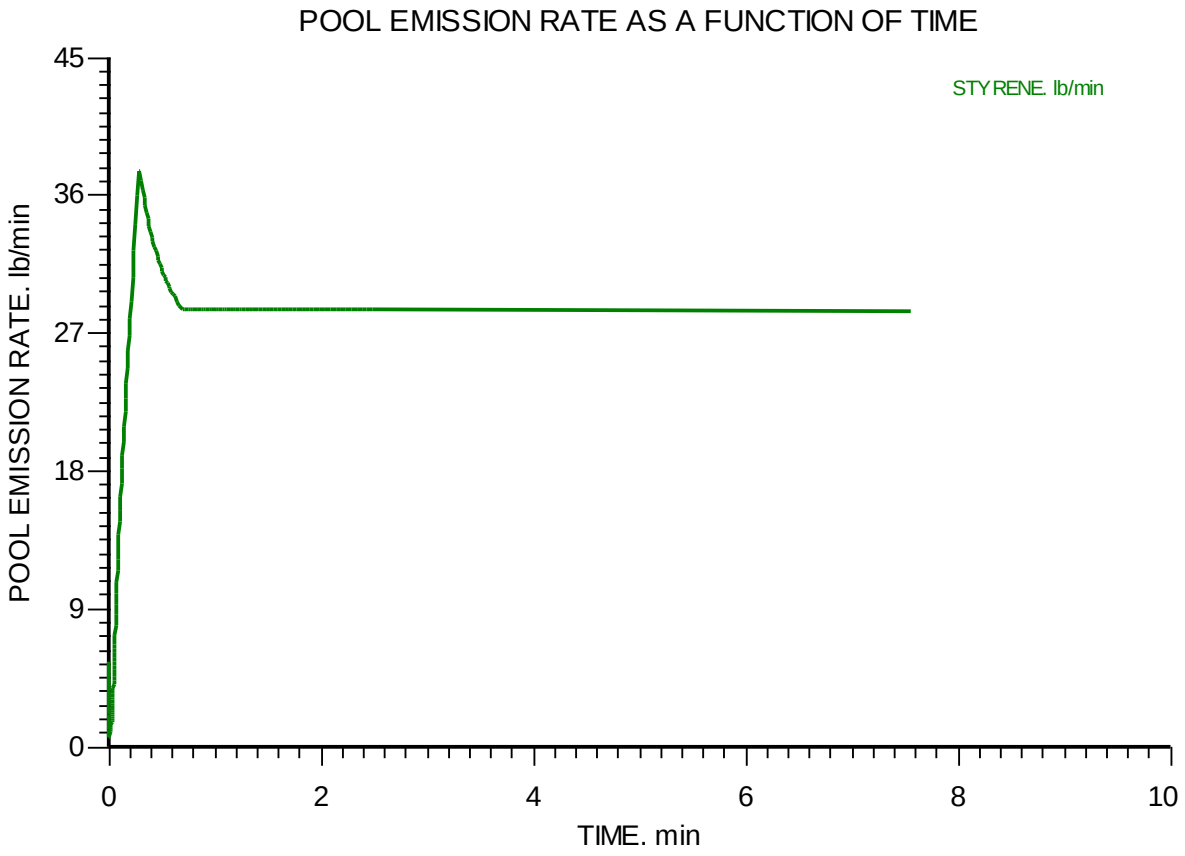


Figure 184: Styrene Evaporation Rate – E-R-15 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

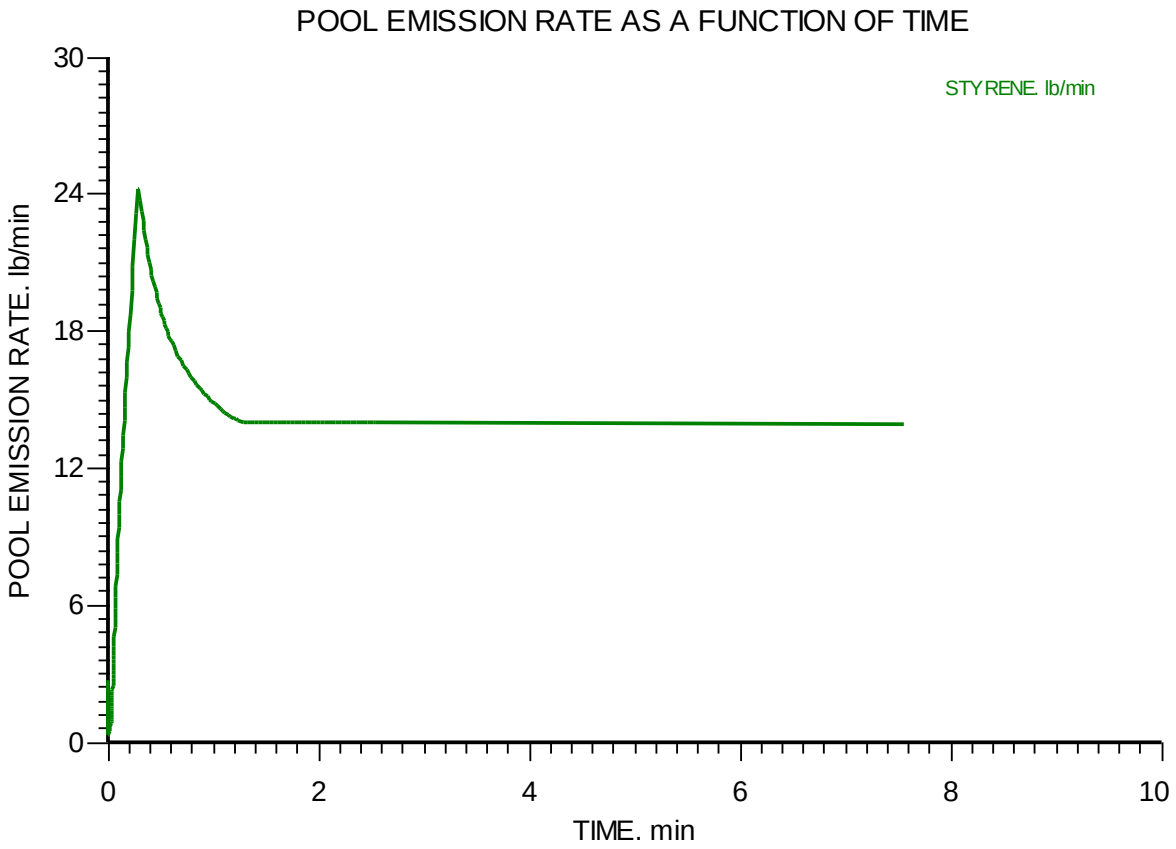


Figure 185: Styrene Evaporation Rate – E-R-15 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

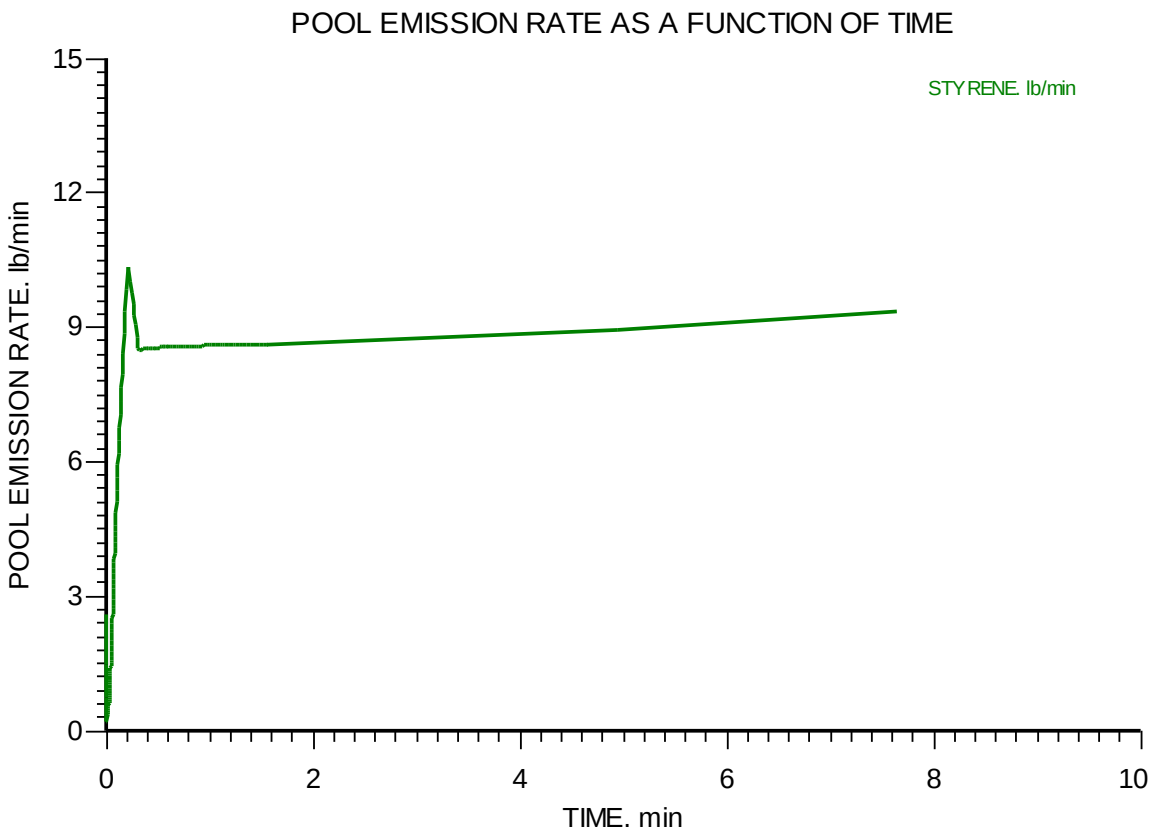


Figure 186: Styrene Evaporation Rate – E-R-15 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

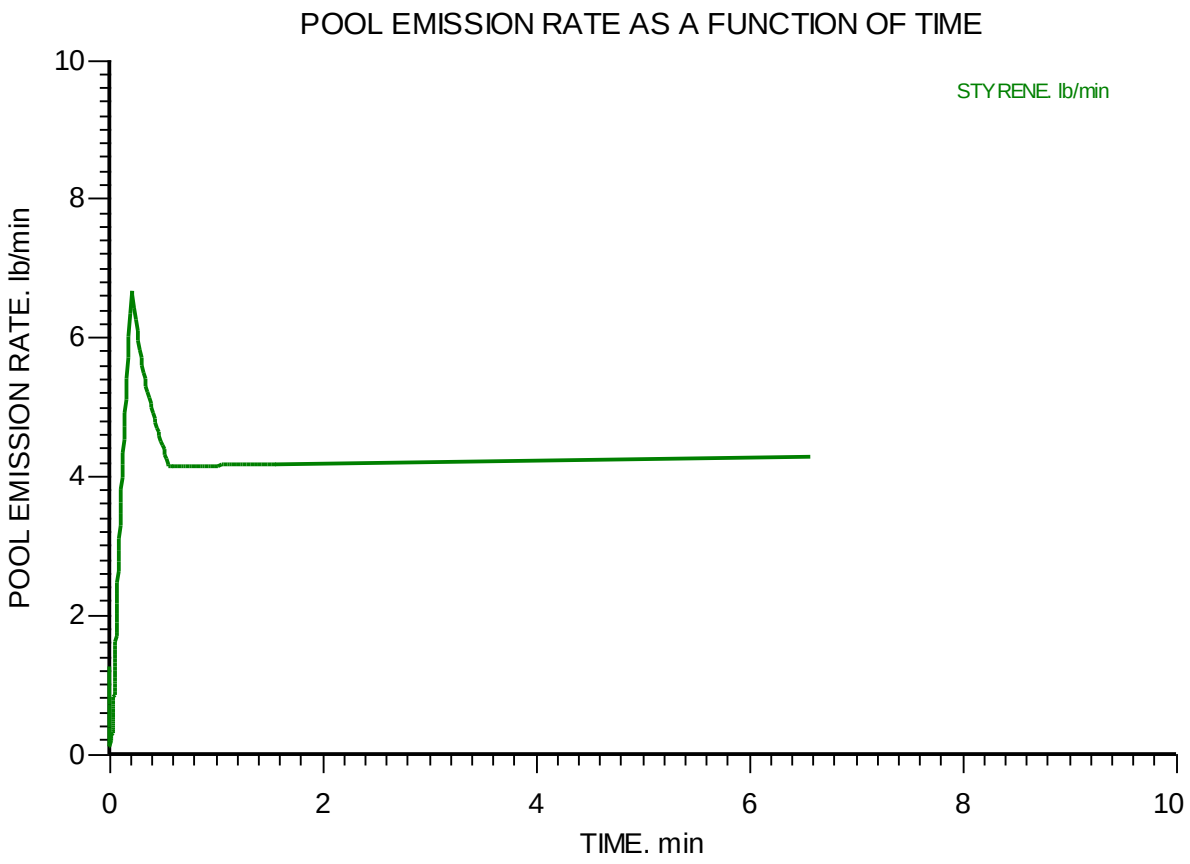


Figure 187: Styrene Evaporation Rate – E-R-15 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

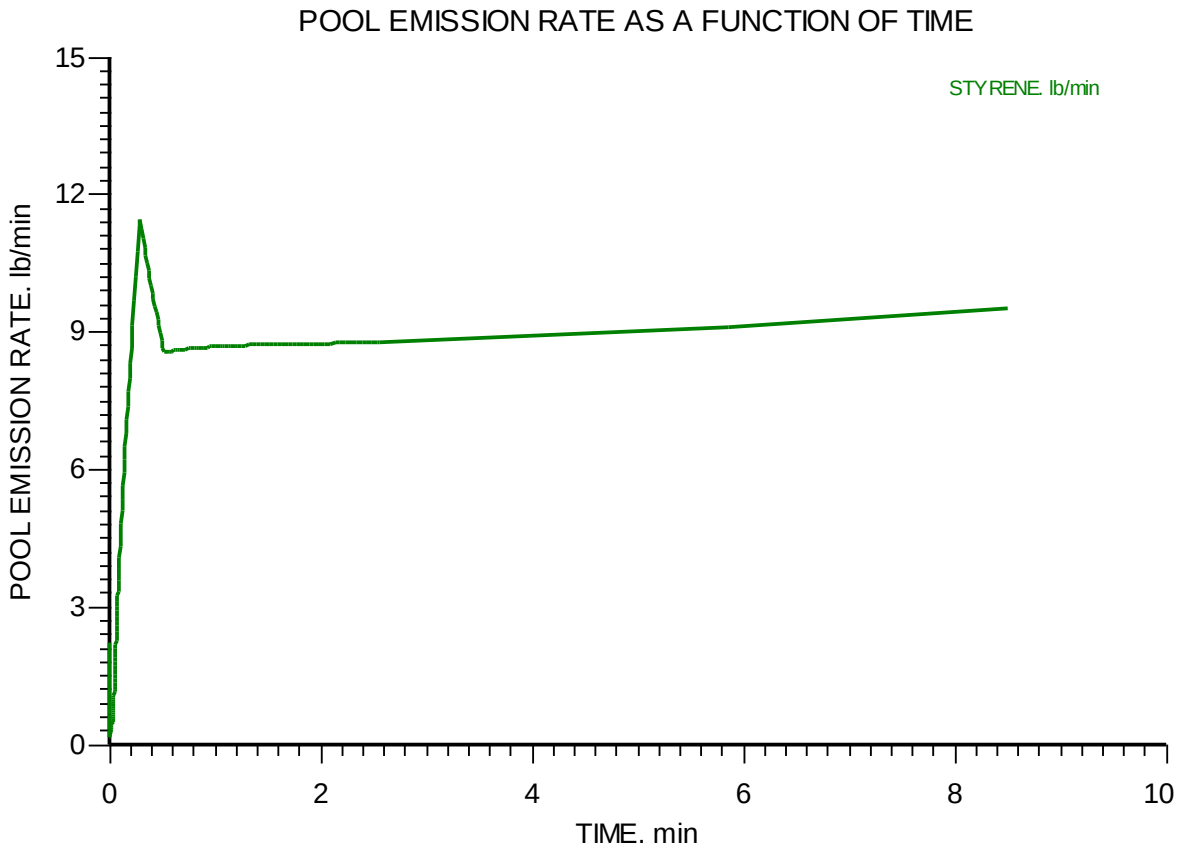
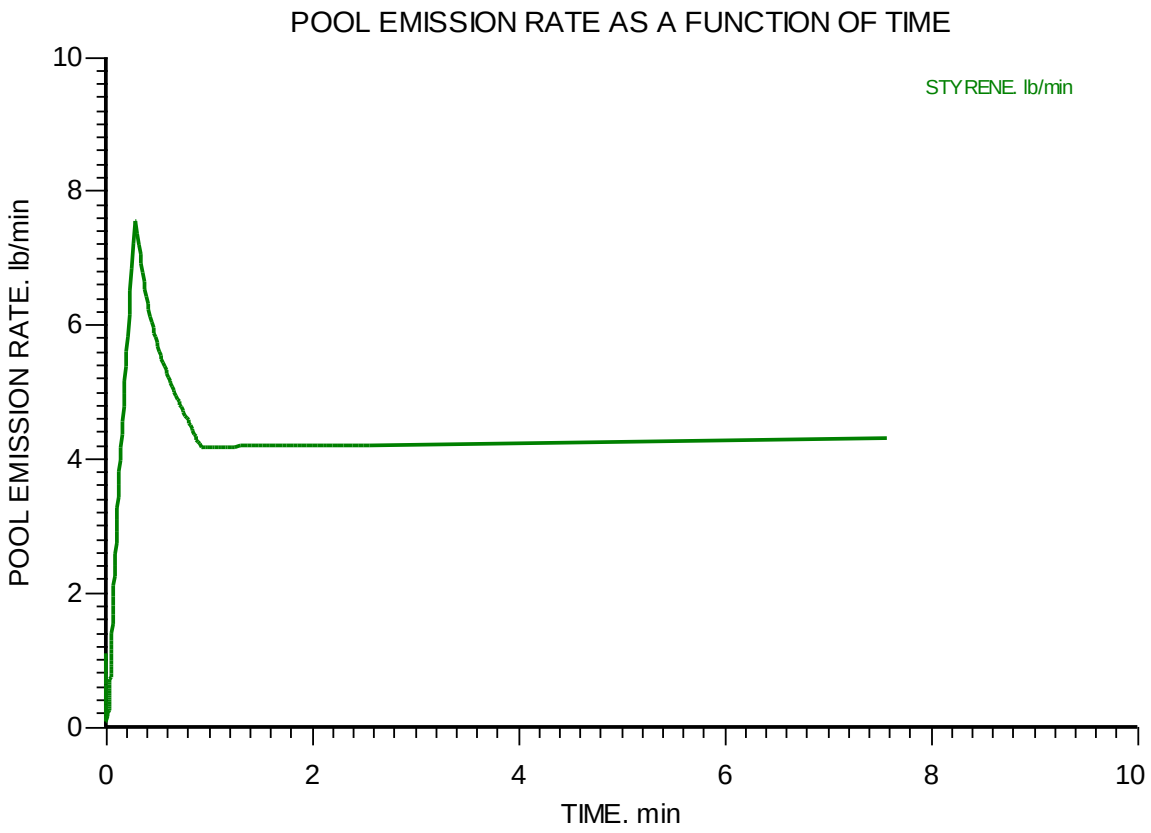


Figure 188: Styrene Evaporation Rate – E-R-15 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix Q: Results – E-R-16 Piping Layout to Pit – Styrene Evaporation Rate

Figure 189: Styrene Evaporation Rate – E-R-16 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

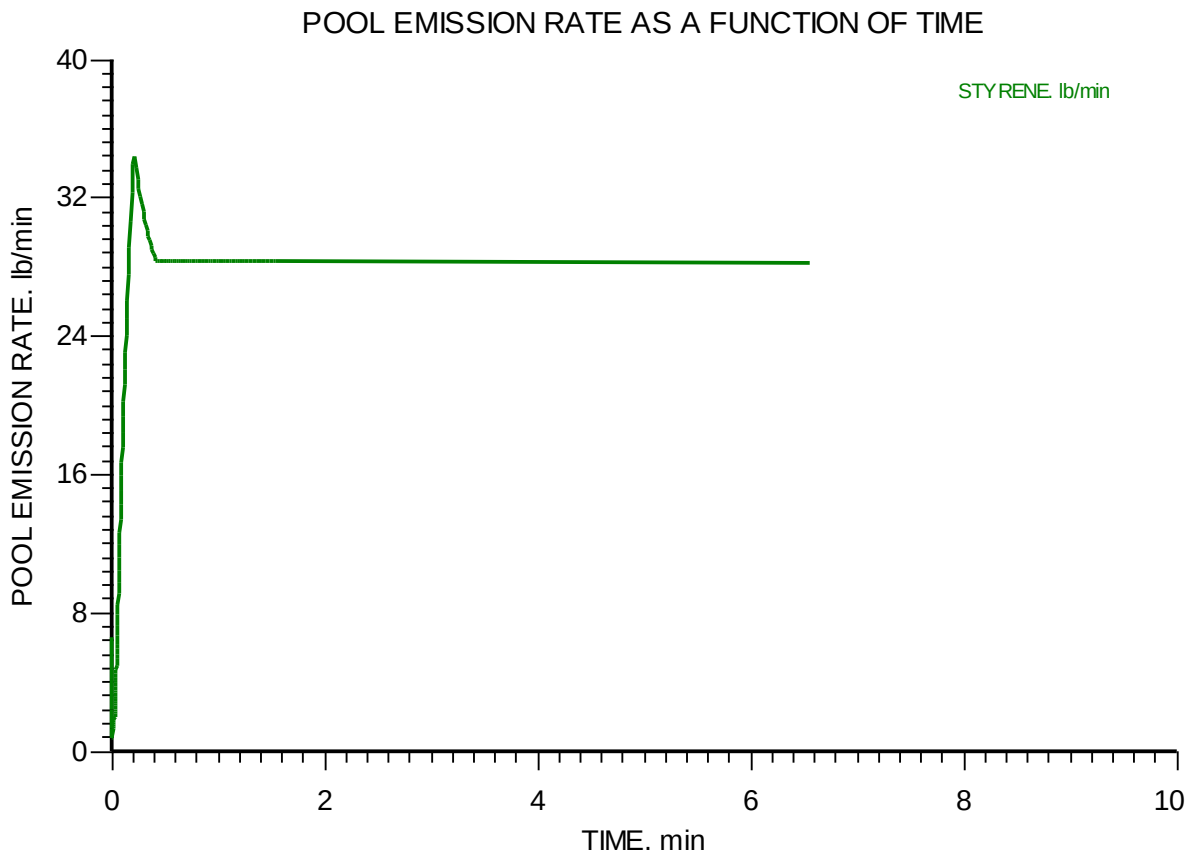


Figure 190: Styrene Evaporation Rate – E-R-16 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

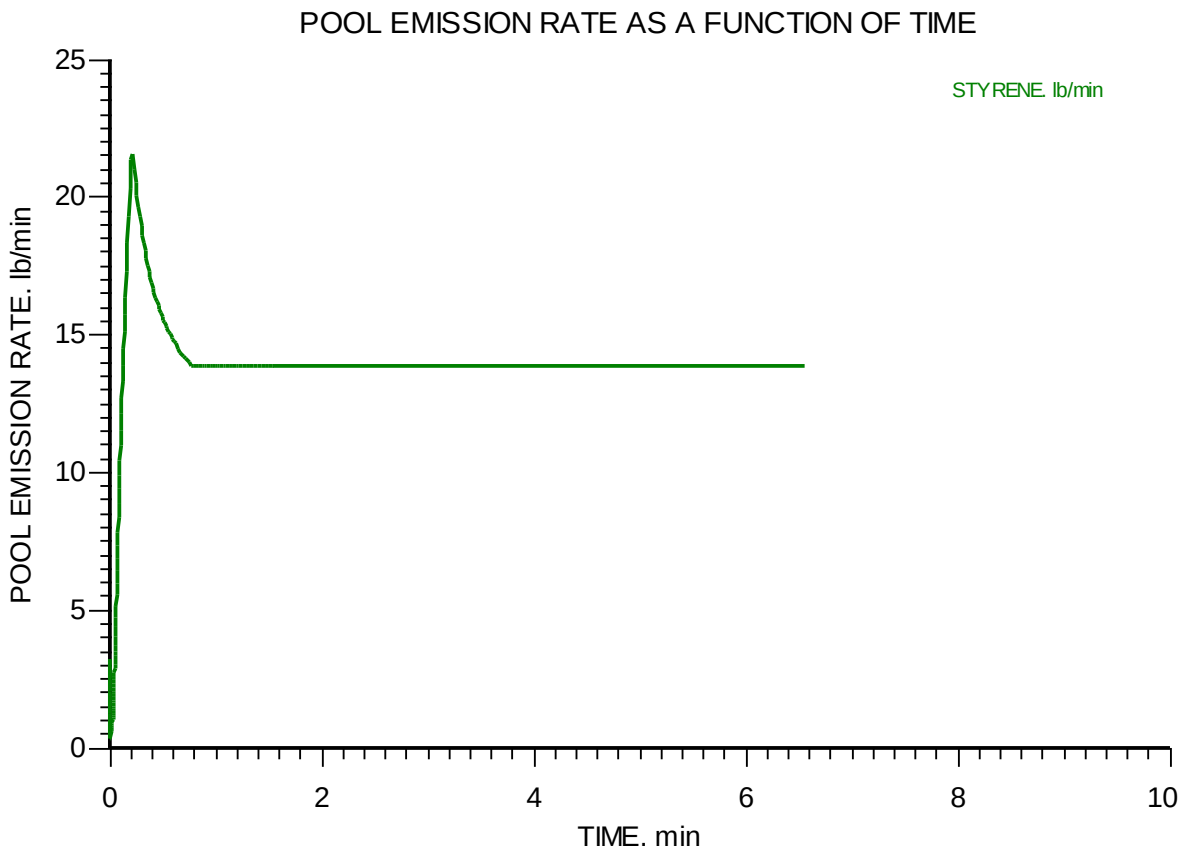


Figure 191: Styrene Evaporation Rate – E-R-16 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

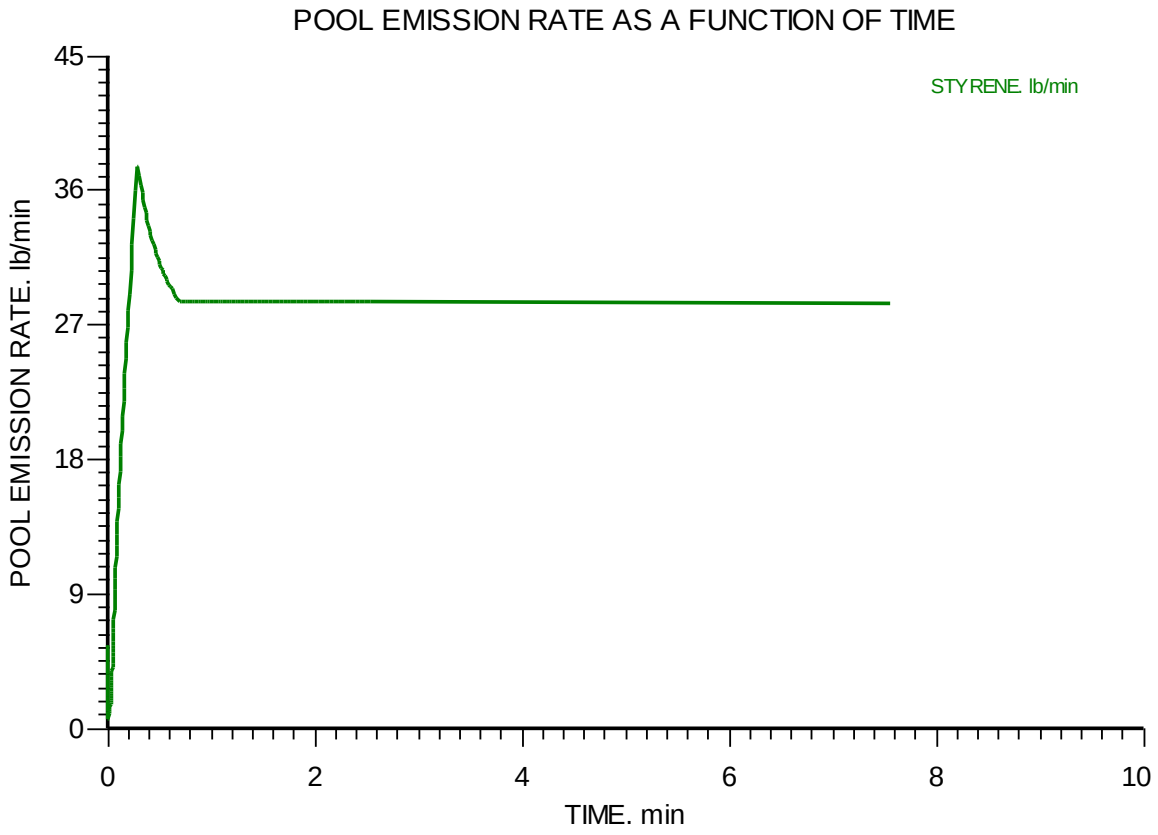


Figure 192: Styrene Evaporation Rate – E-R-16 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

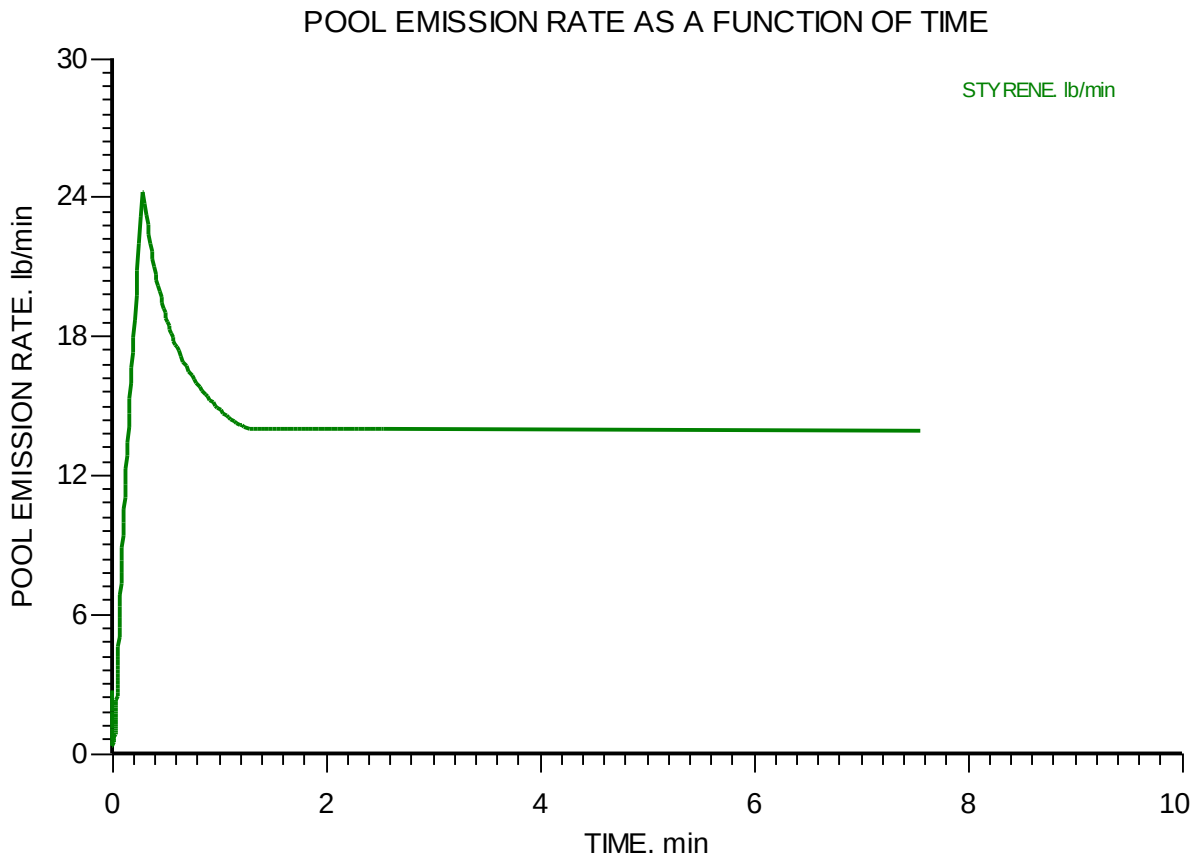


Figure 193: Styrene Evaporation Rate – E-R-16 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

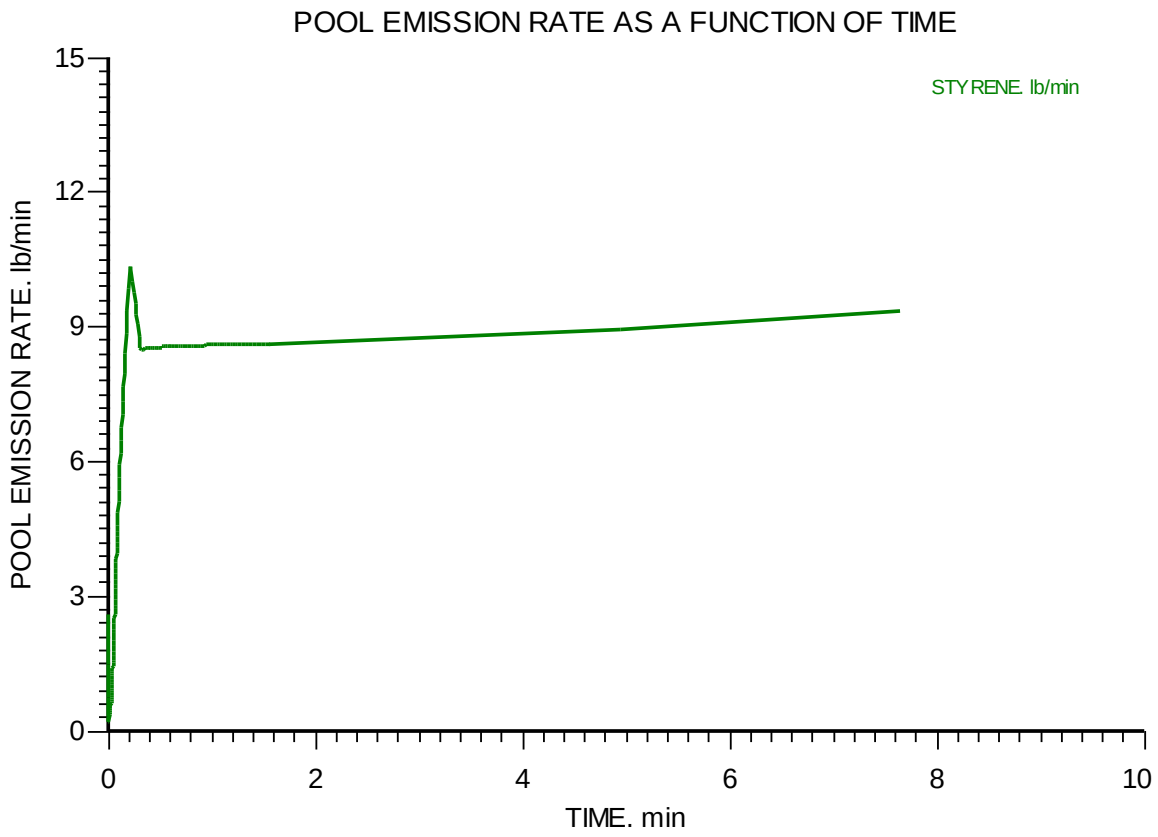


Figure 194: Styrene Evaporation Rate – E-R-16 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

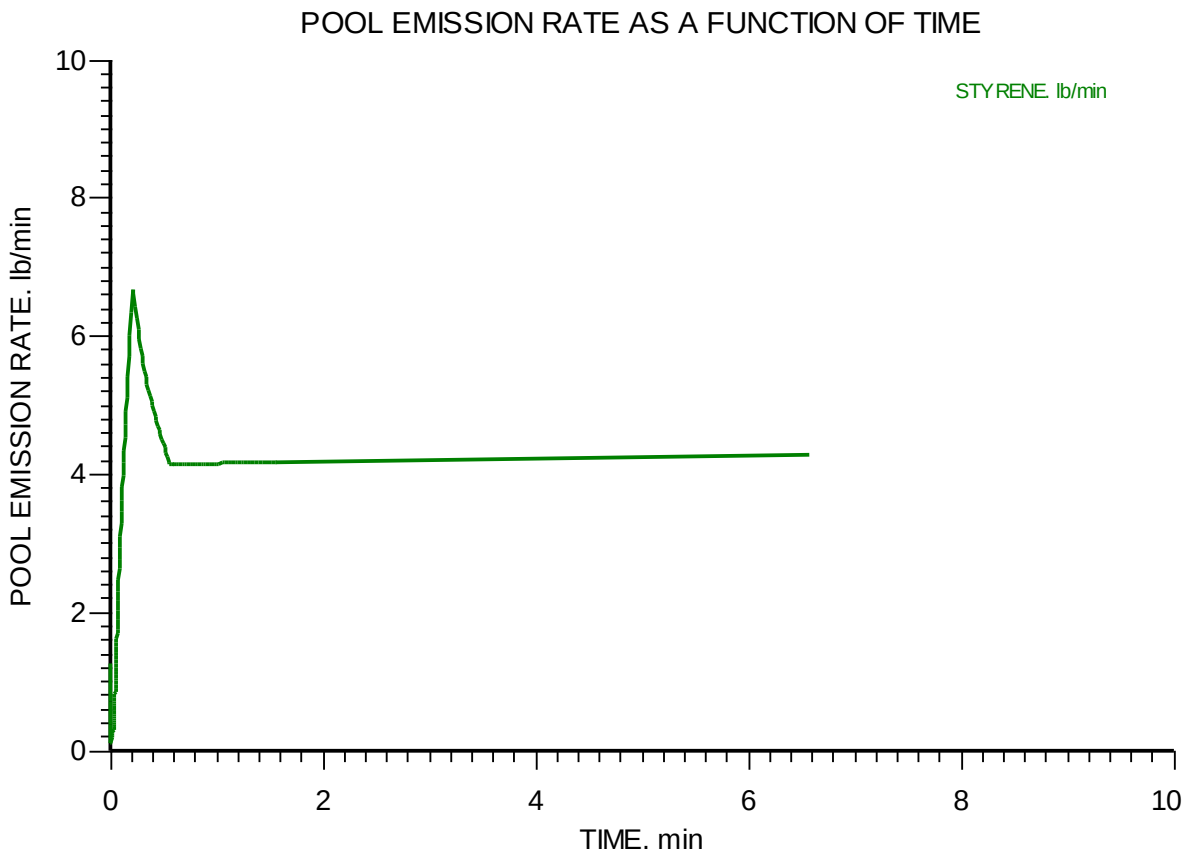


Figure 195: Styrene Evaporation Rate – E-R-16 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

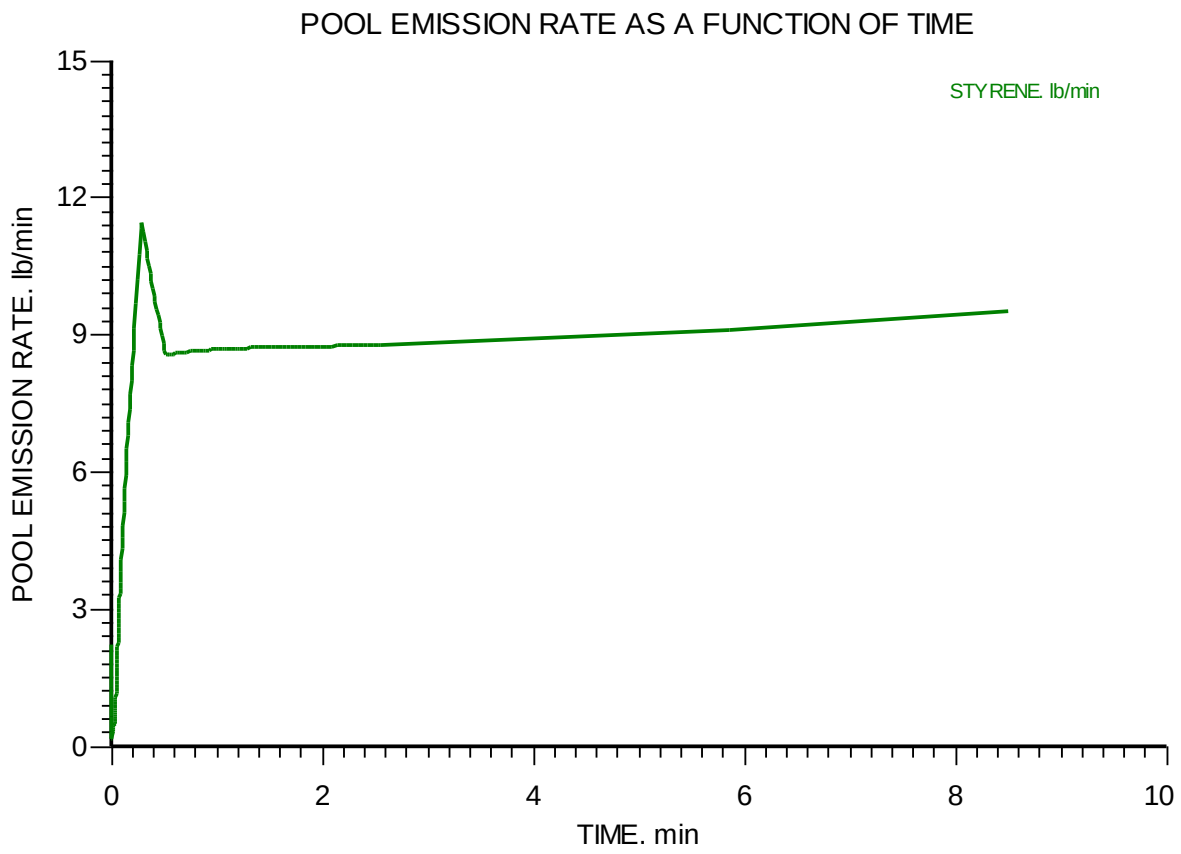
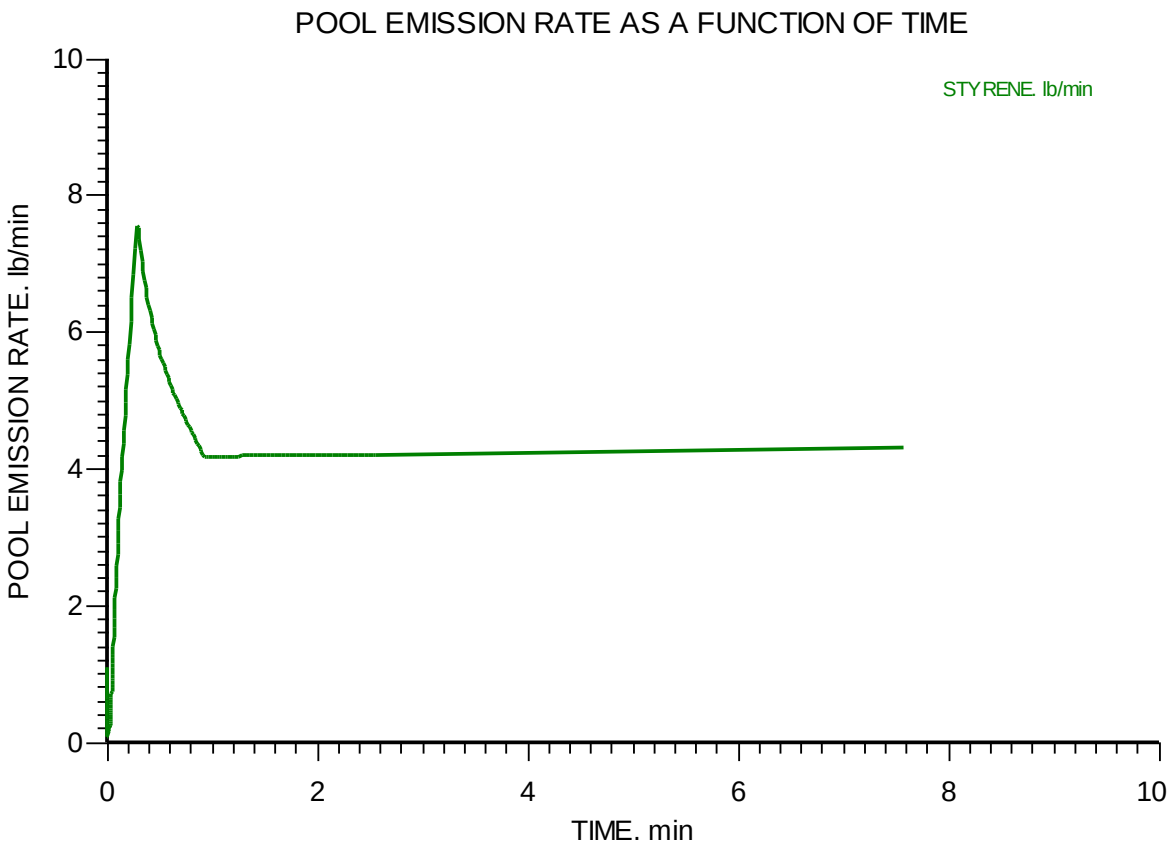


Figure 196: Styrene Evaporation Rate – E-R-16 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix R: Results – E-R-17 Piping Layout to Pit – Styrene Evaporation Rate

Figure 197: Styrene Evaporation Rate – E-R-17 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

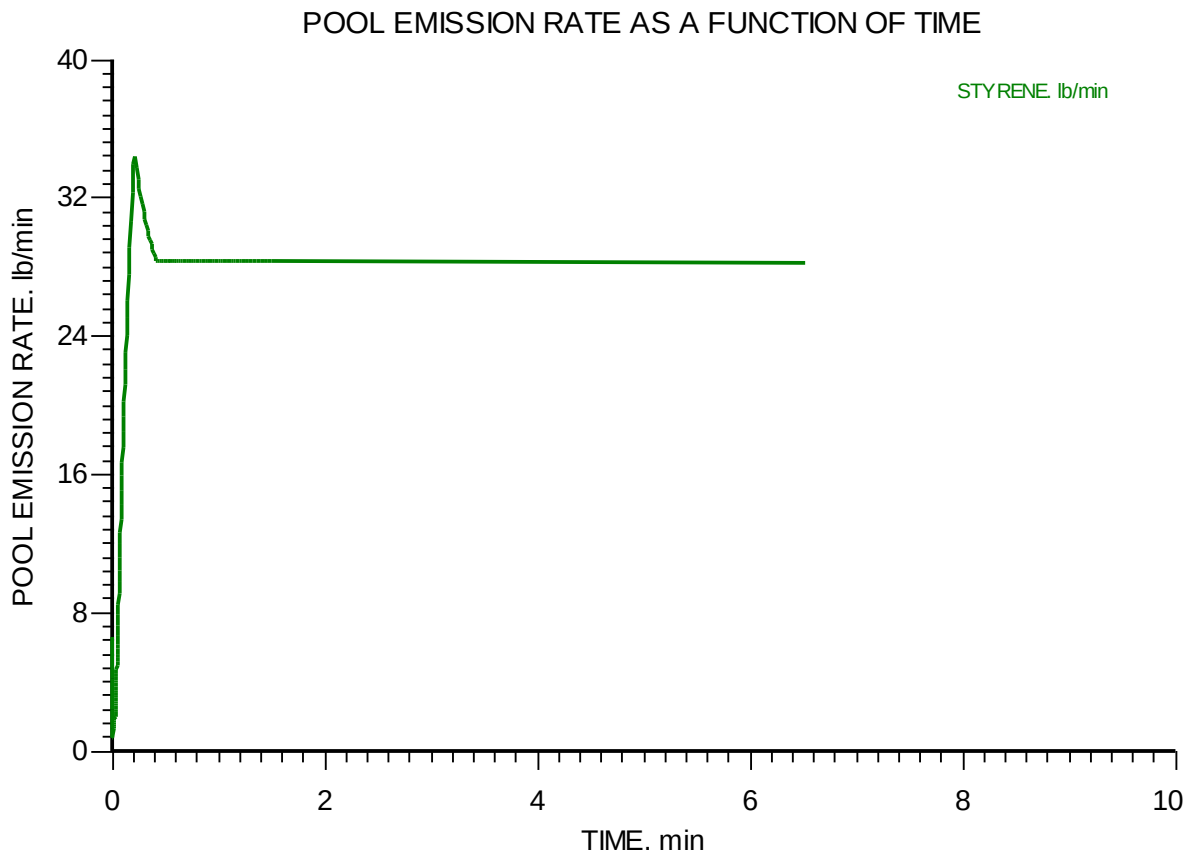


Figure 198: Styrene Evaporation Rate – E-R-17 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

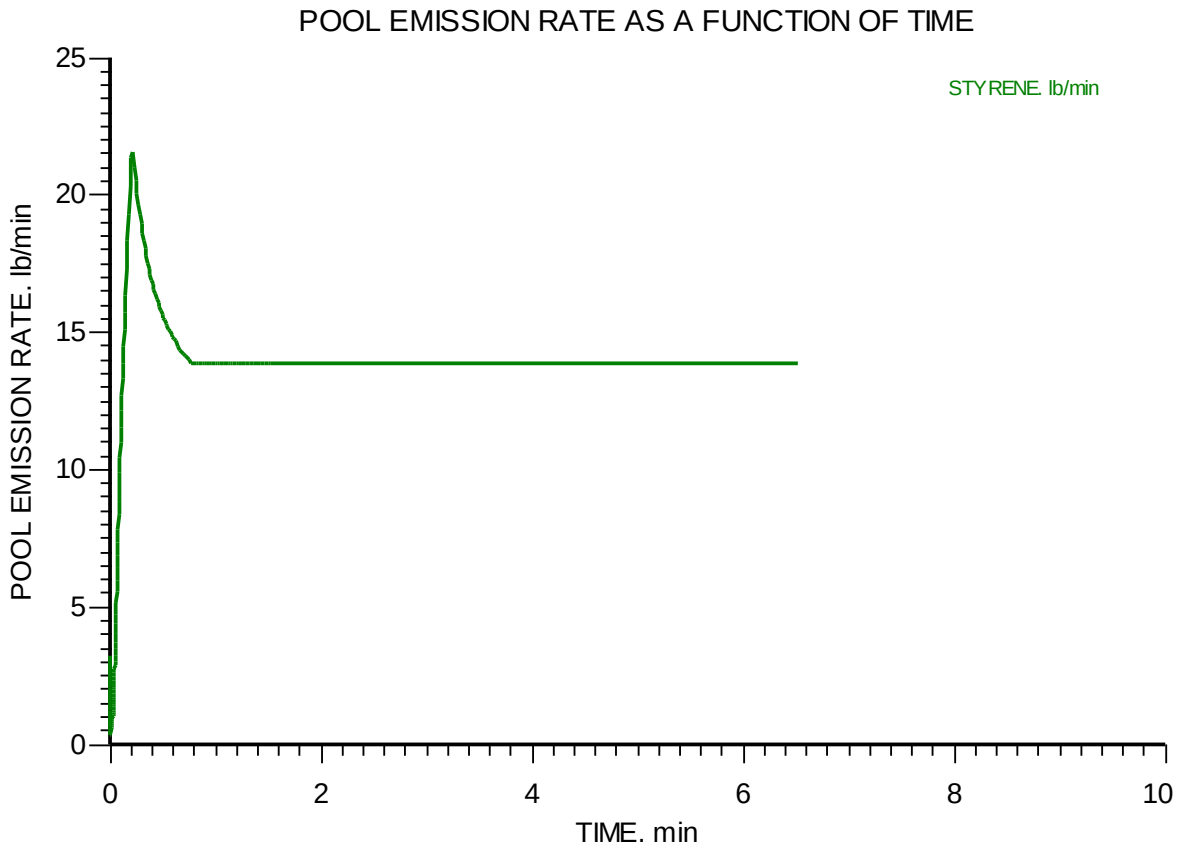


Figure 199: Styrene Evaporation Rate – E-R-17 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

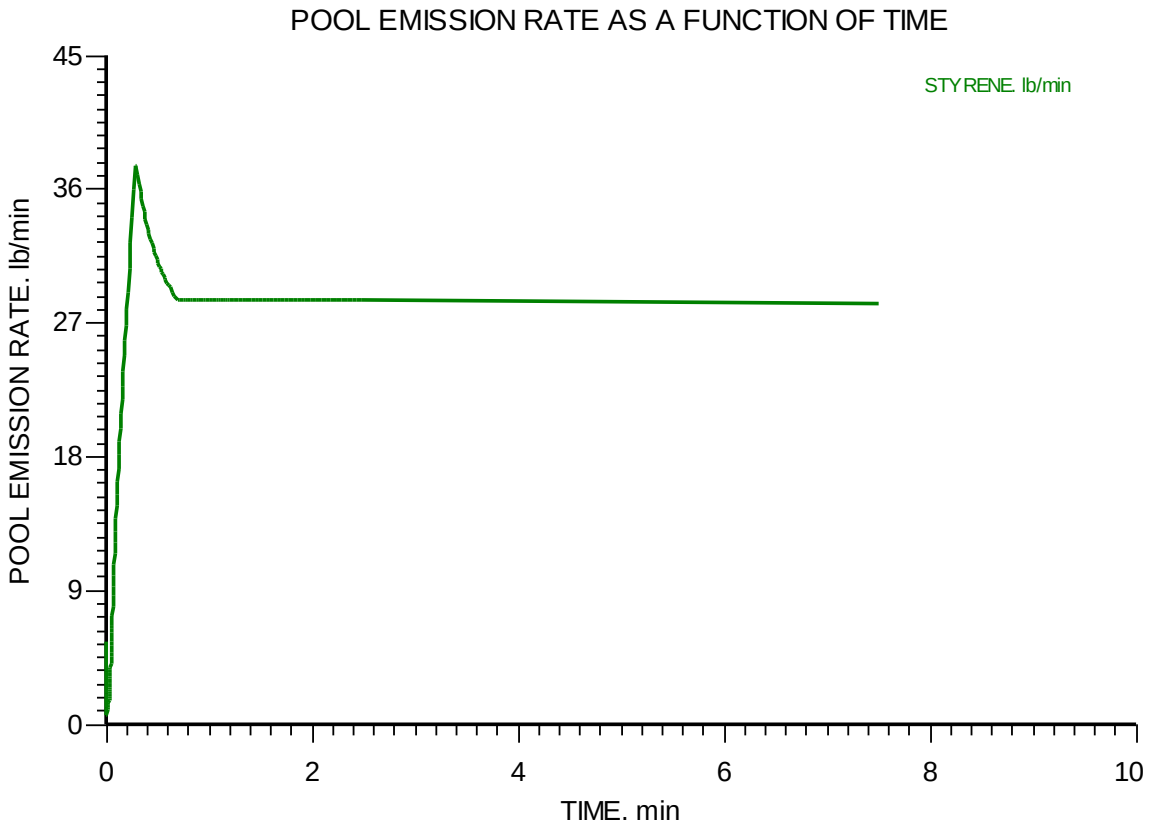


Figure 200: Styrene Evaporation Rate – E-R-17 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

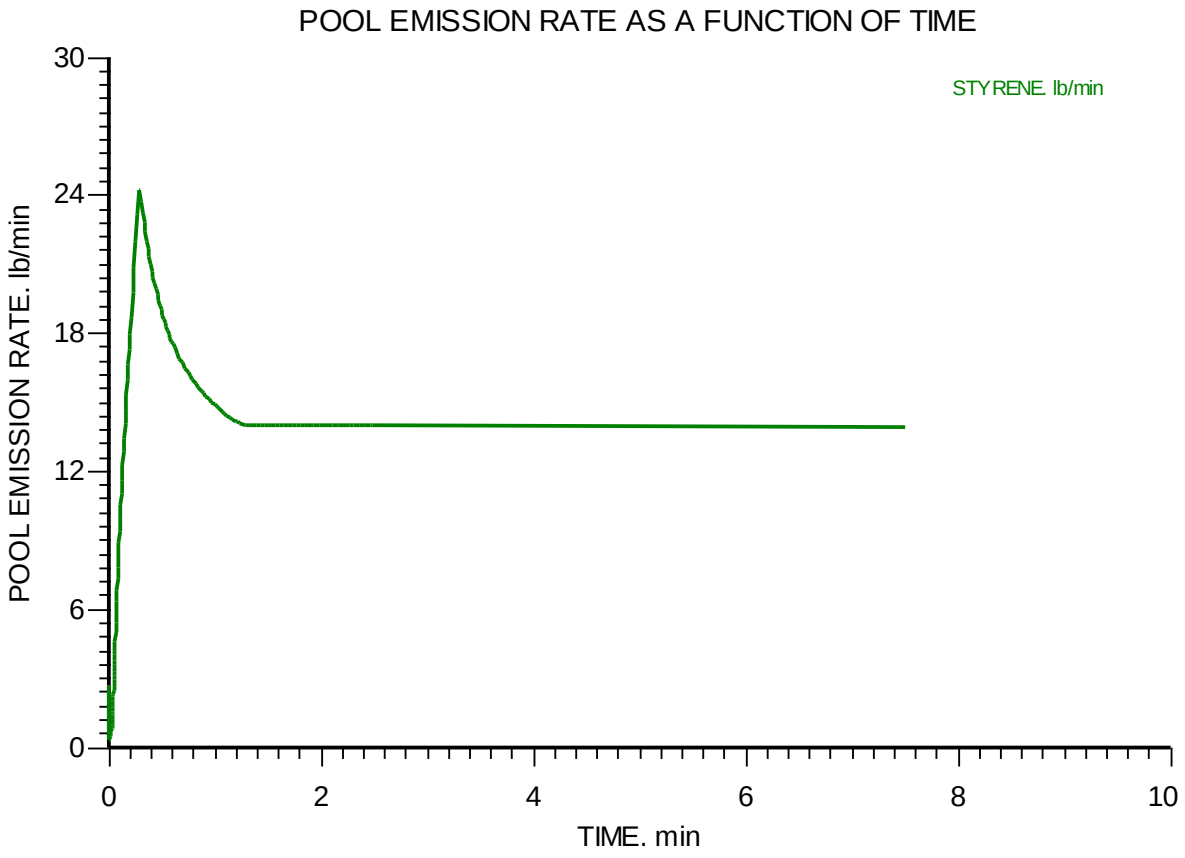


Figure 201: Styrene Evaporation Rate – E-R-17 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

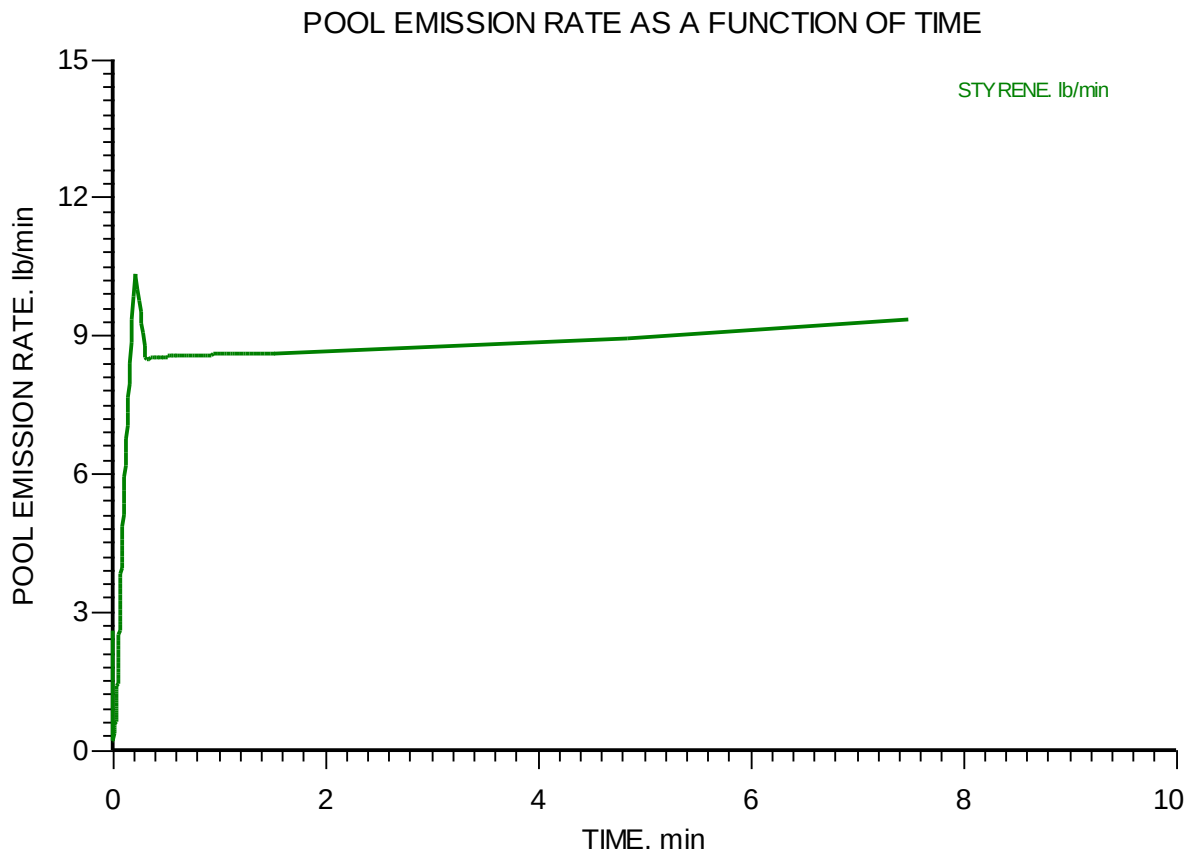


Figure 202: Styrene Evaporation Rate – E-R-17 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

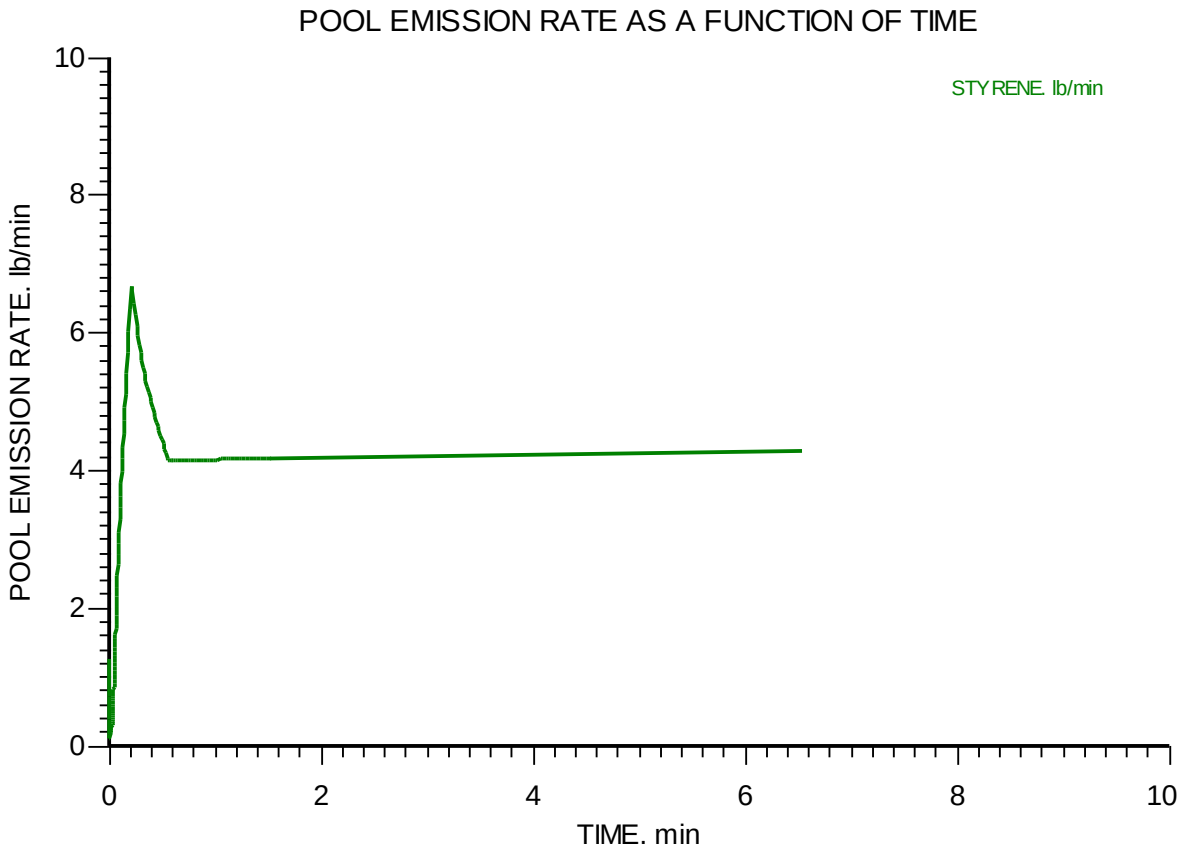


Figure 203: Styrene Evaporation Rate – E-R-17 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

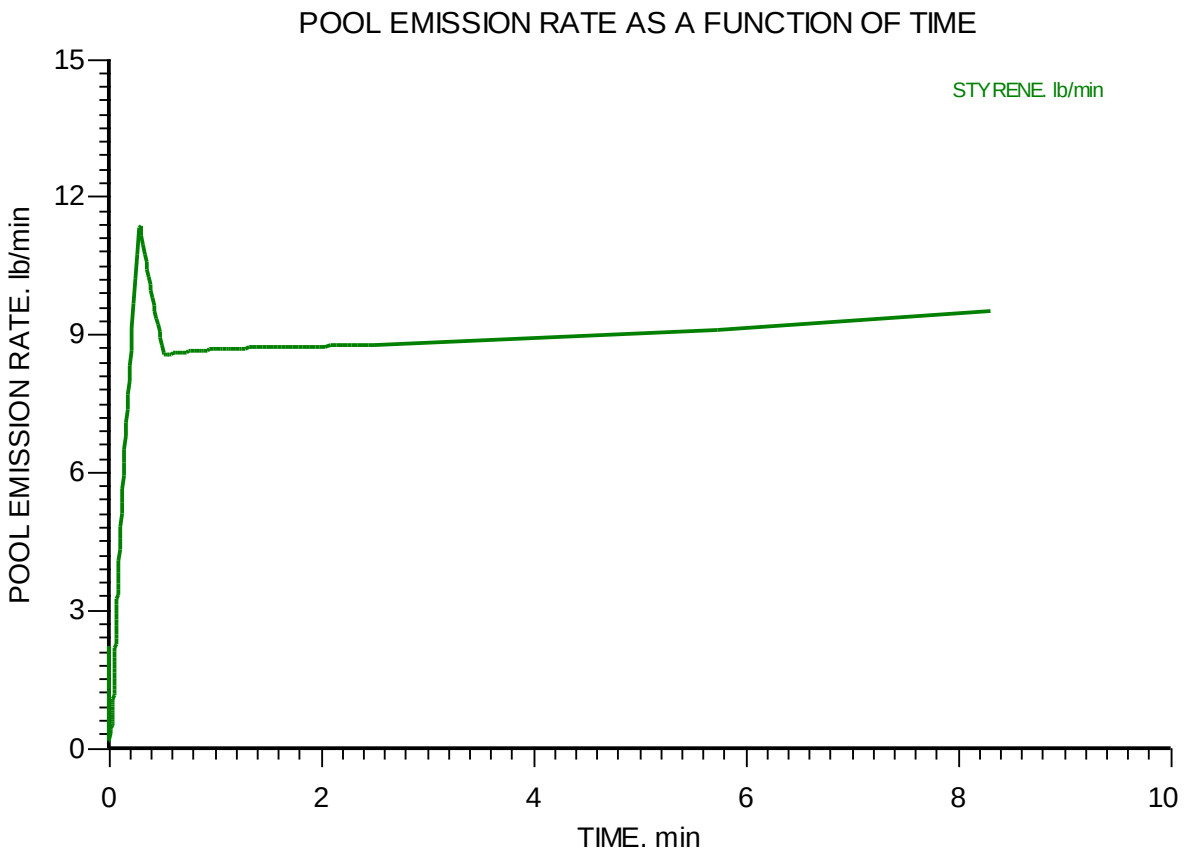
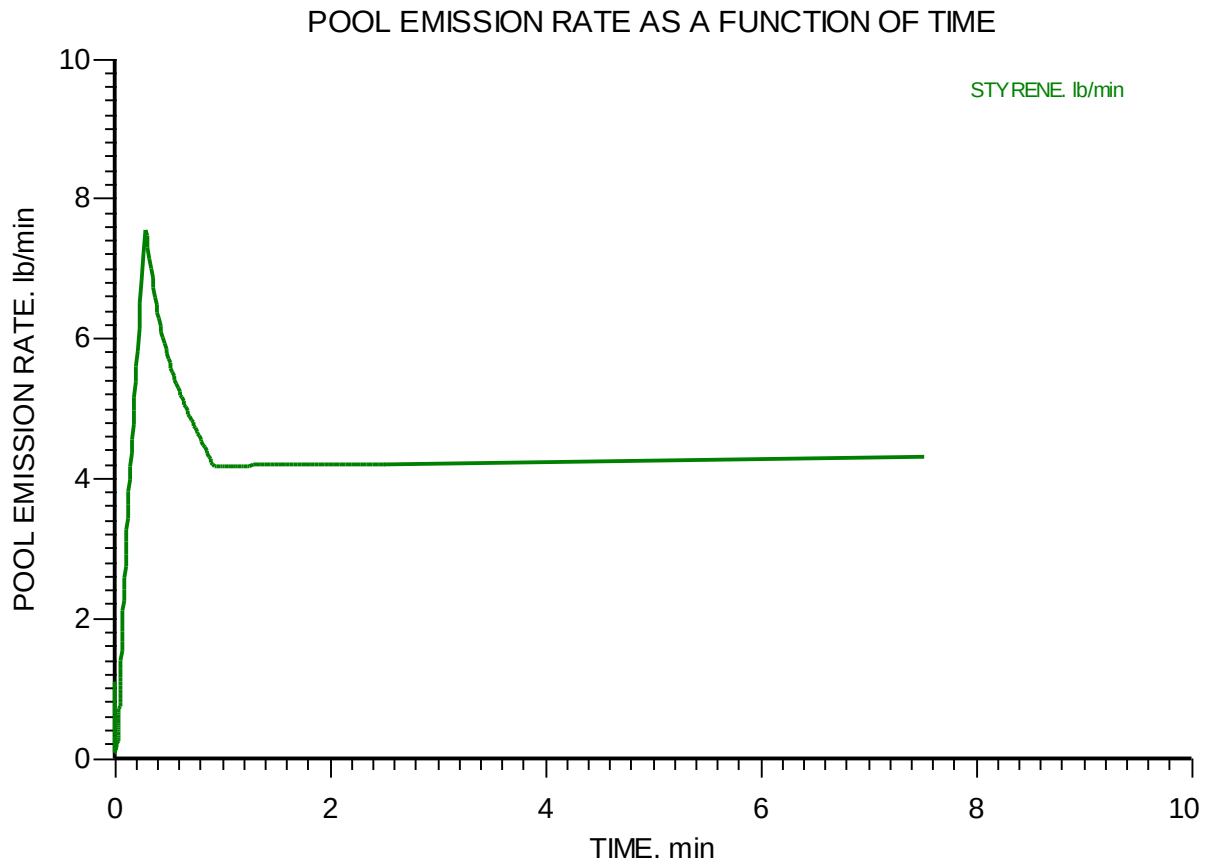


Figure 204: Styrene Evaporation Rate – E-R-17 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix S: Results – E-R-18 Piping Layout to Pit – Styrene Evaporation Rate

Figure 205: Styrene Evaporation Rate – E-R-18 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

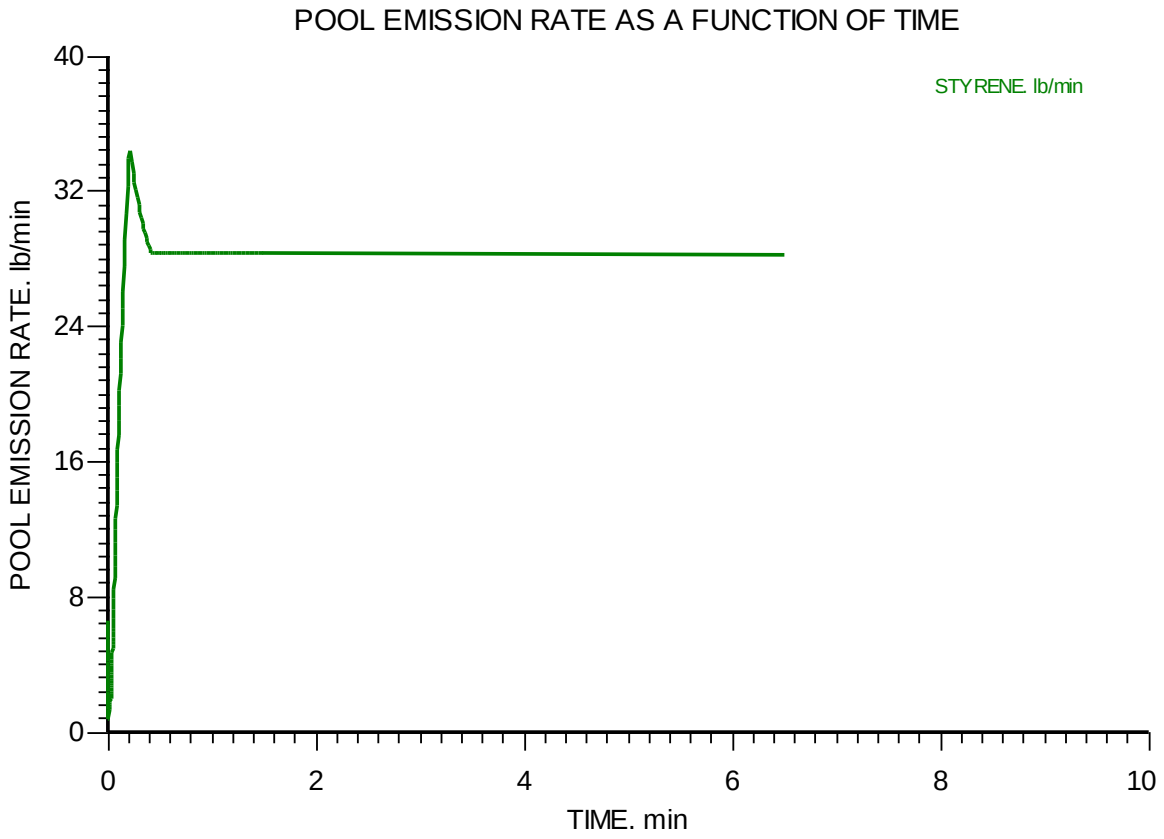


Figure 206: Styrene Evaporation Rate – E-R-18 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

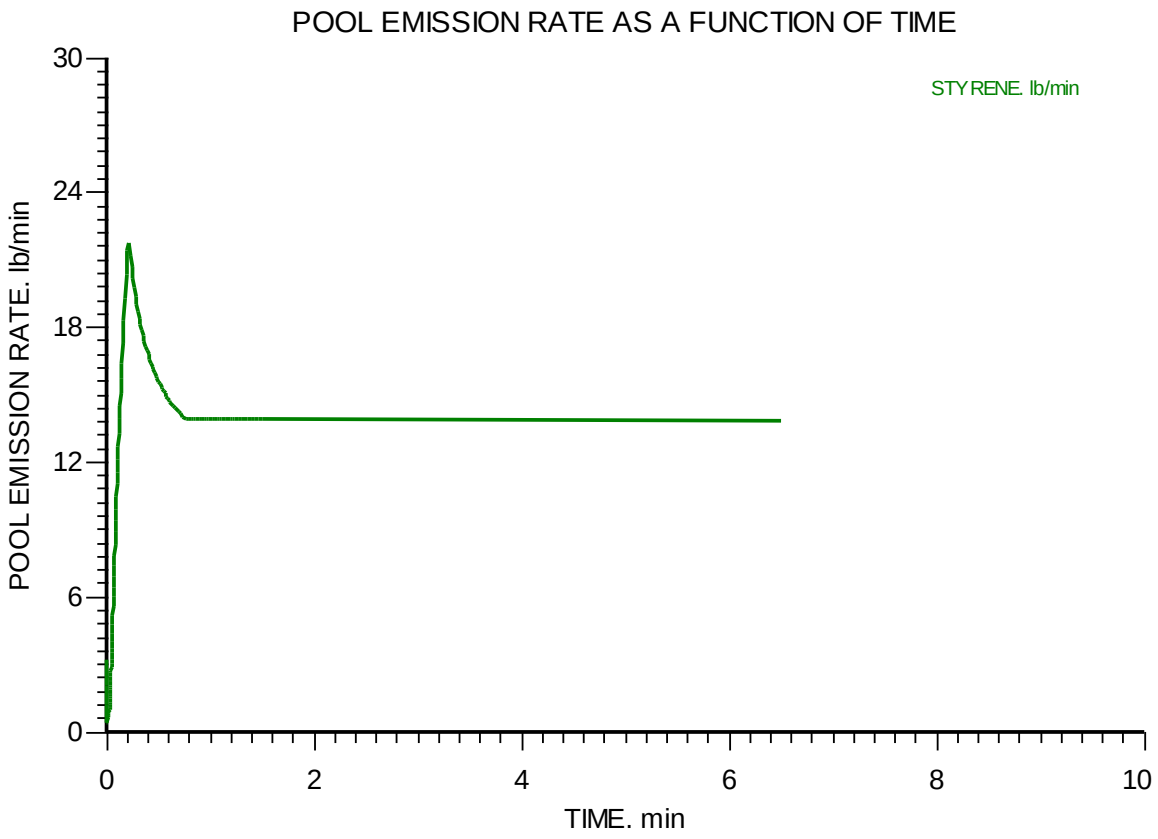


Figure 207: Styrene Evaporation Rate – E-R-18 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

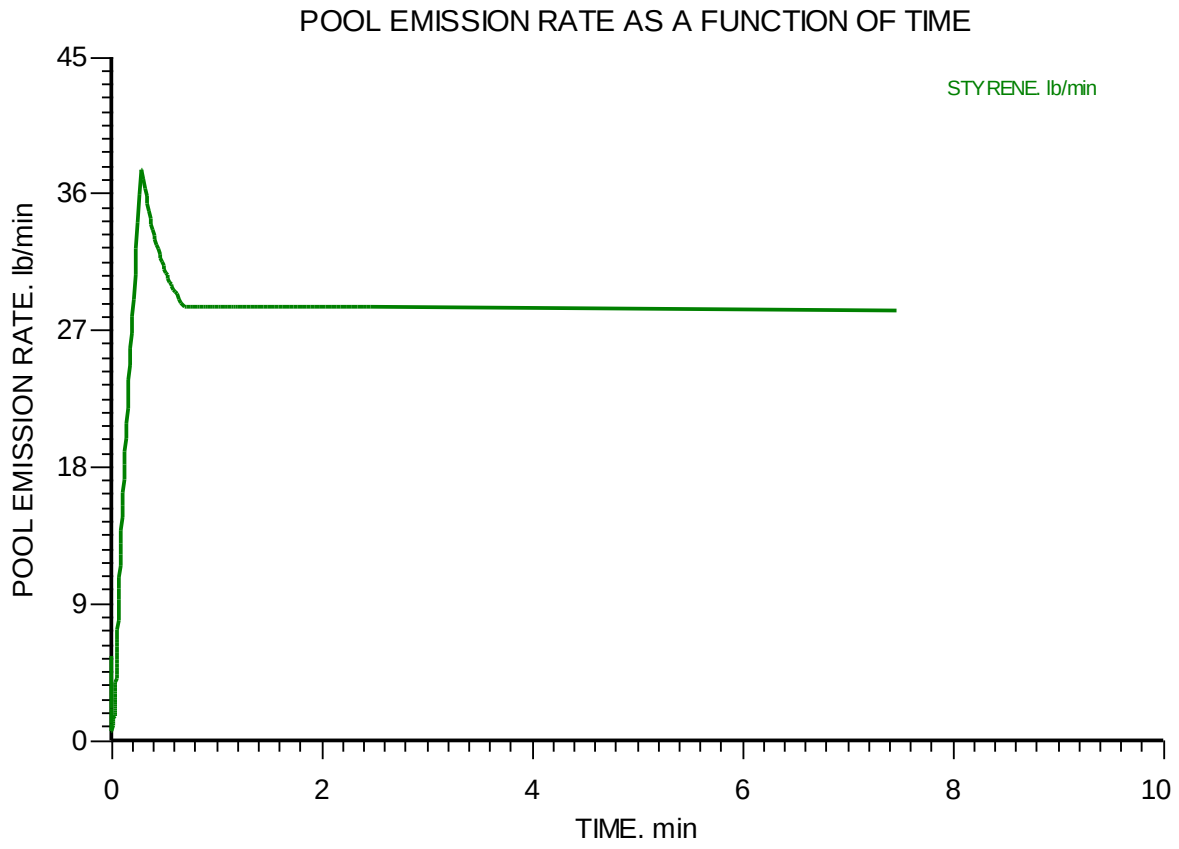


Figure 208: Styrene Evaporation Rate – E-R-18 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

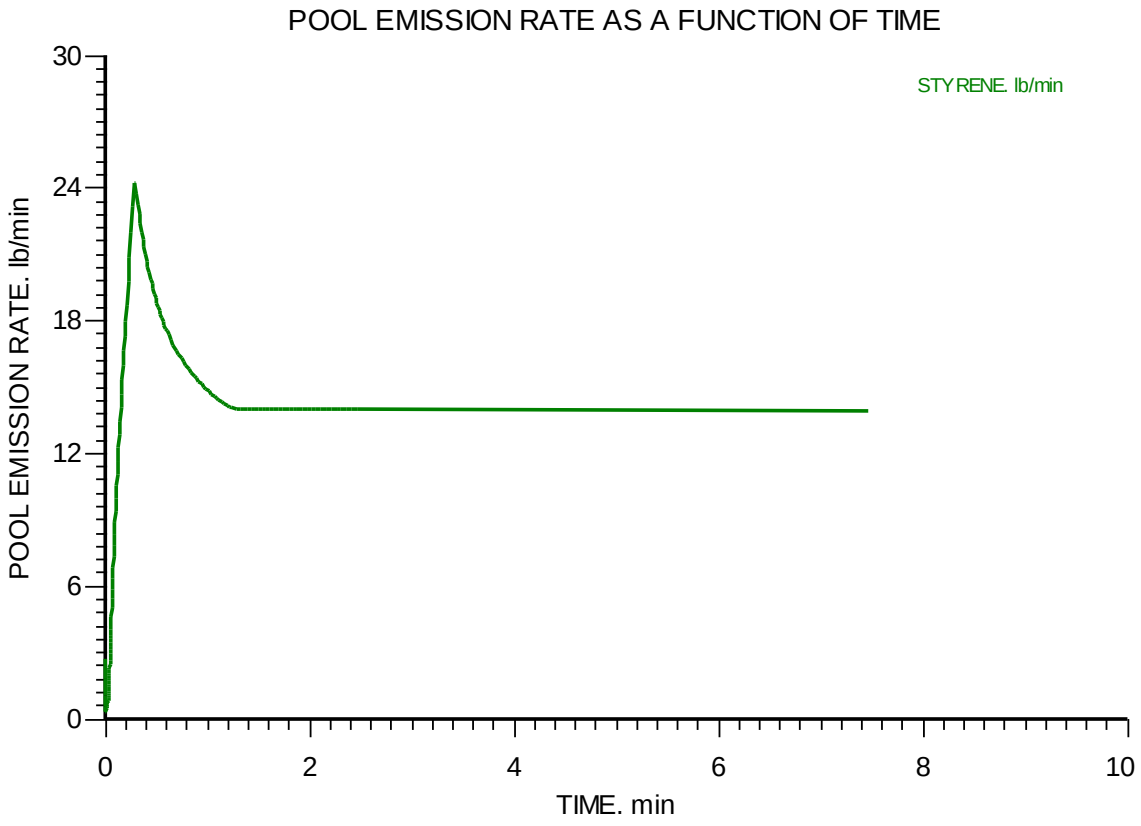


Figure 209: Styrene Evaporation Rate – E-R-18 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

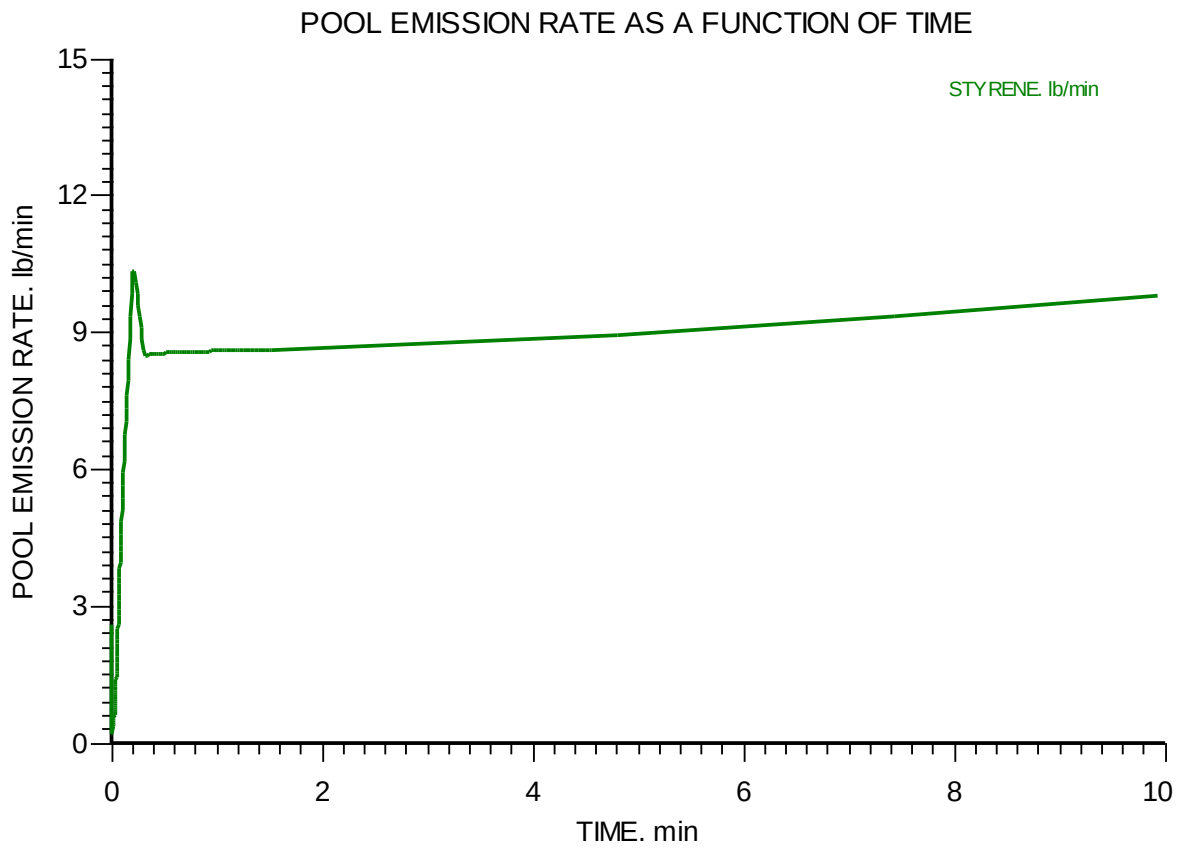


Figure 210: Styrene Evaporation Rate – E-R-18 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

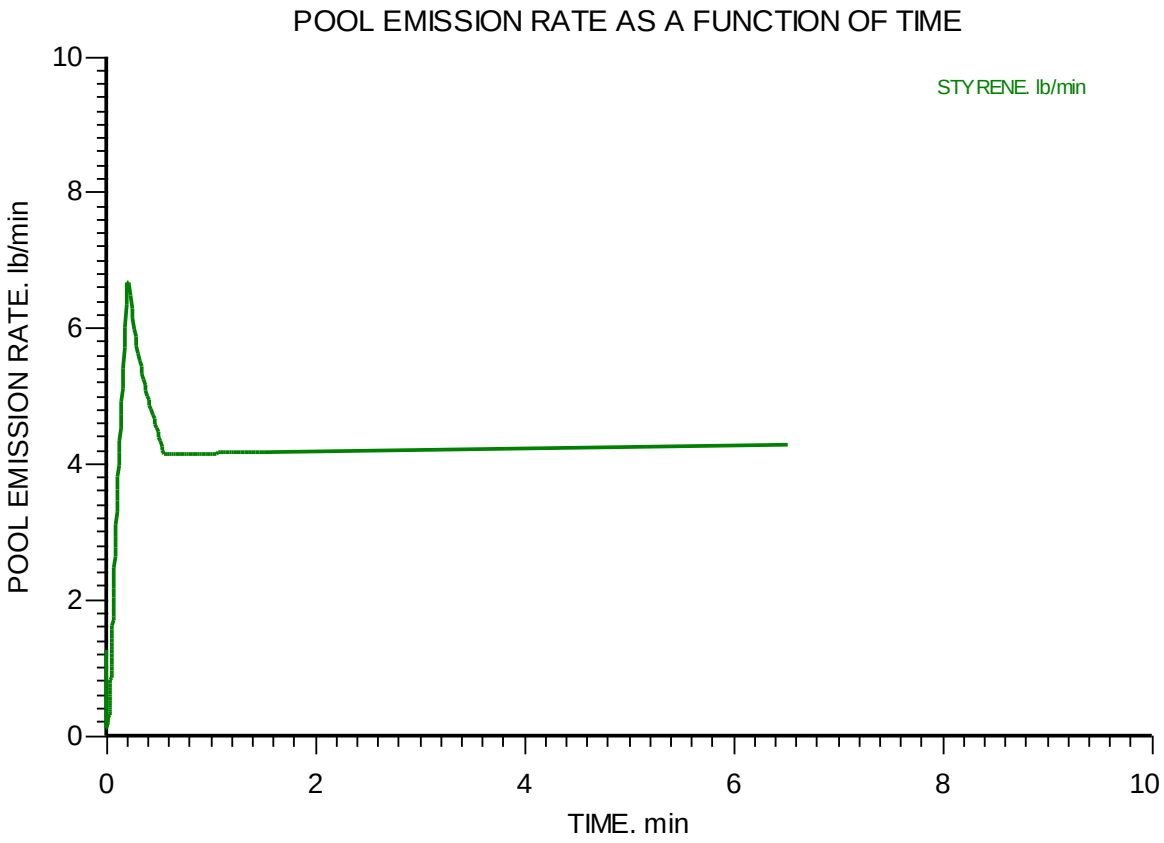


Figure 211: Styrene Evaporation Rate – E-R-18 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

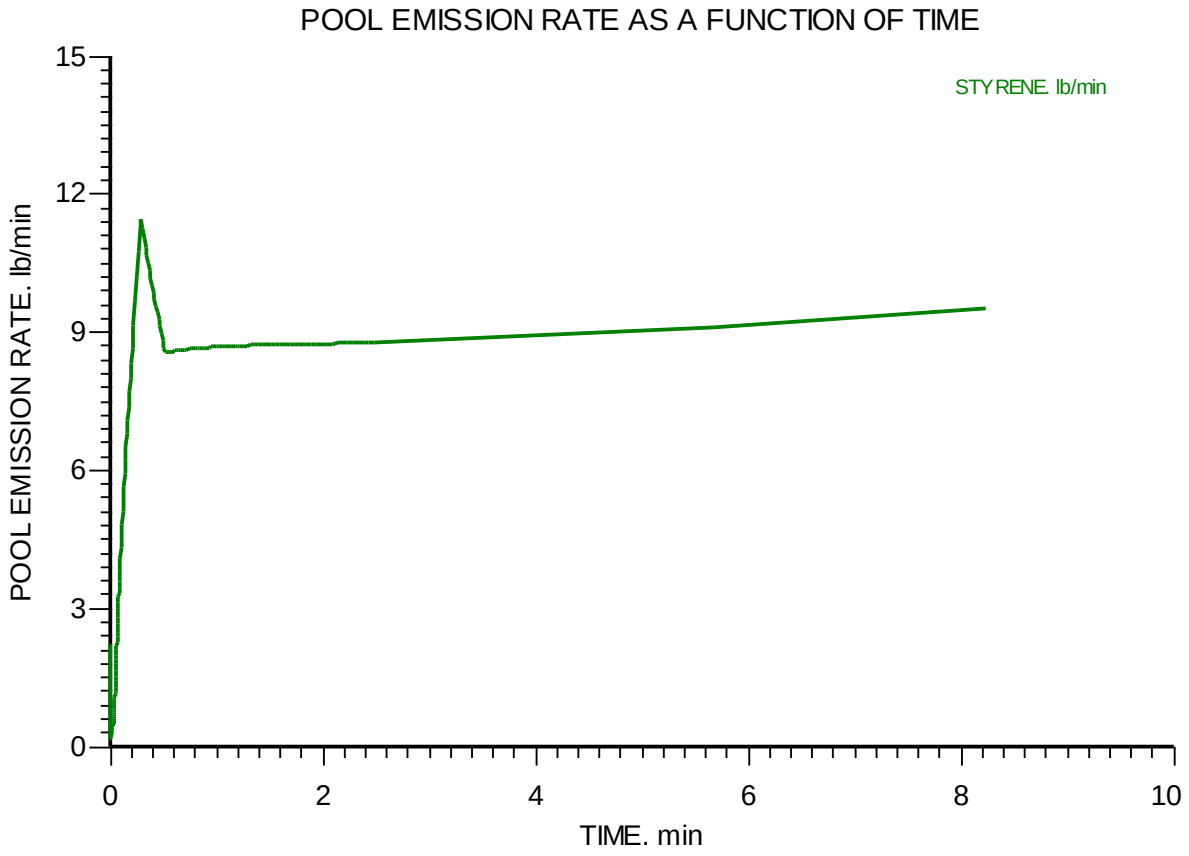
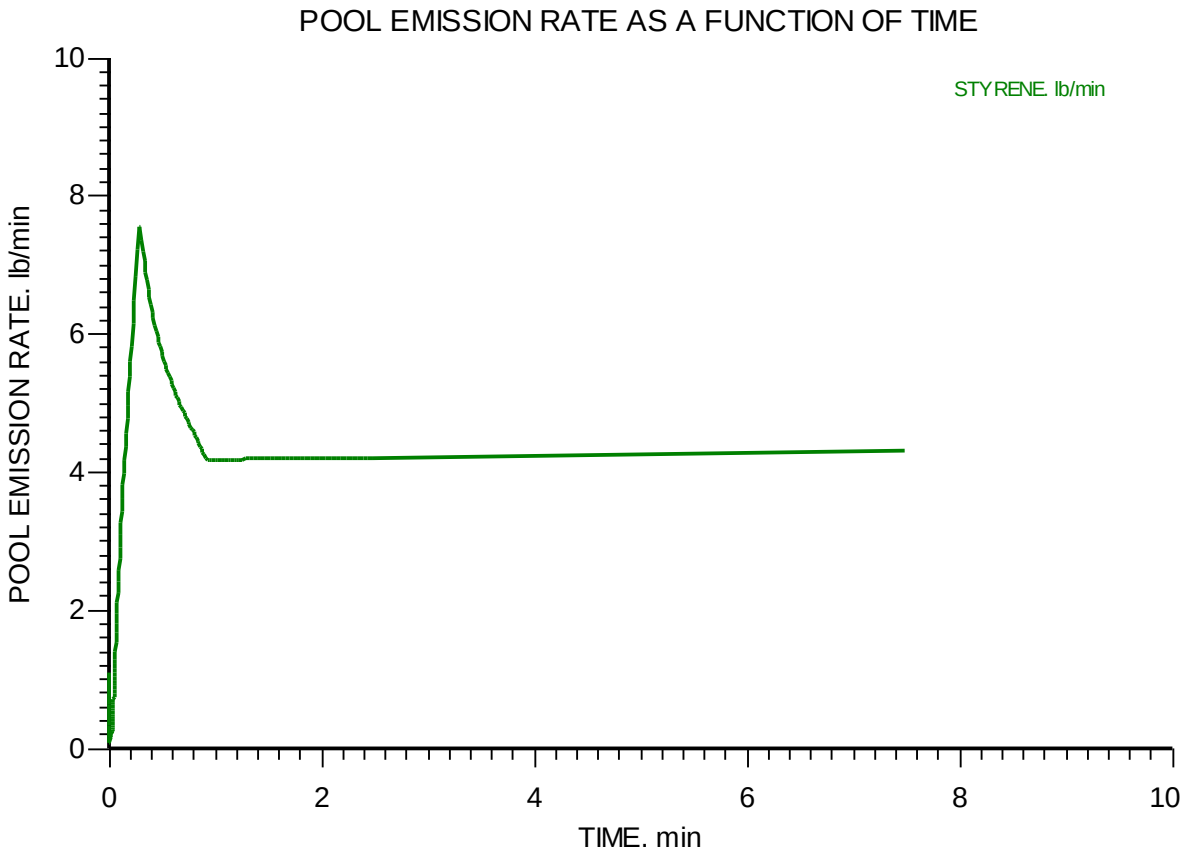


Figure 212: Styrene Evaporation Rate – E-R-18 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix T: Results – PROPOSED Piping Layout to Pit – Styrene Vapor Cloud Dispersion

Figure 213: Vapor Cloud Dispersion – PROPOSED Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

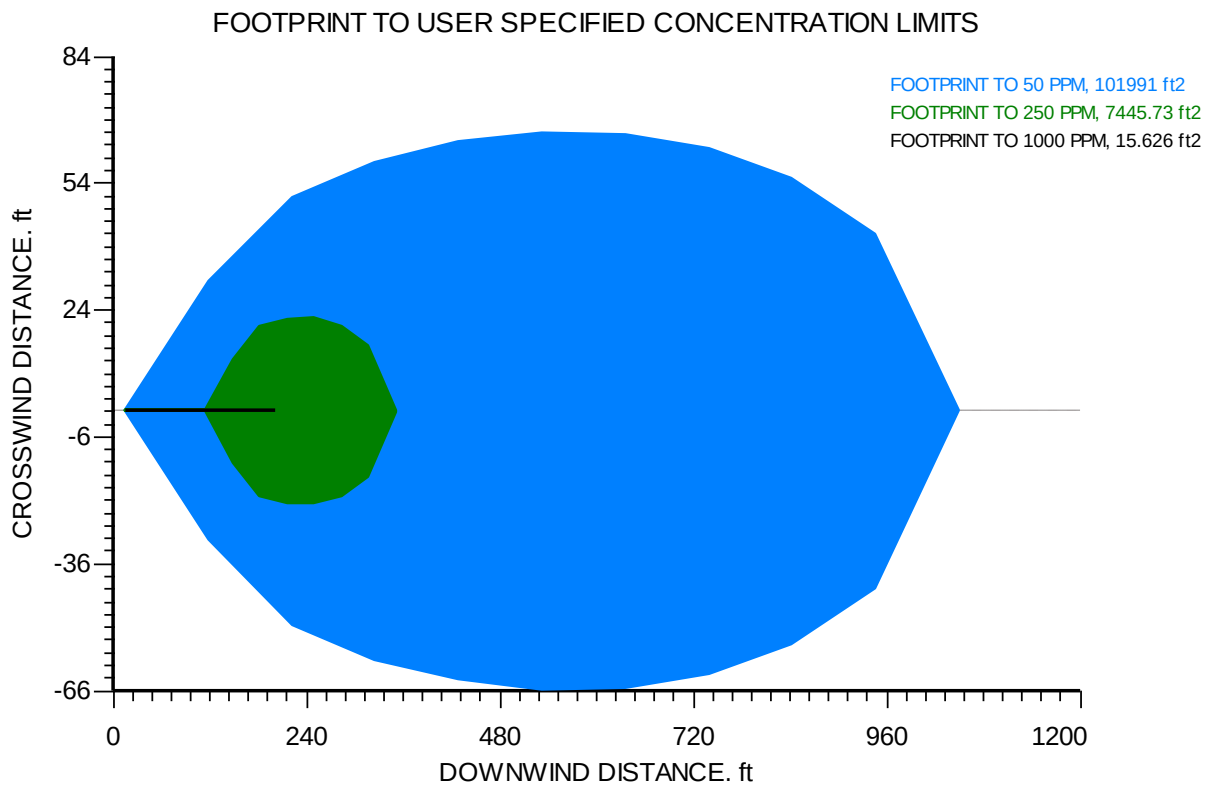


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Figure 214: Vapor Cloud Dispersion – PROPOSED Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

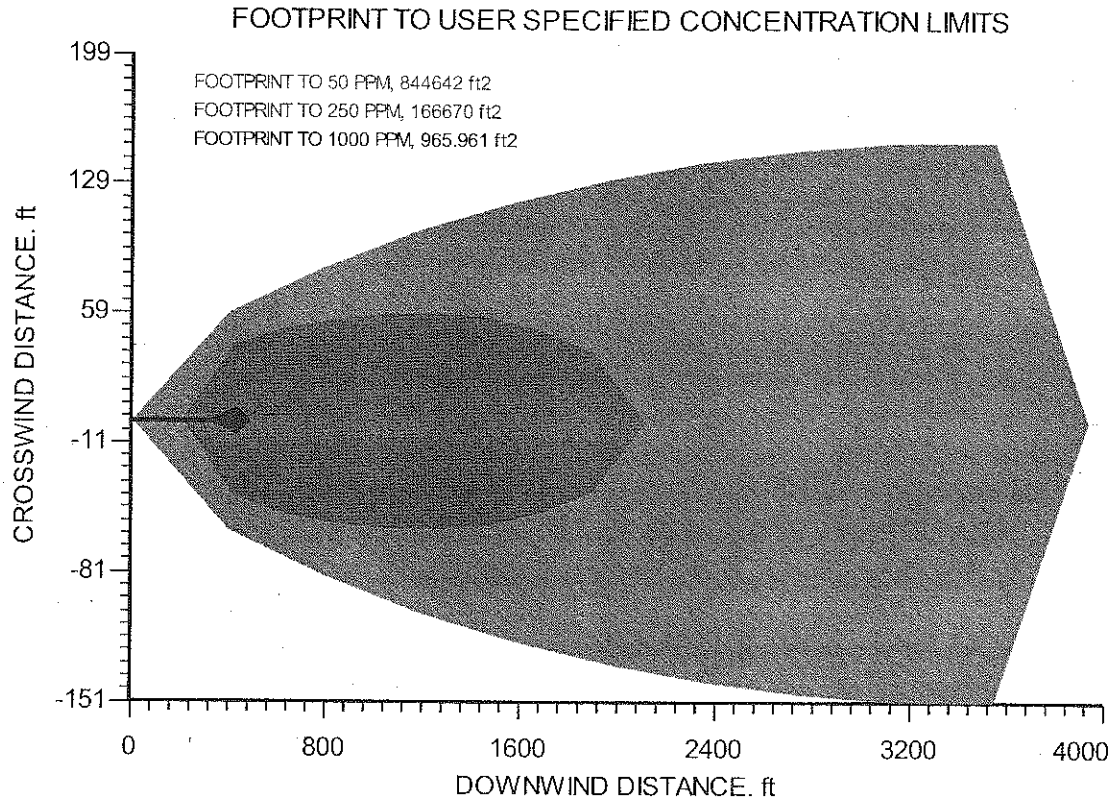


Figure 215: Vapor Cloud Dispersion – PROPOSED Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

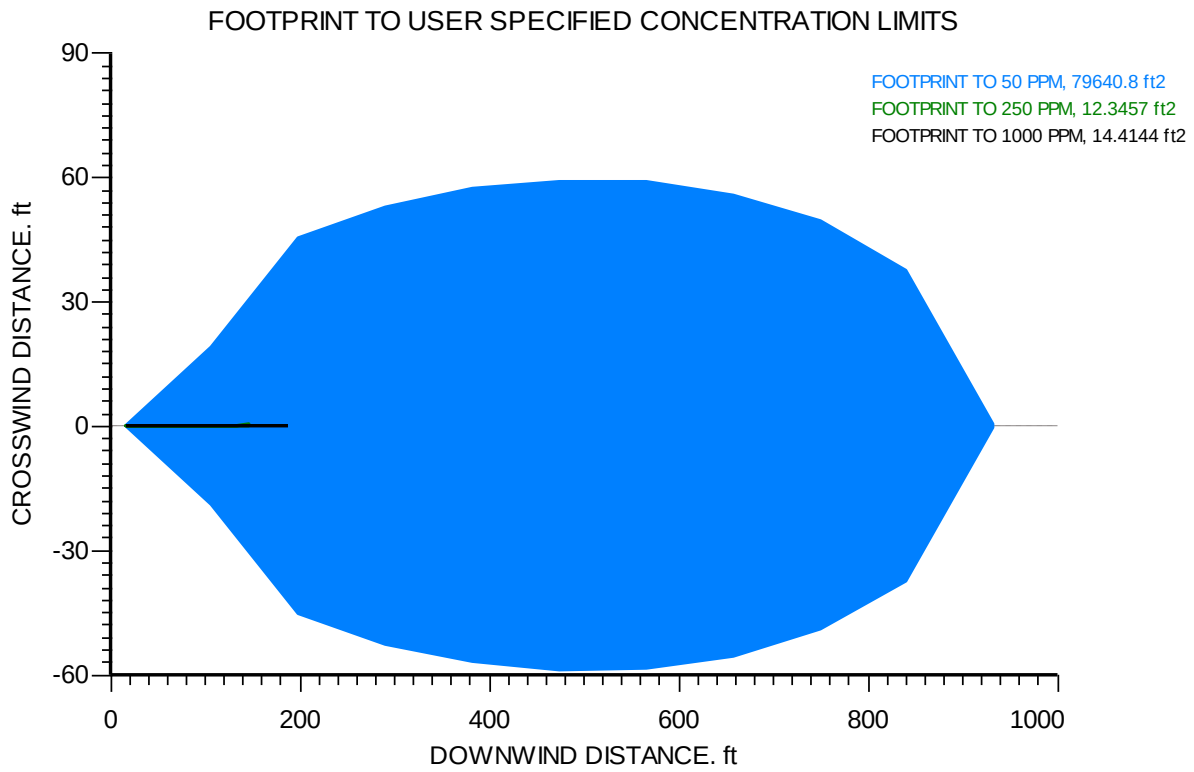


Figure 216: Vapor Cloud Dispersion – PROPOSED Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

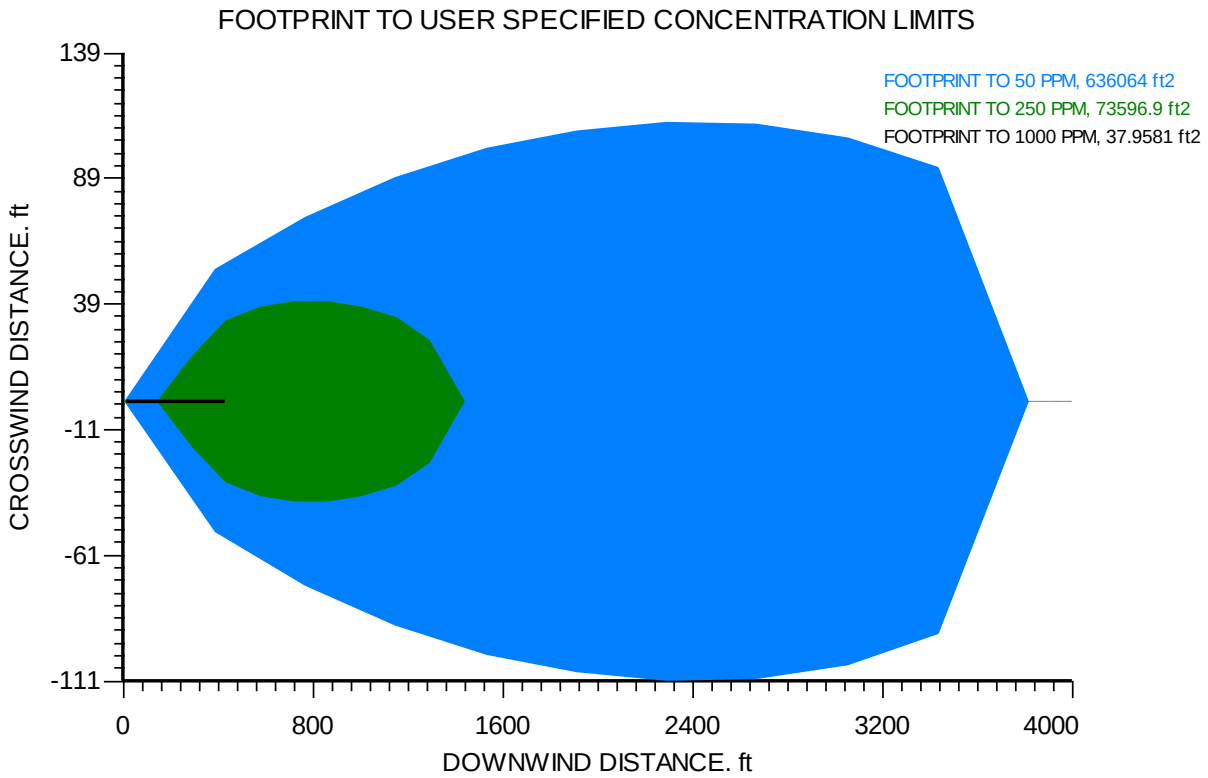


Figure 217: Vapor Cloud Dispersion – PROPOSED Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

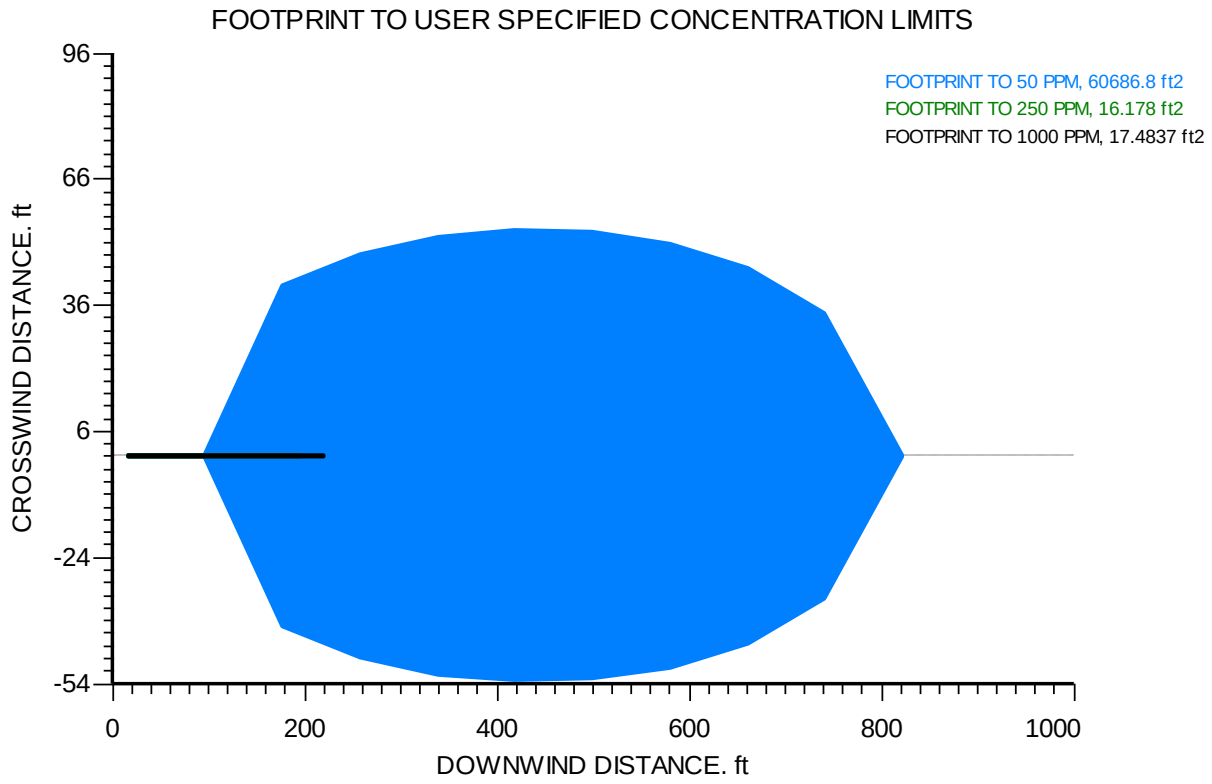


Figure 218: Vapor Cloud Dispersion – PROPOSED Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

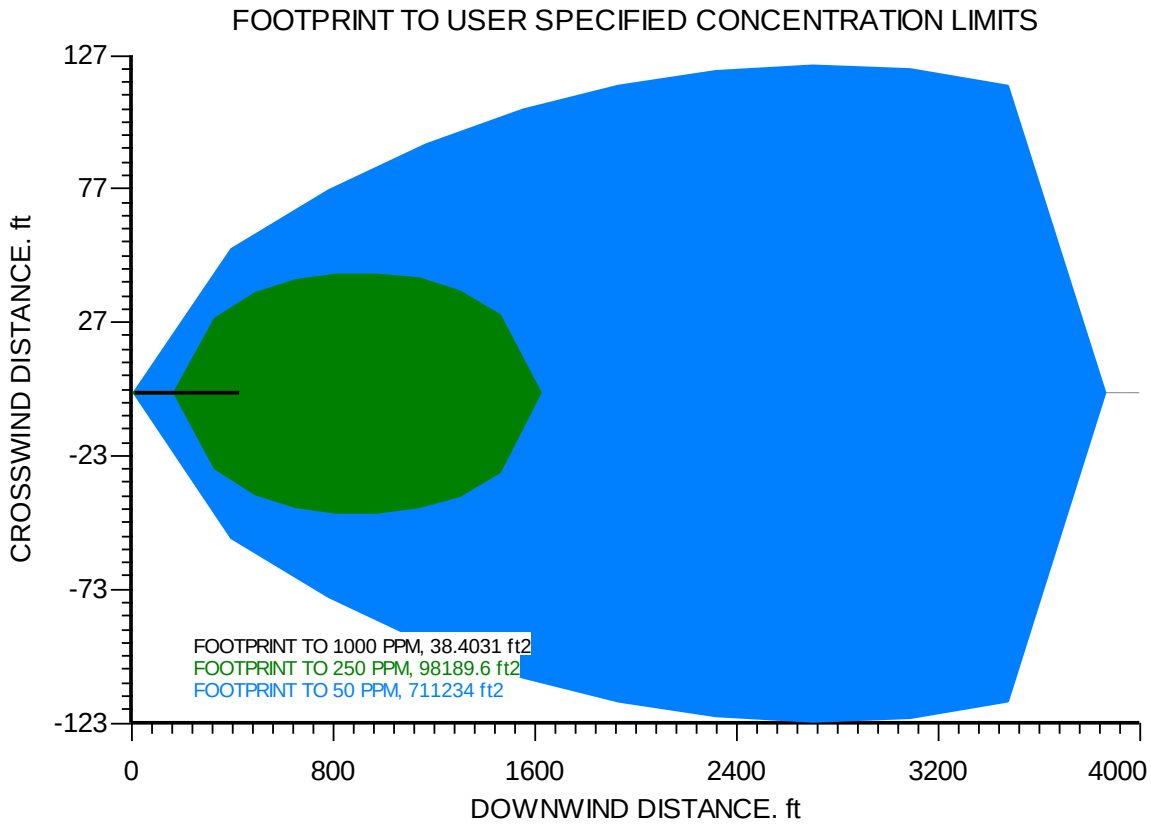


Figure 219: Vapor Cloud Dispersion – PROPOSED Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

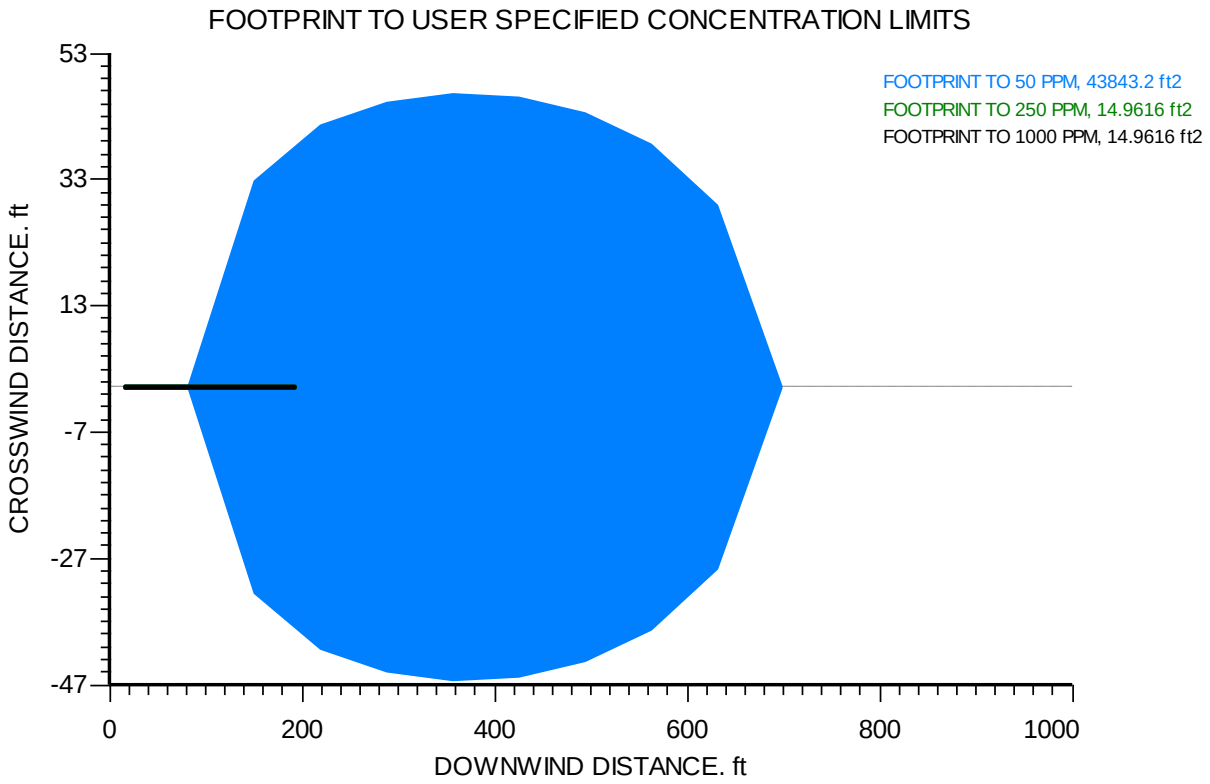
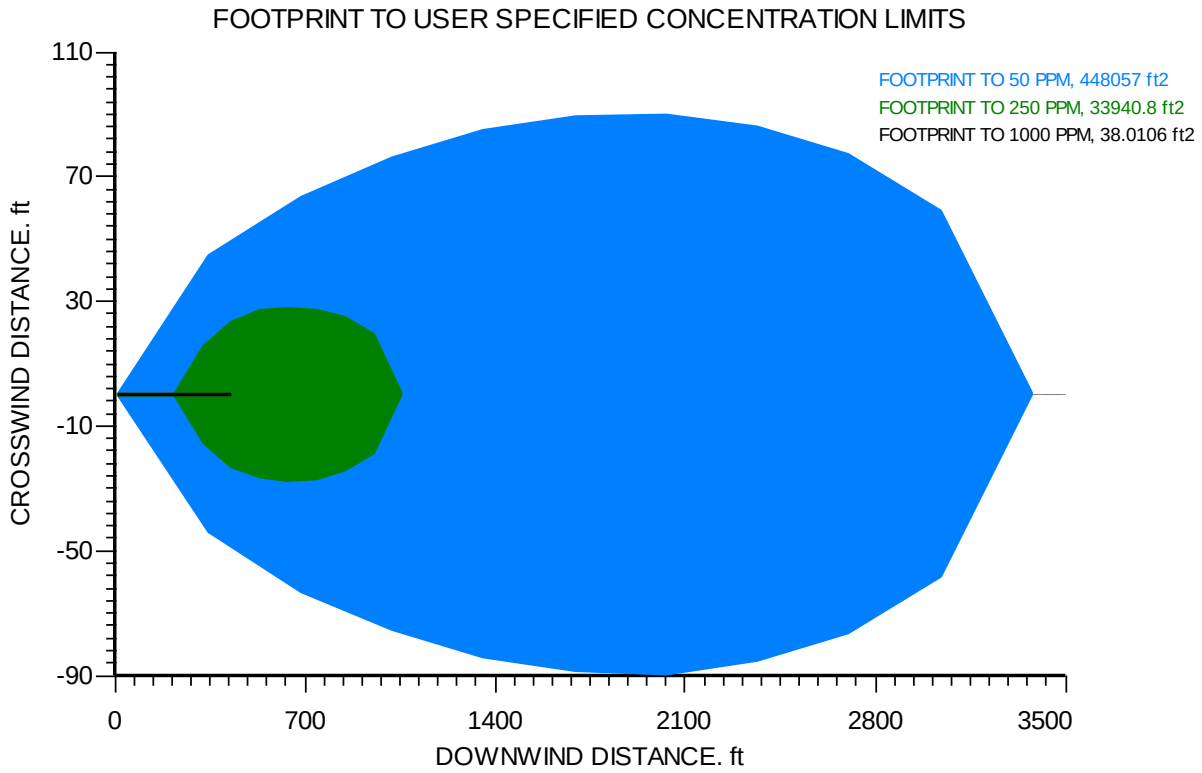


Figure 220: Vapor Cloud Dispersion – PROPOSED Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix U: Results – E-R-14 Piping Layout to Pit – Styrene Vapor Cloud Dispersion

Figure 221: Styrene Evaporation Rate – E-R-14 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

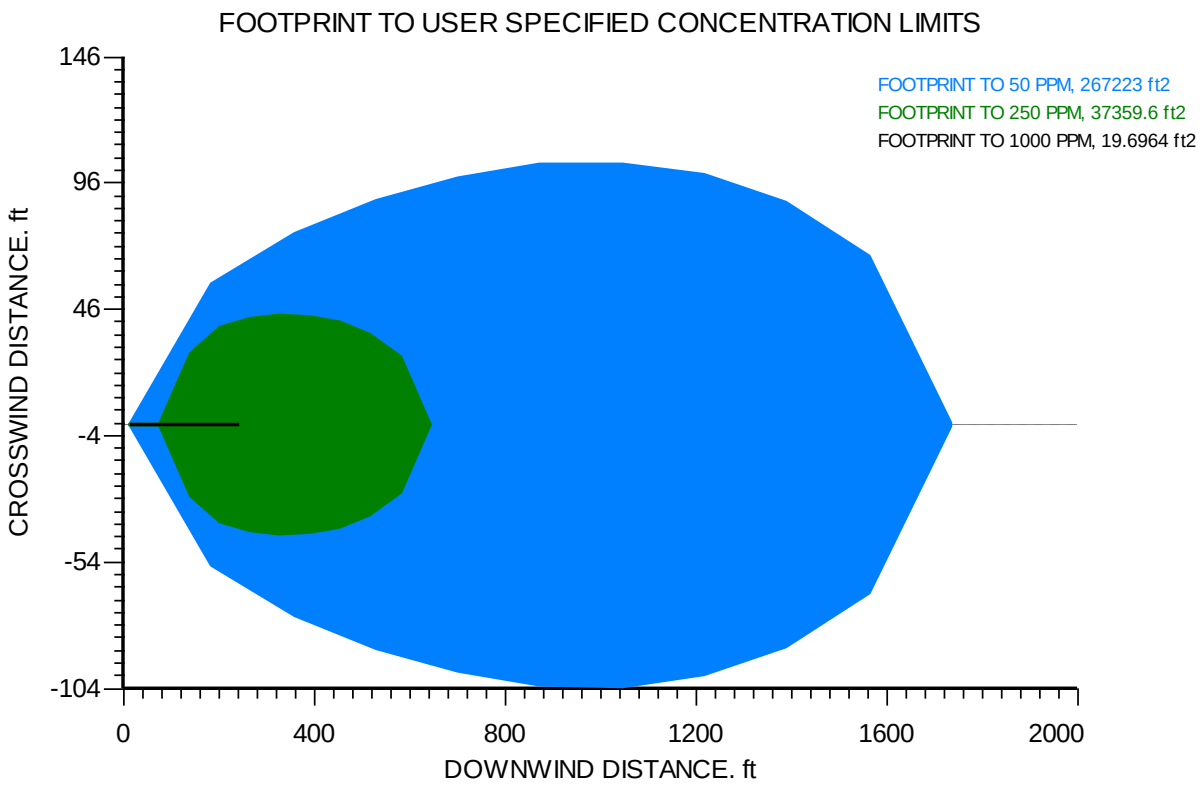


Figure 222: Styrene Evaporation Rate – E-R-14 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

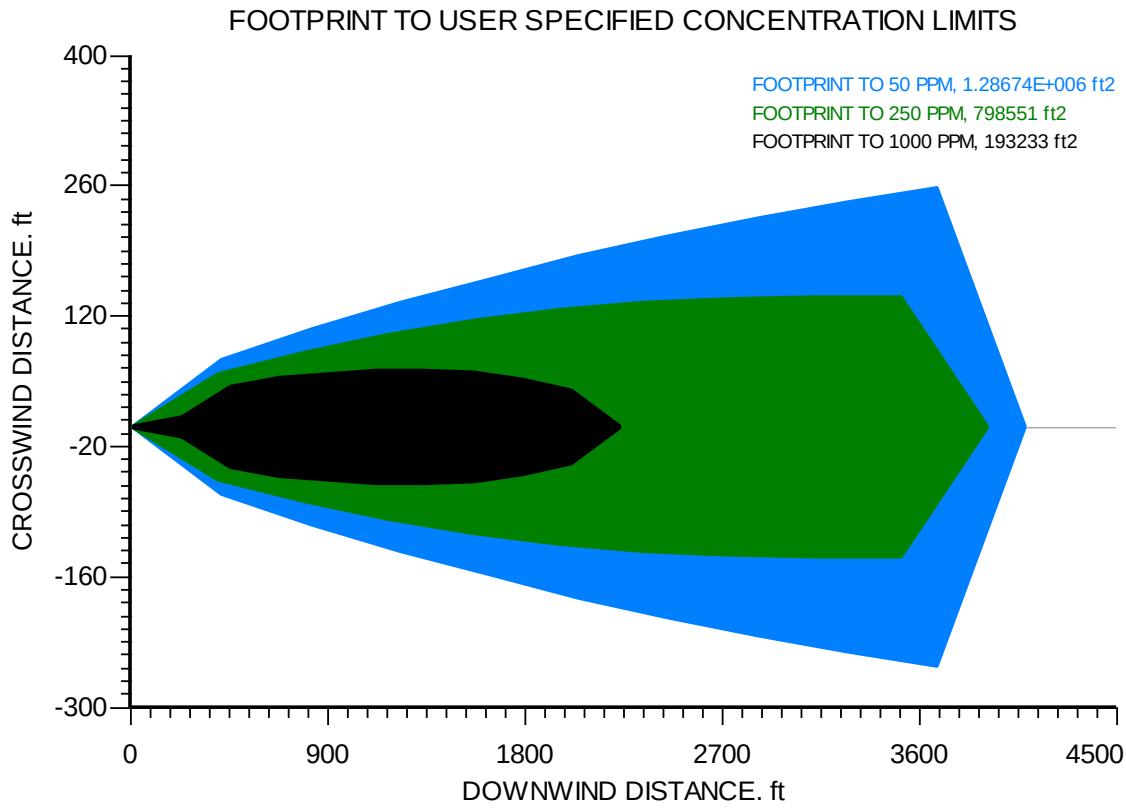


Figure 223: Styrene Evaporation Rate – E-R-14 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

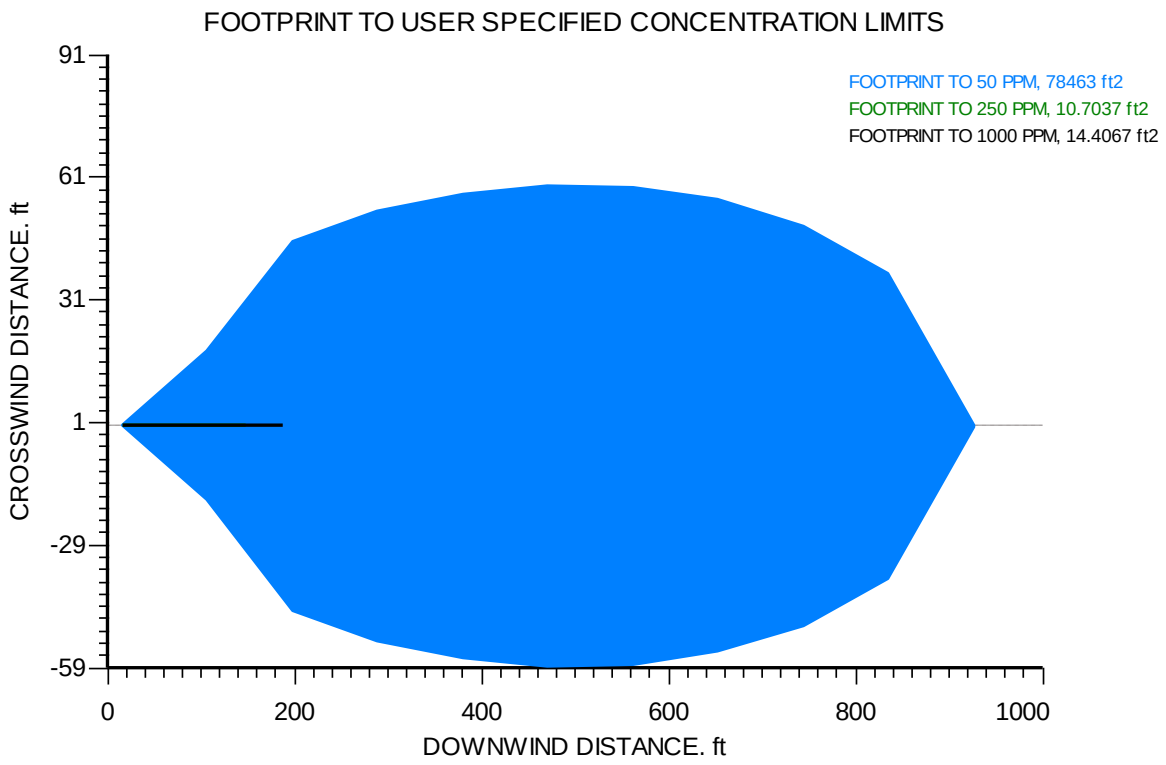


Figure 224: Styrene Evaporation Rate – E-R-14 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

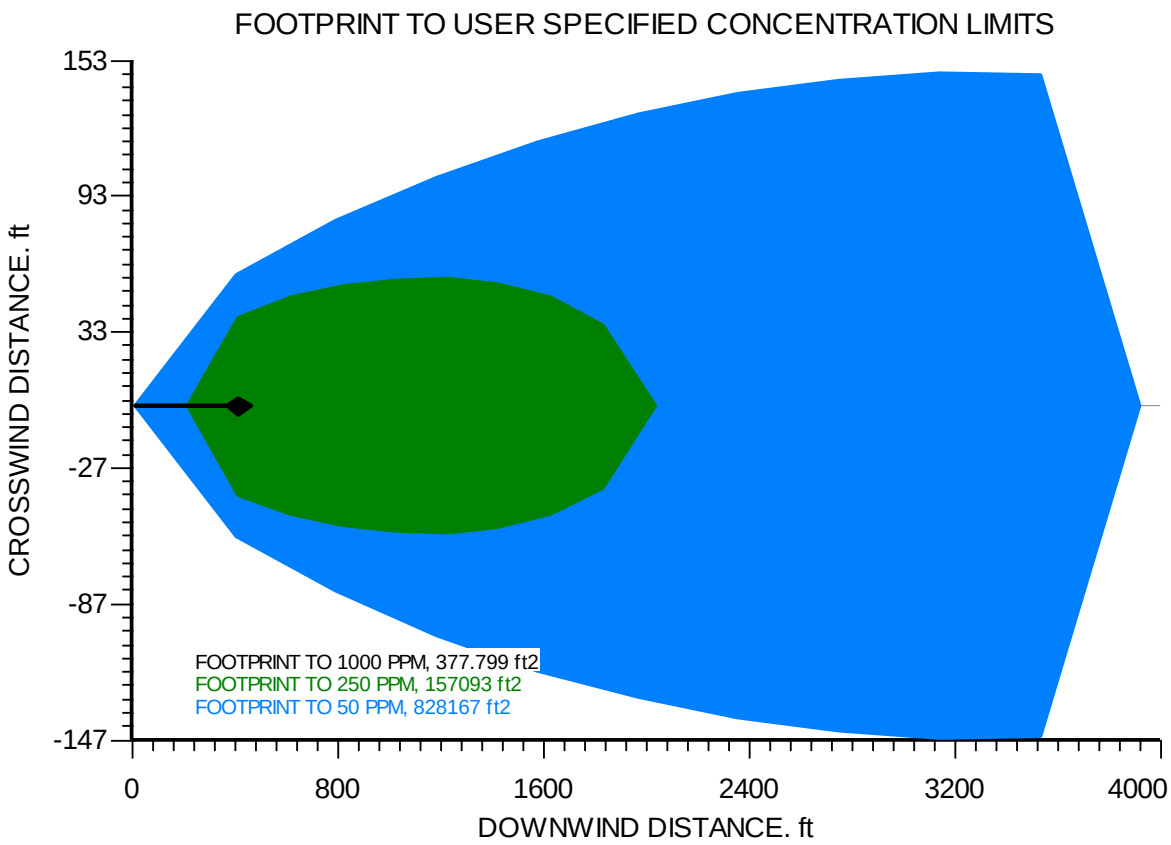


Figure 225: Styrene Evaporation Rate – E-R-14 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

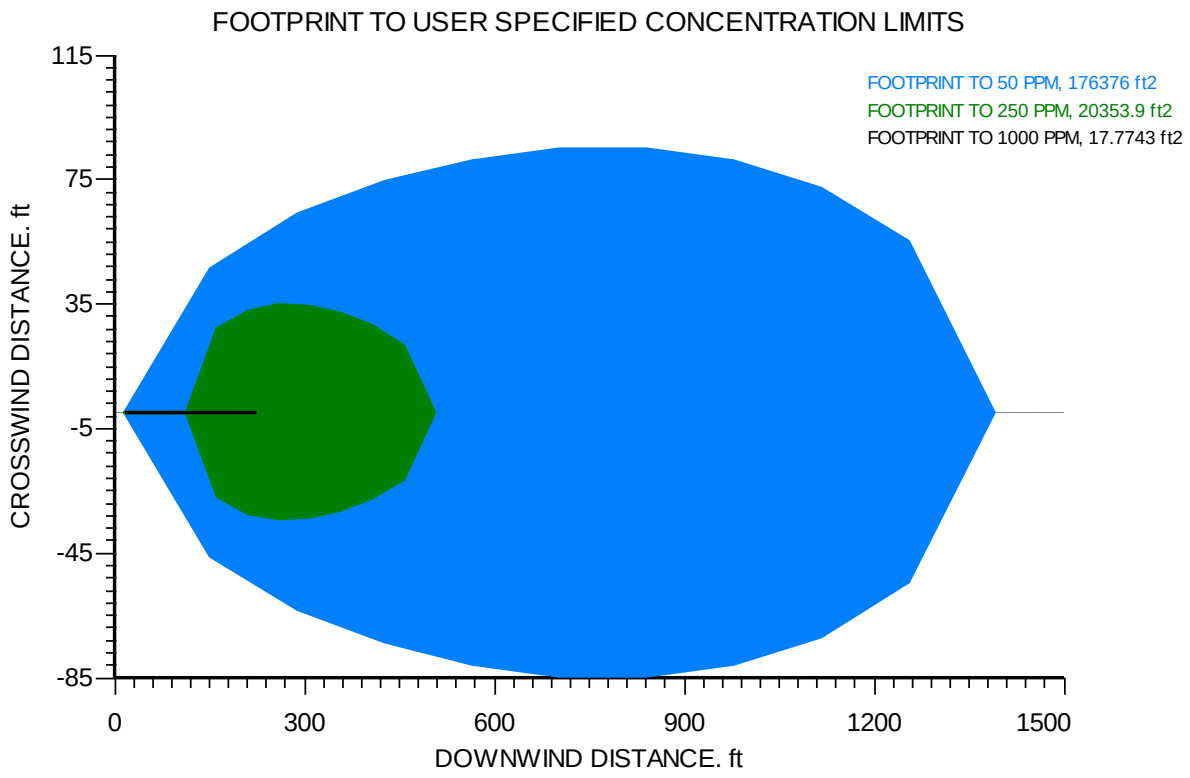


Figure 226: Styrene Evaporation Rate – E-R-14 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

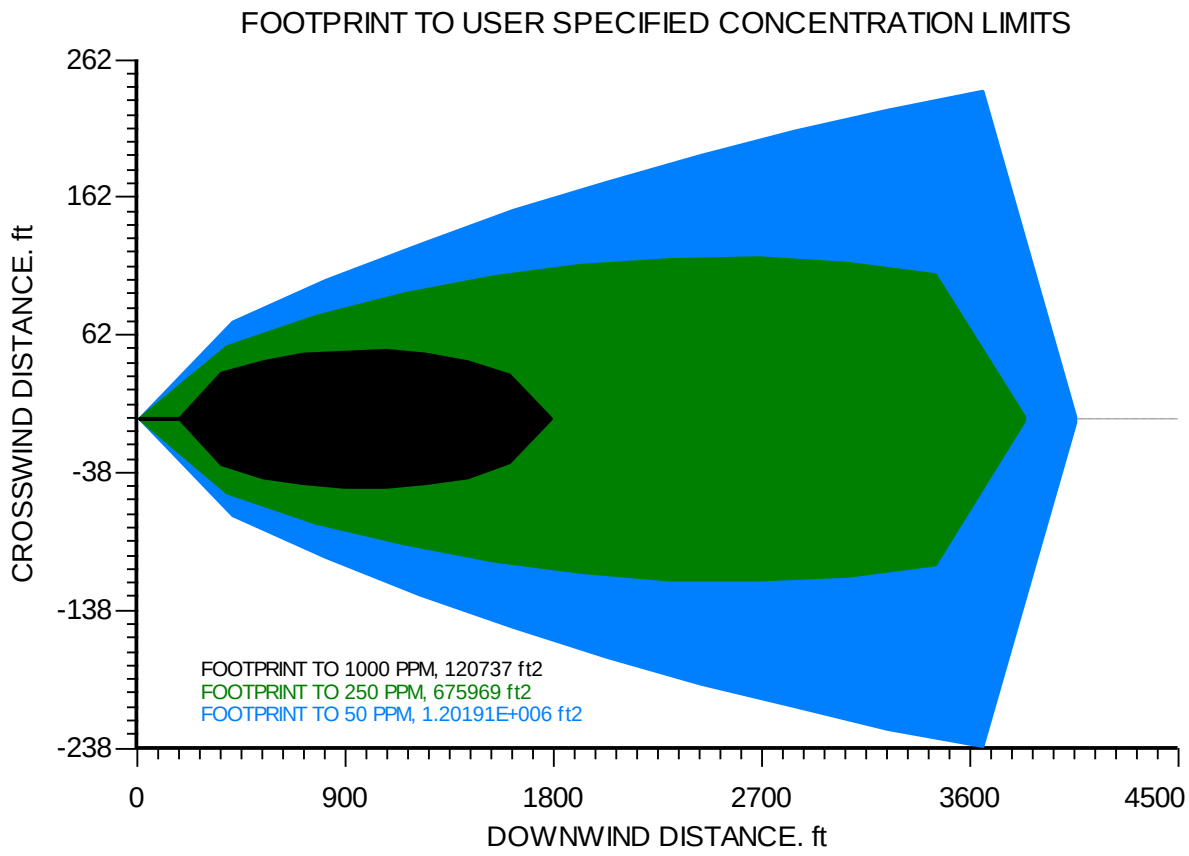


Figure 227: Styrene Evaporation Rate – E-R-14 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

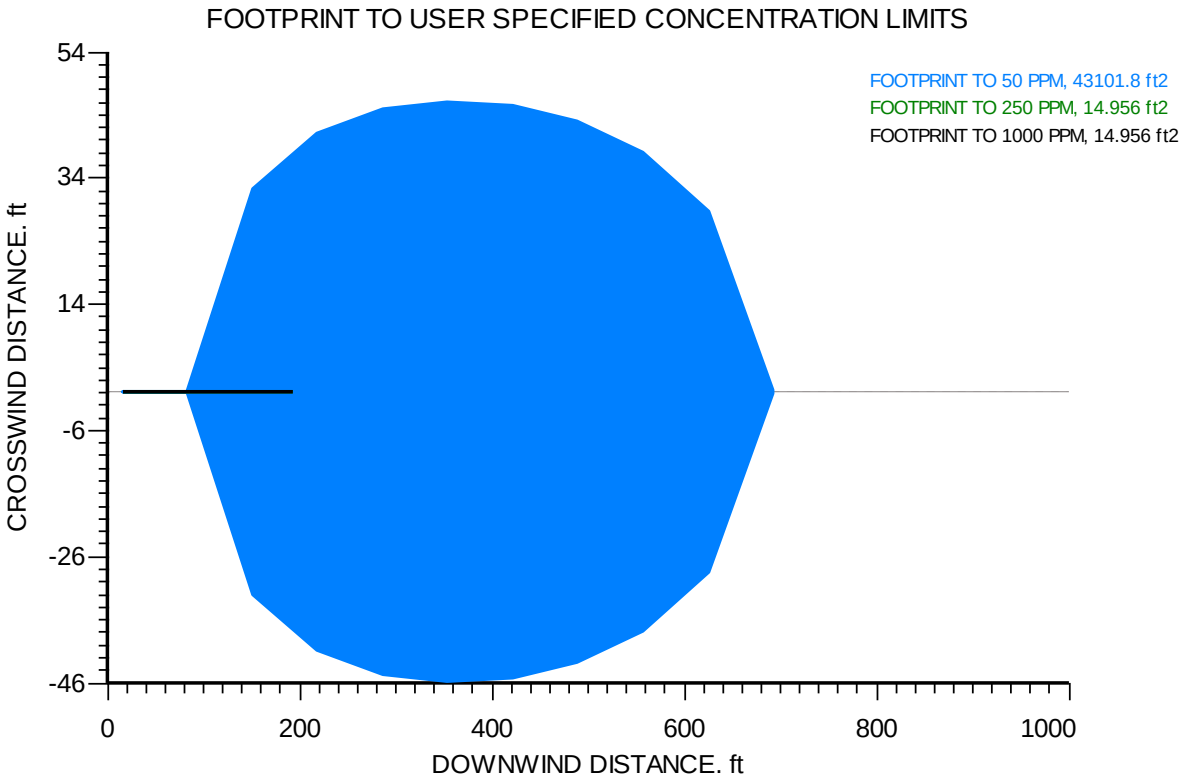
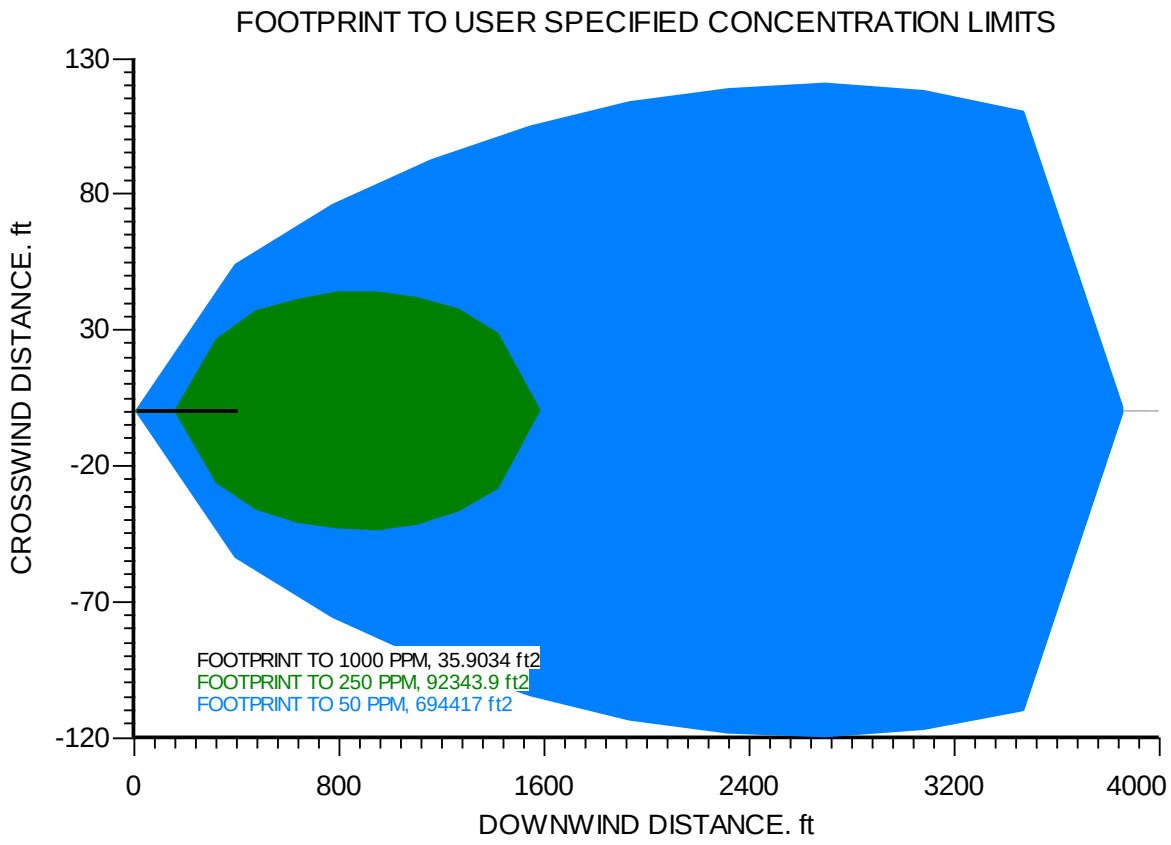


Figure 228: Styrene Evaporation Rate – E-R-14 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix V: Results – E-R-15 Piping Layout to Pit – Styrene Vapor Cloud Dispersion

Figure 229: Styrene Evaporation Rate – E-R-15 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

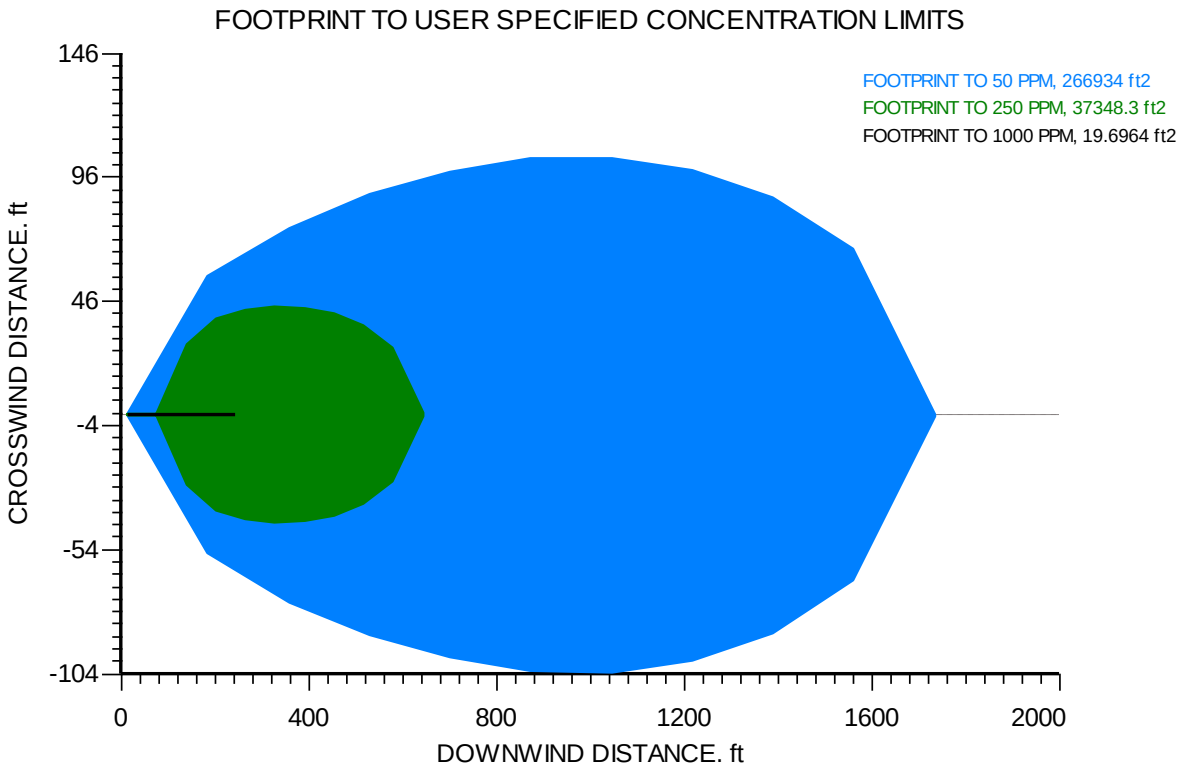


Figure 230: Styrene Evaporation Rate – E-R-15 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

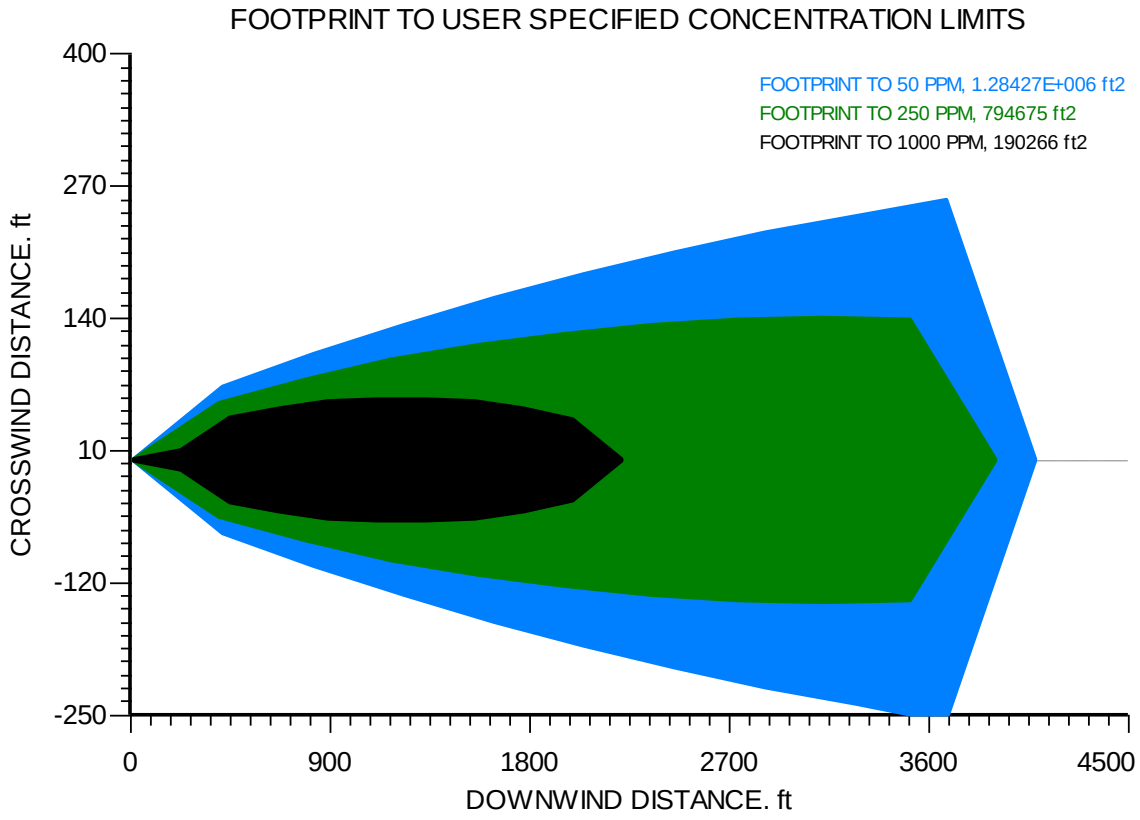


Figure 231: Styrene Evaporation Rate – E-R-15 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

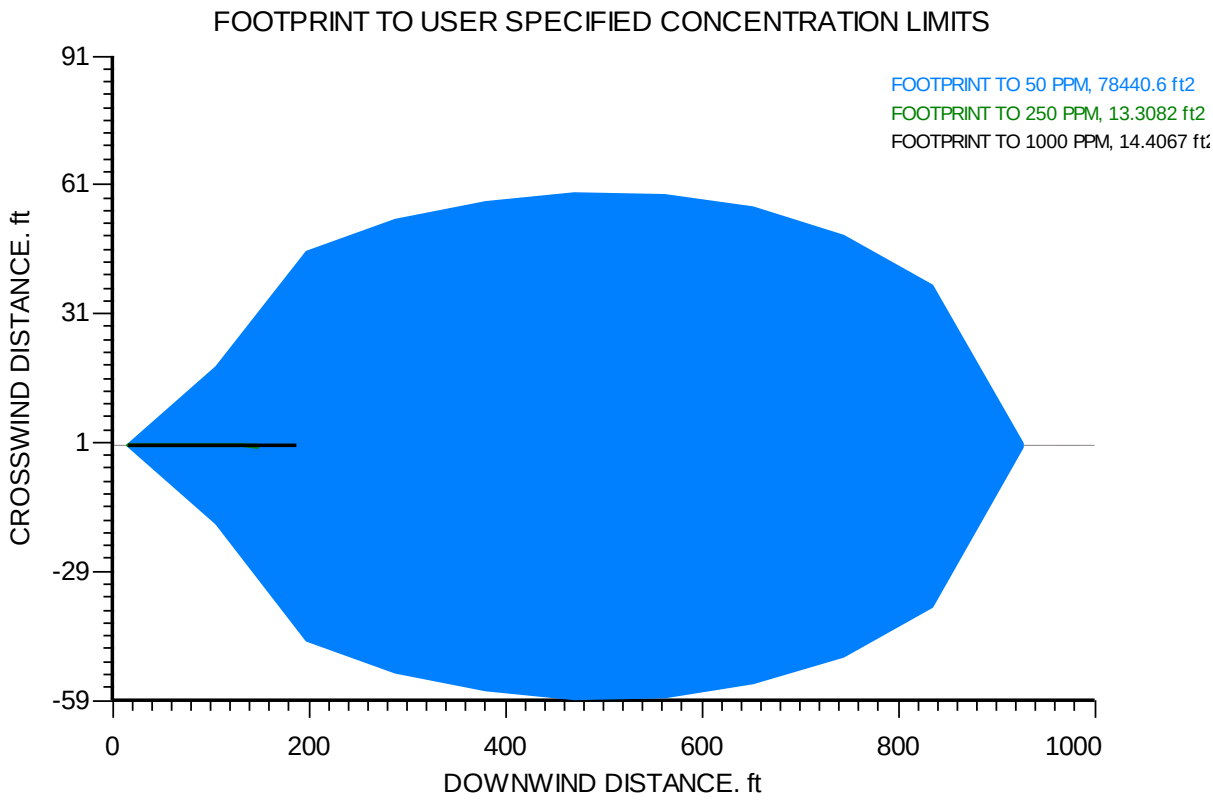


Figure 232: Styrene Evaporation Rate – E-R-15 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

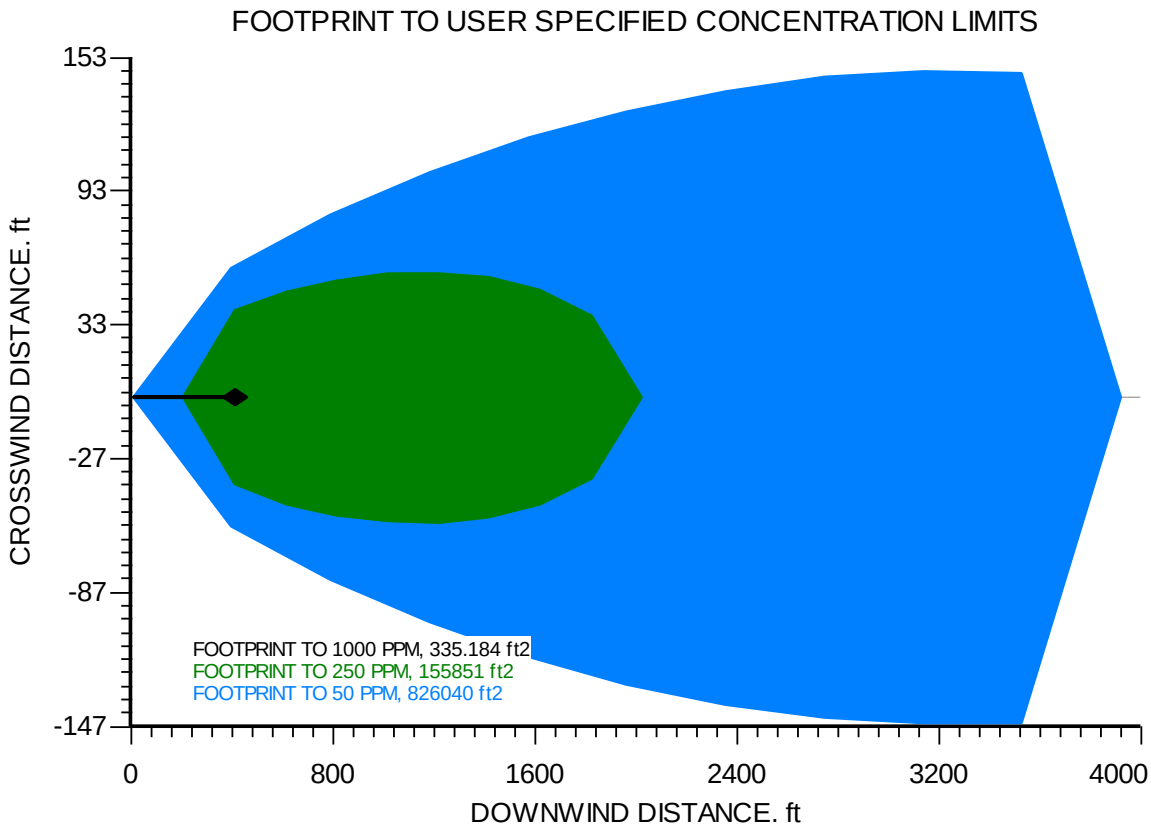


Figure 233: Styrene Evaporation Rate – E-R-15 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

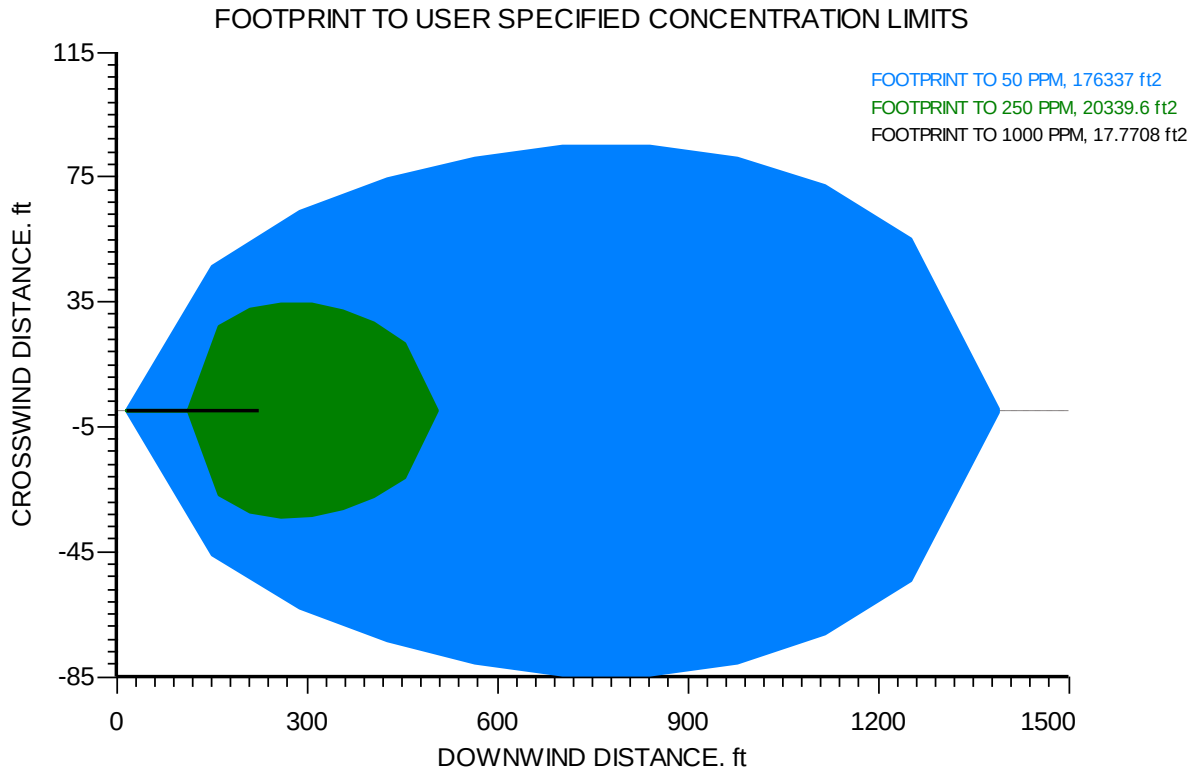


Figure 234: Styrene Evaporation Rate – E-R-15 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

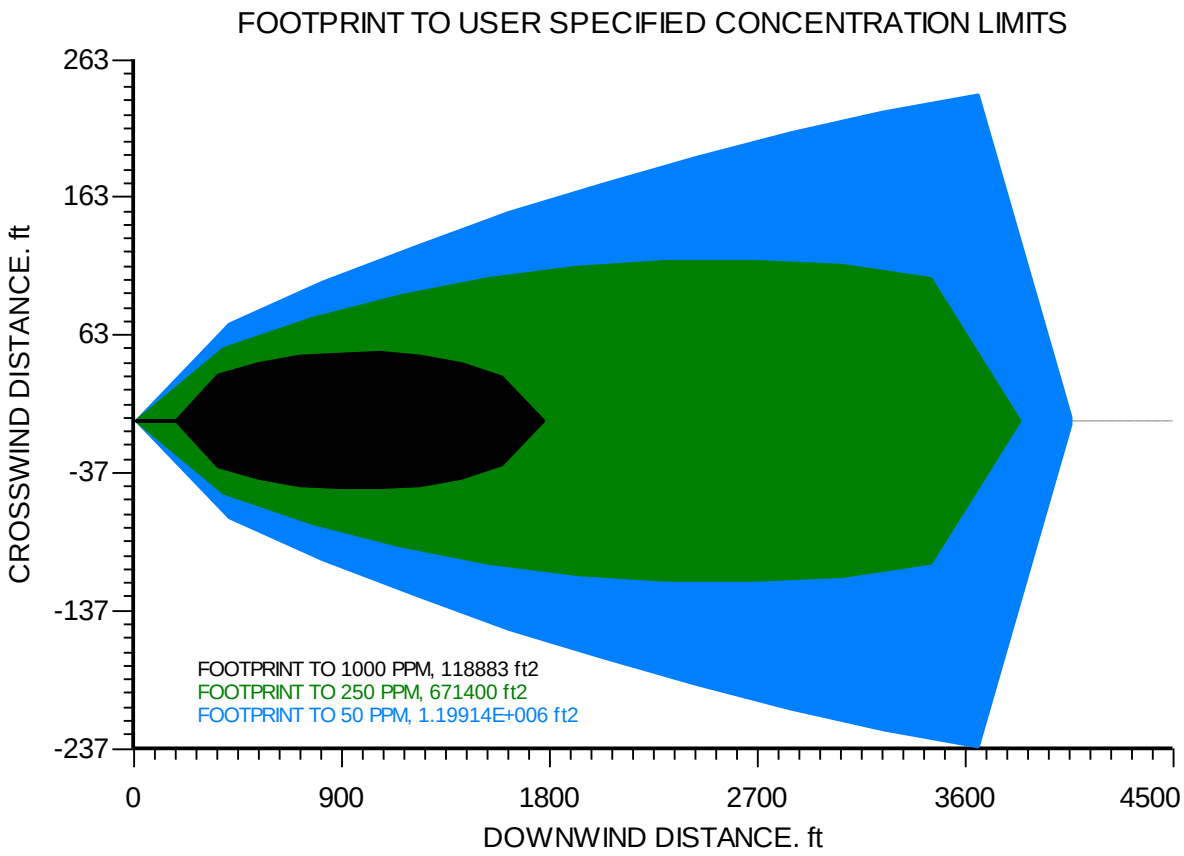


Figure 235: Styrene Evaporation Rate – E-R-15 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

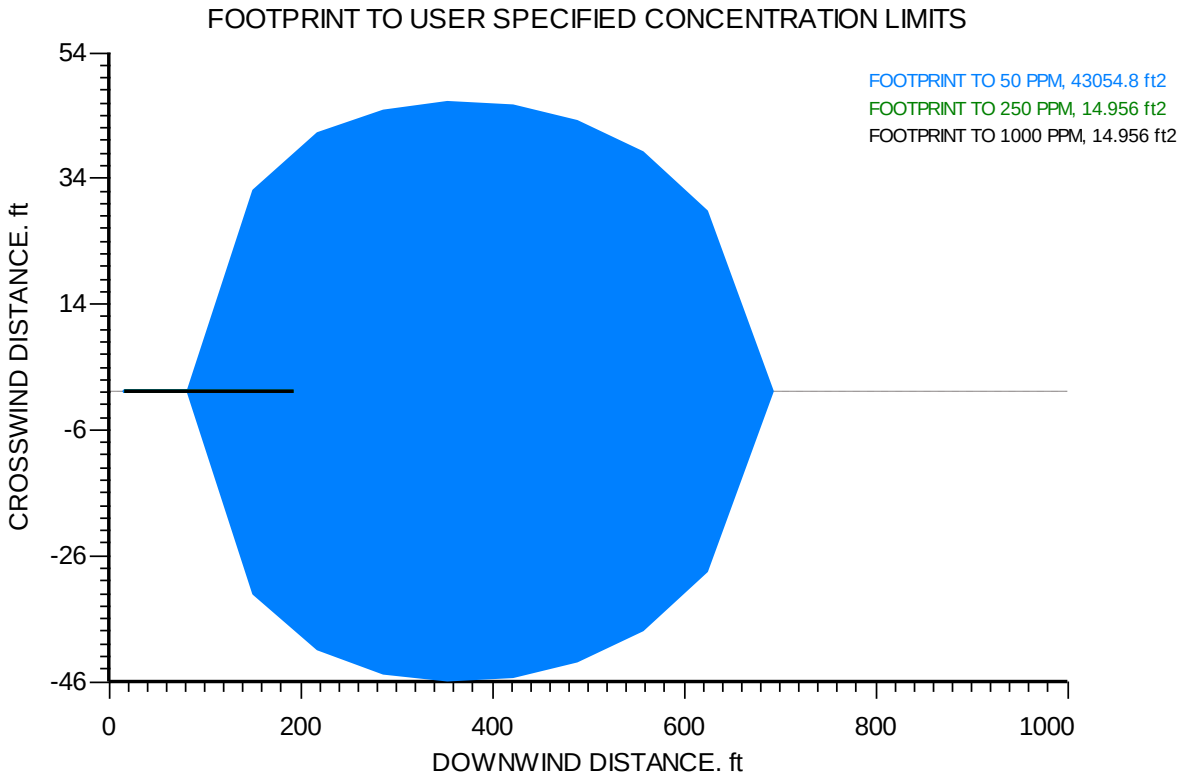
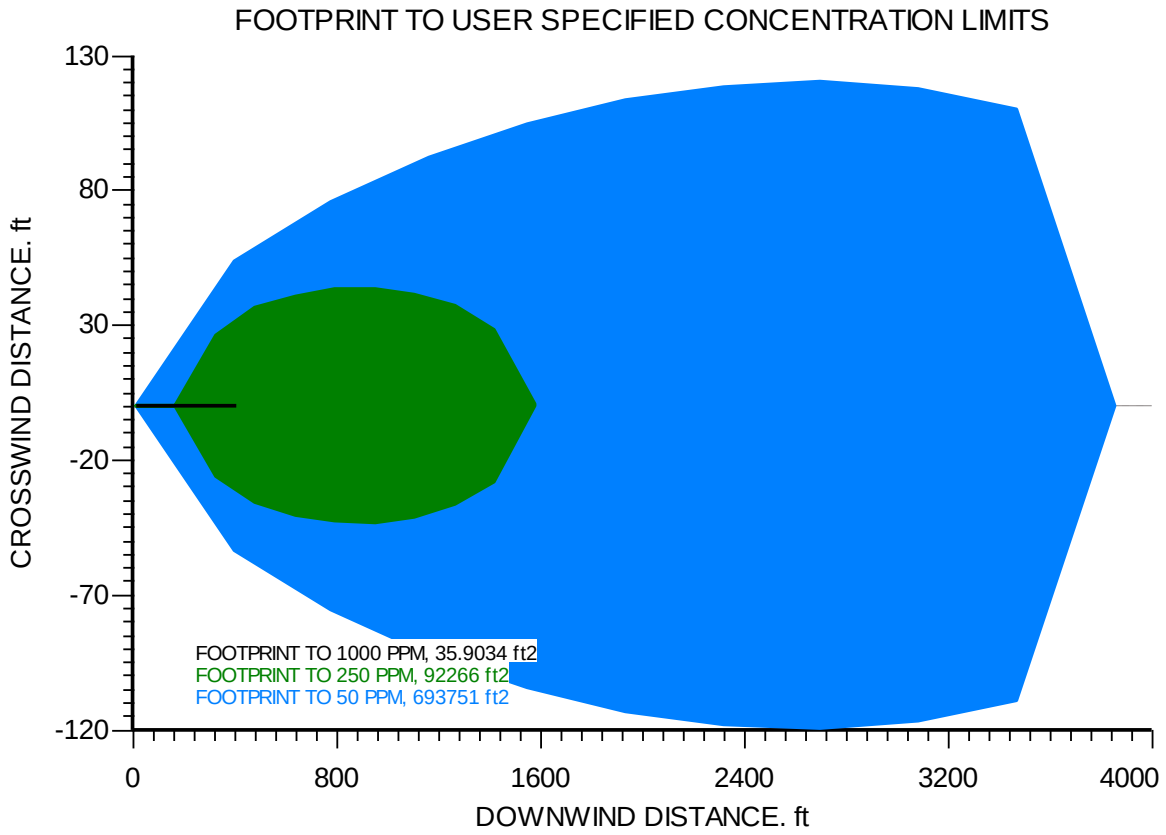


Figure 236: Styrene Evaporation Rate – E-R-15 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix W: Results – E-R-16 Piping Layout to Pit – Styrene Vapor Cloud Dispersion

Figure 237: Styrene Evaporation Rate – E-R-16 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

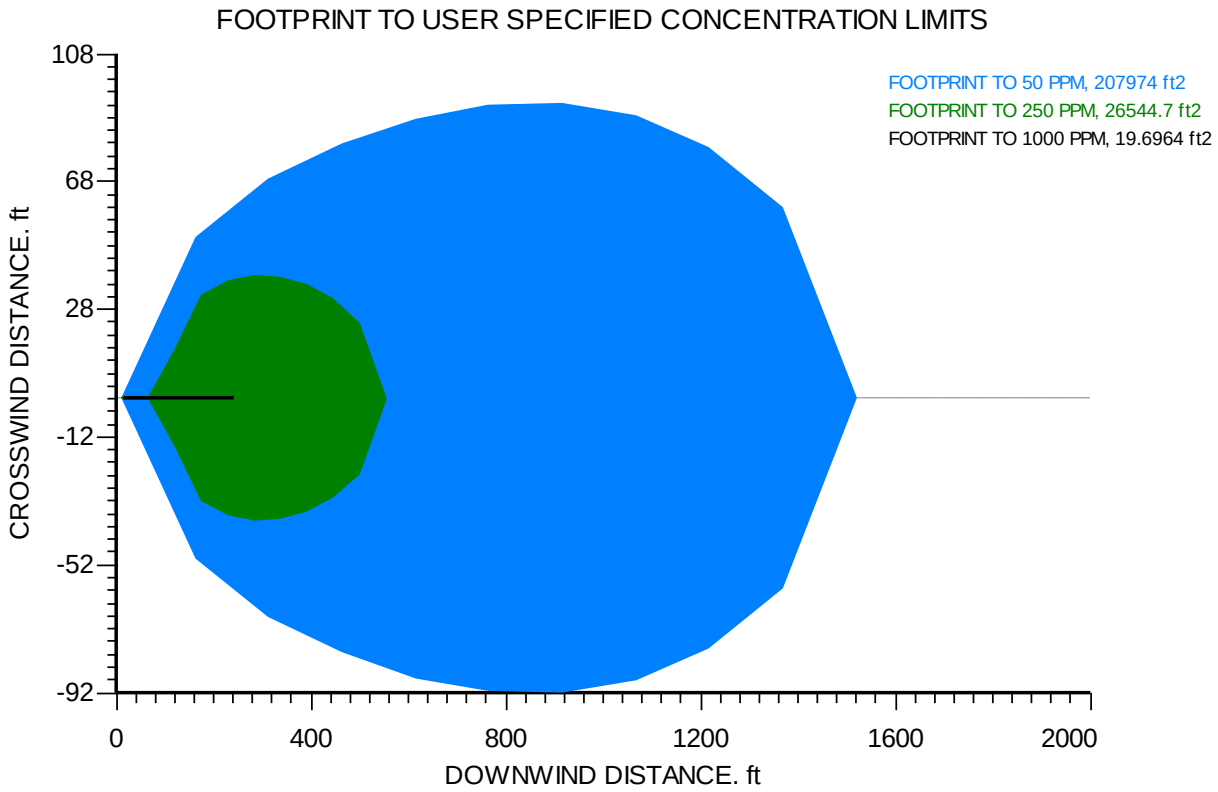


Figure 238: Styrene Evaporation Rate – E-R-16 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

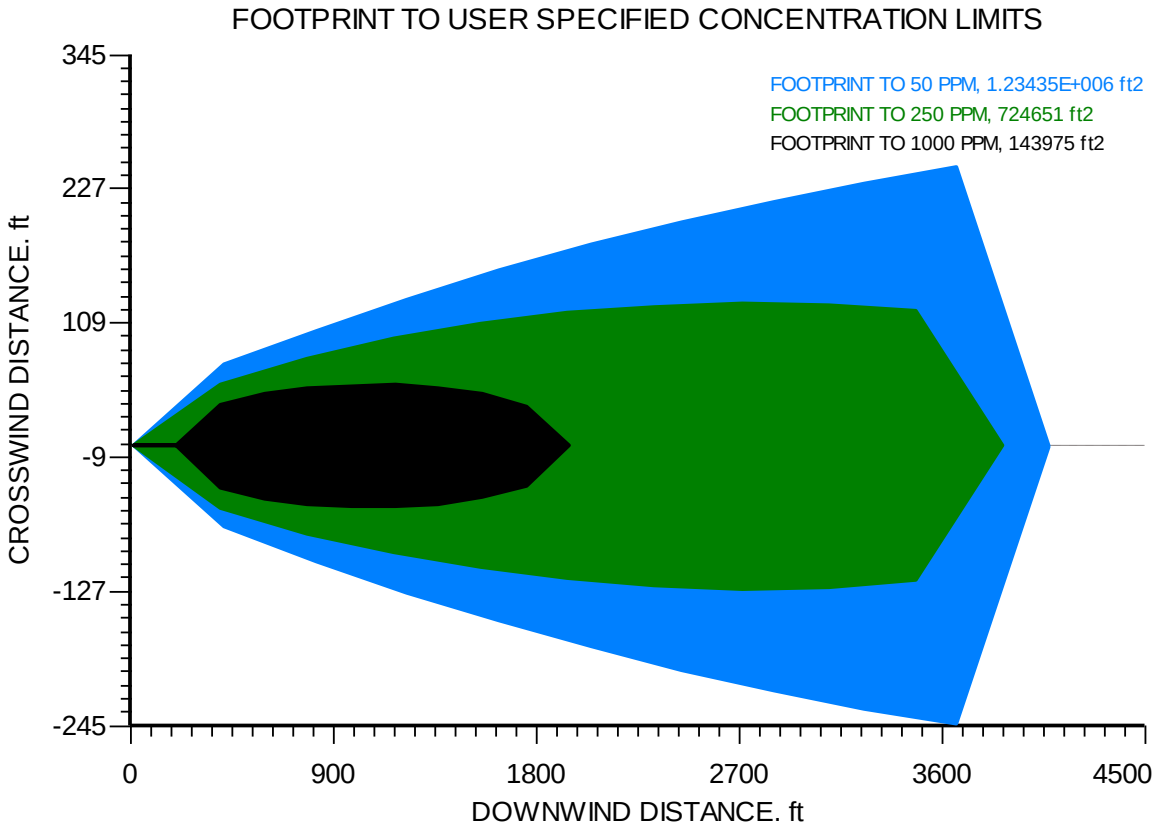


Figure 239: Styrene Evaporation Rate – E-R-16 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

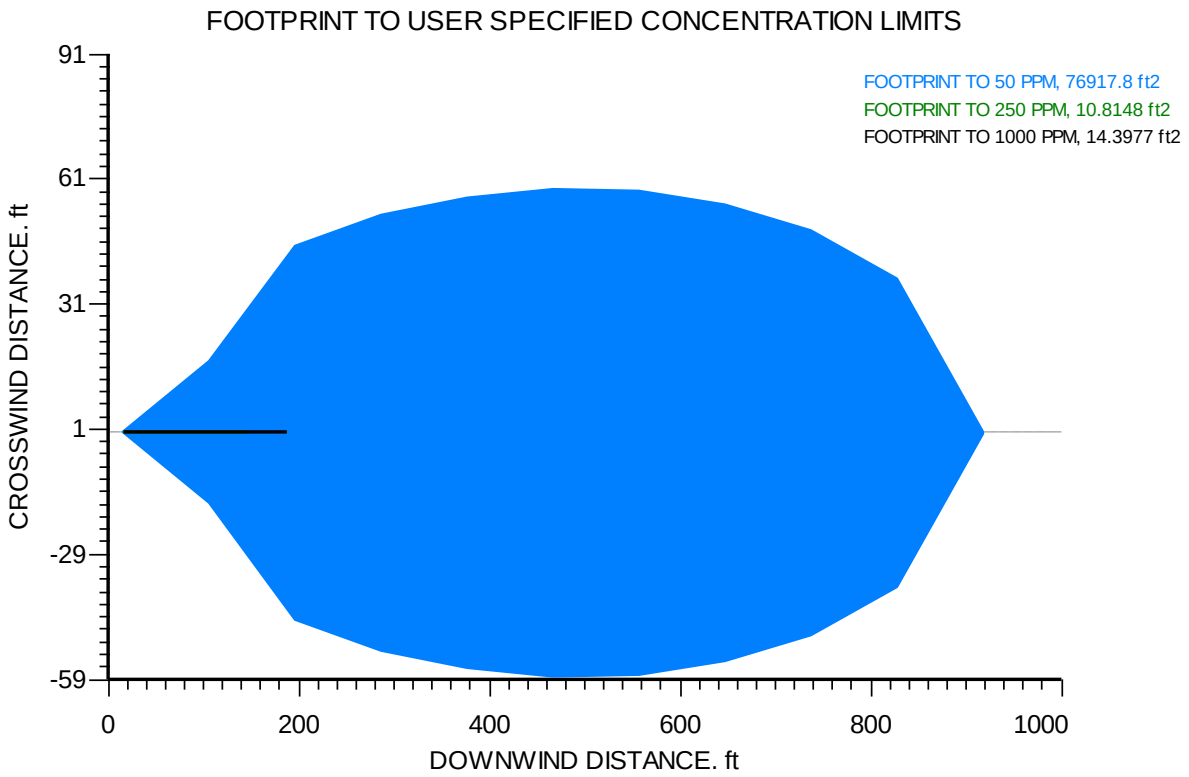


Figure 240: Styrene Evaporation Rate – E-R-16 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

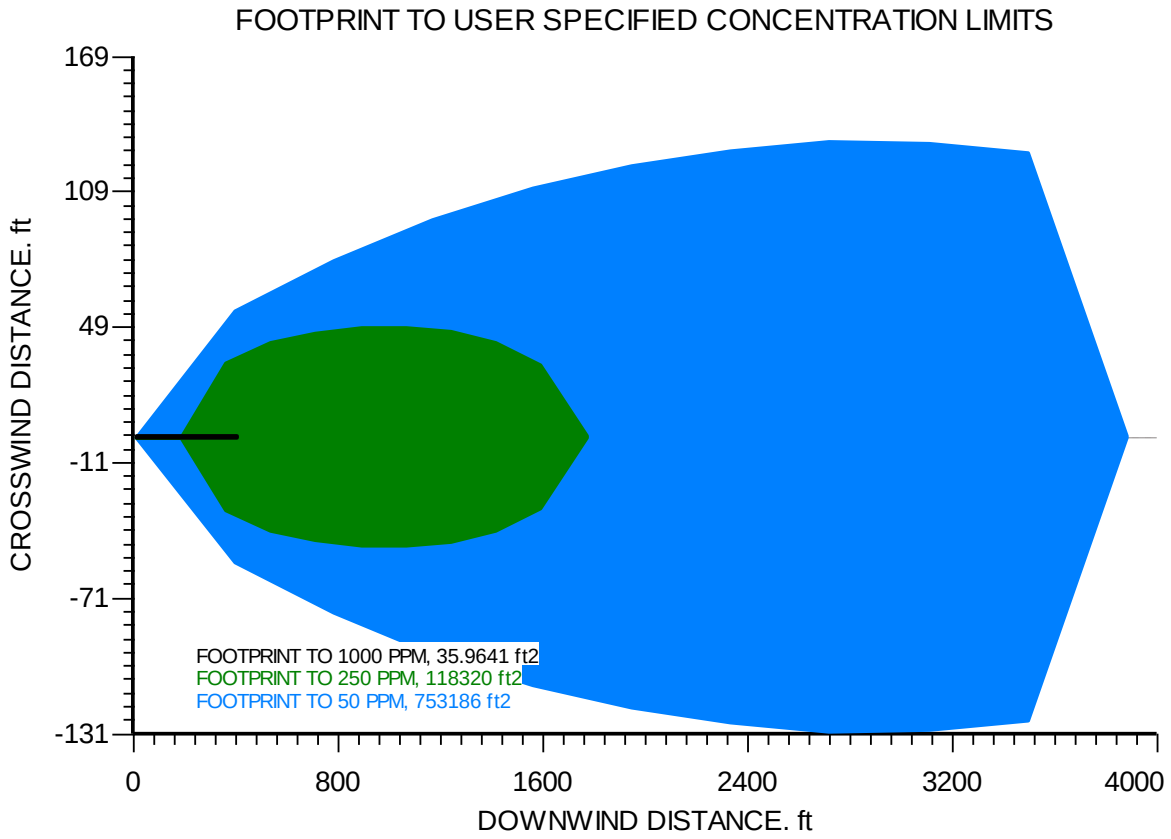


Figure 241: Styrene Evaporation Rate – E-R-16 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

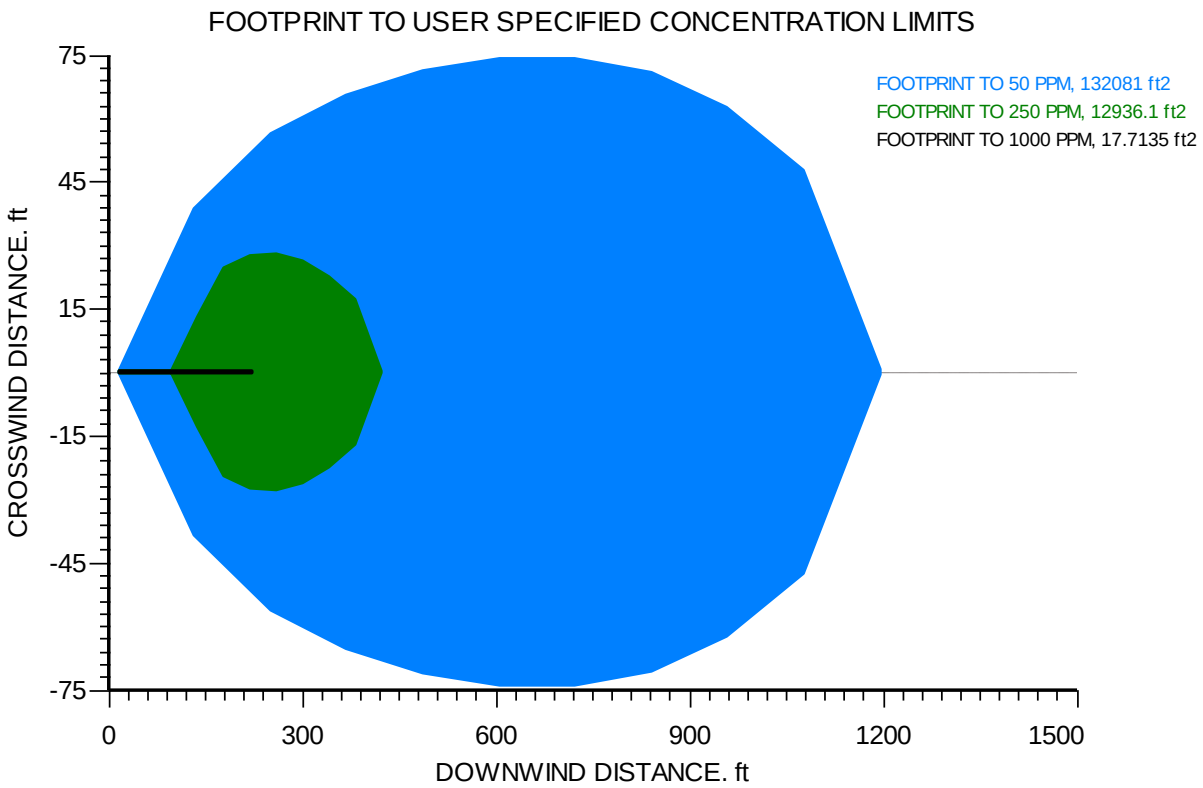


Figure 242: Styrene Evaporation Rate – E-R-16 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

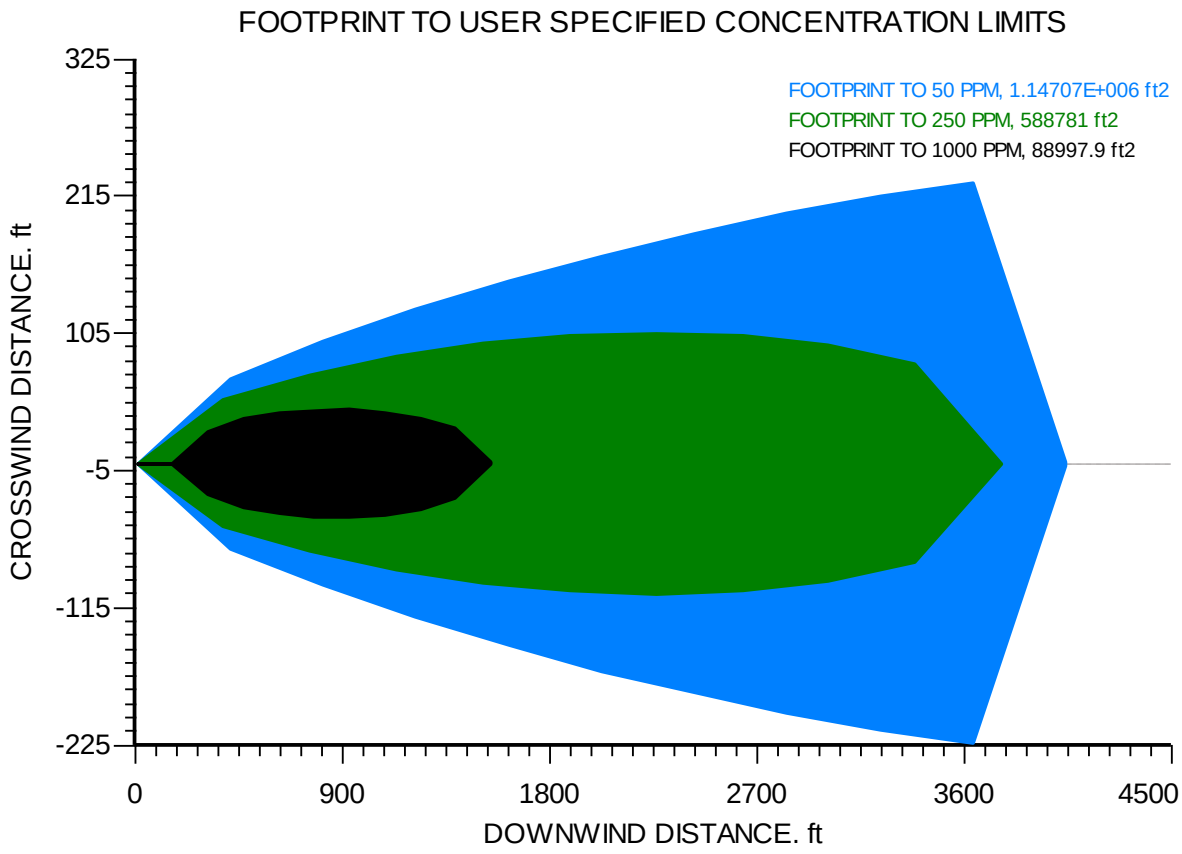


Figure 243: Styrene Evaporation Rate – E-R-16 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

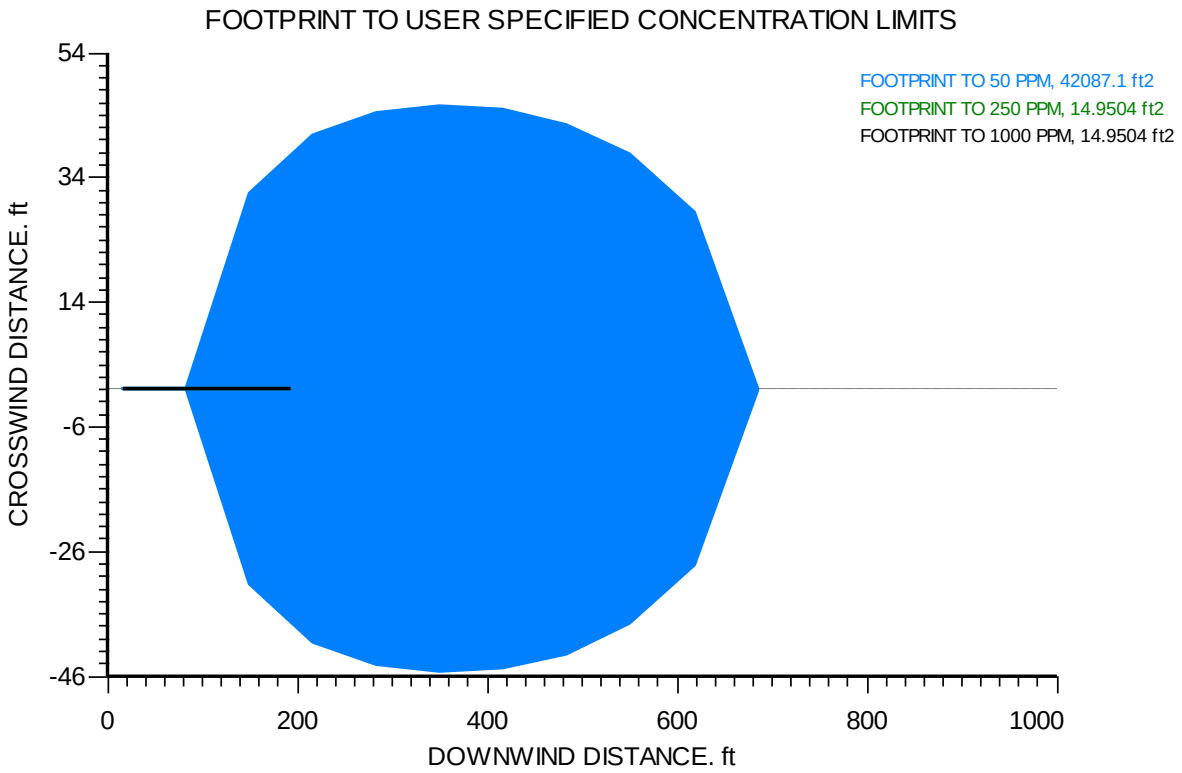
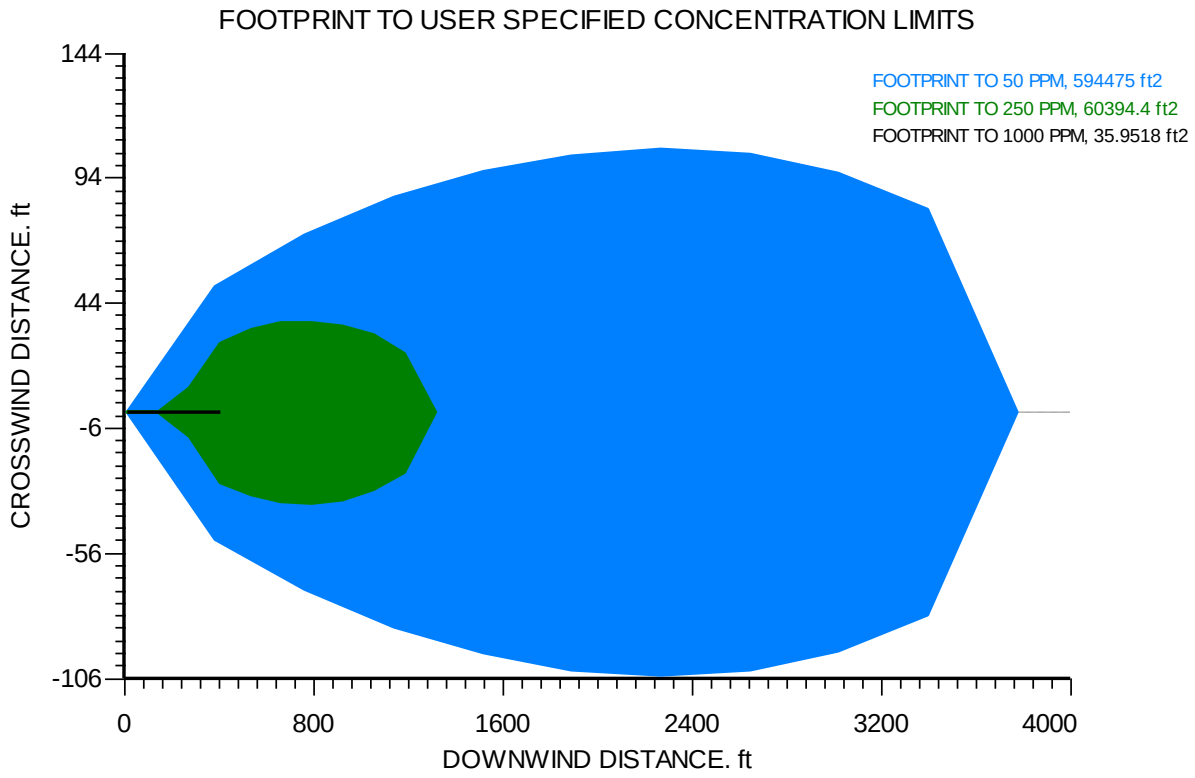


Figure 244: Styrene Evaporation Rate – E-R-16 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix X: Results – E-R-17 Piping Layout to Pit – Styrene Vapor Cloud Dispersion

Figure 245: Styrene Evaporation Rate – E-R-17 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

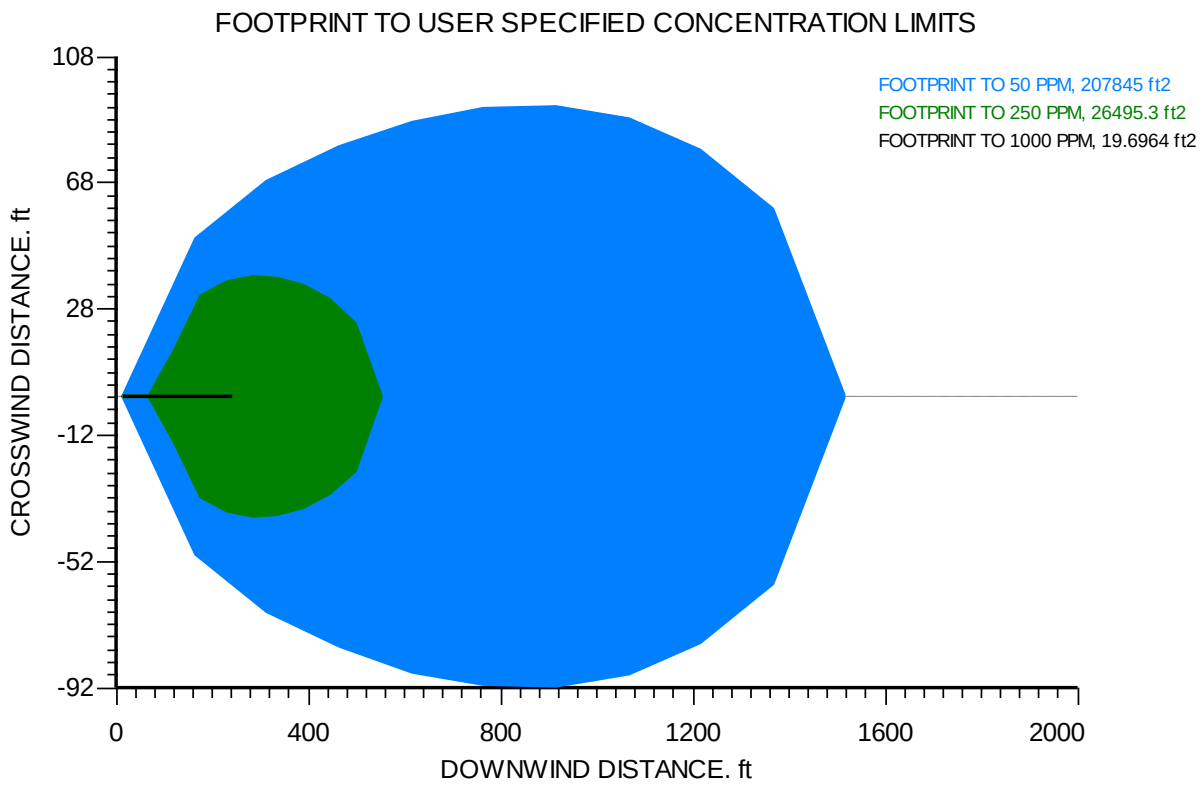


Figure 246: Styrene Evaporation Rate – E-R-17 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

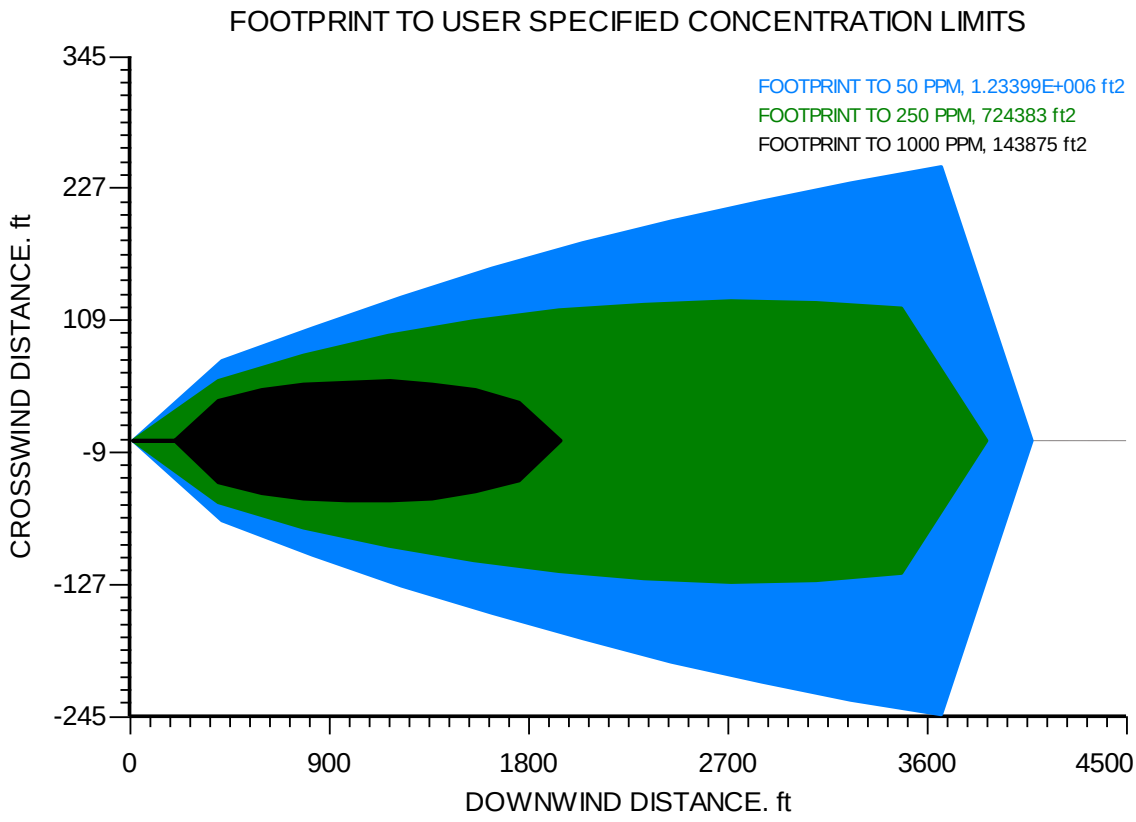


Figure 247: Styrene Evaporation Rate – E-R-17 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

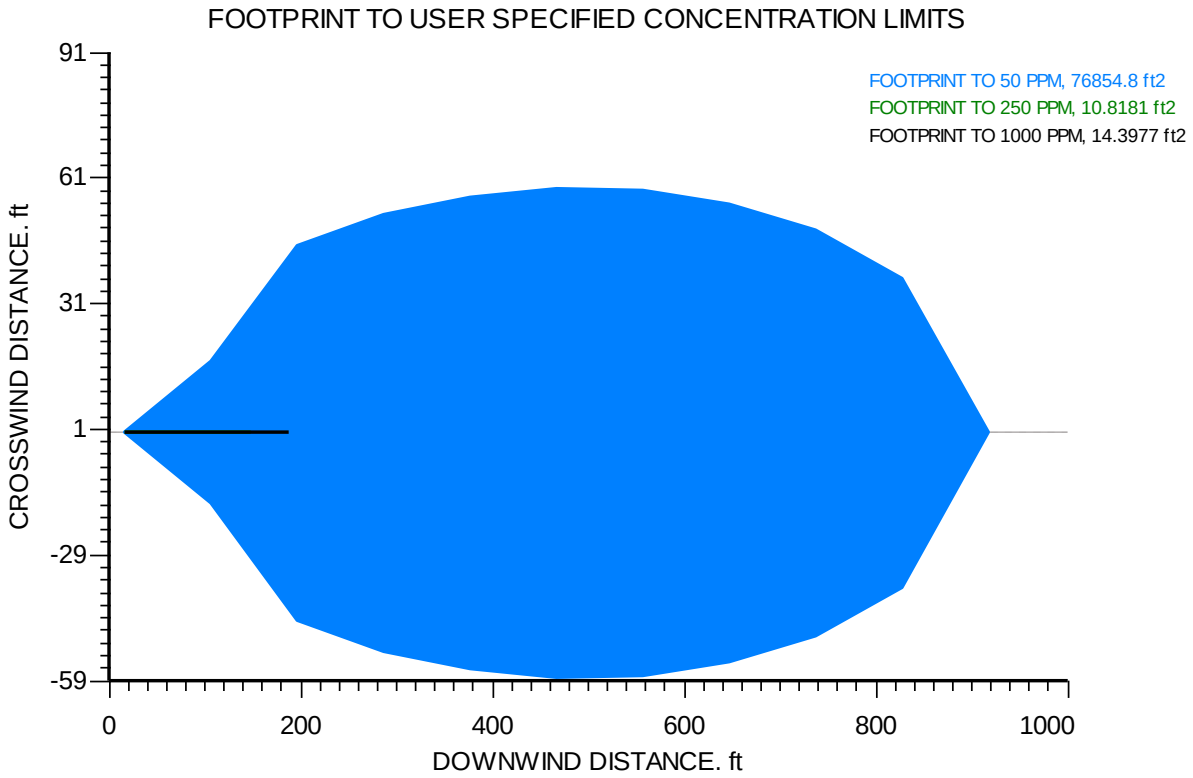


Figure 248: Styrene Evaporation Rate – E-R-17 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

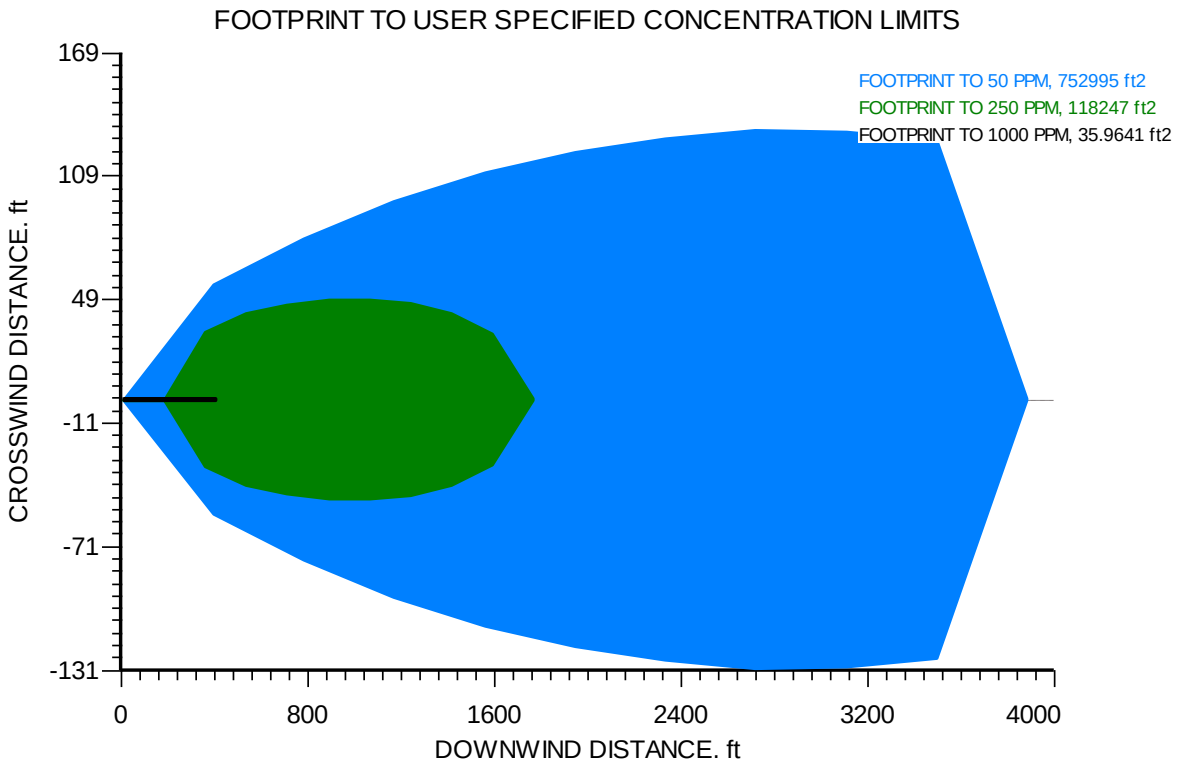


Figure 249: Styrene Evaporation Rate – E-R-17 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

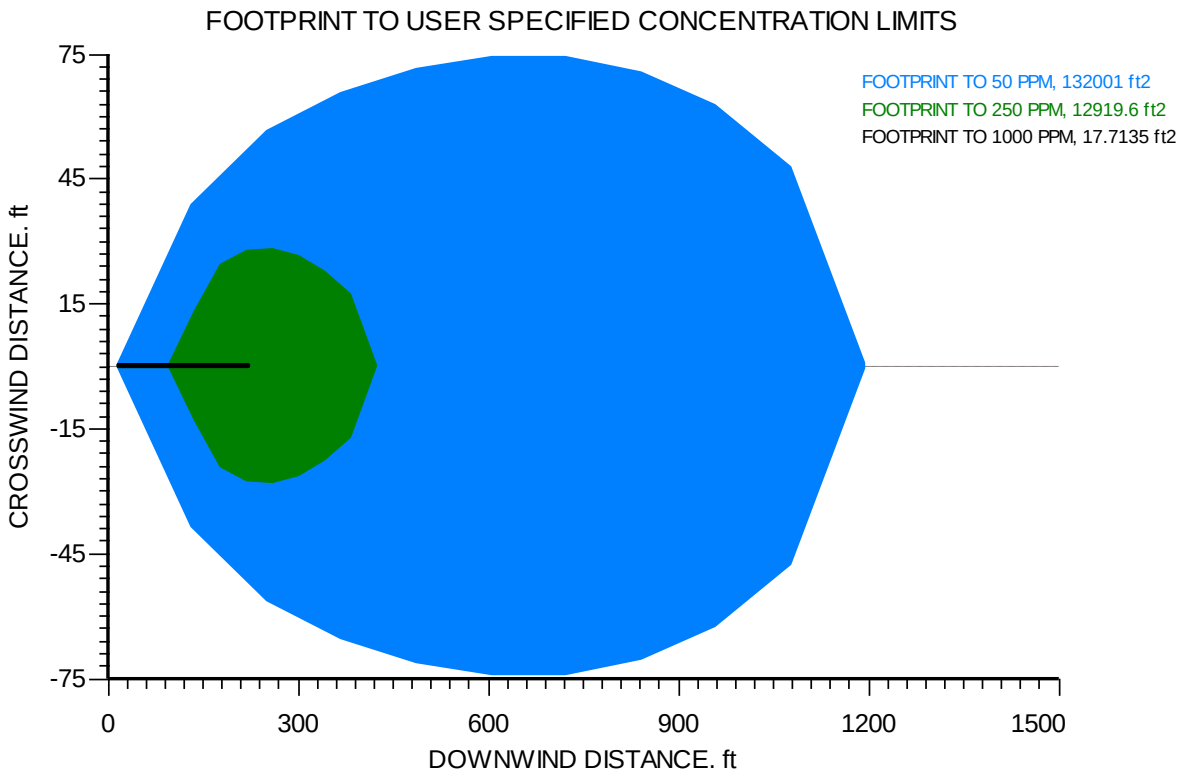


Figure 250: Styrene Evaporation Rate – E-R-17 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

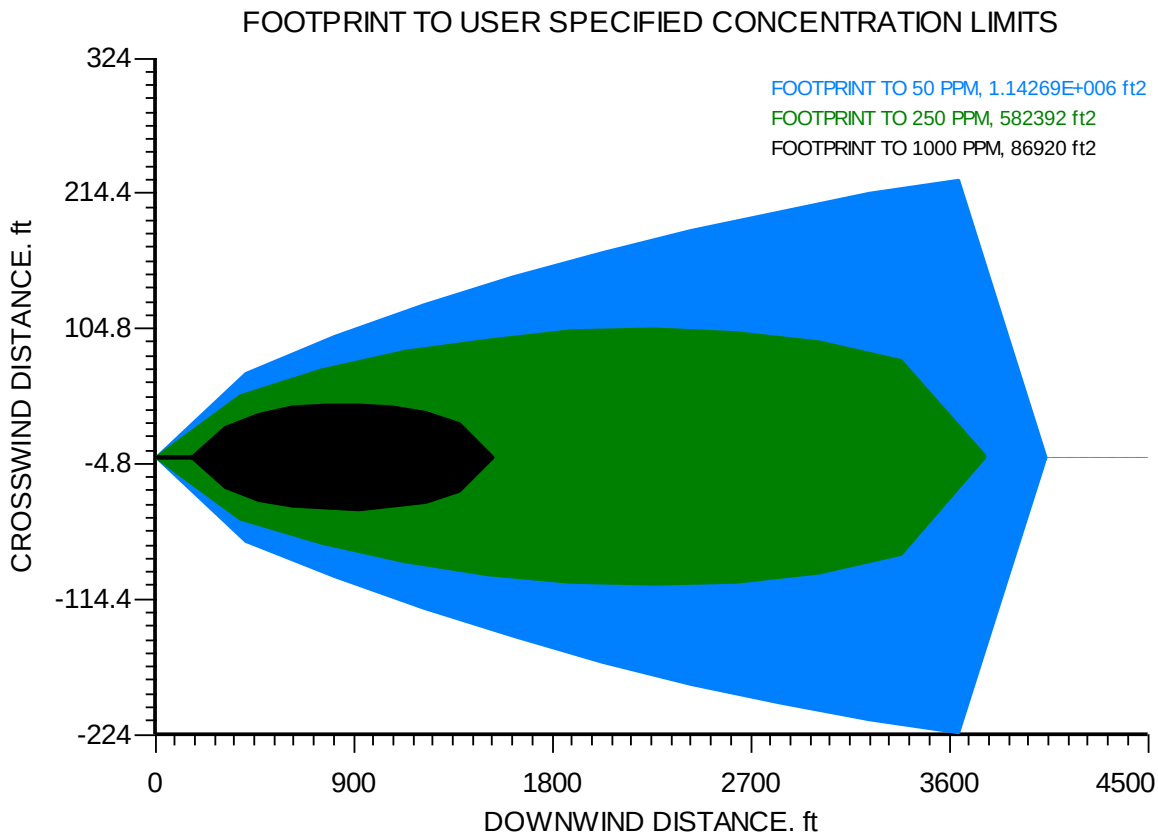


Figure 251: Styrene Evaporation Rate – E-R-17 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

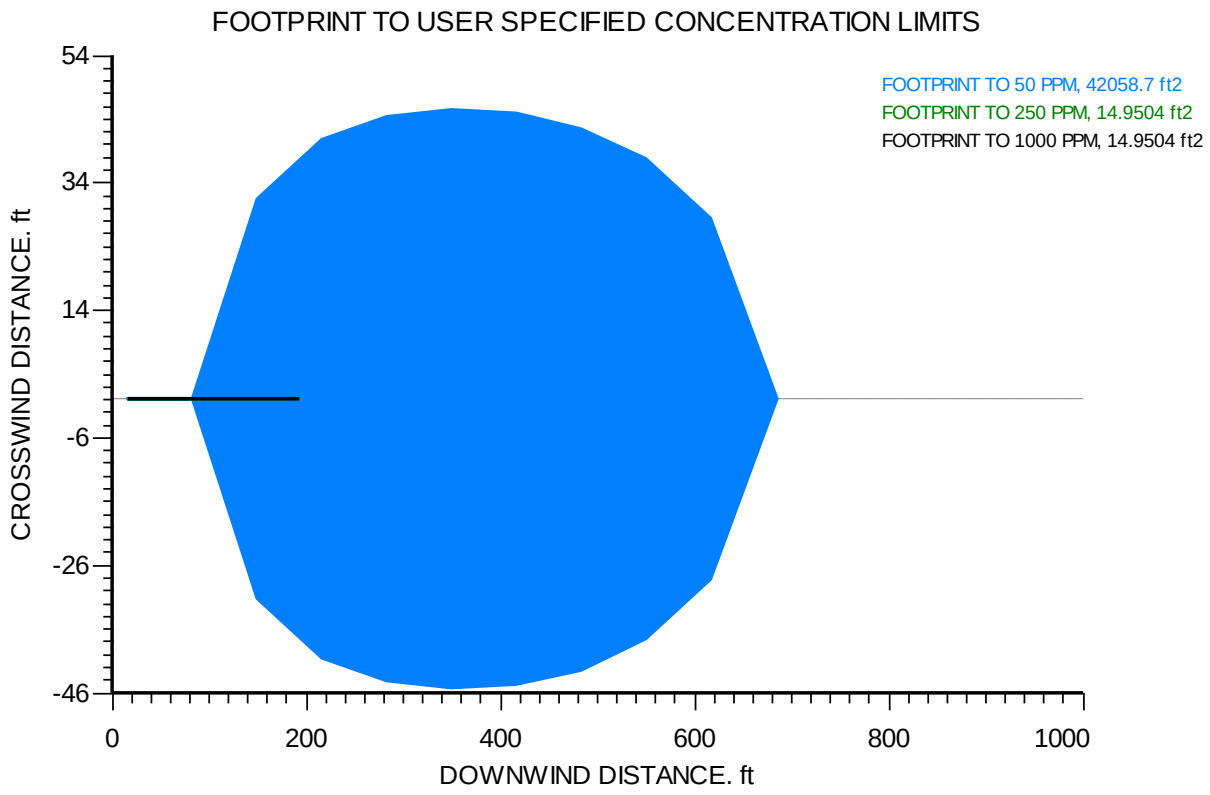
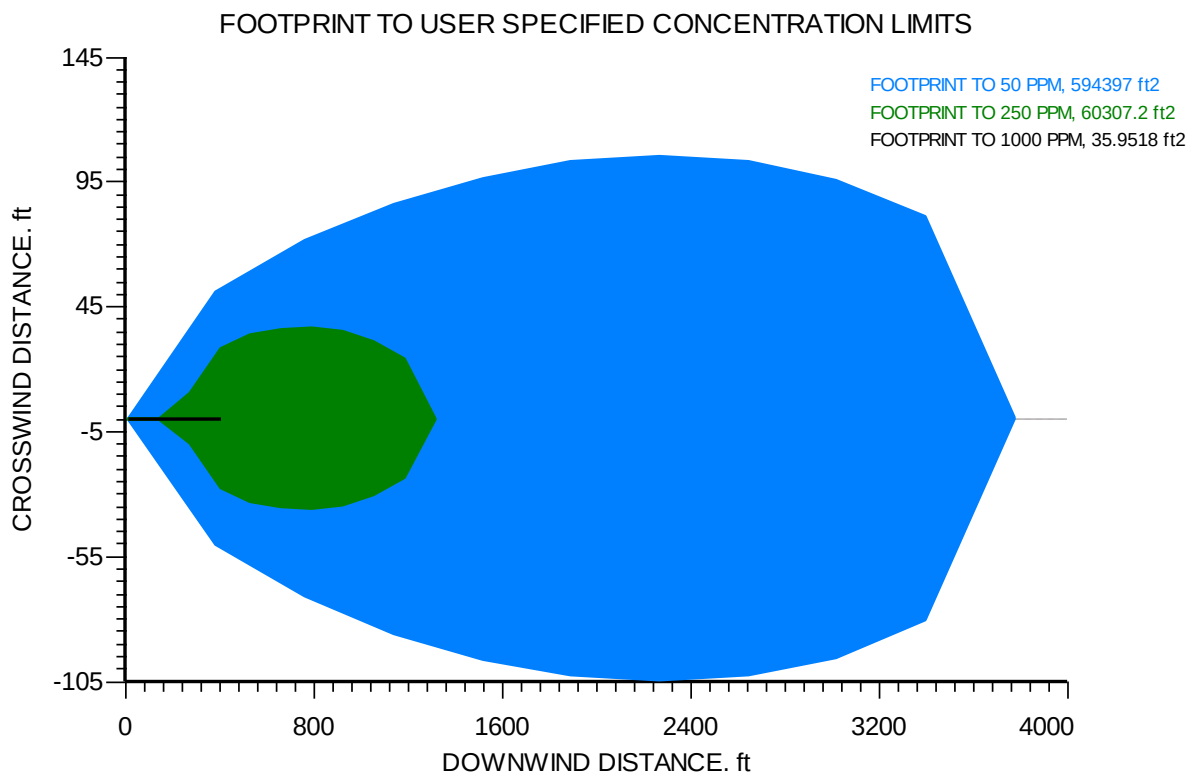


Figure 252: Styrene Evaporation Rate – E-R-17 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix Y: Results – E-R-18 Piping Layout to Pit – Styrene Vapor Cloud Dispersion

Figure 253: Styrene Evaporation Rate – E-R-18 Layout – 0% Reacted; D5 Stability Class; 20 psig and 205°F

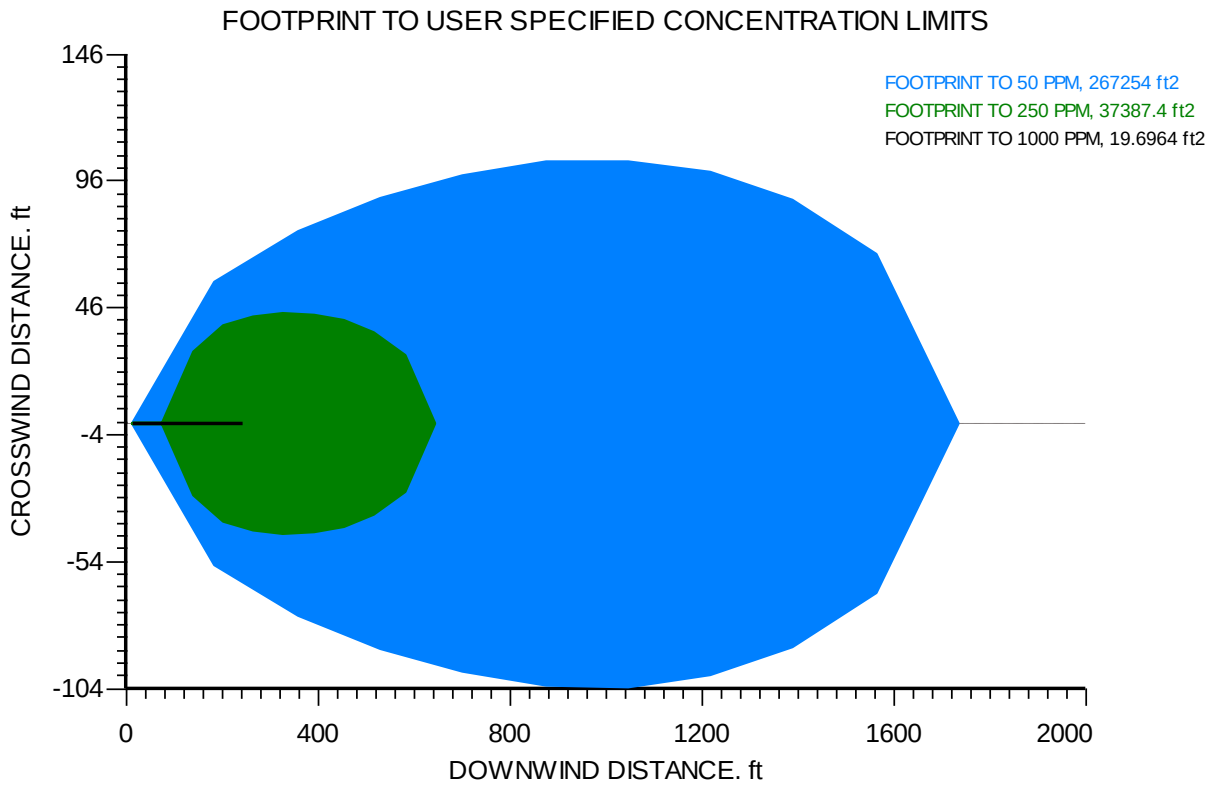


Figure 254: Styrene Evaporation Rate – E-R-18 Layout – 0% Reacted; F2 Stability Class; 20 psig and 205°F

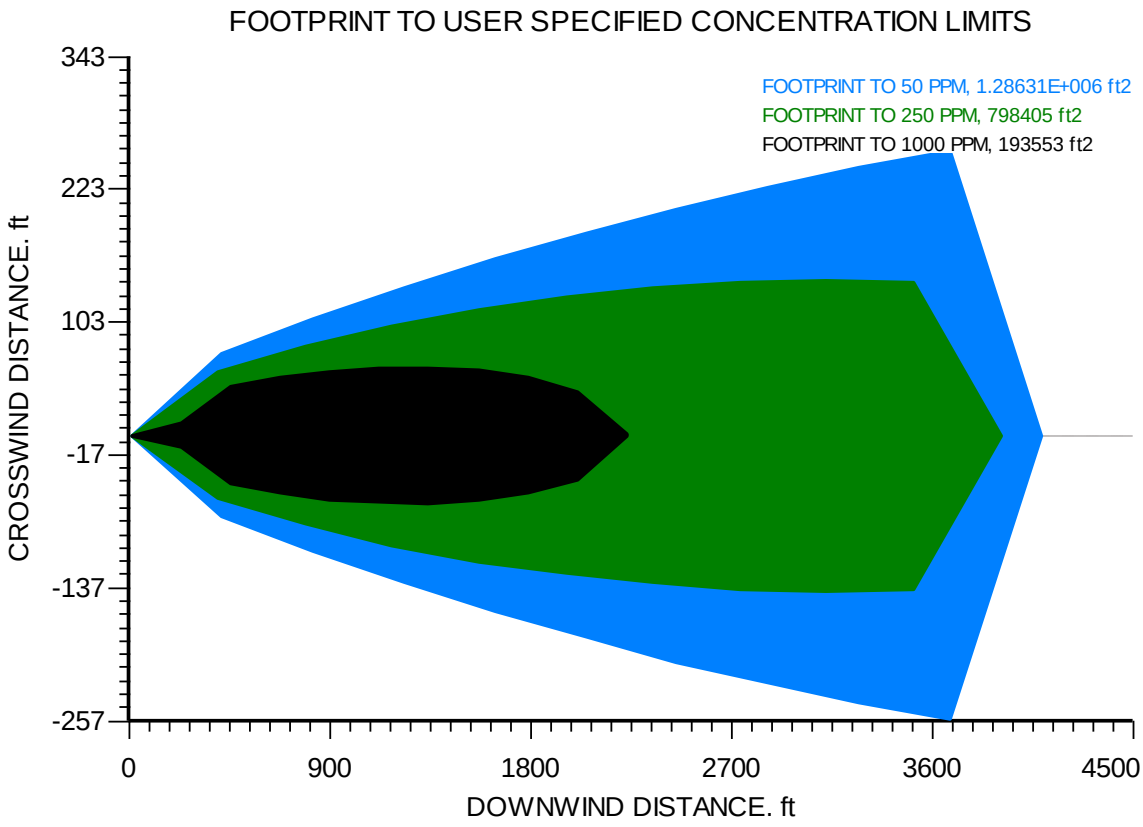


Figure 255: Styrene Evaporation Rate – E-R-18 Layout – 0% Reacted; D5 Stability Class; 5 psig and 210°F

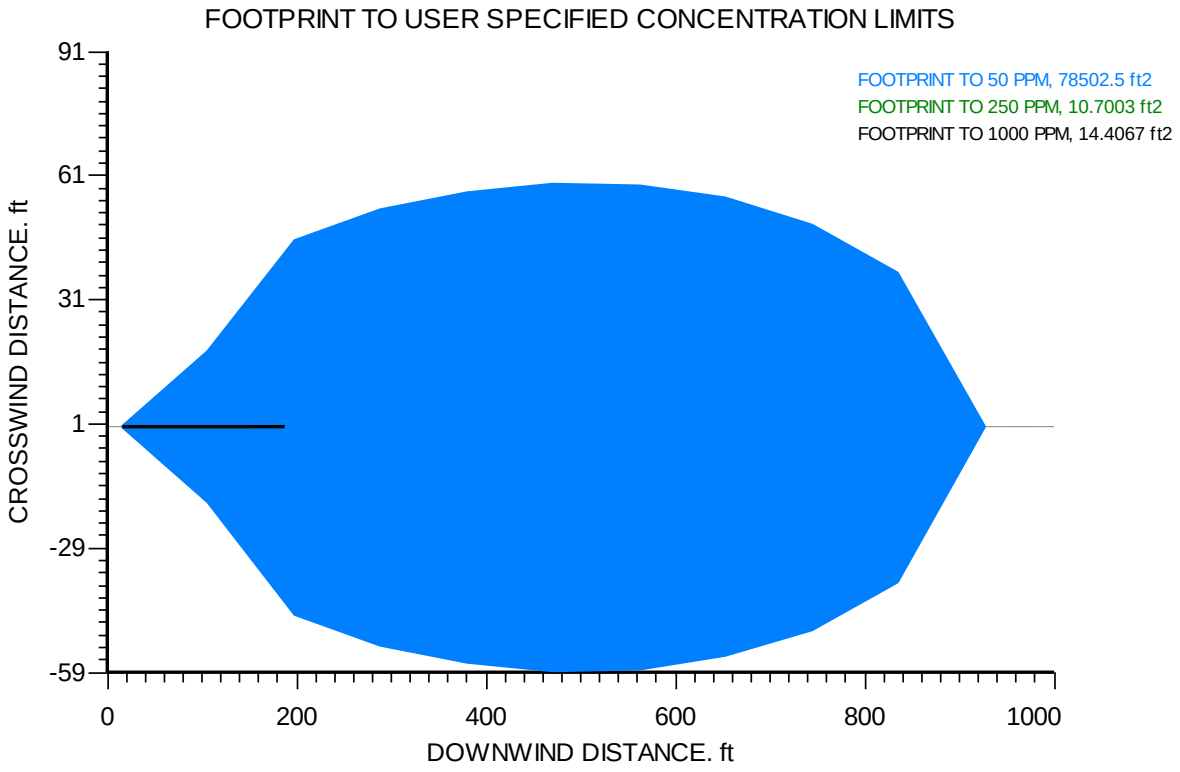


Figure 256: Styrene Evaporation Rate – E-R-18 Layout – 0% Reacted; F2 Stability Class; 5 psig and 210°F

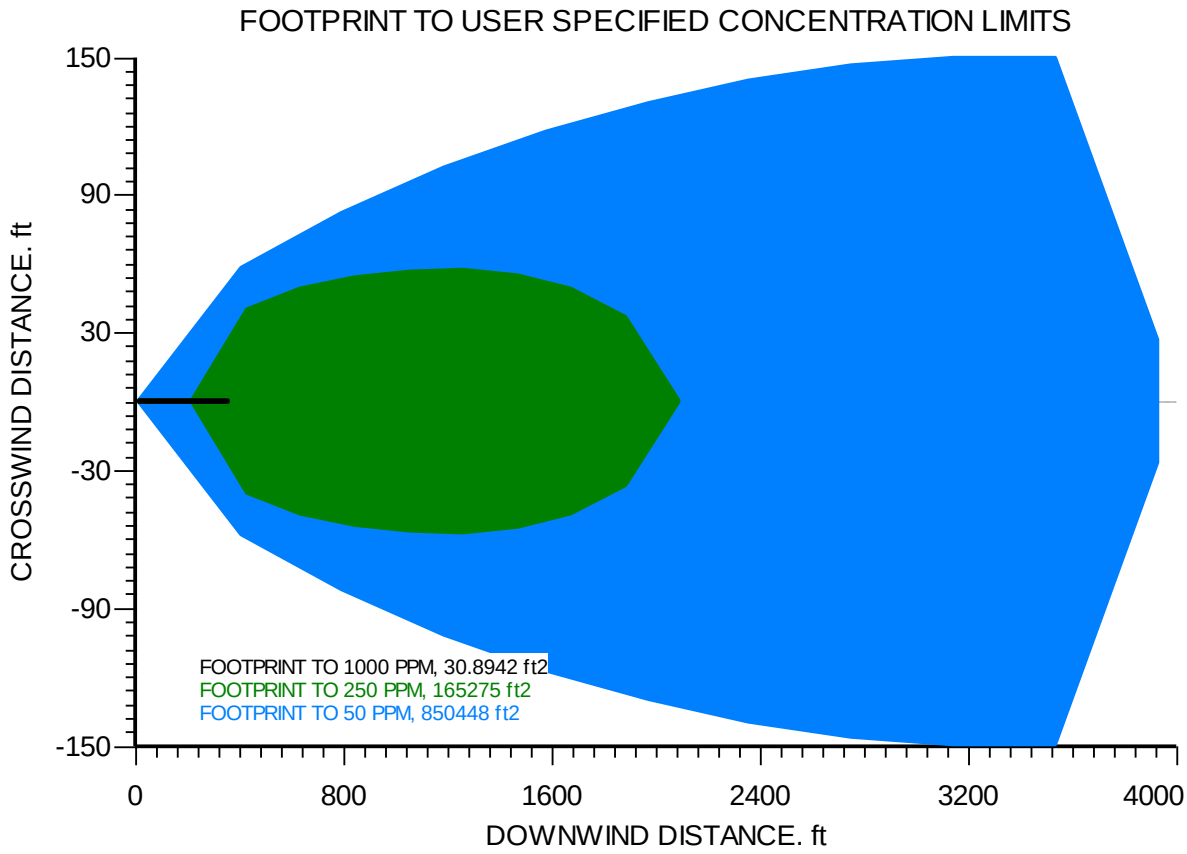


Figure 257: Styrene Evaporation Rate – E-R-18 Layout – 25% Reacted; D5 Stability Class; 20 psig and 205°F

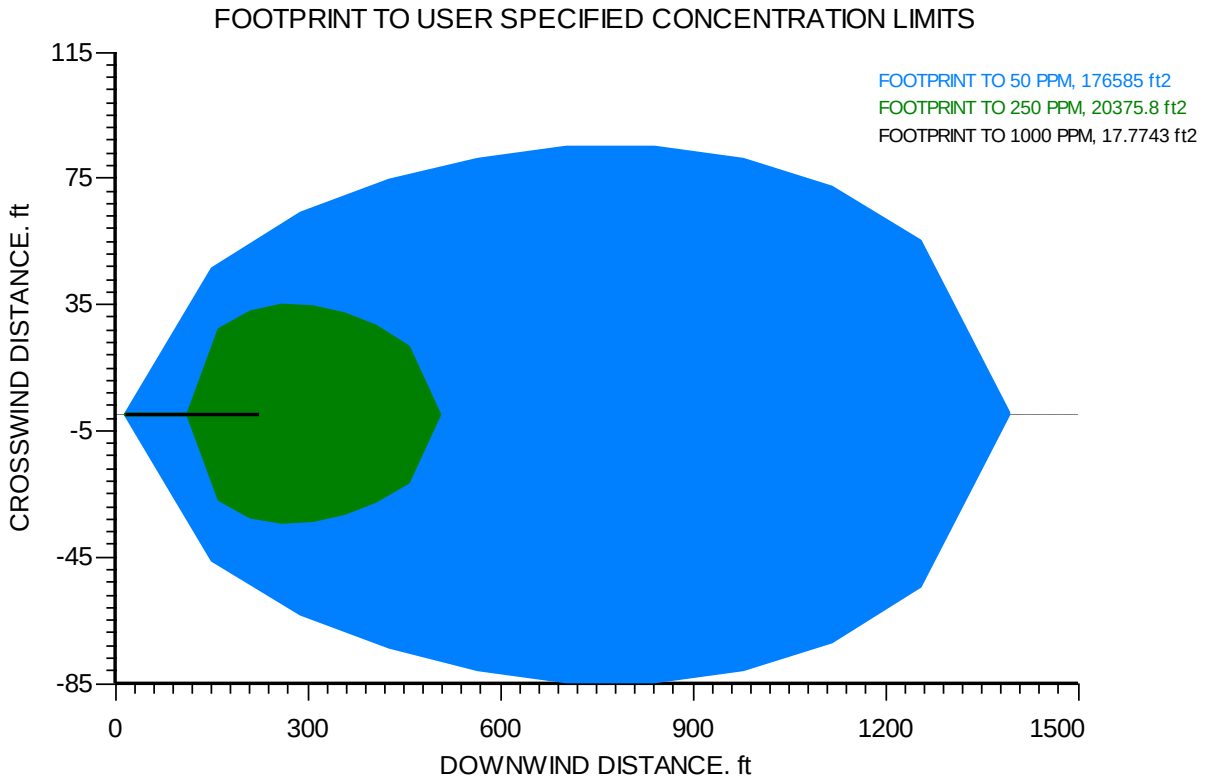


Figure 258: Styrene Evaporation Rate – E-R-18 Layout – 25% Reacted; F2 Stability Class; 20 psig and 205°F

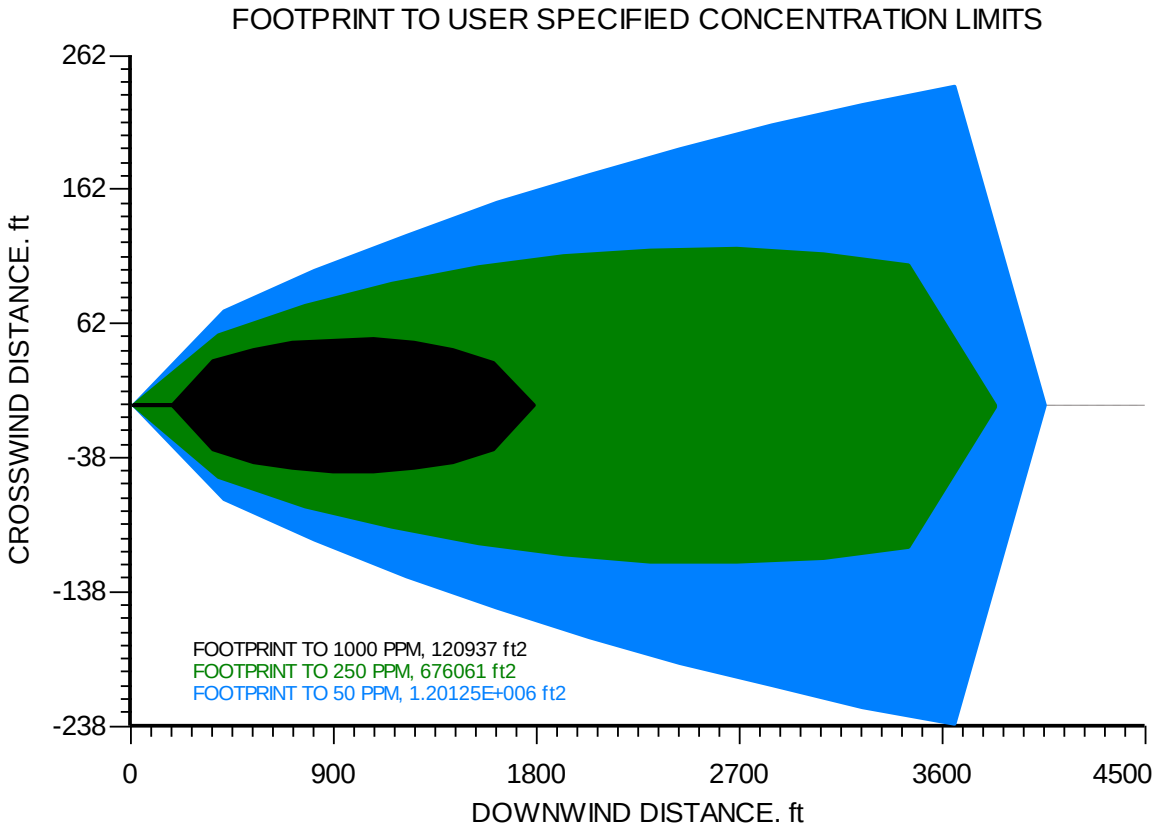


Figure 259: Styrene Evaporation Rate – E-R-18 Layout – 25% Reacted; D5 Stability Class; 5 psig and 210°F

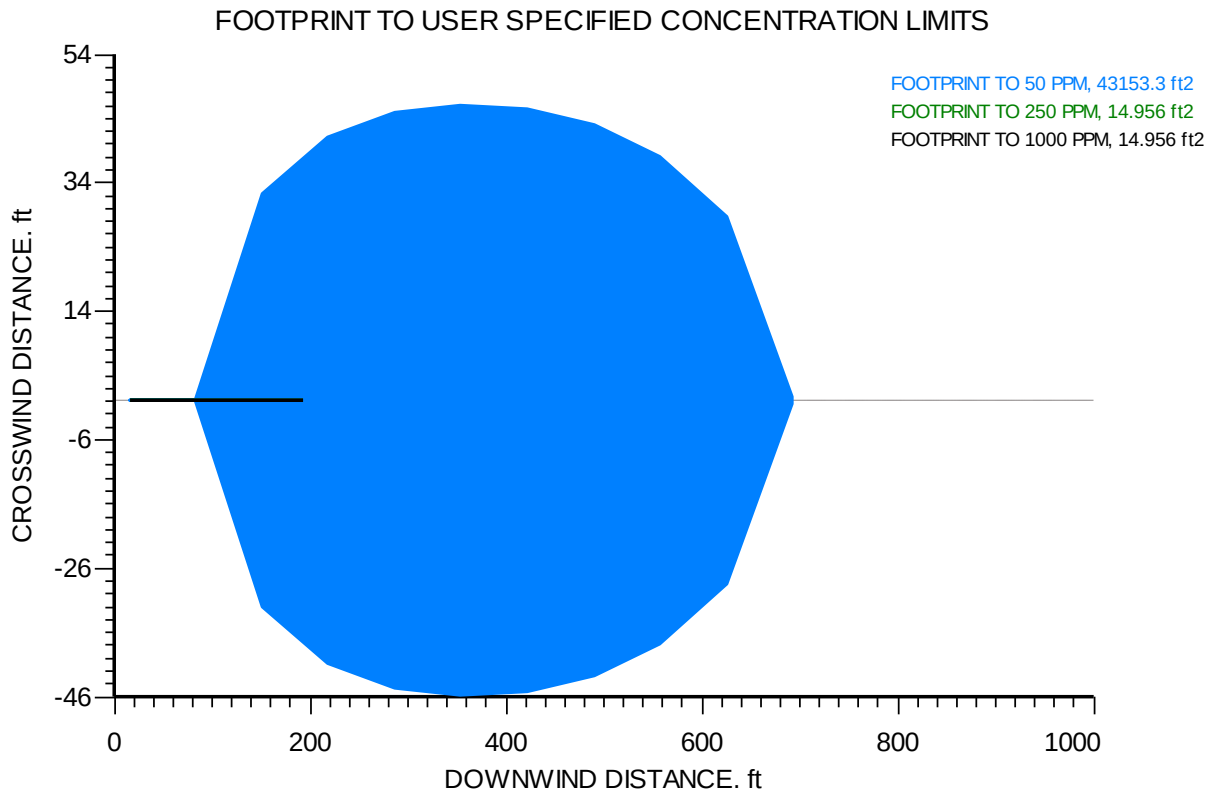
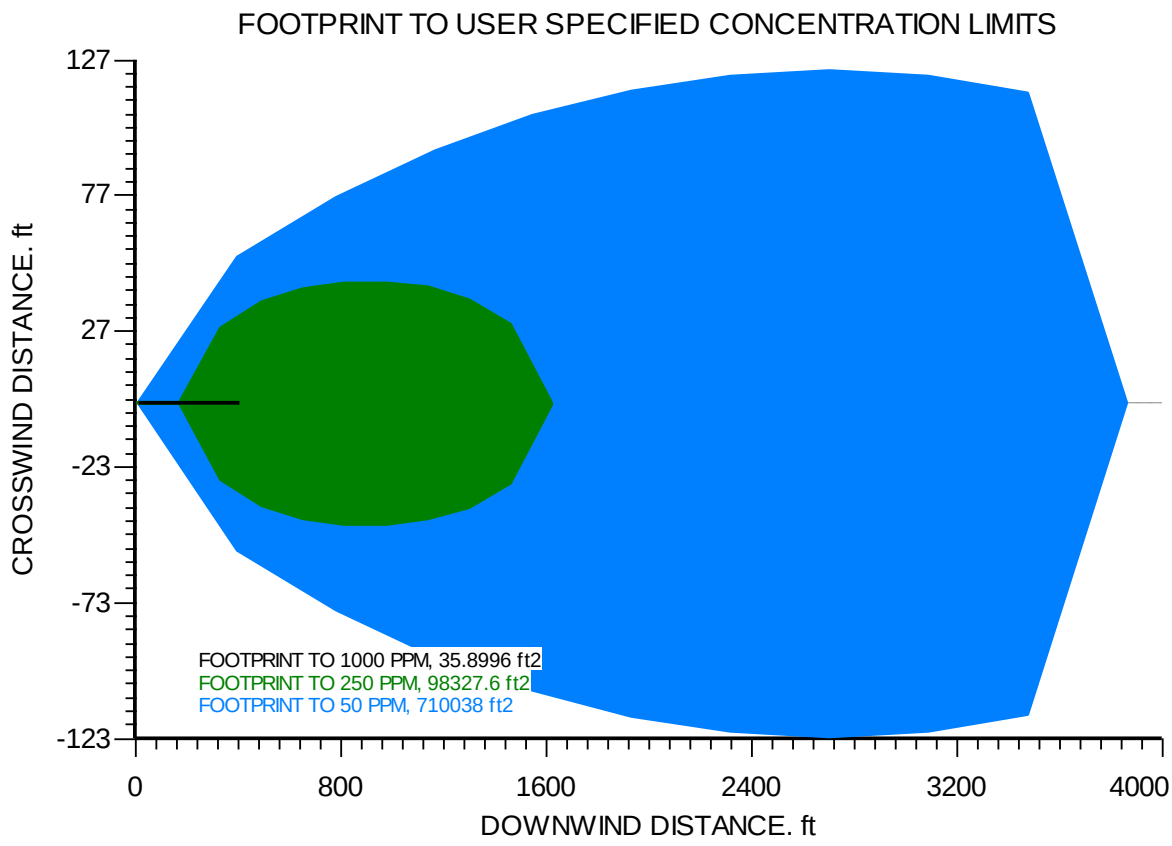


Figure 260: Styrene Evaporation Rate – E-R-18 Layout – 25% Reacted; F2 Stability Class; 5 psig and 210°F



FLINT HILLS resources

PRIVILEGED AND CONFIDENTIAL-PREPARED AT THE REQUEST OF COUNSEL
ATTORNEY-CLIENT PRIVILEGE AND/OR ATTORNEY WORK PRODUCT

MANAGEMENT OF CHANGE FORM

(REFER TO PROCEDURE EHS-I-006 FOR EXPLANATION OF THIS FORM)

PROCESS UNIT/AREA: EPS Reactors/Bldg 4 MOC#: 156640
ORIGINATOR: Greg Medley DATE: 05/07/2014

SECTION A - TECHNICAL BASIS FOR PROPOSED CHANGE

Purpose and Technical Basis:	Modify each of the Building 4 discharge piping down closer to the containment pit to prevent loss of containment. IoMosaic modeled the discharge with different scenarios. The results provided theoretical proof that the contents would flow from the pipes freely without restricting or causing excess back pressure in the pipe.
Description: *Attach additional paper if necessary*	Remove existing discharge end piping and install 14 inch 90 degree elbow directed parallel to Building 4 to end at the top level of the pit concrete wall. The vertical pipe will be increased to 20 inch pipe with a 45 degree elbow on the end. The total vertical length from the end of the 90 degree elbow to the bottom of the 45 degree elbow will be 18 feet. Connections will be flanged and follow Piping Line Specification 150FBT. The 45 degree outlet will be directed to the center of the pit. Piping flanges will be grounded. Pipe supporting is being designed by JL Meece and will be field fit. R16 and R17 14 inch horizontal legs and reducers will be stored back from CS and homemade to the pipe specification.
Impact of change On Environmental Health / Safety:	Prevent loss of containment and reduce emissions based on ioMosaic model.

SECTION B - DOCUMENTATION - *Attach appropriate documentation illustrating proposed changes*

☐	Procedures	☐	Inspections, Testing, PM's	☐	Engineering DWGS	☐	PHA'S
☐	PSM Documentation	☒	CHEMGEMS Specifications	☒	P&ID's	☐	MI Applicability Checklist
☐	MSDS Information	☐	Energy Control Plans	☐	PFD's		
☐	Training/Communication	☐	Floor Plans	☐	LDAR		
☐	Quality Issues	☐	Mechanical Integrity DWGS	☐	Site/Plot Plan	☐	OJT's
☐	Customer Impact	☐	Electrical Schematics	☐	Electrical Single Lines	☐	JSA's
☐	Alarm Response Tables	☐	Loop DWGS	☐	Elect'l Classification	☐	Other

Affected Personnel Needing To Be Informed/Trained On Proposed Change

☐	Operations	☐	I/E Technicians	☐	Community
☐	Production Facilitators	☐	Engineering	☐	Regulatory Entities
☐	Mechanics/Welders	☐	Contractor(s)	☐	Corporate
☐	Electricians	☐	Office Personnel	☐	Other

SECTION C - Is Change Permanent?

☒	**YES**	**Proposed Project Start Date** **05/08/2014**
☐	**NO**	**Proposed Project Completion Date** **06/30/2014**

SECTION D - Is Change Temporary ?

☐	**YES**	**From:**
☒	**NO**	**To:**

SECTION E - Is Change Emergency ?

☐	**Yes**	**Start:**
☒	**NO**	

Approval Received From:

☐ Ops. Mgr./Designee ☐ Env. Eng./Designee
☐ Plant Mgr./Designee (if requested) ☐ Technical Services Mgr./Designee
☐ H&S Mgr./Specialist ☐ Area Mgr./Designee

Approval Received By: _____

Returned To Original Service: ____/____/____

Area Mgr./Designee Signature: _____

Extended To: ____/____/____*

Plant Managers Approval:

Plant Mgr./

Signature *Date*

*Note: Temporary MOCAs may be extended up to 6 months at

SECTION F - DESIGN SAFETY REVIEW

PHA. Does the proposed change require a PHA? (i.e. What-if/Checklist, Hazop, Revalidation, Review) If yes indicate type of PHA in Action to be Taken section.	☐YES	☒NO
PSSR. Does the proposed change require a Pre-Start-up Safety Review (PSSR)? See EHS-I-067 for Requirements. Mandatory if change involves DCS Interface.	☒YES	☐NO

1. RELIEF AND BLOWDOWN

Does the Proposed Change:	YES	NO
1. Introduce or alter any potential cause of over/under pressurizing of the system?	☐	☒
2. In any way affect existing equipment installed to prevent over/under pressurization?	☐	☒
3. Introduce or alter any potential cause of raising/lowering the system temperature?	☐	☒
4. Introduce a risk of creating/reducing vacuum in the system?	☐	☒
5. Have any critical relief devices been identified for verification of proper rating and installation?	☐	☒

2. AREA CLASSIFICATION

Does the Proposed Change:	YES	NO
1. Introduce or alter the storage of flammable materials?	☐	☒
2. Introduce or alter the location of potential leaks of flammable materials?	☐	☒
3. Introduce new or alter existing electrical equipment?	☐	☒
4. Affect area ventilation?	☐	☒
5. Has the established building electrical classification been changed?	☐	☒

3. SAFETY CONSIDERATIONS

Does the Proposed Change:	YES	NO
1. Require any additional safety equipment or layers of protection?	☐	☒
2. Alter or affect existing safety equipment or means of egress?	☐	☒
3. Require changes to the function or independence of existing equipment or layers of protection?	☐	☒
4. Alter or affect critical safety instrumented functions (SIF's)?	☐	☒
5. Alter the noise level in the surrounding area?	☐	☒
6. Increase the potential for exposure to any chemicals?	☐	☒
7. Introduce a new or previously unused chemical/raw material?	☐	☒
8. Affect de-energization? (able to lock-out, drain materials)	☐	☒
9. Create any ergonomic concerns?	☐	☒
10. Affect the Battery Limit Valves (BLV)?	☐	☒
11. Affect the overall security of the facility?	☐	☒
12. Does this increase the risk of potential impact to plant personnel (employees and contractors)?	☐	☒
13. Does the proposed change affect facility siting relative to both people and equipment in any of the following situations: temporary changes, before startup after a permanent change, or before startup after temporary change has been removed/closed/returned to original condition?	☐	☒
14. If the proposed change affects replacement or demolition of piping or conduit, will the entire run be identified and clearly marked prior to work, to ensure safe work activity?	☐	☒
15. Affect the safe transport of hazardous material? For ex., introducing a new hazardous material for transport or changing the method of transportation of the hazardous material.	☐	☒

4. ENVIRONMENTAL CONSIDERATIONS**

	YES	NO
1. Will there be a potential increase in the maximum production rate, which exceeds the currently permitted design capacity of the facility?	☐	☒
2. Will the replacement or modification change any of the basic parameters of the process unit, such as temperature, pressure, etc?	☐	☒
3. Will the change cause increased emissions of regulated pollutants during installation, implementation, or during operations?	☐	☒
4. Will there be any new vents added?	☐	☒
5. Will the change add, remove or modify any permitted emission units (*Example: reactors, wash tanks, dryers, centrifuges, packout bins, screening towers, or styrene or pentane storage.*)?	☐	☒
6. Will the project include the installation of a stationary engine with a ≤ 500 hp? If so, a non-resettable hour meter shall be installed to record operational hours and PMs shall be consistent with RICE NESHAP regulations and the manufacturer's recommended preventative maintenance.	☐	☒
7. Will the project results in the increase in Facility's total throughput of natural gas?	☐	☒
8. Is there the potential to generate a new waste or increase the quantity of an existing waste?	☐	☒

SECTION F - DESIGN SAFETY REVIEW -- cont.

4. ENVIRONMENTAL CONSIDERATIONS** - - cont.

9. Will there be a change in the wastewater characteristics? If the project causes an increase to the discharge of wastewater to the Public Sanitary District, provide calculations with the MOC.	☐	☒
10. Does the project add or remove LDAR Components (Pumps, PRVs, Valves, and Connectors) that come in contact with styrene or pentane?	☐	☒
11. Does the project increase risk to off-site residential & environmental receptors?	☐	☒
12. Will the change affect the control of processes?	☐	☒
13. Will the change affect the composition or physical properties of the final product?	☐	☒
14. Will new chemicals be brought onsite anytime during the project?	☐	☒
15. Does an evaluation of chemical compatibility need to be conducted during the project?	☐	☒
16. Will the project involve decommissioning or demolition of equipment or structure?	☐	☒
17. If yes to 16, does National Emissions Standards for Hazardous Air Pollutants (NESHAP) or deconstruction permit apply?	☐	☐
18. Will this project require a portable engine?	☐	☒

** Consult with Environmental Engineer for completion of this section.

5. OPERATION AND DESIGN

Does the Proposed Change:	YES	NO
1. Affect the process or equipment upstream/downstream of the change?	☐	☒
2. Affect access to process or equipment/controls for personnel?	☐	☒
3. Introduce any new or affect existing interlocks or alarms systems?	☐	☒
4. Affect manpower or qualified personnel?	☐	☒
5. Affect the loads/strengths of existing foundations, structures, vessels, or pipe racks?	☒	☐
6. Impact requirements of existing or proposed piping supports? *(Needs to be adequately designed for expected stresses due to pressure and thermal loadings.)*	☒	☐
7. Alter the DCS/Software logic of process operations?	☐	☒
8. Affect process chemistry? (reactivity/compatibility)	☐	☒
9. Affect maximum intended inventory, which would require updating maximum inventory tables?	☐	☒
10. Affect safe upper/lower limits for such items as temperature, process flows or compositions?	☐	☒
11. Affect material/energy balances?	☐	☒
12. Affect plant utility resources? (i.e. steam, water, electricity, etc.)	☐	☒
13. Affect equipment with heat-up/cool-down cycling requiring bolt retightening after start-up?	☐	☒
14. Is an exception/revision to design codes or standards (CHEM-GEMS, etc.) required?	☐	☒

SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION

Will the Proposed Change:	YES	NO
1. Introduce new or impact existing operational procedures? *	☐	☒
2. Introduce new or impact existing maintenance procedures? *	☐	☒
3. Add or Remove equipment/instrumentation? *(Contact MST to assign Equipment/Instrumentation Location Numbers. If equipment/instrumentation is being added, MI Applicability Checklist MNT-F-161 shall be completed by MOC originator, and approval form(s) sent to the MI coordinator.)*	☐	☒
4. Revise equipment preventative maintenance/ inspections, job plans , and/or frequencies?	☐	☒
5. Require additional training for operational or maintenance personnel? *(requires completion of Leaning and Development Job Aid addendum A)*	☐	☒
6. Require additional notification for operational or maintenance personnel?	☐	☒
7. Require updating controlled drawings? * *(PFD'S, LDAR, P&ID's, Floor Plans, Electrical Single Lines, Loop Drawings/Electrical Schematics, MCC arrangement, MI Iso Drawings)*	☒	☐
8. Require updating equipment files? *(Engineering, Maintenance, Manufacturers Inspect/Test results)*	☐	☒
9. Require a spare parts list and inventory to be developed?	☐	☒
10. Require major project spare equipment to be turned over to maintenance?	☐	☒
11. Require equipment labeling in the field?	☐	☒
12. Require updating of Alarm Response Tables? *	☐	☒
13. Require a new/modification of existing energy control plans? *	☐	☒

SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION –cont'd		
14. Cause any PSM/RMP applicability issues?	☐	☒
15. Cause a change in PSM/RMP program level?	☐	☒
16. Will this change have any effect on the overall plant facility siting issues?	☐	☒
17. Increase or decrease the impact contour for worst-case scenario by a factor of two or more?	☐	☒
18. Will this MOC supersede /interfere with any other Temporary/Emergency/Permanent MOC's?	☐	☒
19. Is there a need to update the EPS-I-004, Chemical Compatibility Matrix?	☐	☒
20. Is a Layer of Protection Analysis (LOPA) study required?	☐	☒
21. Will this affect the Interlock Matrix?	☐	☒
22. Require updating of electrical energy consumption spreadsheet? Update required for any MCC, CB panel or bus bar connection additions or alterations.	☐	☒
23. Will this change impact Proprietary Technology including product, process, equipment, technical data, or other trade secret information licensed to FHR by third parties" If yes, contact the Proprietary Technology Coordinator.	☐	☒
*** NOTE: Refer to Engineering Equipment Location Database for a list of affected documents, sorted by Location Number.**		

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Any questions with a 'YES' answer, requires follow-up activity.
List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'

Item No.	Action To Be Completed Prior to PSSR	Responsible Party	Target Completion Date
F-PSSR	Conduct PSSR.	Medley	06/30/2014
F-5-5	JL Meece provide piping support design.	Medley	06/30/2014
F-5-6	JL Meece provide piping support design.	Medley	06/30/2014
G-7a	Provide redline P&ID.	Medley	06/29/2014

Any questions with a 'YES' answer, requires follow-up activity.
List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'

Item No.	Action To Be Completed After PSSR	Responsible Party	Target Completion Date
G-76	Revise P&ID.	Grant	09/30/2014

MOC APPROVAL FORM

Originator: Greg Medley **MOC No.** 156640

MOC Packet Completeness Verification Review

Title/Position	Verification Review Signatures	Date
Drafting Tech, or Designee		5-9-14
MI Coordinator, or Designee		5-9-14
Maintenance Tech from appropriate area		5-9-14
Operator from affected area		5-9-14
Area Training Contact, or Designee		5-9-14

Signatures required Prior To Implementation of MOC.

Title/Position	Authorizing Signatures	Date
Area Manager/Facilitator or Designee		5-9-14
Technical Services Manager or Designee		5/9/14
Pilot Plant / QC Manager (If Applicable)	N/A	
H&S Specialist or Designee	Mary Steinbach	5-10-14
Operations Manager or Designee		5-9-14
Environment Engineer or Designee		5/9/14

Other Reviewers
(as requested by any of the Authorizing signers)

Title/Position	Review Signature	Date
Plant Manager or Designee		
Electrical Engineer		

VERIFICATION OF MOC CLOSURE

By signing below:

1. The Originator of this MOC confirms that all action items have been completed & that equipment/documentation in this change is set to start up.
2.

MOC closure requires the Originators Signature

MOC Originator: Date:_____

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SERVICE: STYRENE, DEMINERALIZED WATER

RATING:	CORR. ALLOWANCE:	MATERIAL:	VALVE TRIM:
ASME B16.5 CLASS 150,RF	0.000 INCH	304L SS	316L SS

ITEM	NOTES	SIZE (NPS)	SCH/RAT	ENDS	DESCRIPTION	STOCK CODE
PIPE	AAA, N, 11, 69					
		1/2 – 1 1/2	40S	PLAIN	SS,EFW,ASTM A312-TP 304L	
		2 - 12	10S	BEVELED	SS,EFW,ASTM A312-TP 304L	
		14 - 24	10S	BEVELED	SS,EFW,ASTM A358-304L CL.2	
NIPPLES						
IN-LINE	14,100	1/2 – 1 1/2	80S		SS,EFW,ASTM A312-TP 304L	
BRANCH	14,100	1/2 – 1 1/2	80S		SS,EFW,ASTM A312-TP 304L	
SWAGE(CONC)	14,101	1/2 – 1 1/2	80S		SS,ASTM A403-WP304L-W,MSS SP-95	
SWAGE(ECC)	14,101	1/2 – 1 1/2	80S		SS,ASTM A403-WP304L-W,MSS SP-95	
FITTINGS	AAA,69,104					
UNION-X		UNIONS NOT ALLOWED (USE FLANGES)				
90 ELL		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
45 ELL		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
TEE		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
TEE(RED)		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
PLUG	D	1/2 – 1 1/2		THRD	SS,ASTM A182-F304L,ROUND HEAD,ASME B16.11	
COUPLING		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
COUPLING	D	1/2 – 1 1/2	300 LB	THRD	SS,ASTM A182-F304L,ASME B16.11	
COUPLING(RED)		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
CAP		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
CAP	D	1/2 – 1 1/2	300 LB	THRD	SS,ASTM A182-F304L,ASME B16.11	
SOCKOLET		1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
THREADOLET	74	1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
SW LATROLET		1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
SW ELBOWLET		1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
REDUCER(CONC)		1 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
REDUCER(ECC)		1 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
WELDOLET		2 - 6		WELD	SS,STM A182-F304L,LIGHT WEIGHT	
CAP		2 - 24		WELD	SS,ASTM A403-WP304L-S,ASME B16.9	
90 LR ELL		2 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
45 ELL		2 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
TEE		2 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
VALVES	AAA,10,46					
GATE		1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM	V1R36
GATE	46	1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM,F.P.	V1R32
GATE	50	1/2 - 2	800 LB	T/SW	316L SS EXTENDED BODY W/316 SS TRIM,MPE X FNPT	V1R38
GATE		1/2 – 2	800 LB	T/SW	316L SS BODY W/316 SS TRIM	V1R34
GATE	43	3/4 – 2	150 LB	RF	316 SS BODY W/316 SS TRIM	V1R33
GATE	43,86	3/4 – 2	300 LB	RF	316 SS BODY W/316 SS TRIM	V1R3
GATE	57	1	800 LB	T/SW	316L SS BODY W/316 SS TRIM,F.P.	V1R68
GATE	57	1 1/2 – 2	150 LB	RF	316 SS BODY W/316 SS TRIM,F.P.	V1R67
GATE		3 - 24	150 LB	RF	316 SS BODY W/316 SS TRIM,F.P.	V1R49
GLOBE		1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM	
GLOBE		3 - 12	150 LB	RF	316 SS BODY W/316 SS TRIM	V2R1
CHECK		1 1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM,PISTON H ONLY	V3R42
CHECK		1 1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM,PISTON V ONLY	V3R44
CHECK		1/2 - 12	150 LB	RF	316 SS BODY W/316 SS TRIM,F.P.,SWING,H OR V	V3R3
WAFER CHECK	77	14 - 24	150 LB	RF	316 SS BODY W/316 SS DISC/ST,DUAL PLT,H OR V	V3R25
FLG'D BUTTERFLY		3 - 24	150 LB	RF	316 SS BODY W/316 SS DISC,316 SS LAMINAT SEAL,P.O.	V5R27
BALL		1/2 – 2	300 LB	RF	316 SS BODY W/316 SS TRIM,F.S.,F.P.	V5R39
BALL		3 - 24	150 LB	RF	316 SS BODY W/316 SS TRIM,I.F.S.,F.P.	V5R31
PLUG	47	1/2 – 1	300 LB	SOCW	316L SS BODY W/TS&D,316 SS PLUG,F.S.	V4R6
PLUG	47	1 1/2 – 3	150 LB	RF	316 SS BODY W/TS&D,316 SS PLUG.F.S.	
PLUG	47	4 - 12	150 LB	RF	316 SS BODY W/TS&D,316 SS PLUG.F.S.,G.O.	

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FLANGES AAA,104,116

SOCKET WELD	1/2 – 1 1/2	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SOCKET WELD 84	1/2 – 1 1/2	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SOCKET WELD 86	1/2 – 1 1/2	300 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
BLIND	1/2 – 24	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
BLIND	1/2 – 24	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
BLIND 86	1/2 – 24	300 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
WELD NECK82	1 1/2 - 24	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
WELD NECK82,84	1 1/2 - 24	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
WELD NECK86	2 - 24	300 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SLIP-ON	2 - 24	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SLIP-ON 84	2 - 24	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
STUB END-LAP JOINT	1/2 - 24		LJ	SS,ASTM A403-WP304L-W,ASME B16.9,TYPE A,SHORT,SF
PAIR WN ORIFICE 87	2 - 24	300 LB	RF	SS,ASTM A182-F304L,ASME B16.36,1/2" SW TAPS,STD FIN

GASKETS

FULL FACE 90	1/2 – 24	FF1	1/16" FLEX GRAPH W/316 SS TANGED INSERT,ASME B16.21
		FR1	1/16" FLAT RING,ARAMID FIBER W/NBR BINDER (GARLOCK STYLE 3000)
SPIRAL WOUND 88	1/2 – 24	RF	316L SS WINDING W/FLEX GRAPH FILL,ASME B16.20
		RF	304 OR 316L SS WINDING W/GRAFOIL® GRADE GT™ B OR GT™ K FILLER,CS OR SS CENTERING RING,304 OR 316 SS SOLID
INNER			RING,FLEXITALLIC STYLE CGI,LAMONS STYLE WRI,FURON STYLE RWI OR APPROVED EQUAL,ASME B16.20
		(GRAFOIL IS A REGISTERED TRADEMARK OF UNION CARBIDE	
CORPORATION)			

BOLTING B

STUD BOLTS	1/2 – 24	ASME A320 GR B8 CL 2 STUD WITH ASTM A194 GR 8 NUTS ASME A193 BR B7 STUD WITH ASTM A194 GR 2H NUTS

MISCELLANEOUS

Y-STRAINER 96	1/2 – 1 1/2	600 LB	SOCW	304L SS BODY W/304 SS SCREEN (100 MESH,0.0045" WIRE)
Y-STRAINER 97	1/2 – 1 1/2	600 LB	SOCW	304L SS BODY W/304 SS SCREEN (20 MESH,0.016" WIRE)
FIGURE 8 62,86	1/2 – 12	300 LB	RF	304 SS,PER API 590,STD.FIN
FIGURE 8 62	1/2 – 18	150 LB	RF	304 SS,PER API 590,STD.FIN
STRAINER(PUMP)	1 1/2 – 24	150 LB	RF	304 SS,3/16" DIA PERF & 1/4" ON CNETERS(150% BASK)

PRESSURE – TEMPERATURE LIMITATIONS: ASME B16.5 – GROUP 2.3

TEMPERATURE	PRESSURE
-20F (-29C)	
TO 100F (38C)	230 PSIG
200F (93C)	195 PSIG

HYDROSTATIC TEST:
300 PSIG MAX.

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SPECIFIC PIPING NOTES

AAA. SPECIAL REQUIREMENTS FOR PIPING CLASSES WITH **SUFFIX "S"**
(1) ONLY VALVE TAG NOS. WITH SUFFIX "S"(CERTIFIED SILICON FREE)SHALL BE USED.
(2) PIPING IN THE PO PURIFICATION AND STORAGE AREAS SHALL BE THOROUGHLY CLEANED TO REMOVE ANY TRACE OF SILICONE AFTER FABRICATION,ASSEMBLY & BEFORE STARTUP. PIPING INCLUDES BLIND FLANGES,STRAINERS,BOLTING,ETC.
(3) CLEANING METHOD AND PROCEDURE SHALL BE SUBMITTED FOR REVIEW AND APPROVAL.
(4) ALL GASKETS SHALL BE CERTIFIED SILICONE FREE.

10. VALVES TO BE ORDERED WITH CHEM-GEMS J-1M AND COMPLETE VALVE SPECIFICATION SHEET FROM CHEM GEMS J-2M.
11. MINIMUM LINE SIZE SHALL BE 3/4". SIZE SMALLER THAN 3/4" IS ONLY FOR INSTRUMENTS CONNECTIONS AND OTHER SPECIAL APPLICATIONS.
14. THREADED JOINTS ARE ONLY PERMITTED AT TERMINAL POINTS.
43. TO BE USED AGAINST FLANGED EQUIPMENT (I.E. STORAGE TANKS,VESSELS,LEVEL GAGES,ETC.).
46. USE FULL PRT VALVES AT INLET AND DISCHARGE OF PSV'S AND IN PUMP SUCTIONS WHERE PRESSURE DROP IS CRITICAL.
47. THIS VALVE IS RESTRICTED TO A MAX SERVICE TEMPERATURE OF 300F (149C). 150 FB,FBS,FF NO.28. & DEMINERALIZED WATER.
50. USE EXTENDED BODY VALVE AT VENT,DRAIN,AND INSTRUMENT CONNECTIONS. WHEN THICKNESS OF HEADER INSULATION WILL COVER THE VALVE BODY,USE STANDARD NON-EXTENDED BODY VALVE WITH PROPER LENGTH OF PIPE NIPPLE.
57. USE FULL PORT VALVES AT SAMPLE PROBE CONNECTIONS. REFER TO DRAWING NOS. A14-18-129/130 FOR DETAILS.
62. USE OF FIGURE 8 BLINDS SHALL BE LIMITED TO THE SIZES LISTED DUE TO LIMITATION ON WEIGHT OF 150 POUNDS MAXIMUM:
CLASS 150:18 INCH;CLASS 300:12 INCH;CLASS 600:10 INCH;CLASS 900:8 INCH;CLASS 1500:6INCH. FIGURE 8 GLINDS, SPACERS,AND BLANKS LARGER THAN 24" OR WHEN NOT COVERED BY THE SIZE RANGE IN THE SPECS SHALL BE DESIGNED BY PIPING MECHANICAL.
69. DO NOT BEND OR THREAD SCHEDULE 10S PIPE. WHERE THREADING OR BENDING IS REQUIRED,USE SCHEDULE 40S MINIMUM.
74. THREADED OUTLET REINFORCED BRANCH WELD FITTINGS TO BE USED ONLY FOR HYDROSTATIC TEST CONNECTIONS.
77. THESE VALVES HAVE NO FLANGES BUT ARE INSTALLED BETWEEN LINE FLANGES WITH EXTRA LENGTH BOLTS.
82. WELD NECK FLANGES SHALL BE USED AGAINST BUTT WELD FITTINGS.
84. PROVIDE FLAT FACE FLANGES ADJACENT TO FLAT FACE CAST IRON VALVES,FLANGES,AND EQUIPMENT NOZZLES.
86. TO BE USED ONLY TO MATCH CLASS 300 RATED FLANGE CONNECTIONS AT CONTROL VALVES AND SPECIAL EQUIPMENT.
87. INSTALL ORIFICE FLANGES PER DRAWING D-J-111.
88. ALLOW 1/8" BETWEEN FLANGES FOR GASKETS.
90. USE FULL FACE GASKETS AT FLAT FACED FLANGES.
96. TO BE USED FOR AIR,GAS,OR STEAM SERVICE.
97. TO BE USED FOR LIQUID SERVICE.
100. NIPPLES (IN-LINE OR BRANCH),SHALL BE PROVIDED WITH BOTH ENDS BEVELED. WHERE REQUIRED,NIPPLES MAY BE PROVIDED WITH ONE END THREADED.
101. SWAGE NIPPLES SHALL BE PROVIDED WITH BOTH ENDS BEVELED. WHERE REQUIRED SWAGE NIPPLES MAY BE PROVIDED WITH LARGE END BEVELED X SMALL END THREADED,OR WITH LARGE END THREADED X SMALL END BEVELED.
104. BUTTWELDING FITTINGS/FLANGES THICKNESS SHALL MATCH PIPE THICKNESS.
116. SEE CHEMGEMS K-9D FOR SELECTION,CONSTRUCTION,AND INSTALLATION OF TEMPERATURE INSTRUMENTS.
B. CADMIUM PLATED FOR ASME 150 & 300 SERVICES.
N. TUBING IS ALLOWED,USE PLS MISC.C1FA.

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BRANCH CONNECTION
      LEGEND, NOTES & CHART
LEGEND
 C - TO BE CALCULATED (SEE J-2D)
 E - REDUCING TEE
 S - SOCKOLET
 T - TEE
 W - WELDOLET
 X - NOT PERMITTED          11
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        24   T
        20   C T
B       18   C C T
R       16   C C C T
A       14   C C C C T
N       12   C C C C C T
C       10   C C C C C C T
H        8   C C C C C C C T
         6   W W W W W W W W T
S        4   W W W W W W W W W T
I        3   W W W W W W W W W W T
Z        2   W W W W W W W W W W W T
E      1.5   S S S S S S S S S S S S T
         1   S S S S S S S S S S S S E T
      0.75   S S S S S S S S S S S S E E T
       0.5   S S S S S S S S S S S S E E E X

             2 2 1 1 1 1 1 8 6 4 3 2 1 1 0 0
             4 0 8 6 4 2 0           .   . .
                                     5   7 5
                                         5
                 H E A D E R   S I Z E
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Revision Log		
Distribution Date	Deviation #	Brief Description of Change
1/28/14	089	Allow use of 150# ball valve ½"-2"
4/20/10	068	Allow 150# flanges around reactors for ½"-2" valves.
2/5/09	065	Allow Sch40 CS Pipe, Sch40 Weld Fittings and 150# RF CS Flanges.
8/11/08	063	Allow use of 150# RF Ball Valve
7/11/07	058	150# ball valves ½"-8"
2/1/06	-	Change 150# RF flanged check valve size to ½"-12" from 3"-12"
4/25/05	053	Allow use of 1" flanged check valve on BA line
7/2/04	050	Styrene/Pentane Filter Rupture Disc
1/13/04	-	Correct typographical error
08/18/03	048	Direct Pentane Project Deviation
02/19/03	-	Correct note on plug valves from #48 to #47
02/19/03	046	SA/CAT tank slurry piping improvement at Building 4
1/26/01	041	Use of Threaded Fittings and Ball Valves on Reactor Vent Condensor Project
4/6/01	036	No X-Rays for Di Filters Project
4/6/01	035	Threaded Fittings and Valves on Drain Line for DI Filters Project
2/26/01	-	Remove Valve Specification
1/12/01	-	Add Styrene to Service, Change 3000 lb Fittings to 300 lb, Add SS Material to Spiral Wound Centering Ring, Change Hydrostatic Test Pressure to 300 psig Max.
12/28/00	-	Peru On-Line System
9/6/00	019	Allow Swing Check Valve in Horizontal Plane for SGS Circuit Modification Project
1/14/99	006	Add Bolting Specification

FHRPRU003875

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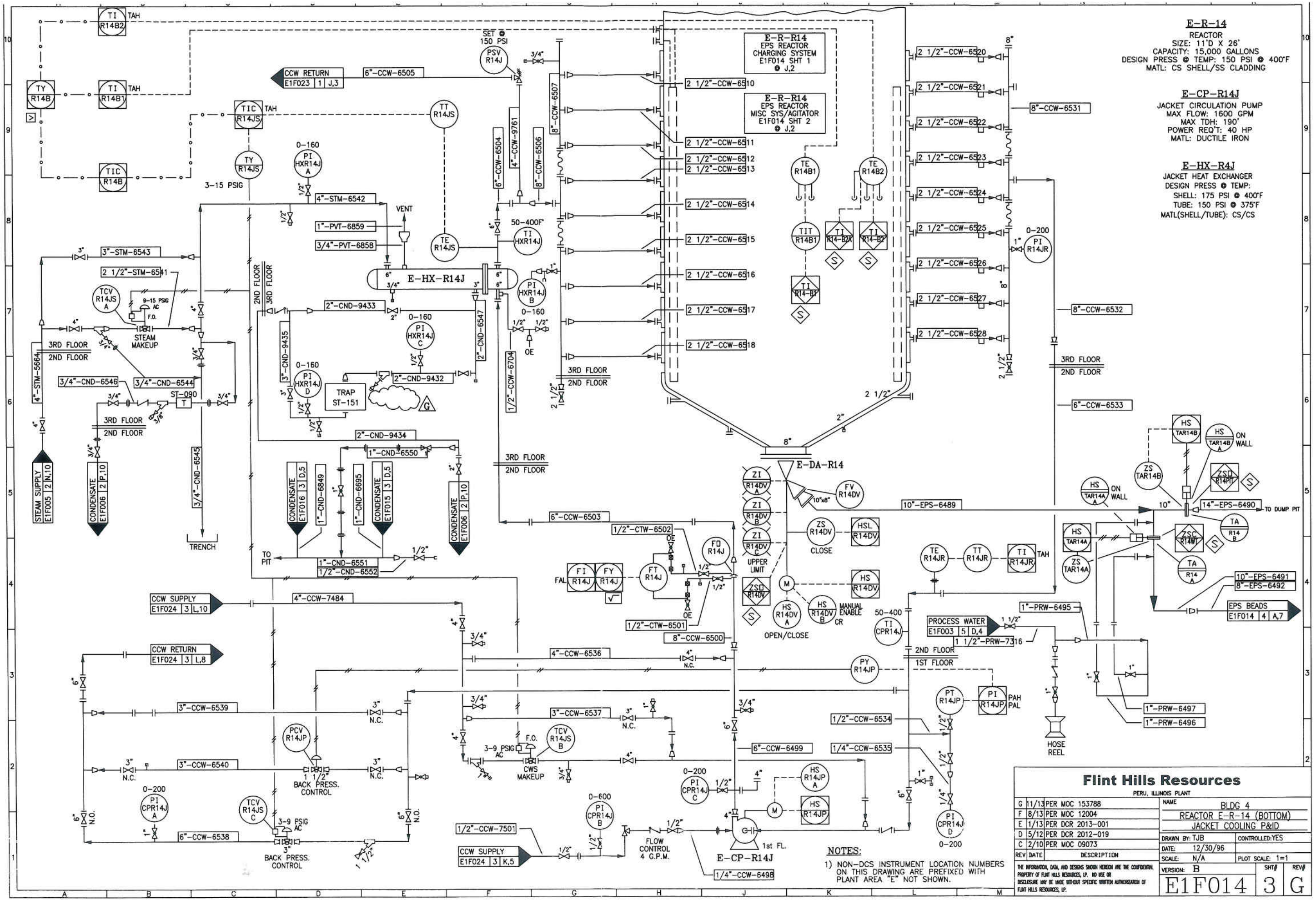

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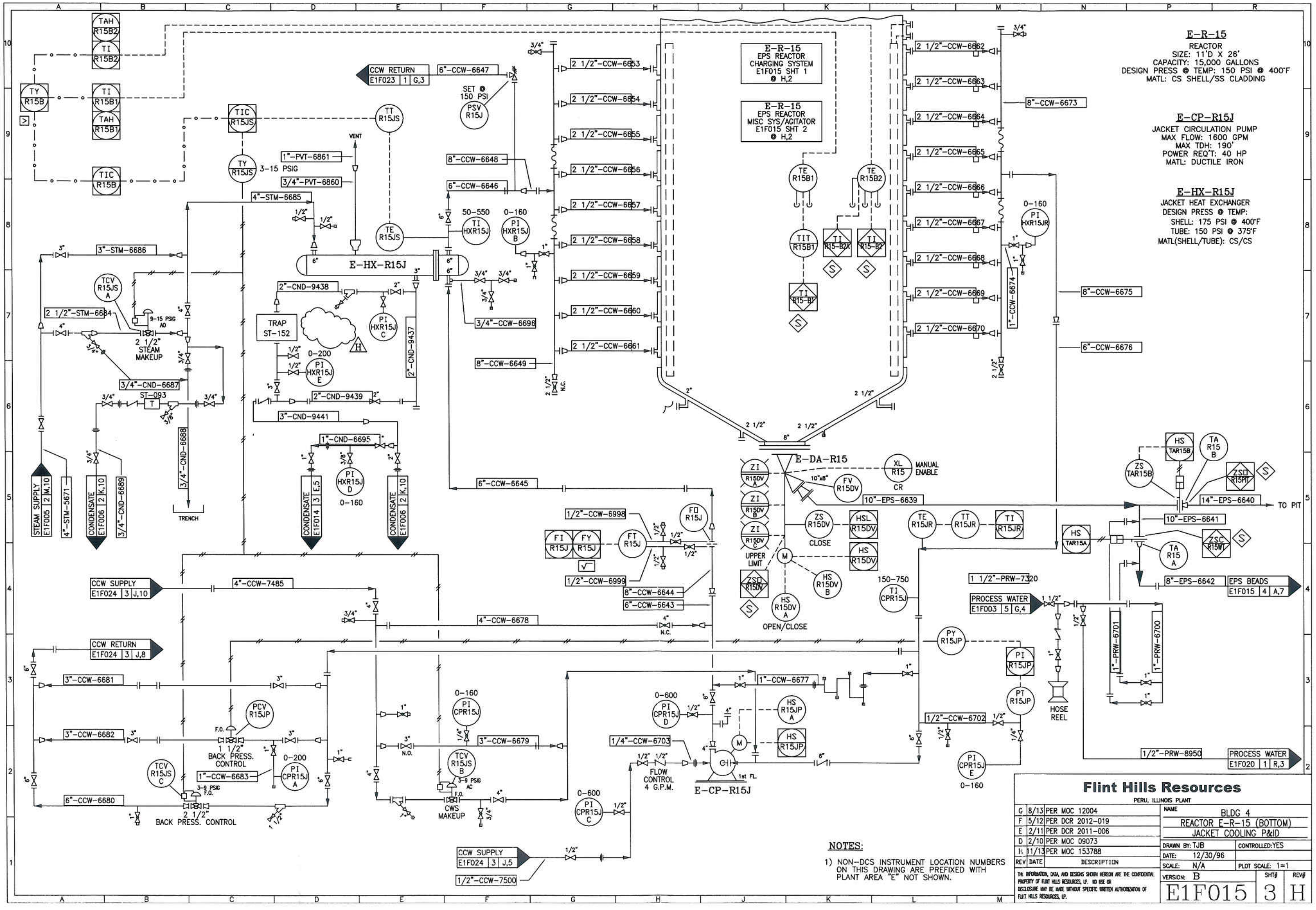

NOTES:

1) NON-DCS INSTRUMENT LOCATION NUMBERS ON THIS DRAWING ARE PREFIXED WITH PLANT AREA "E" NOT SHOWN.

Flint Hills Resources

PERU, ILLINOIS PLANT

REV	DATE	DESCRIPTION
G	8/13	PER MOC 12004
F	5/12	PER DCR 2012-019
E	2/11	PER DCR 2011-006
D	2/10	PER MOC 09073
H	11/13	PER MOC 153788

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NAME: BLDG 4 REACTOR E-R-15 (BOTTOM) JACKET COOLING P&ID

DRAWN BY: TJB | CONTROLLED: YES

DATE: 12/30/96

SCALE: N/A | PLOT SCALE: 1=1

VERSION: B | SHT# 3 | REV# H

E1F015

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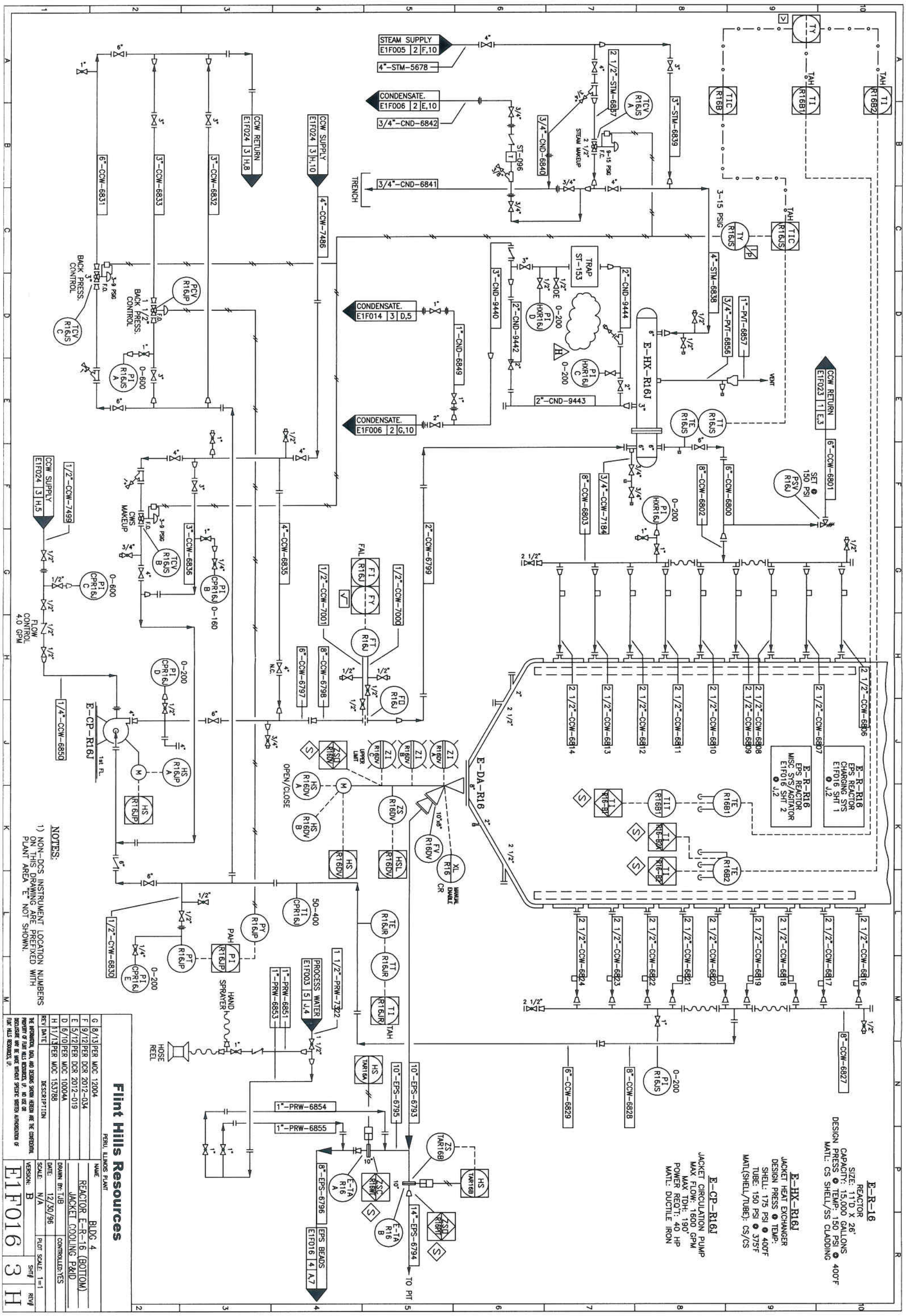

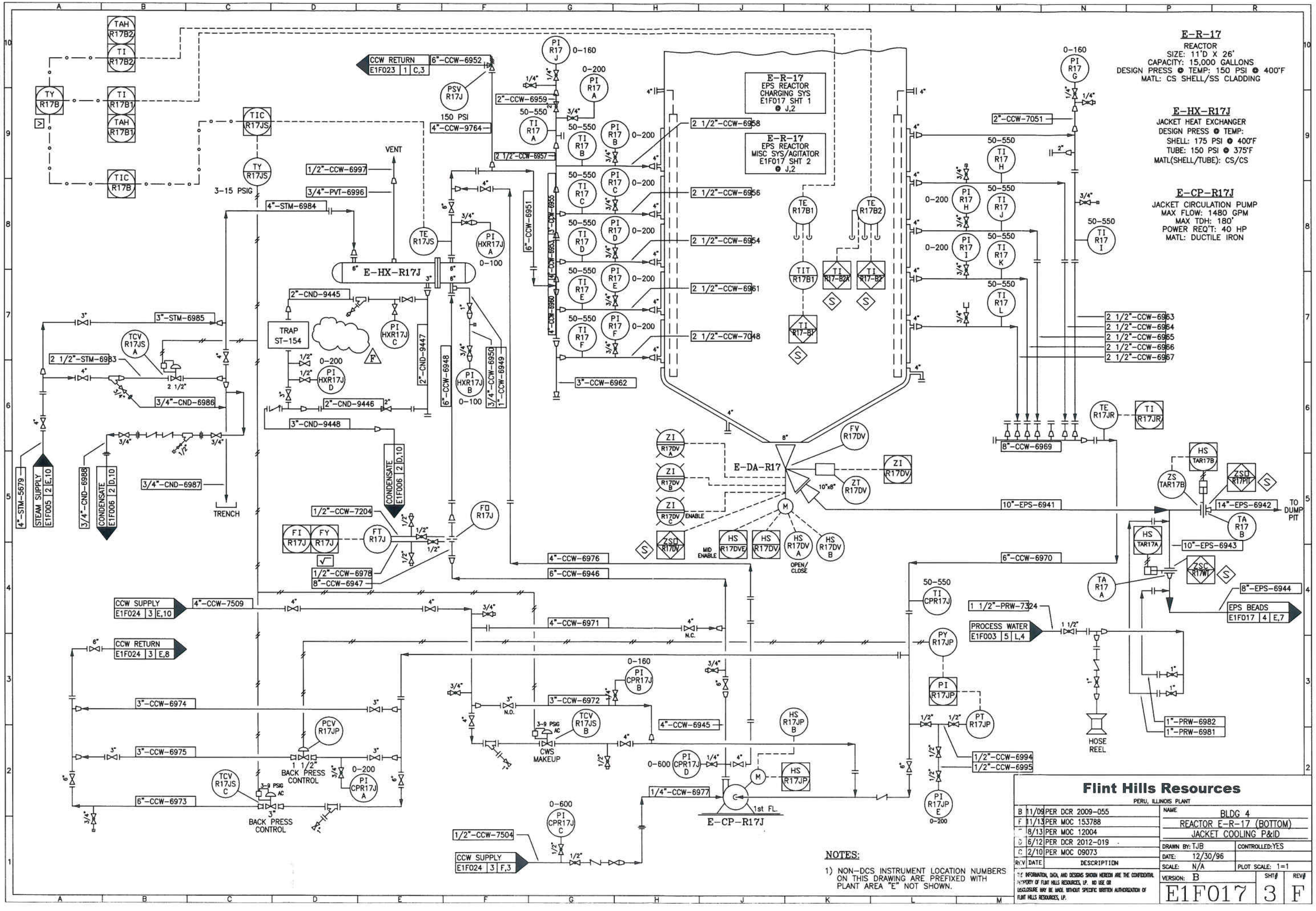

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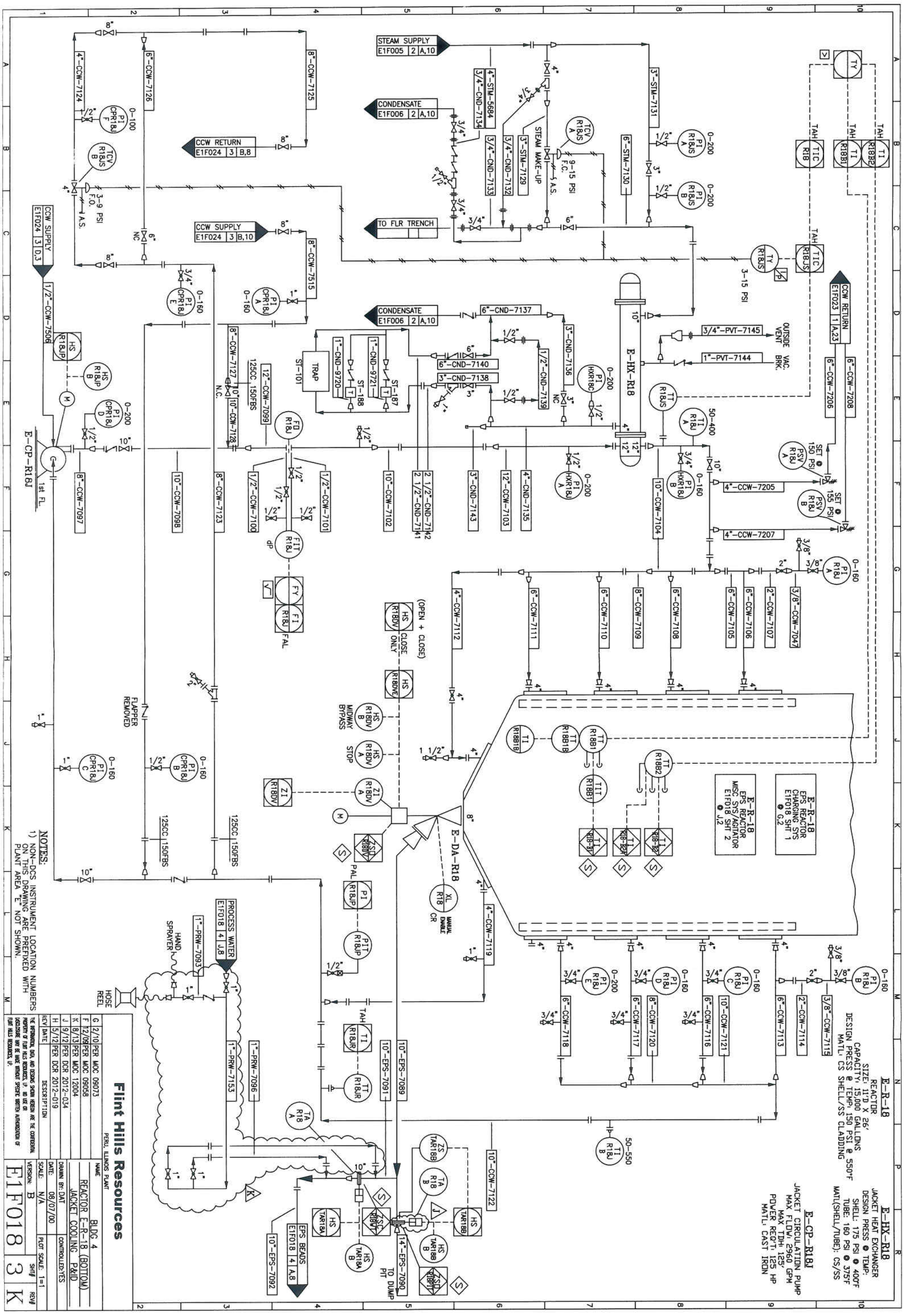
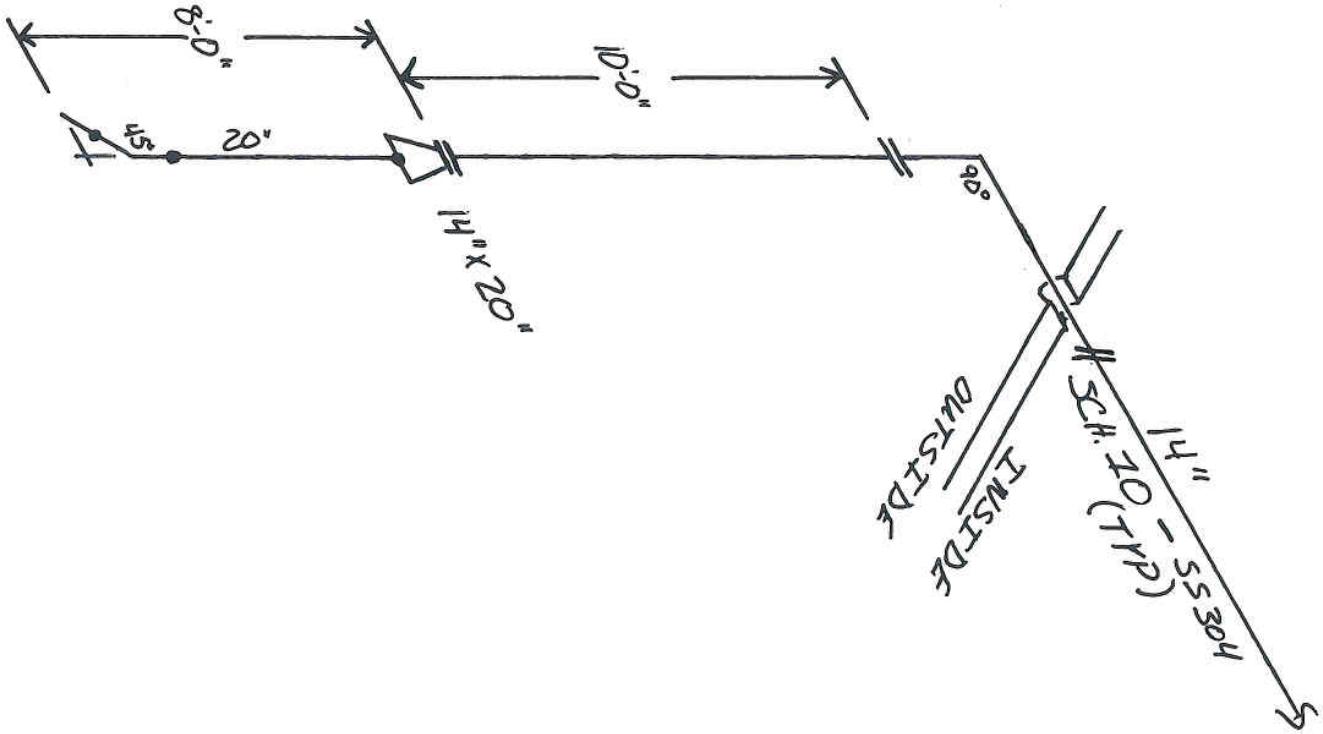


Reactor Piping to Pit Isometric Rev2



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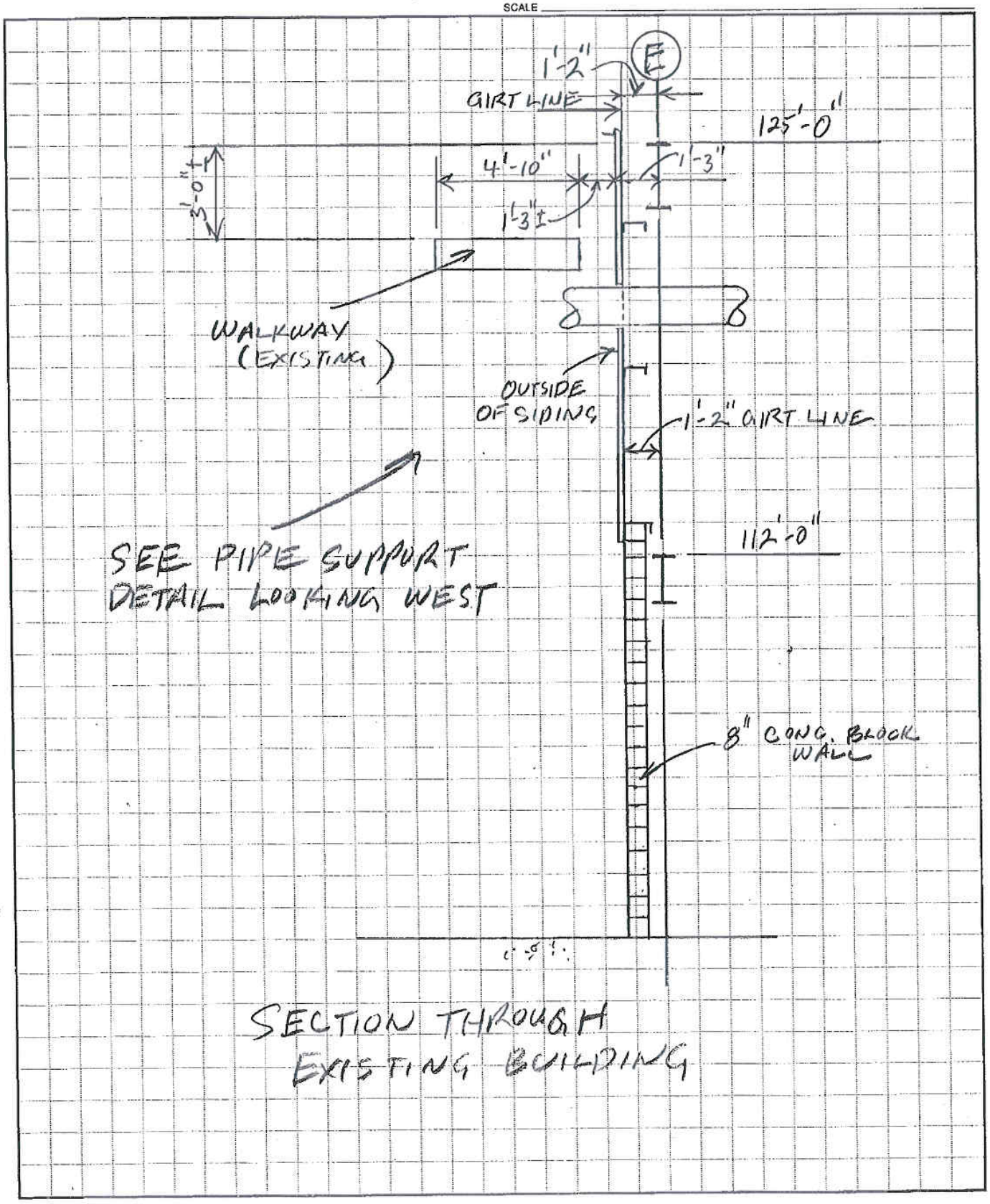
REACTOR PUMP LINE SUPPORTS

JOB 2014-232 F.H.
SHEET NO. 1 OF 14
CALCULATED BY S. CUSTER DATE 5-9-14
CHECKED BY DATE
SCALE



SECTION THROUGH EXISTING BUILDING

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CALCULATED BY S. CUSTER DATE 5-9-14

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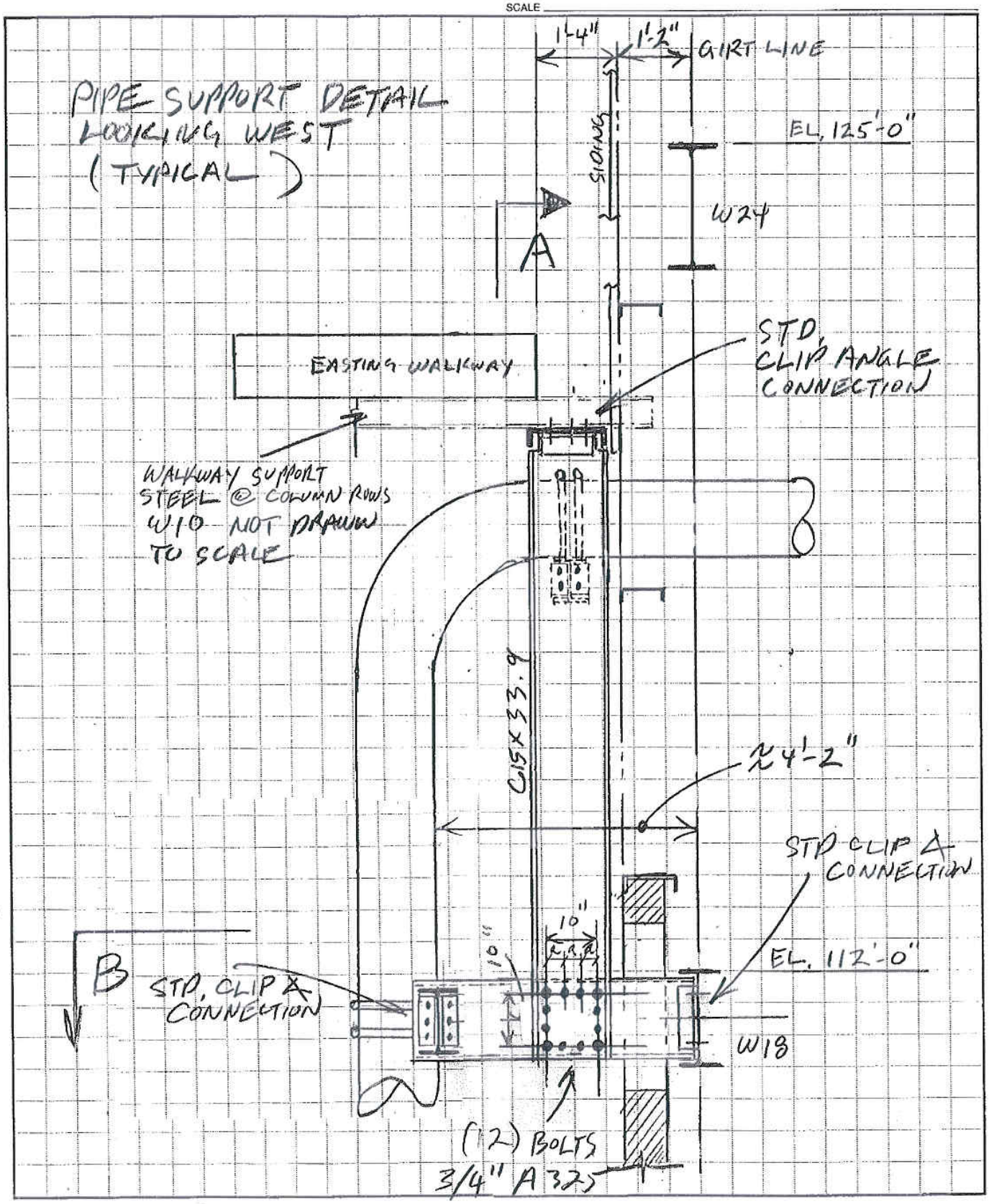

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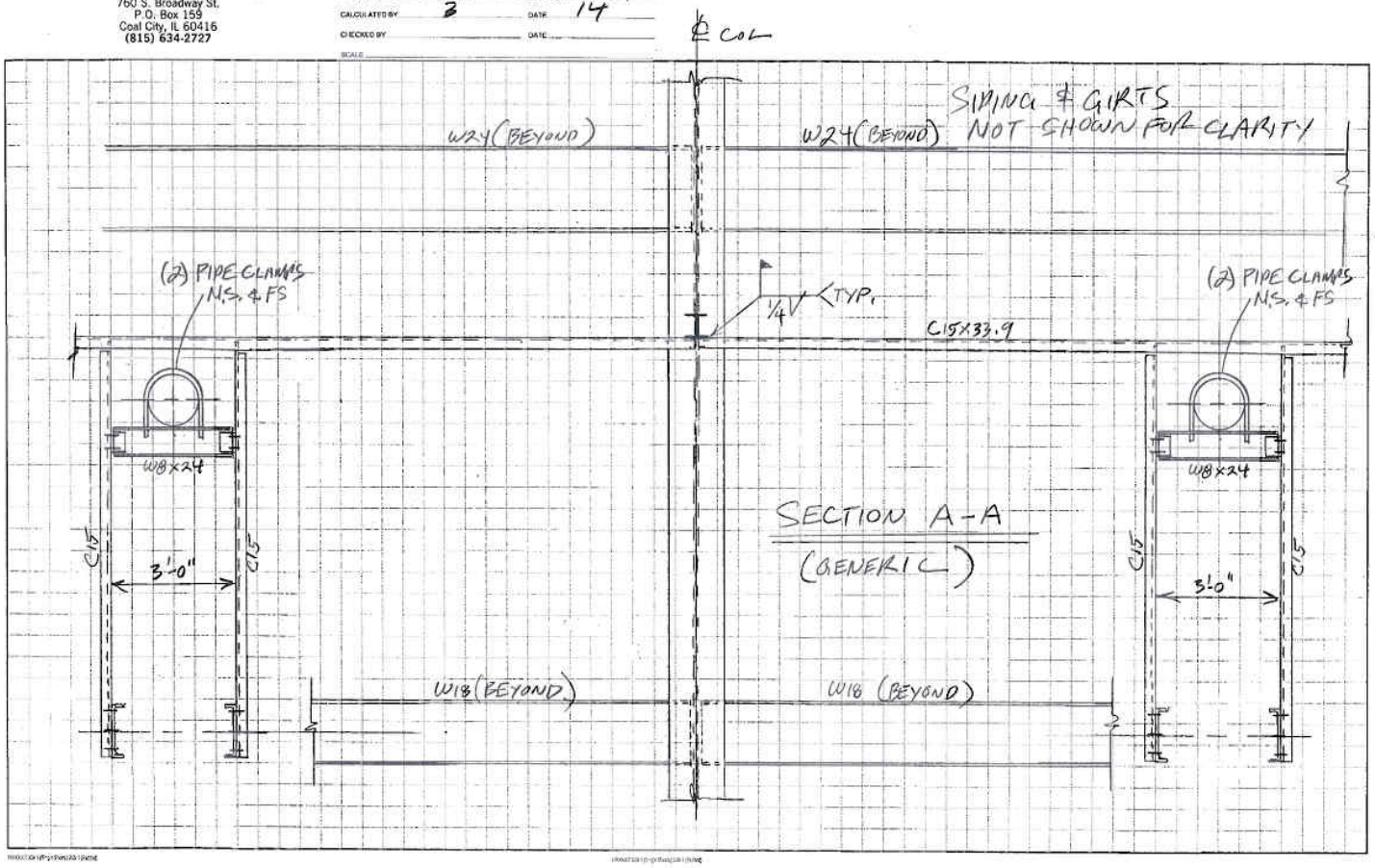
JOB 2014-232 F.M.
SHEET NO. S. CUSTER OF 5-9-14
CALCULATED BY B DATE 14
CHECKED BY DATE
SCALE



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JOB 2014-232 F.H.
SHEET NO. 4 OF 14
CALCULATED BY S. CUSTER DATE 5-9-14
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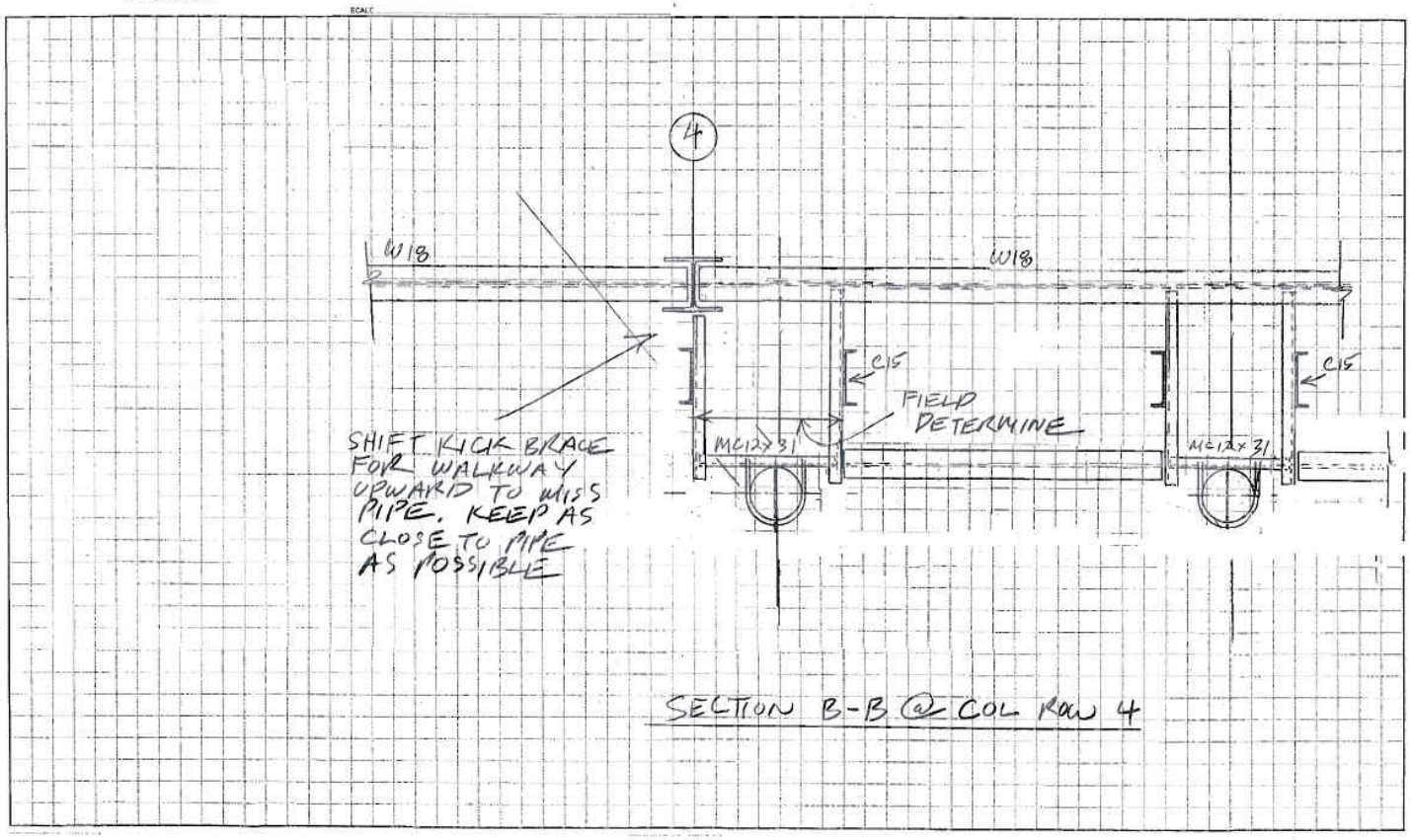

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REACTOR DUMP LINE SUPPORTS

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SHEET NO. 5 OF 14
CALCULATED BY S. CUSTER DATE 5-9-14
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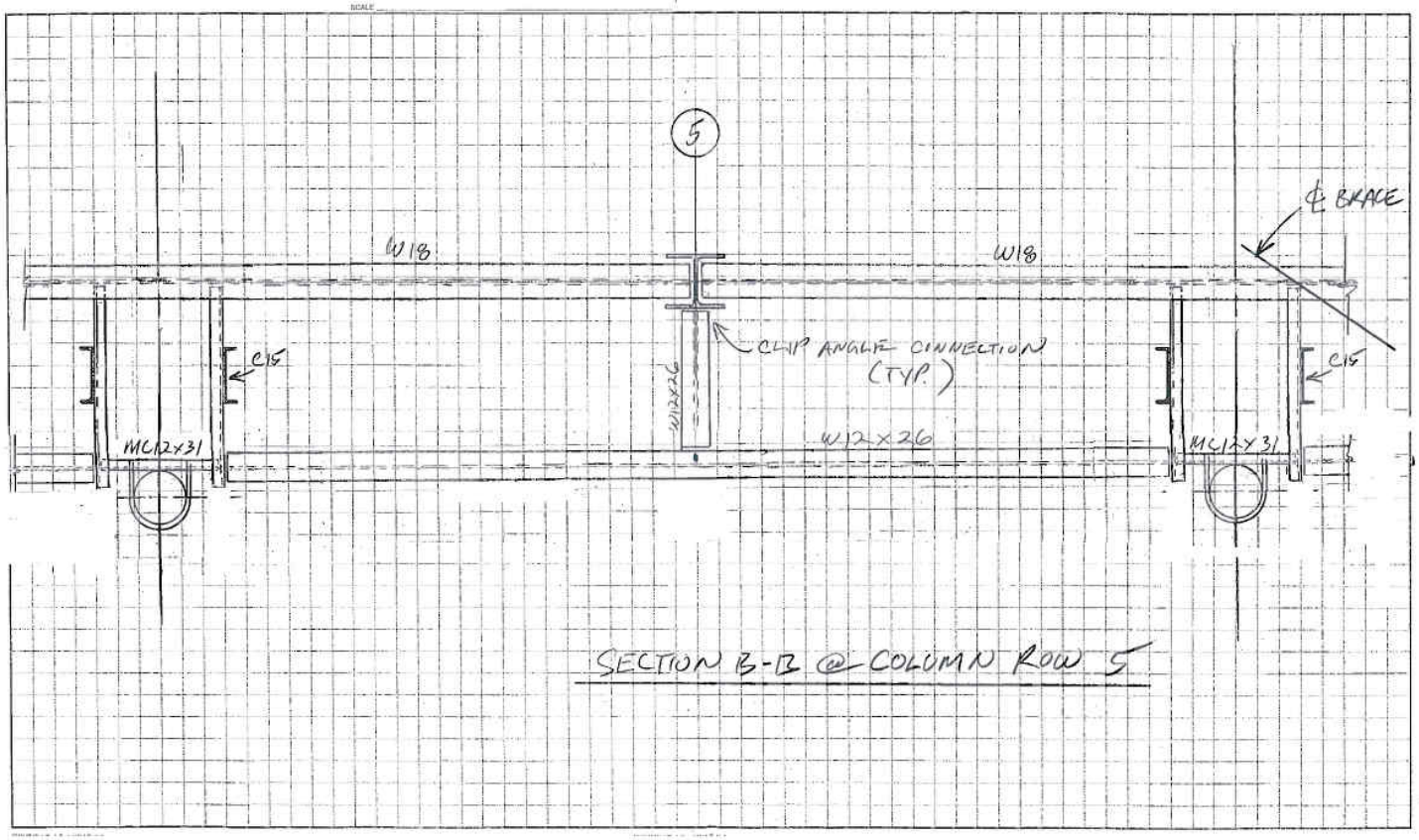

SECTION B-B @ COLUMN ROW 5

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JOB 2014-232 F.H.
SHEET NO. 6 OF 14
CALCULATED BY S. LUSTER DATE 5-9-14
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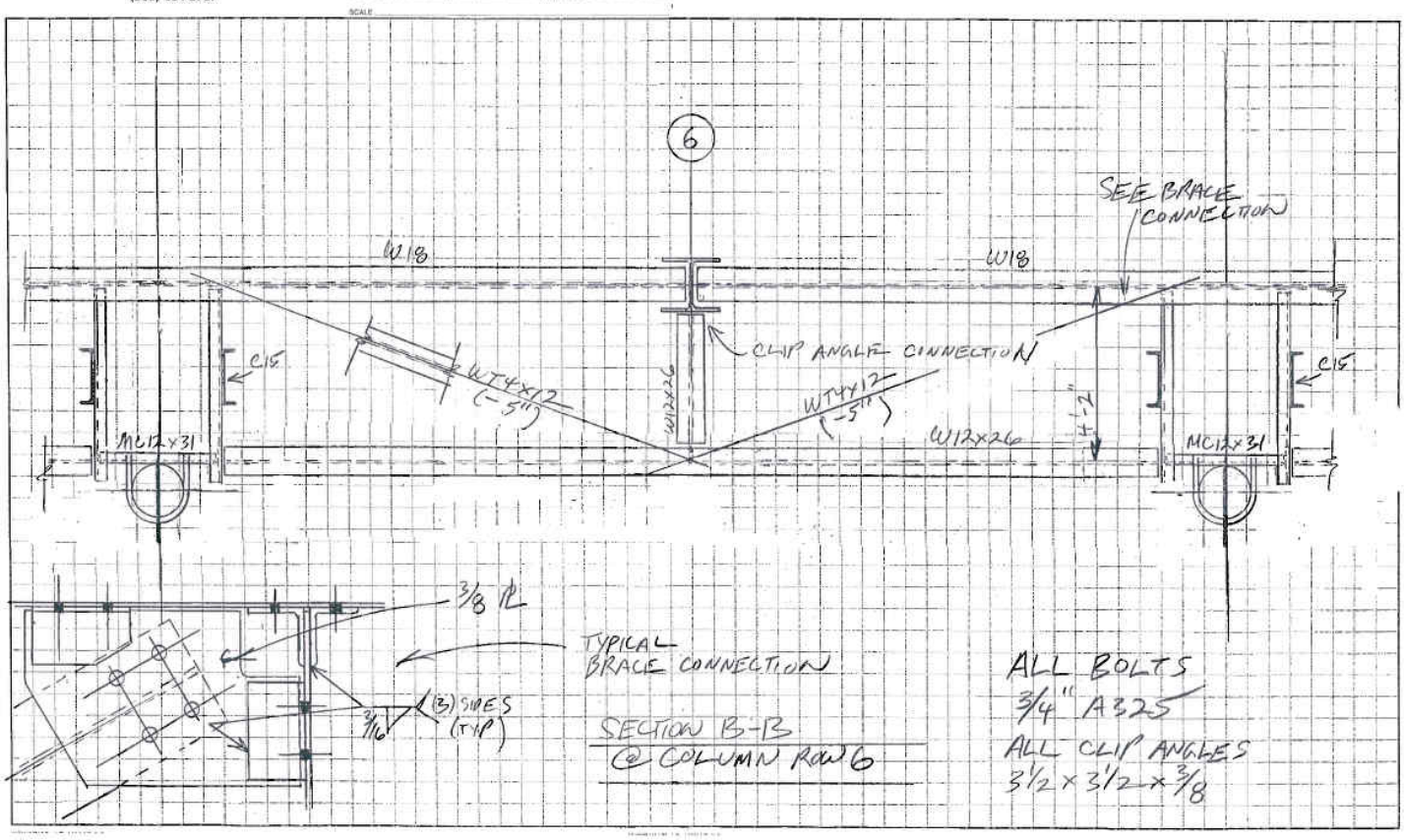
SCALE



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JOB 2014-232 F.H.
SHEET NO. 7 OF 14
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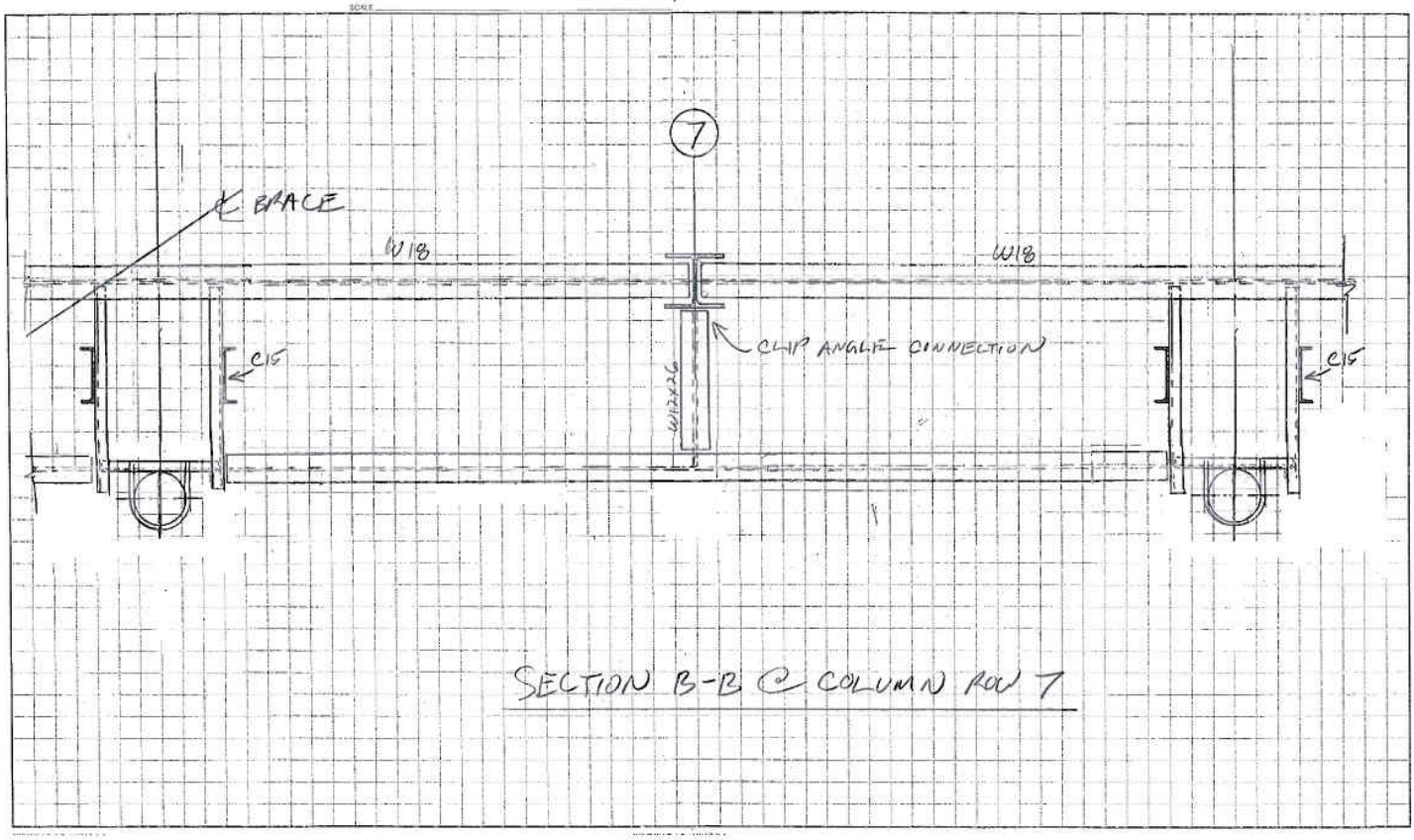

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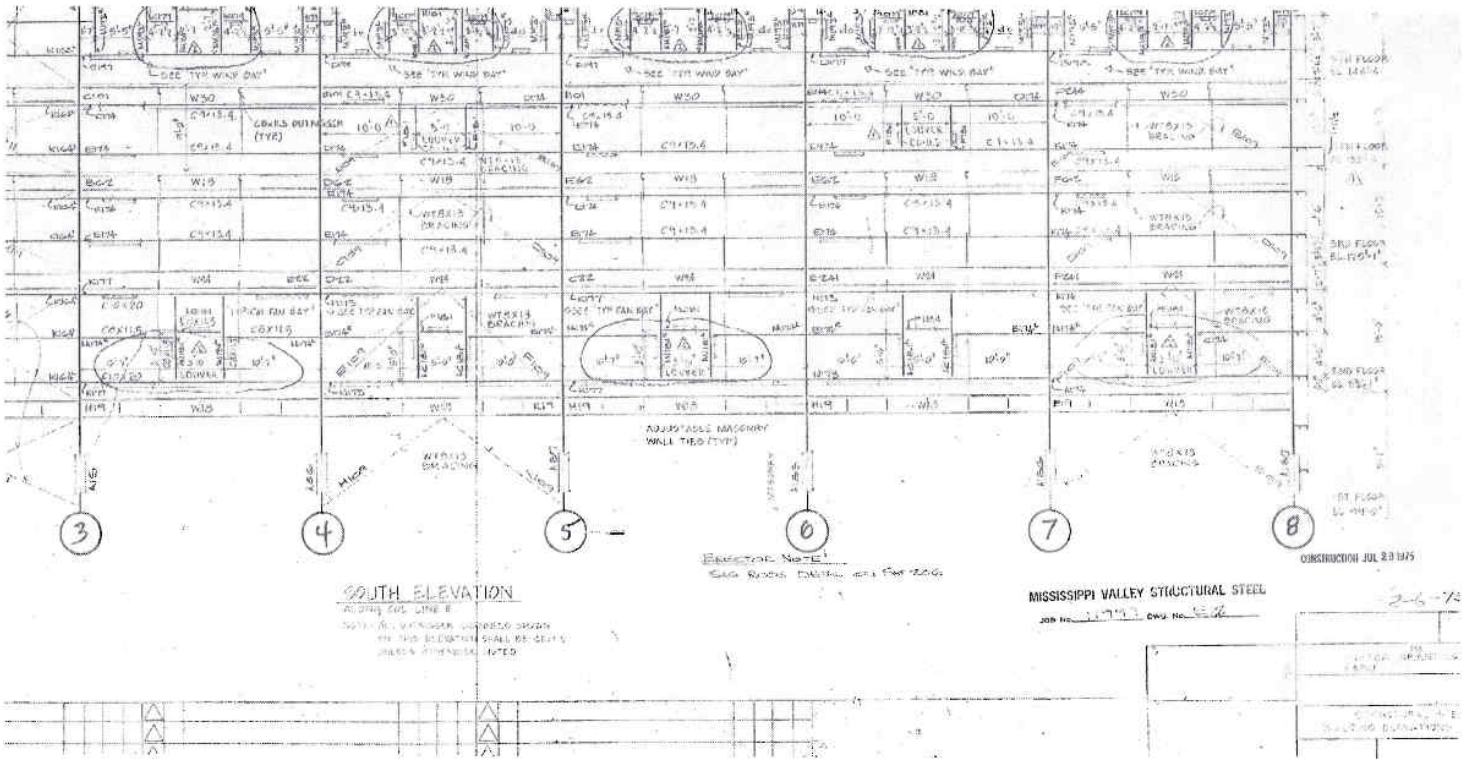

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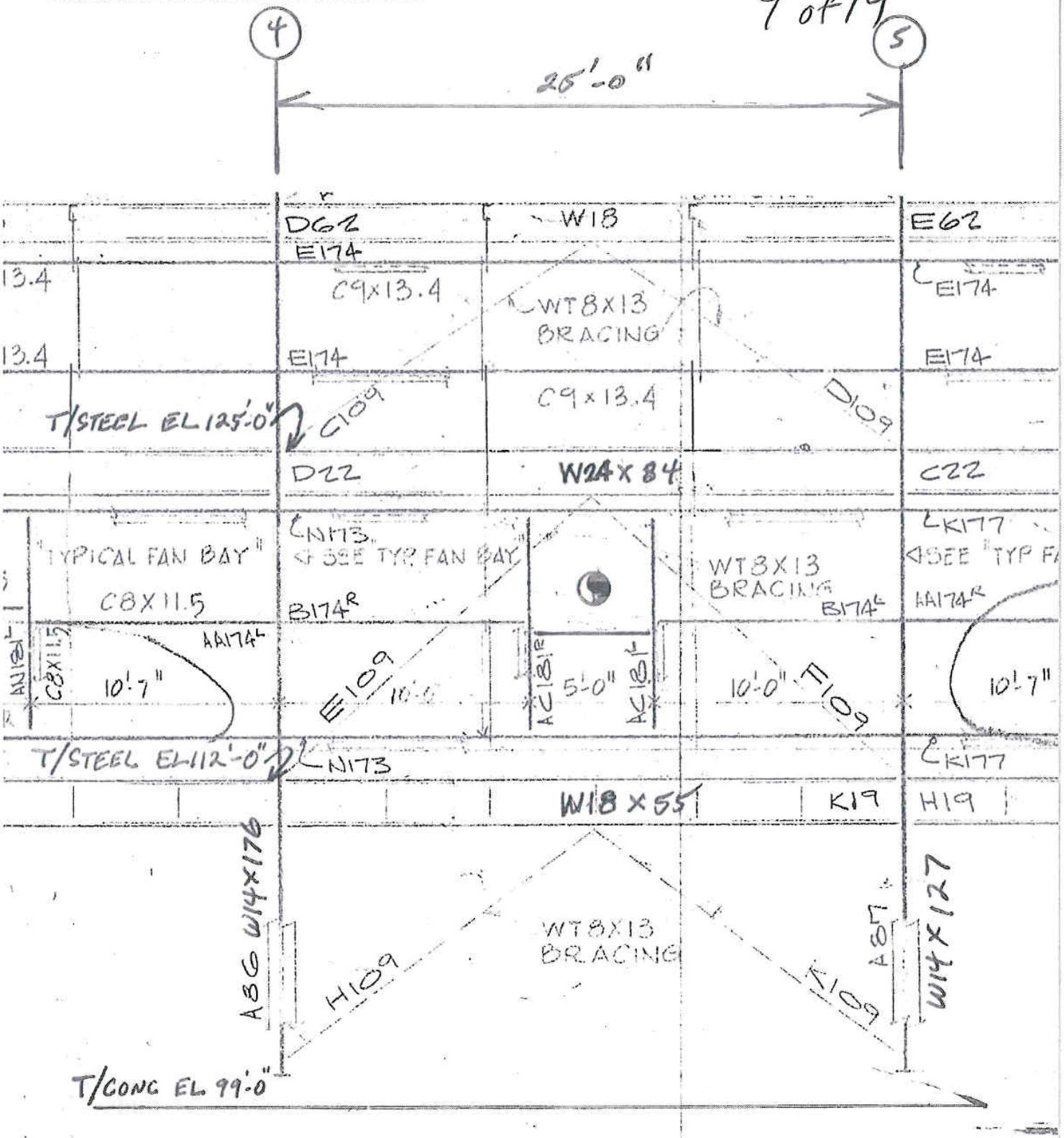

SCALE: 1"=5'-0"

SOUTH ELEVATION

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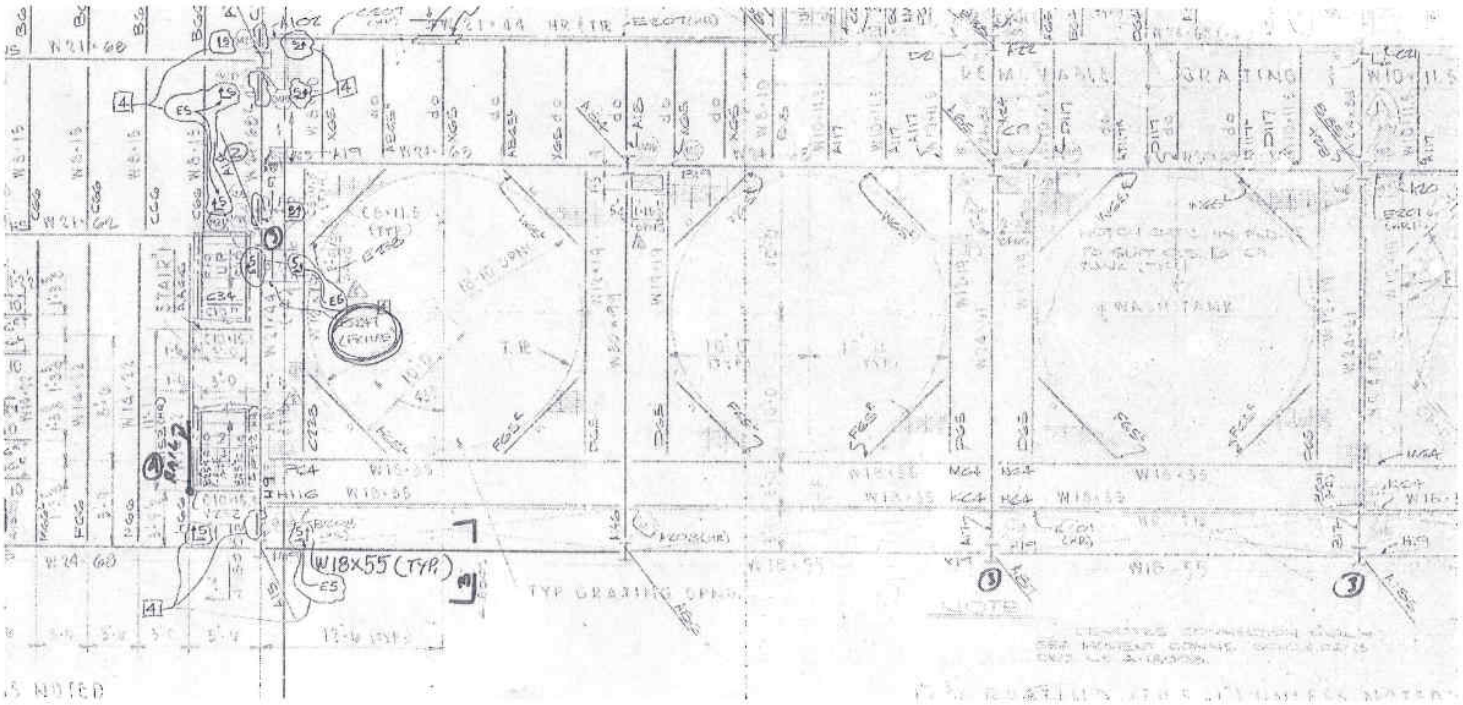

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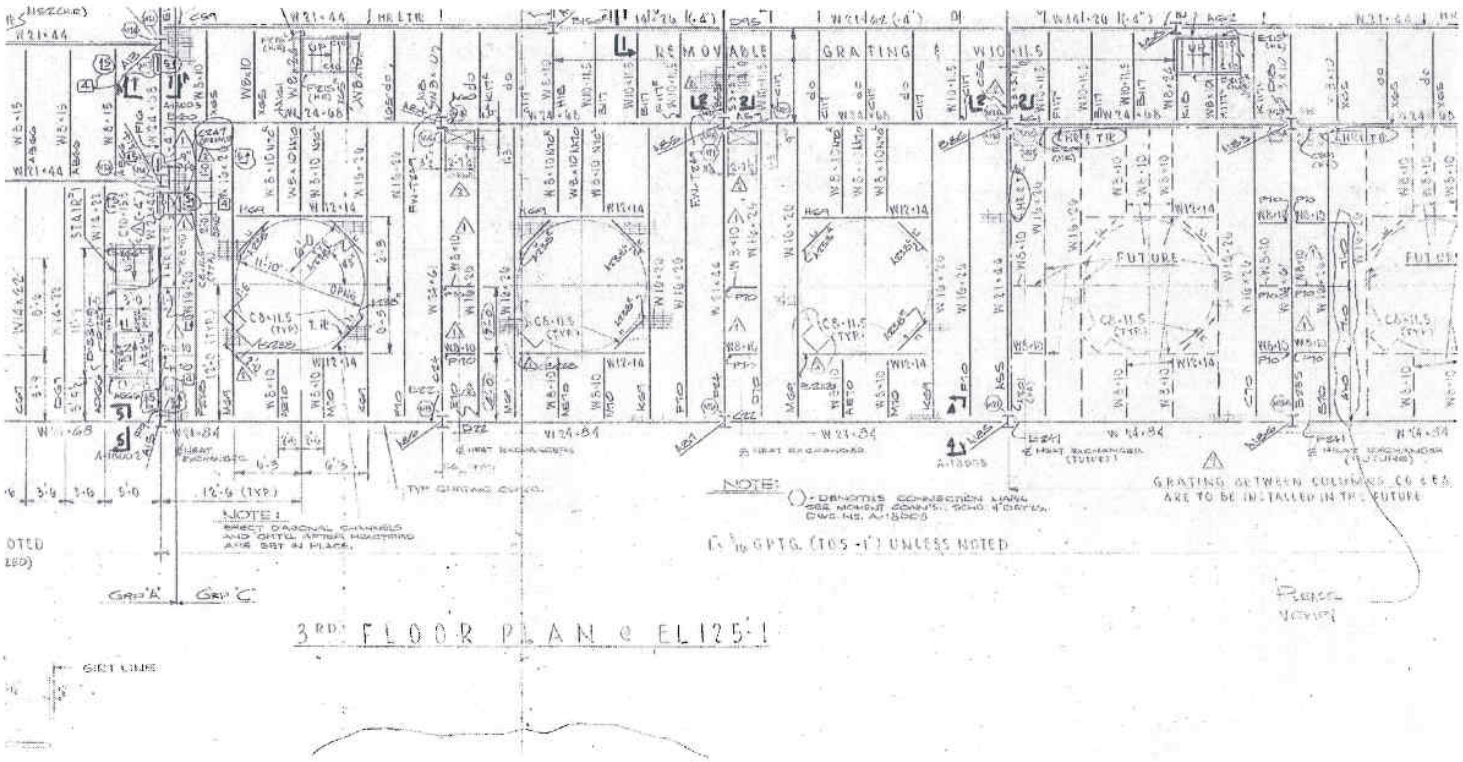

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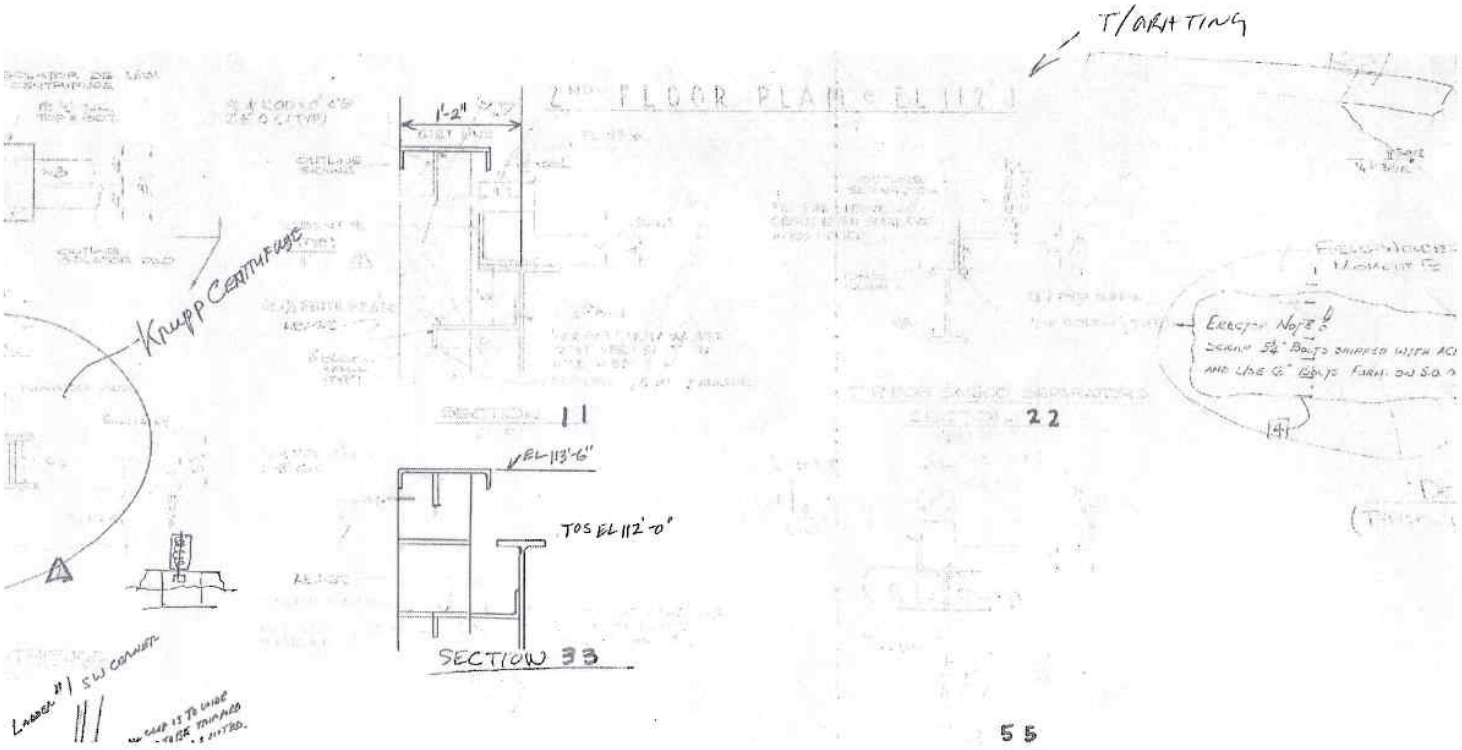

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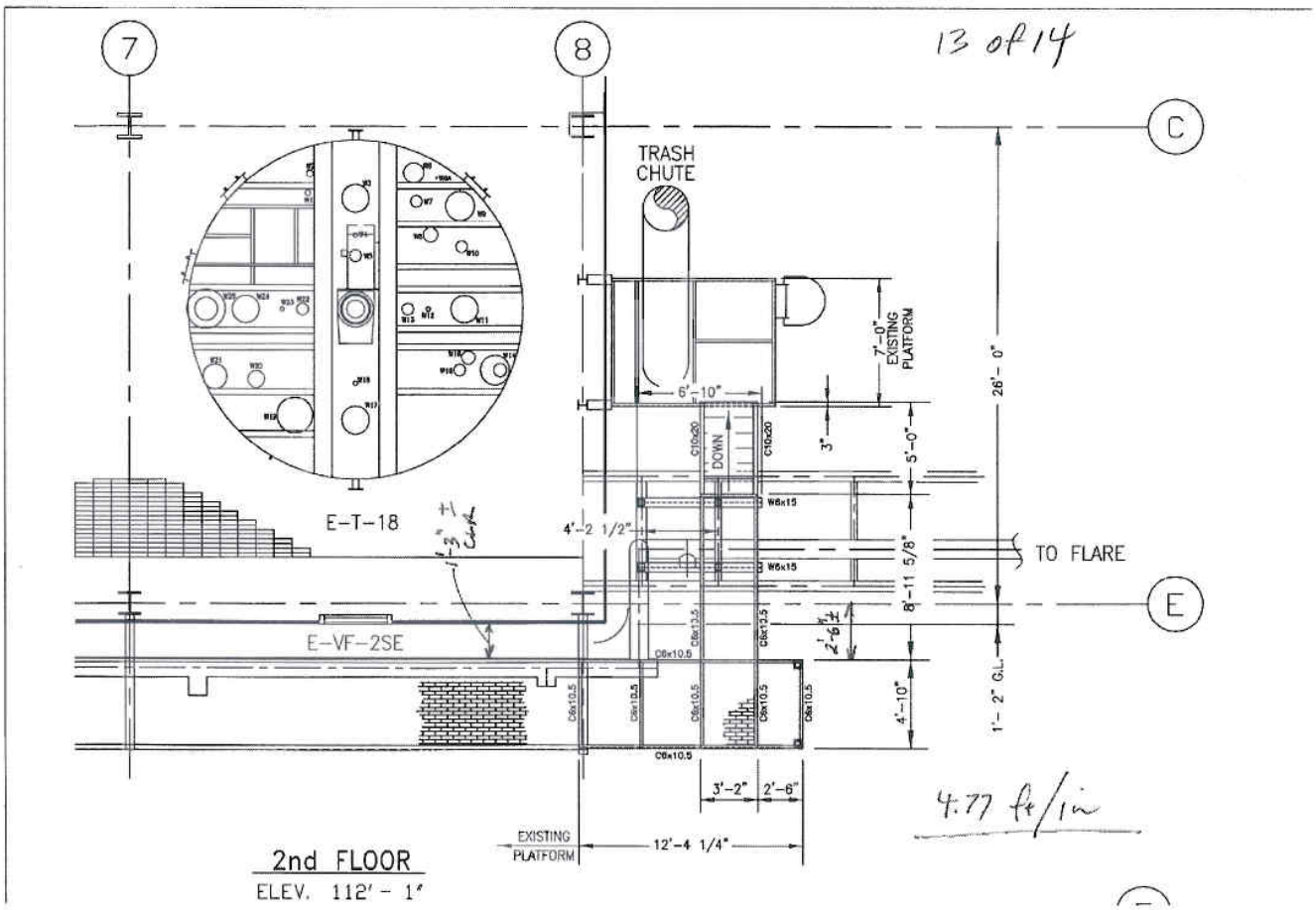

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REACTOR DUMPLINE SUPPORTS

JOB 2014-232 FH

SHEET NO. 14 OF 14

CALCULATED BY S. CUSTER DATE 5-9-14

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Material Take OFF

C15 x 33.9

(10) 12'-0" Long
(4) 26'-0" Long
(10) 6'-0" LONG
TOTAL 284' = 9.628 KIPS

W8x24

(1) 20'-0" LONG
TOTAL 20' = .480 KIPS

MC12x31

(1) 12'-0" LONG
TOTAL 12' = .372 KIPS

W12x26

(4) 25'-0" LONG
(5) 6'-0" LONG
TOTAL 130' = 3.38 KIPS

WT4x12

(2) 14' LONG
TOTAL 28' = .364 KIPS

(1) 3/8 x 4 x 4 A36 H.R. PL

TOTAL = .050 KIPS

L3 1/2 x 3 1/2 x 3/8

130 ft total

TOTAL 1.105 KIPS

(600) 3/4" A325 BOLTS

GRAND TOTAL
15.6 KIPS
7.8 TONS

ioMosaic

Minimizing risk. Maximizing potential.™

Reactor Dump Line to Pit Redesign

Peru, Illinois EPS Facility

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Preliminary Draft Report to: Flint Hills Resources

FLINT HILLS resources®

Date: May 9, 2014

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ioMosaic Reference: ioMosaic Project #14105

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FHRPRU003897

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Executive Summary

At the request of Flint Hills Resources (FHR) Peru, Illinois Expandable Polystyrene (EPS) facility, ioMosaic evaluated the validity of redesigning the dump lines from the Building 4 Reactors (E-R-14/15/16/17/18) to the containment pit on the south side of Building 4. The primary objective of the evaluation was to determine if the redesigned piping will adequately flow the contents of the reactor to the containment pit and assess the trajectory of the liquid exiting the pipe to ensure the contents are contained within the pit in the event of an operator initiated or Safety Instrumented System (SIS) initiated dump.

FHR provided the drawings of the reactor dump lines to the pit and provided guidance for the desired changes to the piping. The original dump line design routes the reactor contents to the building exterior, approximately 18 ft above grade, with the end segment directed down toward the pit at either a 30° or 45°angle. The piping redesign evaluated by ioMosaic includes replacing the 30° or 45° elbow with a 90° elbow and approximately 10 ft of NPS 14 pipe oriented vertically down toward the pit, expanded to NPS 20 with an additional 8 ft of pipe to the top of the containment pit. A 45° elbow is fitted to the end of the pipe. Refer to **Appendix A** for the piping details.

Two dump cases were considered at the request of FHR: the dump initiated with reactor contents at (1) 205°F and 20 psig and (2) 210°F and 5 psig. The evaluation was performed at multiple stages throughout the reaction, using the recipe for product 5454 as a basis; the five stages considered were (1) 0% of the styrene reacted, (2) 25% mass of styrene reacted to polystyrene, (3) 50% reacted, (4) 75% reacted, and (5) 100% of the initial mass of styrene reacted to polystyrene.

FHR is in the process of designing and implementing a foam spray system to cover the containment pit following a reactor dump. Based on guidance from FHR personnel, the foam spray system is expected to be initiated within 5 minutes of a reactor dump. With this information, the liquid pool resulting from a reactor dump to the containment pit was evaluated in addition to the hydraulic analysis of the liquid flow through the proposed reactor dump line piping. The liquid pool was used to evaluate the liquid level in the containment pit following a reactor dump; additionally, the evaporation rate of styrene and the resulting vapor cloud from the release was modeled. Two stability classes were considered in the dispersion analysis: (1) D5 and (2) F2. The vapor cloud was conservatively evaluated at 10 minutes following the release. Refer to **Appendices B, C and D** for results of all cases evaluated. A 10 minute dispersion duration is conservative because the foam is expected to actuate instantaneously and no later than 5 minutes post-release.

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It is recommended to install the proposed dump line piping to work in tandem with the foam spray system asa short term design with consideration for a long term solution of a quench or containment vessel designed to adequately handle emergency effluent from the reactors.

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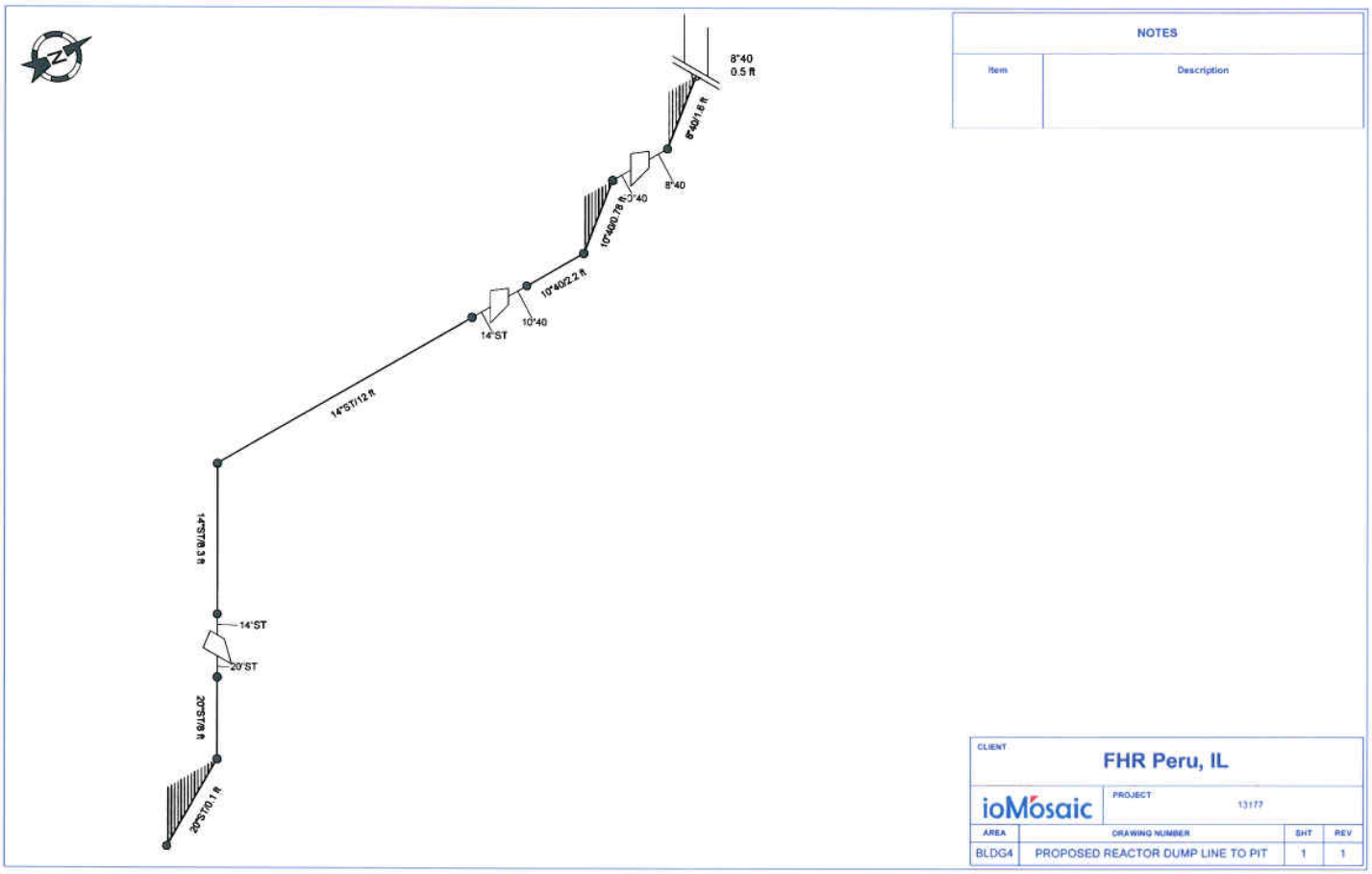
Appendix A: Piping Layouts


8"40
0.5 ft
8"40/1.6 ft
8"40
10"40/0.76 ft
10"40
10"40/2.2 ft
10"40
14"ST
14"ST/12 ft
14"ST/8.3 ft
14"ST
20"ST
20"ST/8 ft
20"ST/0.1 ft
NOTES
Item
Description
CLIENT
FHR Peru, IL
ioMosaic
PROJECT
13177
AREA
DRAWING NUMBER
SHT
REV
BLDG4
PROPOSED REACTOR DUMP LINE TO PIT
1
1

PROPOSED RXR DUMP TO PIT
Proposed Dump Line to Pit

SECTION: 1.1

PID/PFD Reference E1F014-3

Number of segments 11
Number of rupture disks 0
Number of relief valves 0

Approximate total piping flow resistanc 2910/NRe + 2.9 + 1.4/ID

Total piping mass. lb 1913.432
Total piping volume. ft3 37.940
Total piping length. ft 36.980

1st piping segment elevation relative t 0.000 <<< All segment elevations are reported with respect to vessel bottom.

Piping Node Name	Node Type	Start Elevation. ft	End Elevation. ft	Length. ft	Flow area. in2	Flow diameter. ft	Angle. Deg	Flow Solver
14.DUMP.00	Segment	0.000	0.000	0.500	50.027	0.665	0.00	Normal
14.DUMP.01	Segment	0.000	0.000	1.583	50.027	0.665	0.00	Normal
14.DUMP.02-EXP	Expander	0.000	0.000	1.016	78.854	0.835	0.00	
14.DUMP.03	Segment	0.000	0.000	0.781	78.854	0.835	0.00	Normal
14.DUMP.04	Segment	0.000	0.000	2.167	78.854	0.835	0.00	Normal
14.DUMP.05-EXP	Expander	0.000	0.000	1.083	137.886	1.104	0.00	
PROPOSED.DUMP.06	Segment	0.000	0.000	11.751	137.886	1.104	0.00	Normal
PROPOSED.DUMP.07	Segment	0.000	-8.333	8.333	137.886	1.104	-90.00	Normal
PROPOSED.DUMP.08-EXP	Expander	-8.333	-10.000	1.667	291.039	1.604	-90.00	
PROPOSED.DUMP.09	Segment	-10.000	-18.000	8.000	291.039	1.604	-90.00	Normal
PROPOSED.DUMP.10	Segment	-18.000	-18.071	0.100	291.039	1.604	-45.00	Normal

Piping Segment Name	TAG	Reference	Material	OD. ft	ID. ft	Length. ft	Angle	K1	Kinf	Kid	Roughness . ft
14.DUMP.00	NA	NA	STEEL	0.719	0.665	0.500	0.000	160.000	0.500	0.000	0.000500
14.DUMP.01	NA	NA	STEEL	0.719	0.665	1.583	0.000	800.000	0.400	0.400	0.000500
14.DUMP.03	NA	NA	STEEL	0.896	0.835	0.781	0.000	500.000	0.150	0.150	0.000500
14.DUMP.04	NA	NA	STEEL	0.896	0.835	2.167	0.000	150.000	0.500	0.500	0.000500
PROPOSED.DUMP.06	NA	NA	STEEL	1.167	1.104	11.751	0.000	800.000	0.200	0.200	0.000500
PROPOSED.DUMP.07	NA	NA	STEEL	1.167	1.104	8.333	-90.000	0.000	0.000	0.000	0.000500
PROPOSED.DUMP.09	NA	NA	STEEL	1.667	1.604	8.000	-90.000	500.000	0.150	0.150	0.000500
PROPOSED.DUMP.10	NA	NA	STEEL	1.667	1.604	0.100	-45.000	0.000	1.000	0.000	0.000500

Fittings Summary	Fitting Type	K1	Kinf	Kid	Number
14.DUMP.00	Entrance	160	0.5	0	1
14.DUMP.01	Tee used as elbow, long radius, threaded	800	0.4	0.4	1
14.DUMP.03	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
14.DUMP.04	Tee, run through, flanged/welded	150	0.5	0.5	1
PROPOSED.DUMP.06	90 deg elbow, long-radius (R/D=1.5), all ty	800	0.2	0.2	1
PROPOSED.DUMP.09	45 deg elbow, long radius (R/D=1.5), all ty	500	0.15	0.15	1
PROPOSED.DUMP.10	Exit	0	1	0	1

Reducer Name	Material	Inlet Diameter, ft	Exit Diameter, ft	Length, ft	Angle	Roughness, ft
14.DUMP.02-EXP	STEEL	0.665	0.835	1.016	0.000	0.000500
14.DUMP.05-EXP	STEEL	0.835	1.104	1.083	0.000	0.000500
PROPOSED.DUMP.08-EXP	STEEL	1.104	1.604	1.667	-90.000	0.000500

Appendix B: Results – Liquid Pool Depth

Figure 1: Liquid Pool Depth – 0% Reacted; D5 Stability Class; 20 psig and 205°F

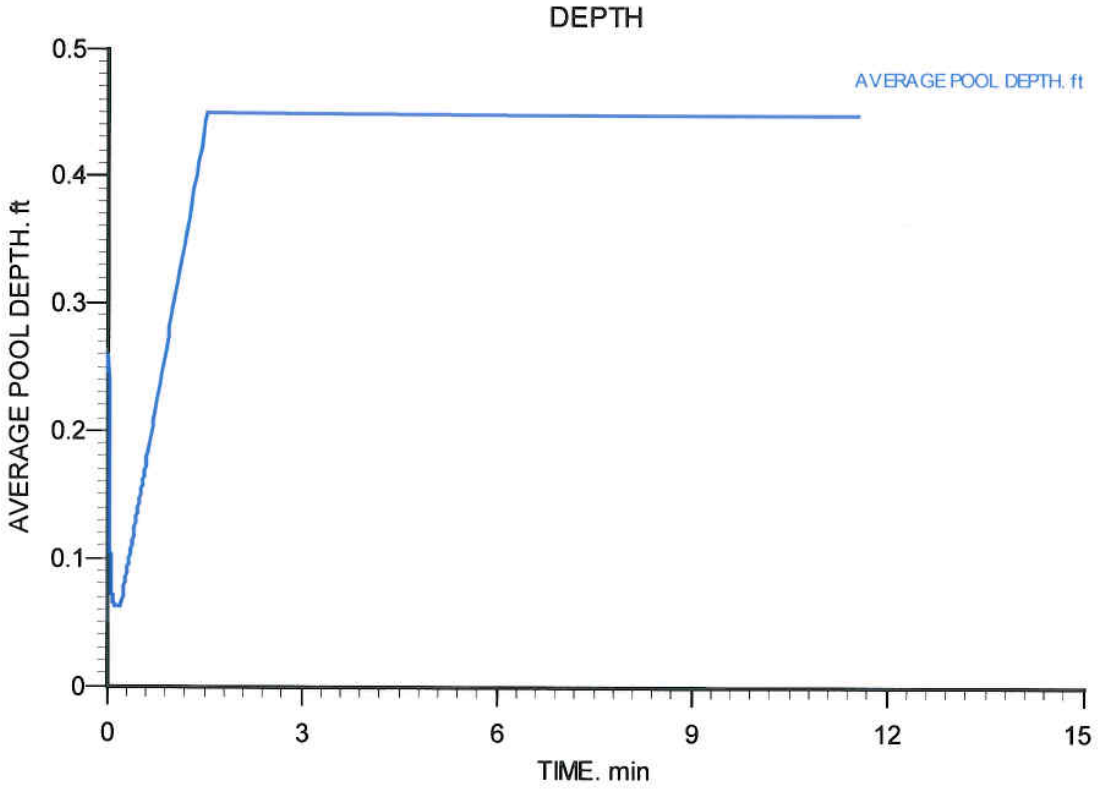


Figure 2: Liquid Pool Depth – 0% Reacted; F2 Stability Class; 20 psig and 205°F

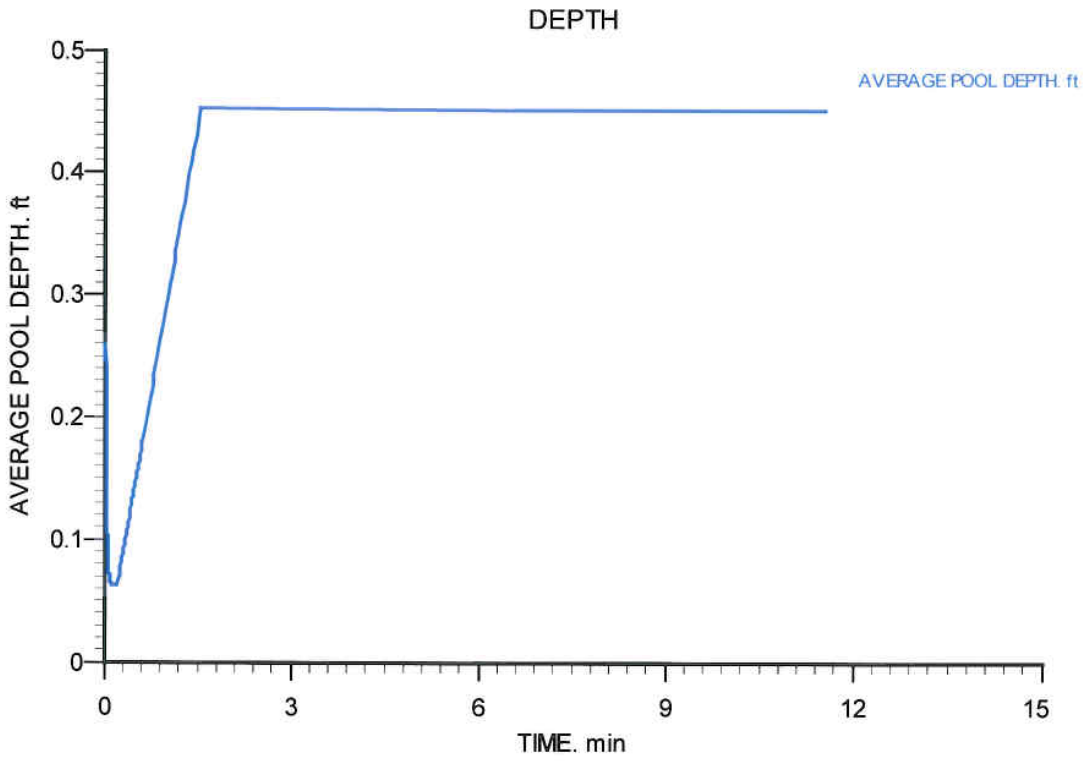


Figure 3: Liquid Pool Depth – 0% Reacted; D5 Stability Class; 5 psig and 210°F

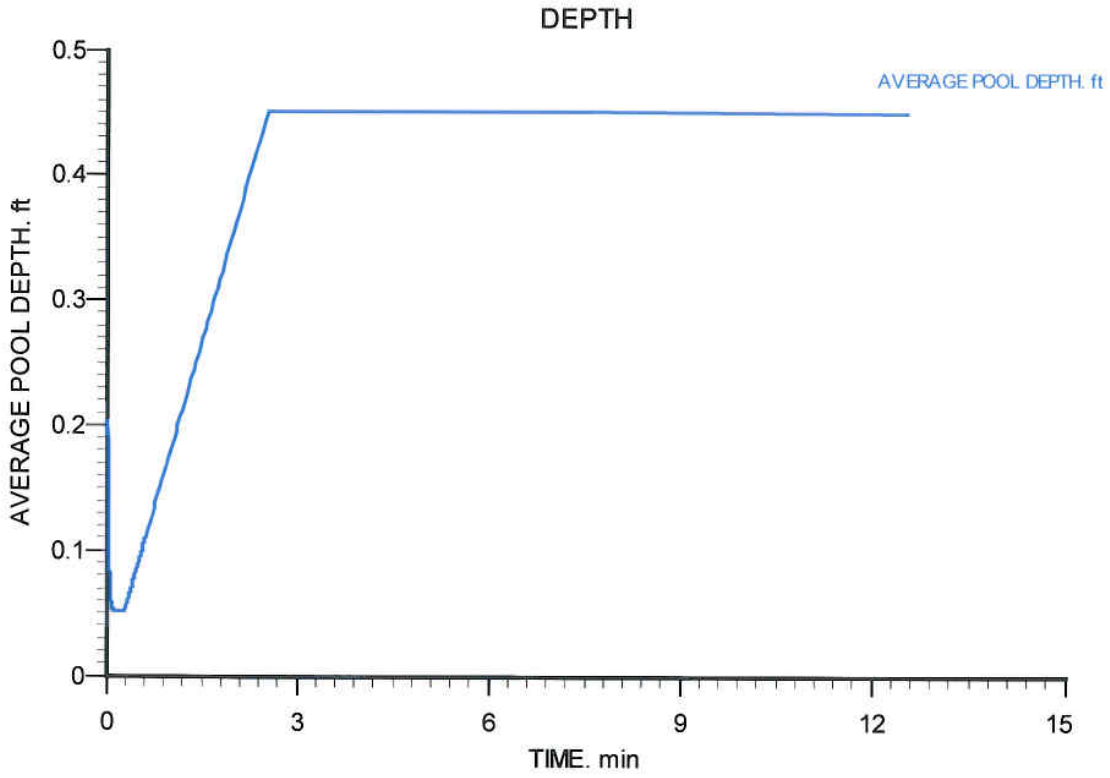


Figure 4: Liquid Pool Depth – 0% Reacted; F2 Stability Class; 5 psig and 210°F

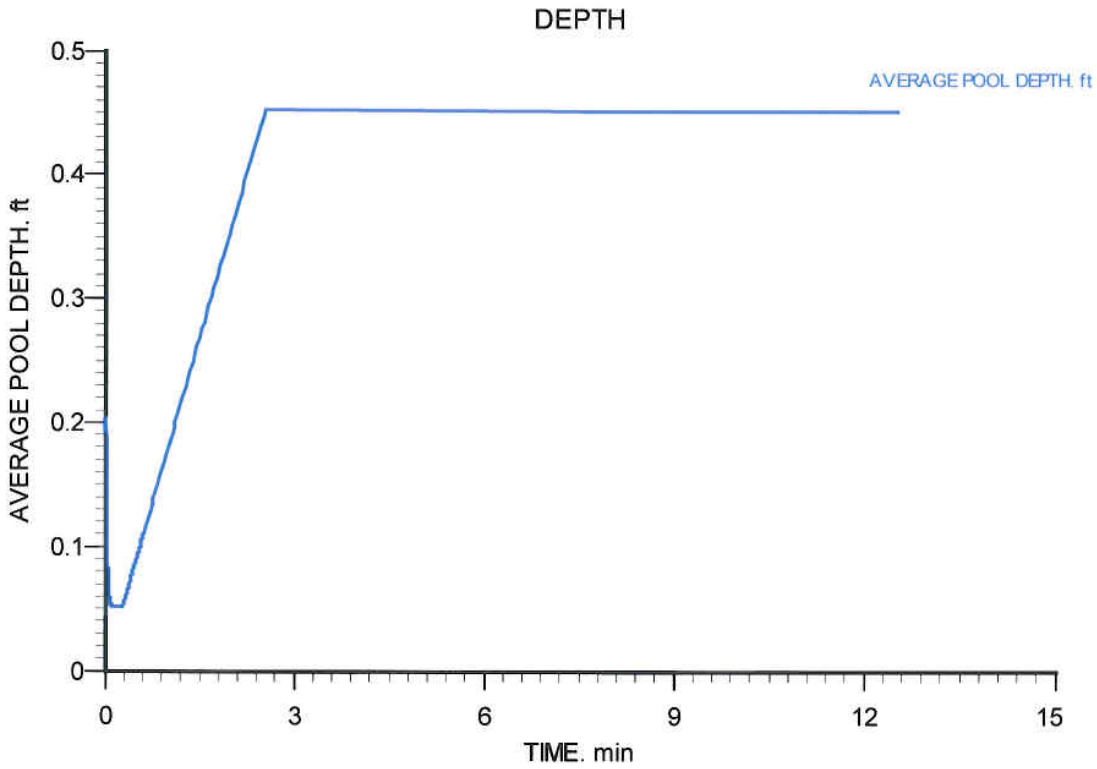


Figure 5: Liquid Pool Depth – 25% Reacted; D5 Stability Class; 20 psig and 205°F

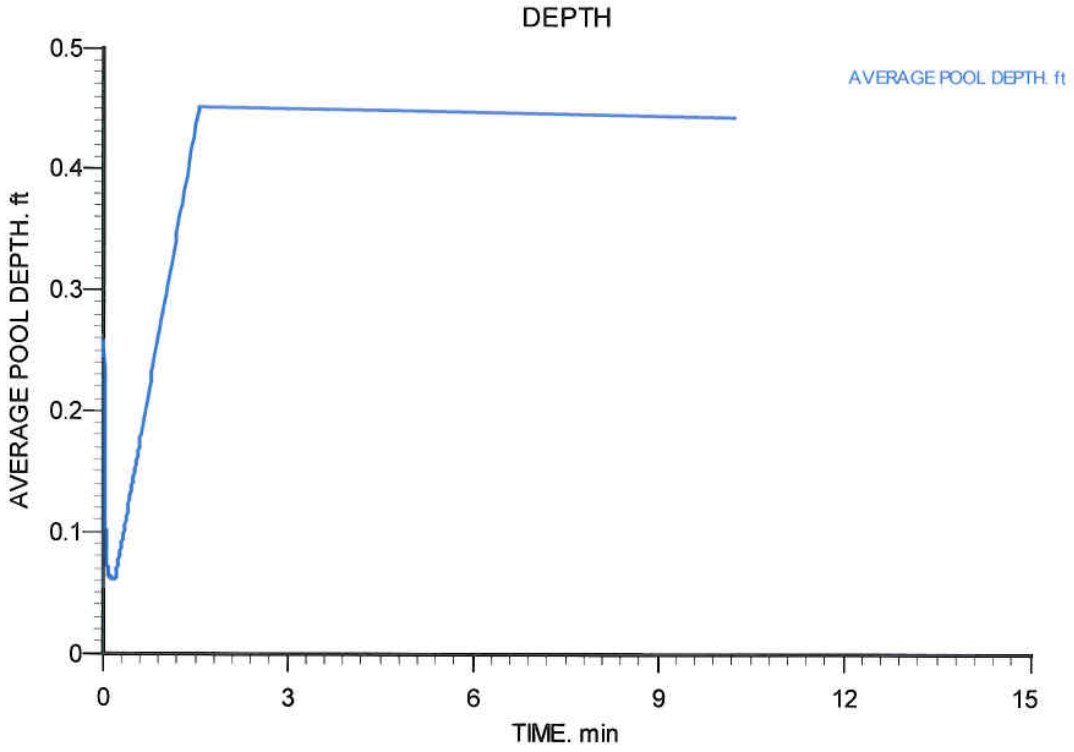


Figure 6: Liquid Pool Depth – 25% Reacted; F2 Stability Class; 20 psig and 205°F

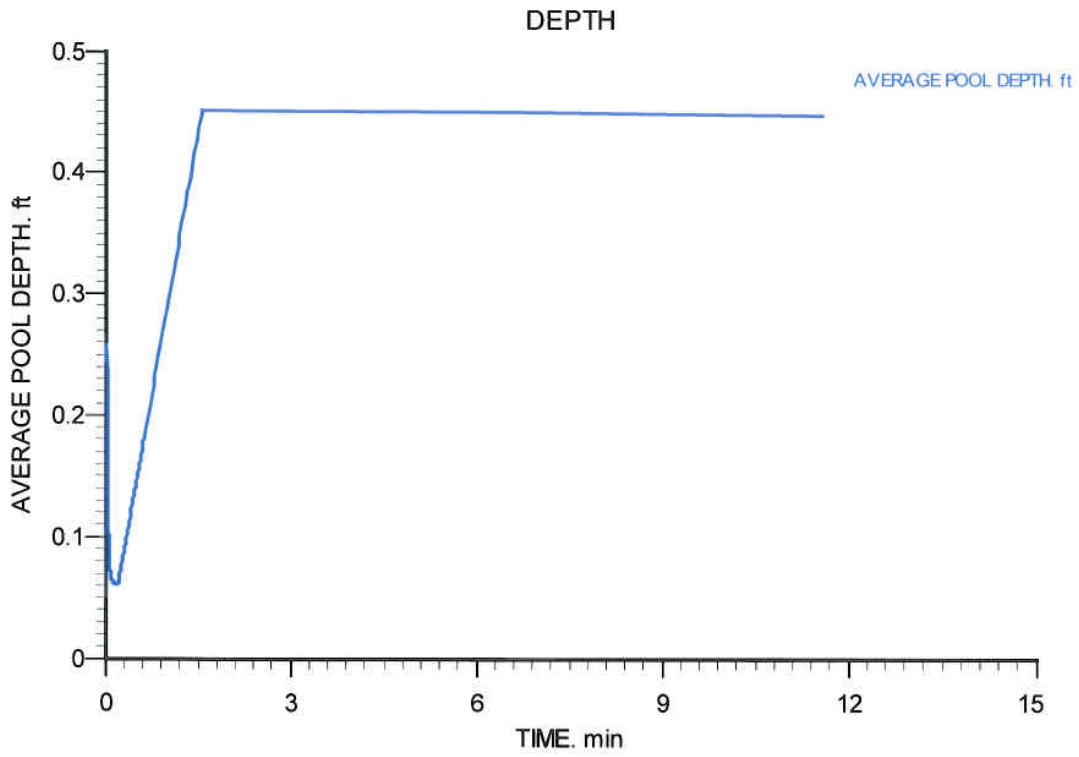


Figure 7: Liquid Pool Depth – 25% Reacted; D5 Stability Class; 5 psig and 210°F

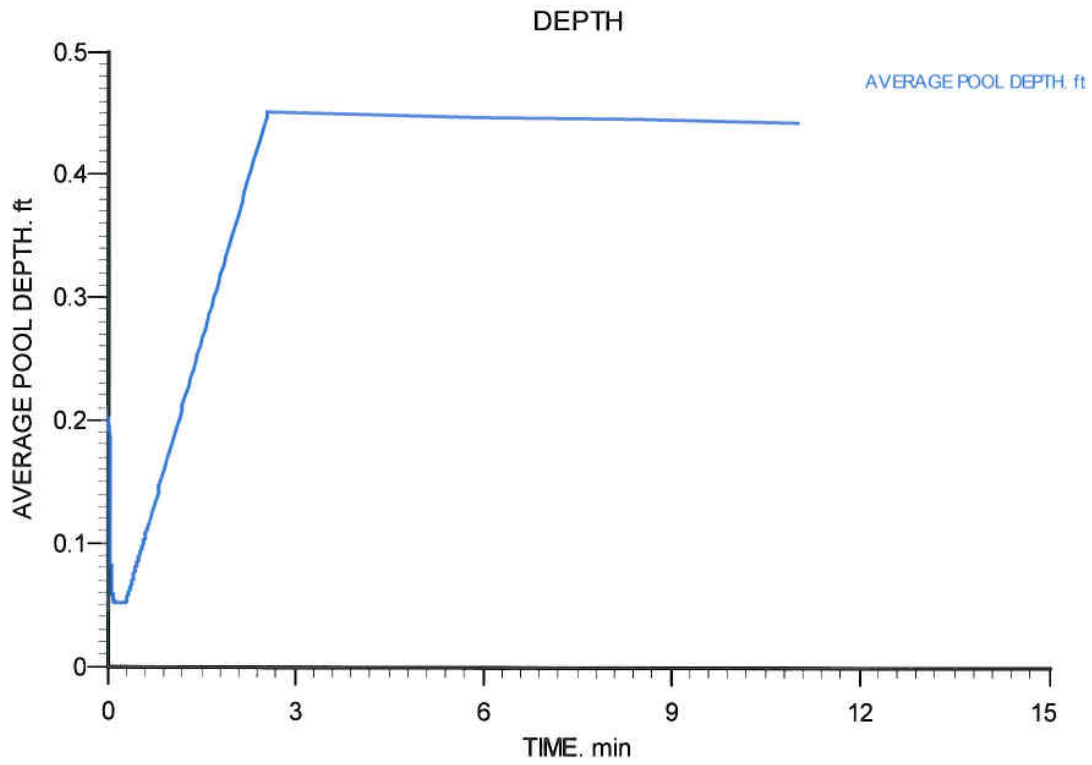


Figure 8: Liquid Pool Depth – 25% Reacted; F2 Stability Class; 5 psig and 210°F

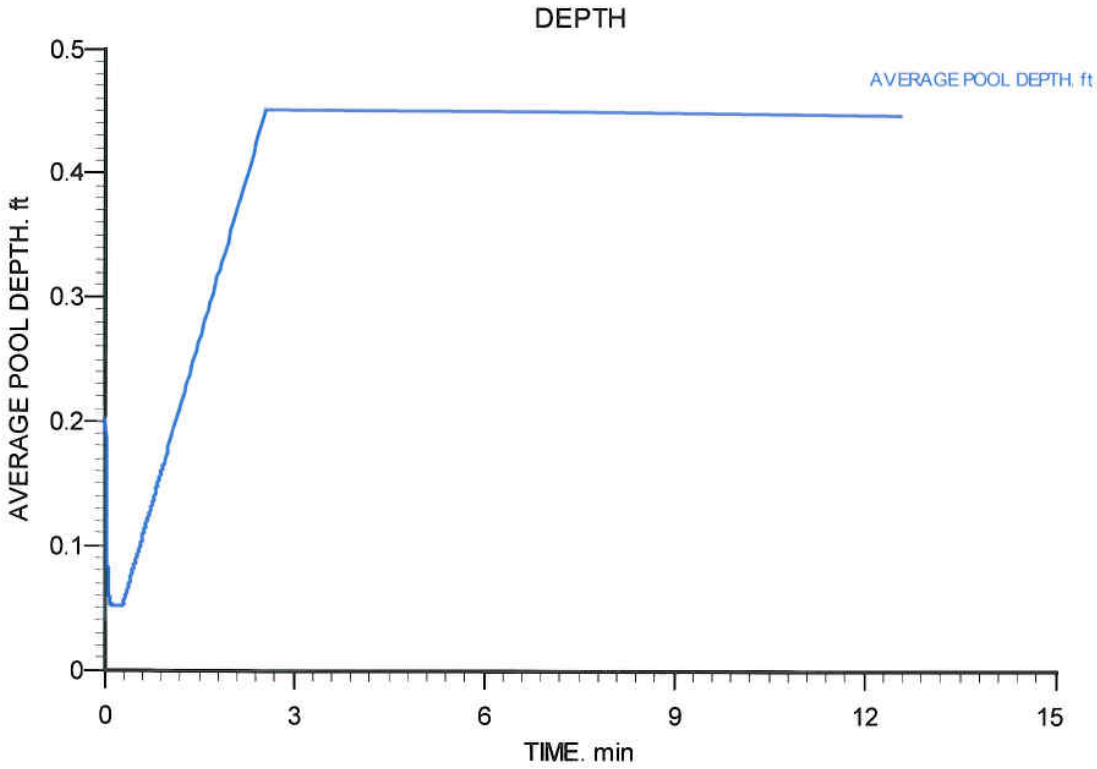


Figure 9: Liquid Pool Depth – 50% Reacted; D5 Stability Class; 20 psig and 205°F

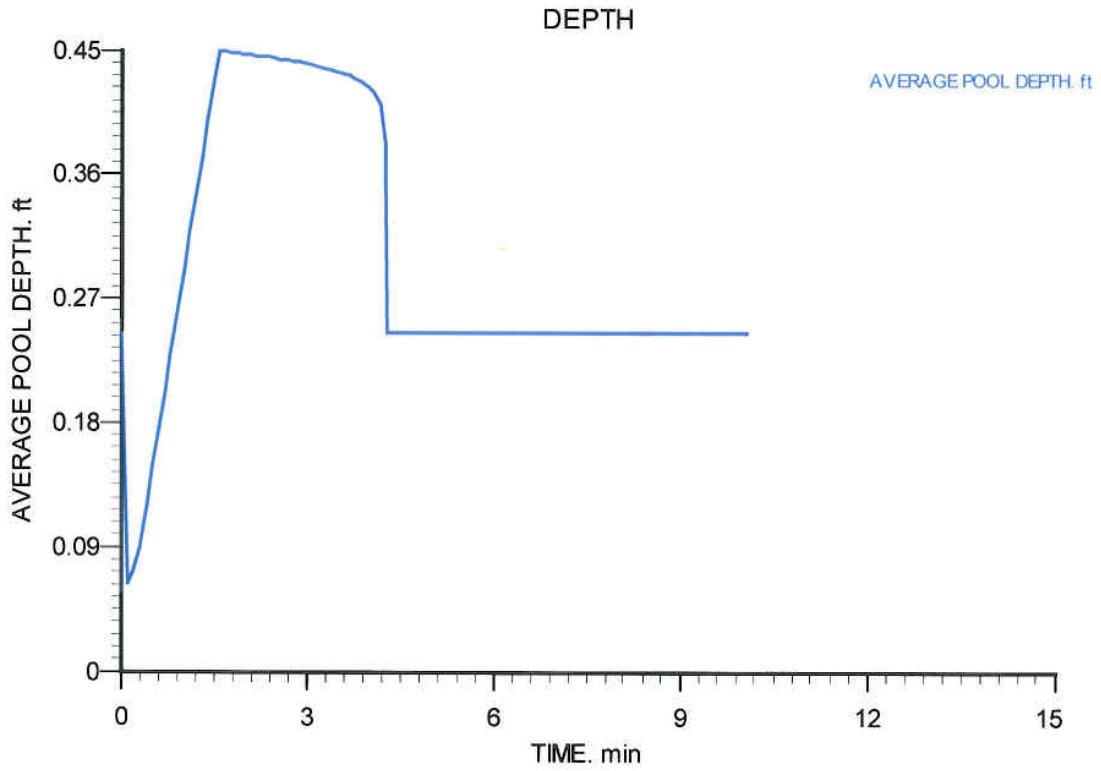


Figure 10: Liquid Pool Depth – 50% Reacted; F2 Stability Class; 5 psig and 210°F

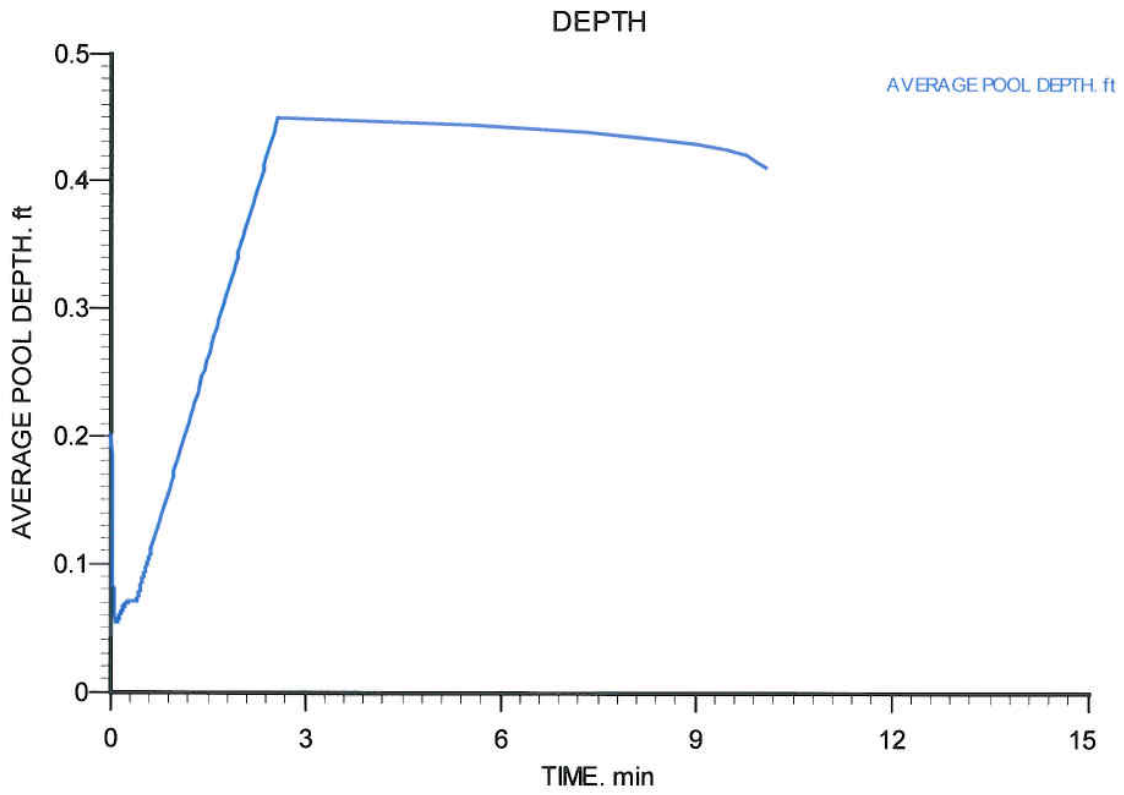


Figure 11: Liquid Pool Depth – 75% Reacted; F2 Stability Class; 20 psig and 205°F

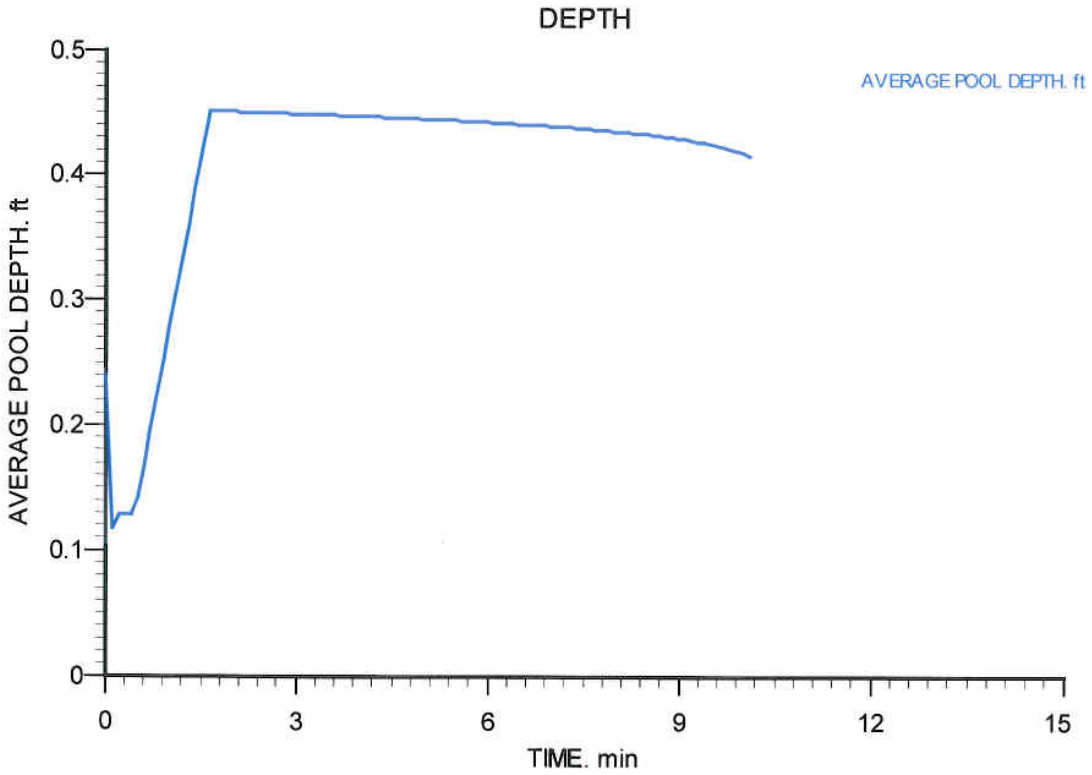
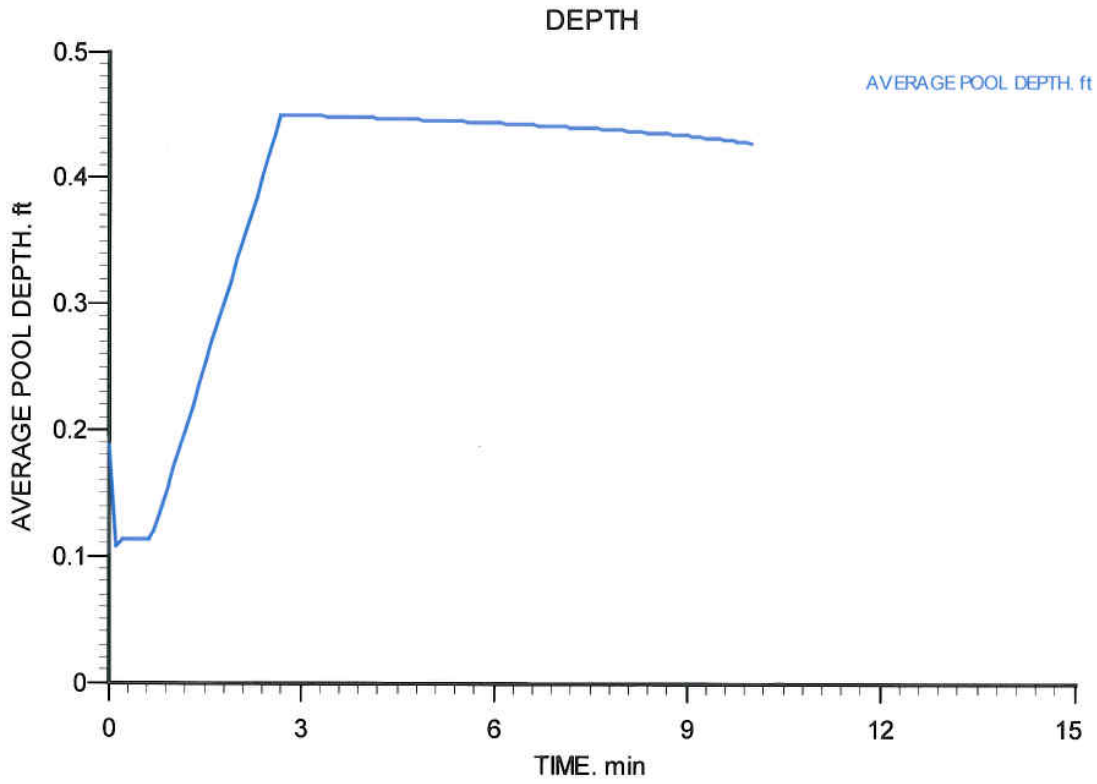


Figure 12: Liquid Pool Depth – 75% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix C: Results – Liquid Release Jet Profile

Figure 13: Liquid Release Jet Profile – 0% Reacted; D5 Stability Class; 20 psig and 205°F

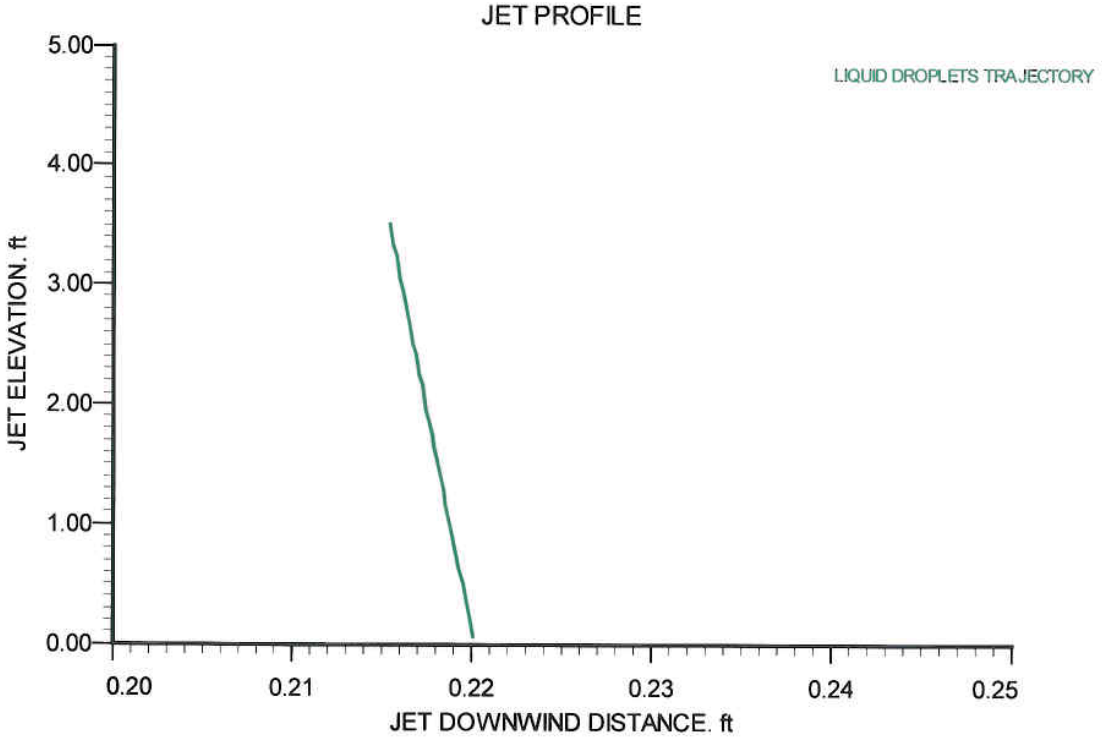


Figure 14: Liquid Release Jet Profile – 0% Reacted; F2 Stability Class; 20 psig and 205°F

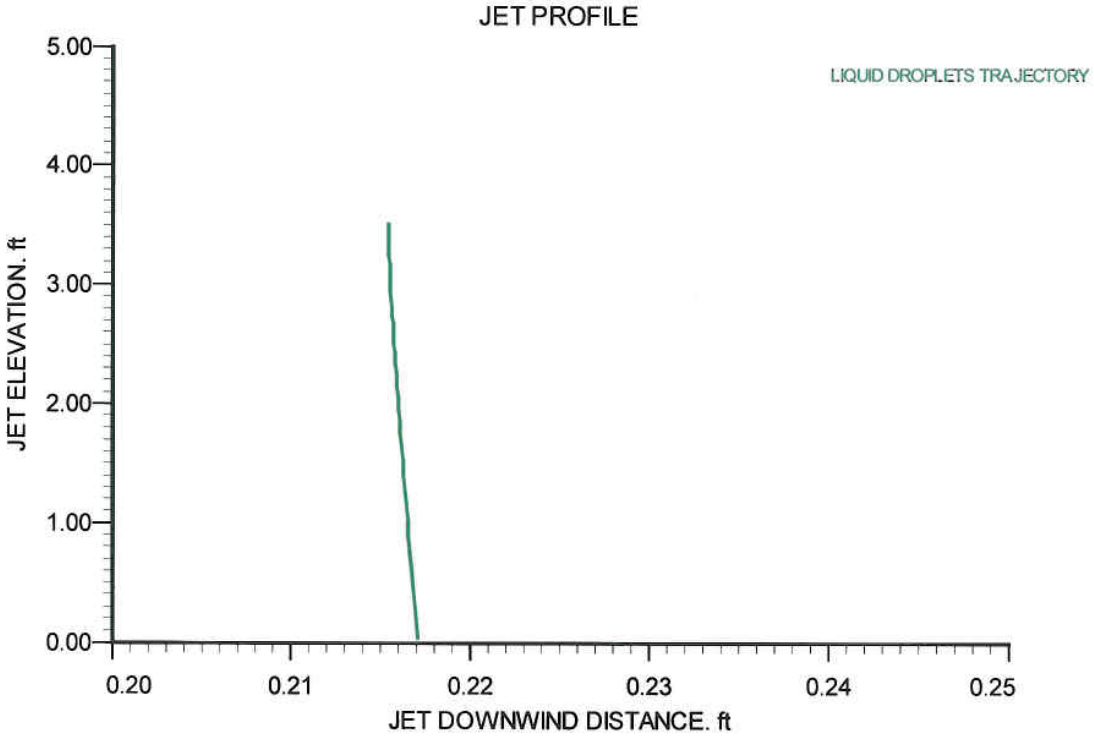


Figure 15: Liquid Release Jet Profile – 0% Reacted; D5 Stability Class; 5 psig and 210°F

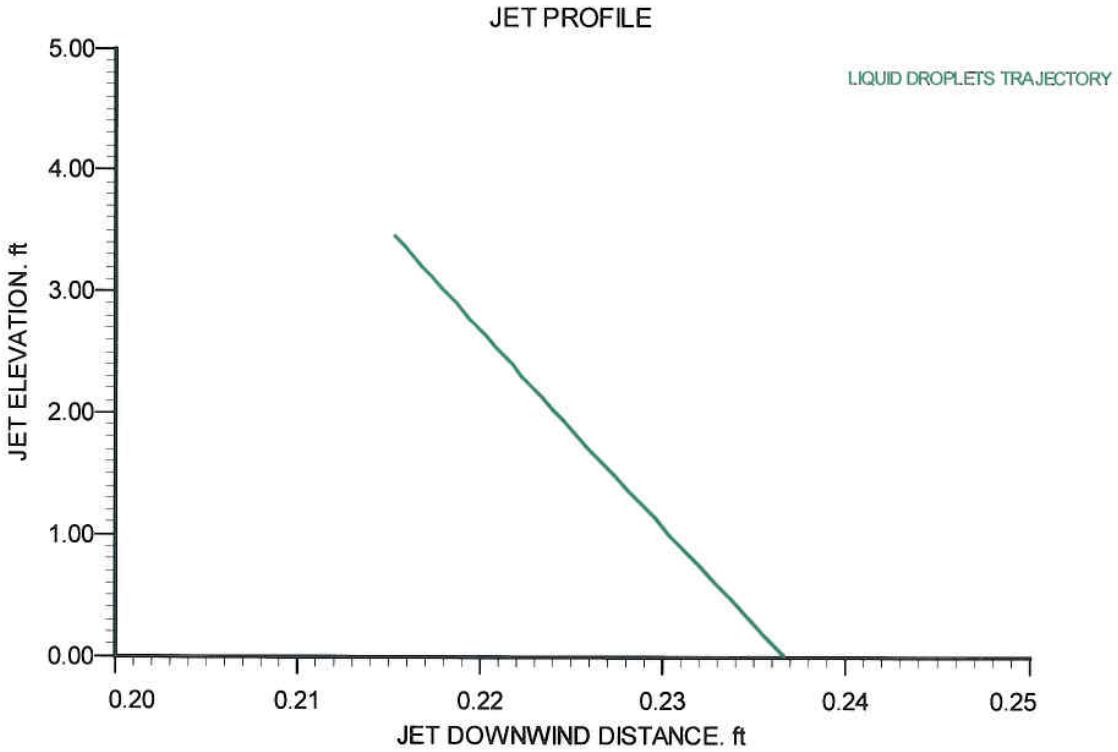


Figure 16: Liquid Release Jet Profile – 0% Reacted; F2 Stability Class; 5 psig and 210°F

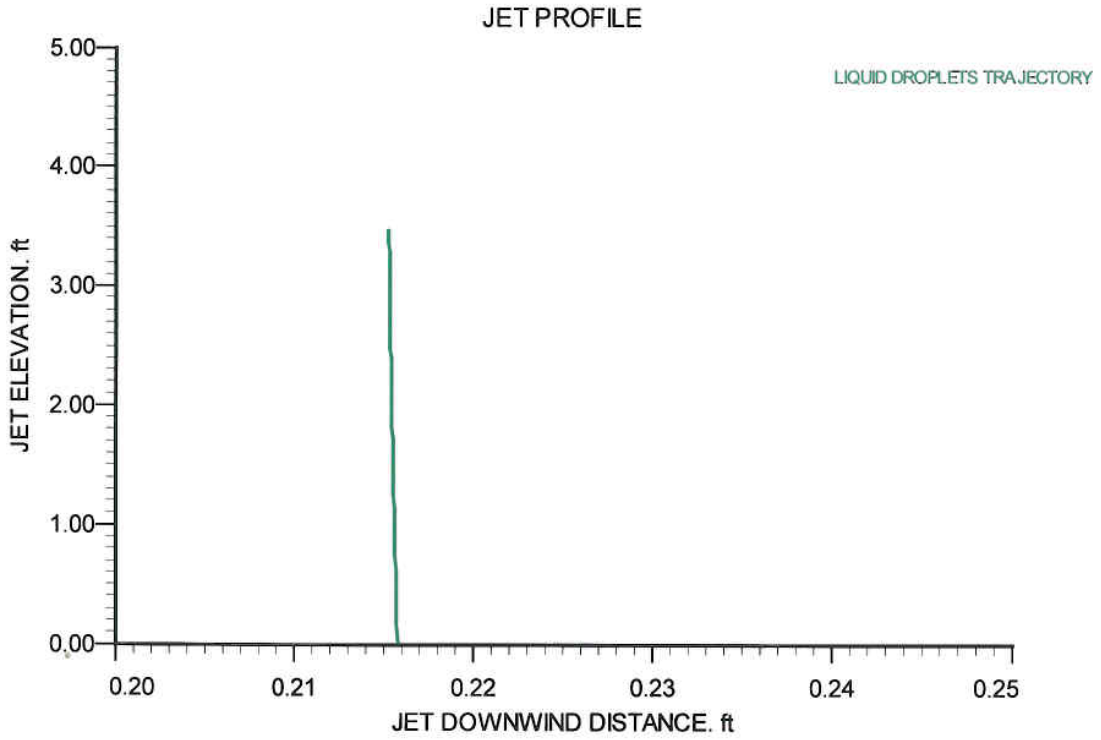


Figure 17: Liquid Release Jet Profile – 25% Reacted; D5 Stability Class; 20 psig and 205°F

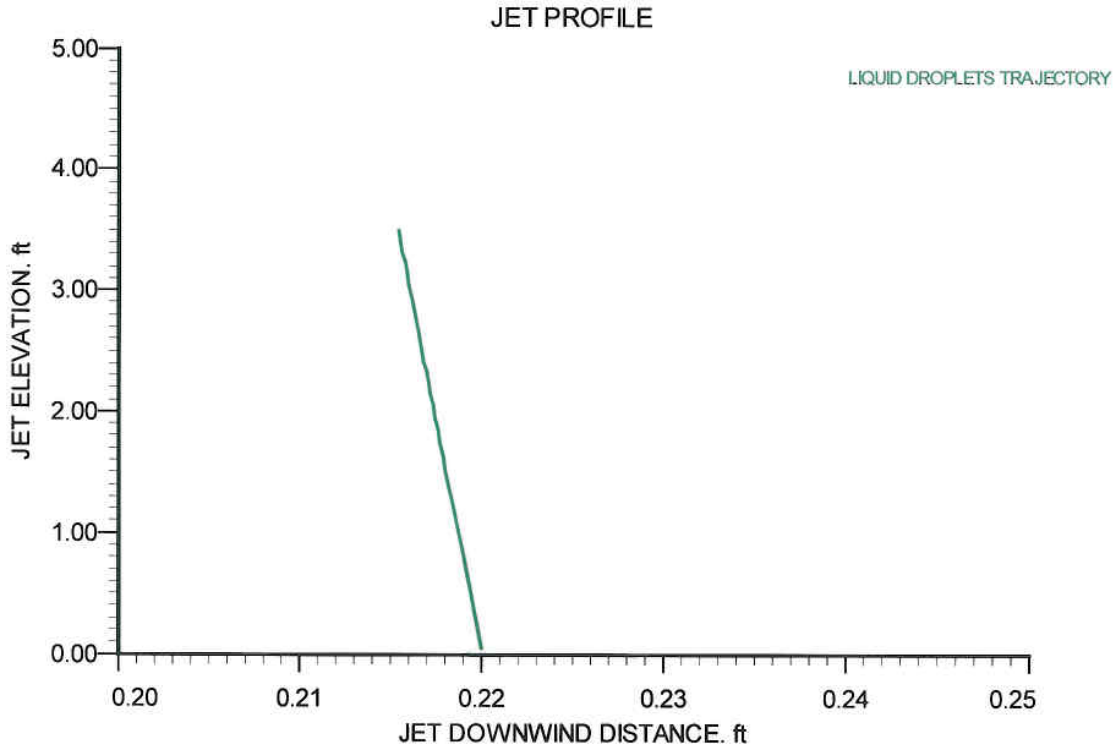


Figure 18: Liquid Release Jet Profile – 25% Reacted; F2 Stability Class; 20 psig and 205°F

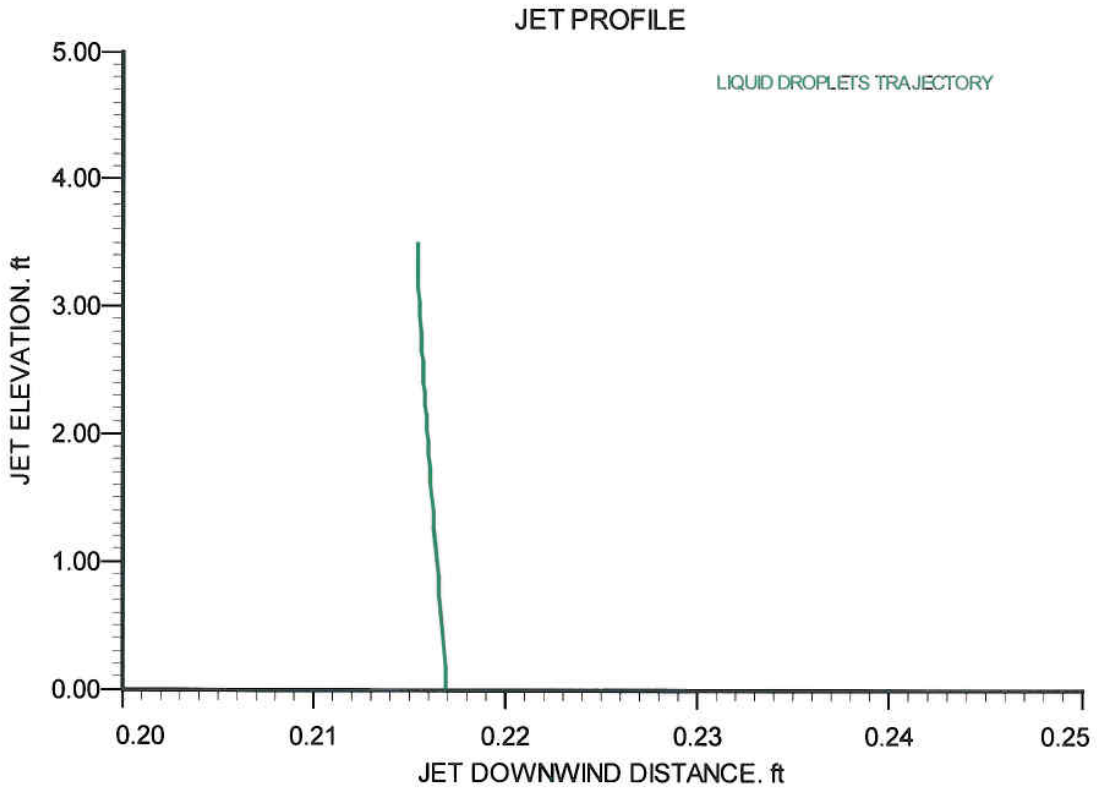


Figure 19: Liquid Release Jet Profile – 25% Reacted; D5 Stability Class; 5 psig and 210°F

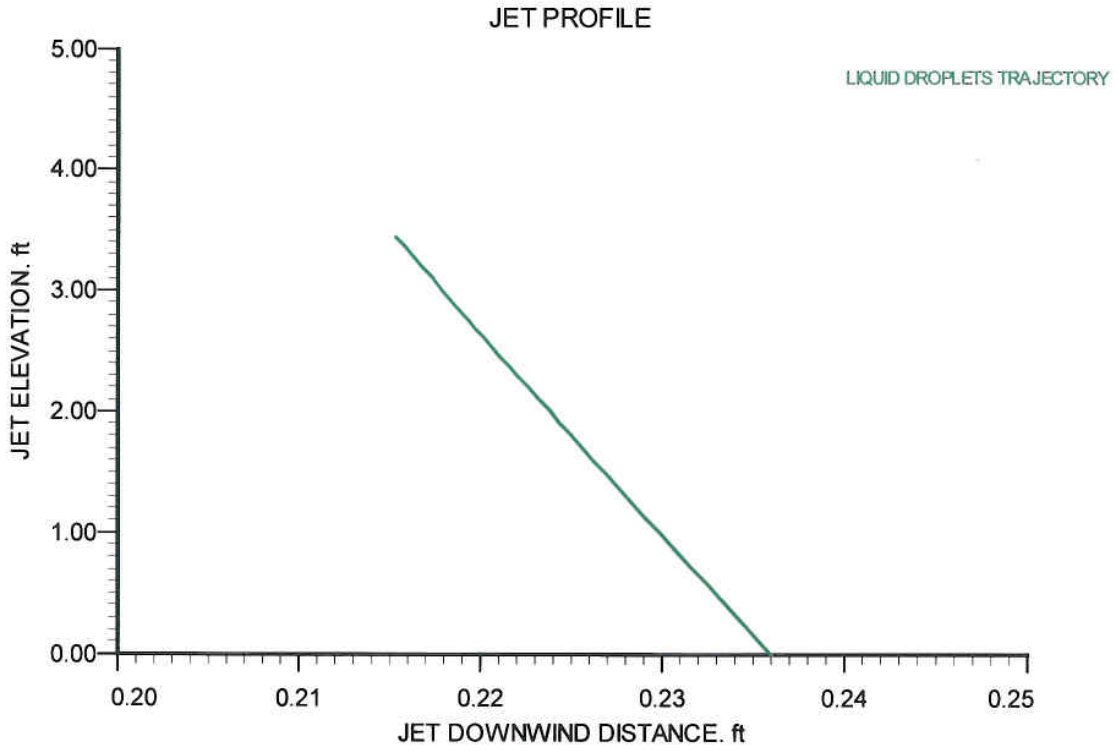


Figure 20: Liquid Release Jet Profile – 25% Reacted; F2 Stability Class; 5 psig and 210°F

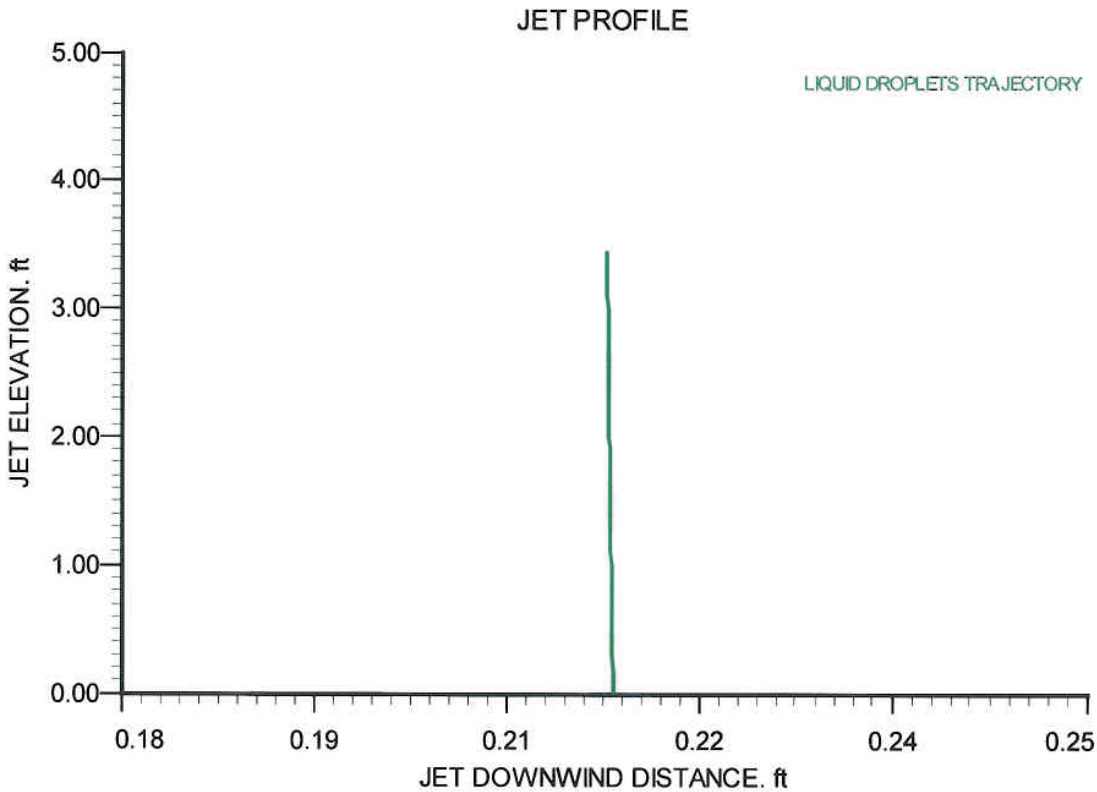


Figure 21: Liquid Release Jet Profile – 50% Reacted; D5 Stability Class; 20 psig and 205°F

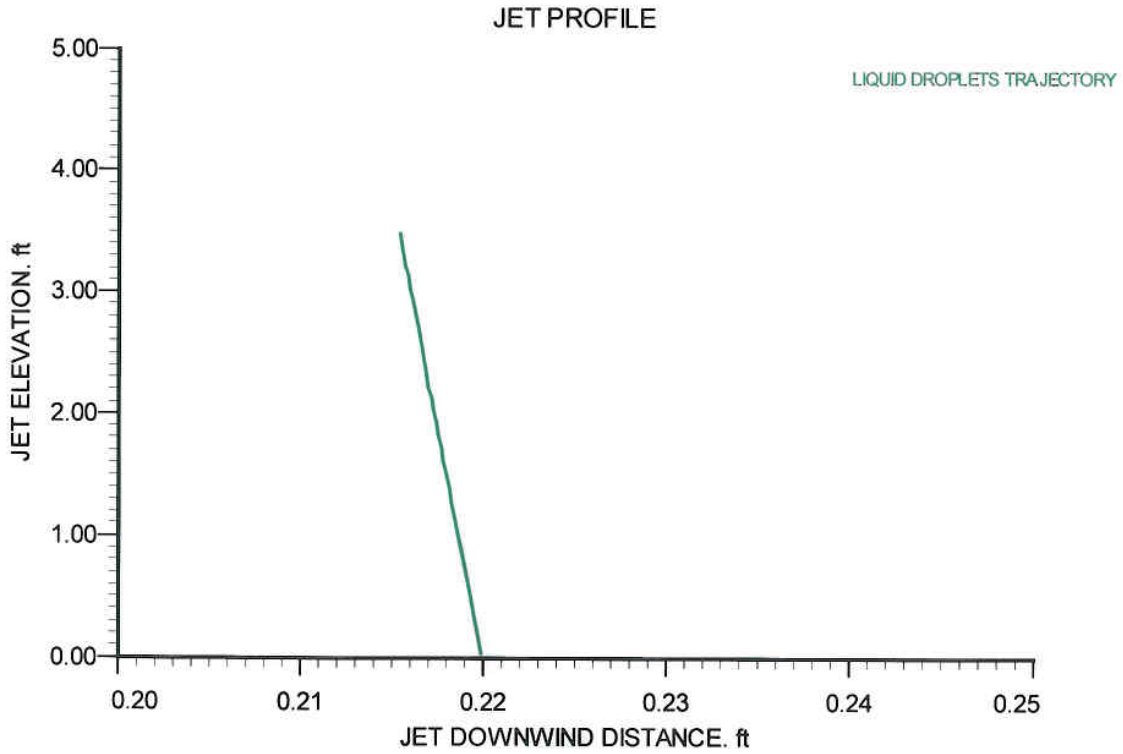


Figure 22: Liquid Release Jet Profile – 50% Reacted; F2 Stability Class; 5 psig and 210°F

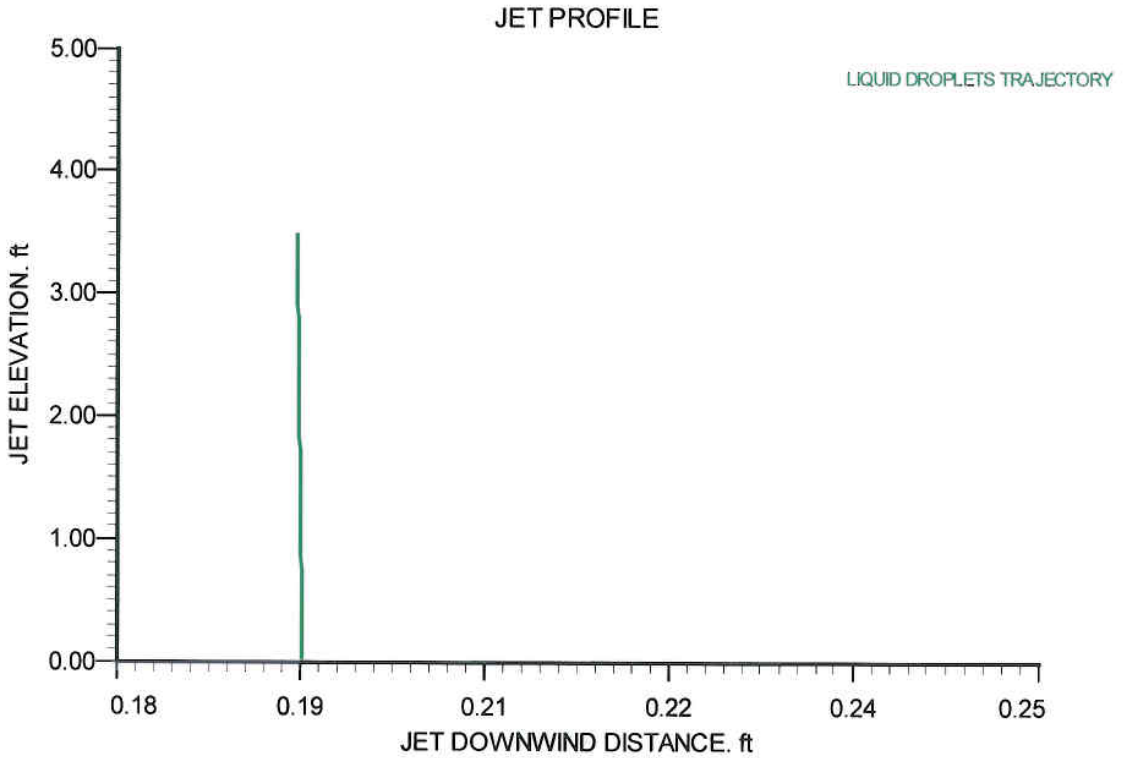


Figure 23: Liquid Release Jet Profile – 75% Reacted; F2 Stability Class; 20 psig and 205°F

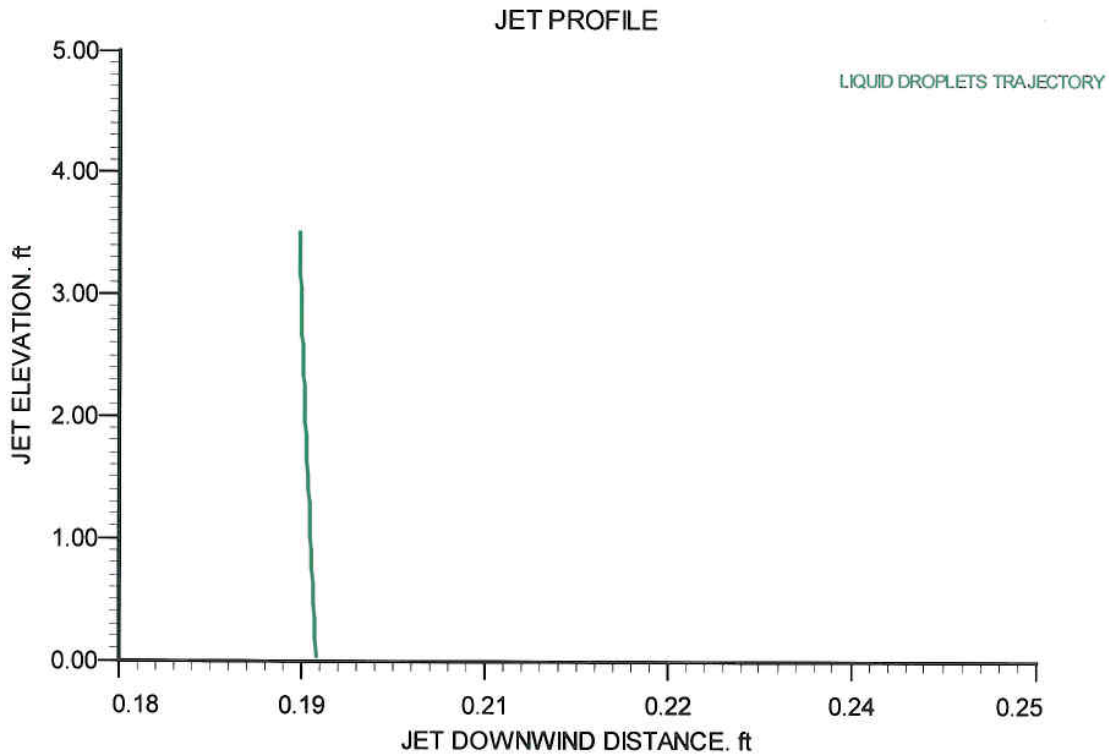


Figure 24: Liquid Release Jet Profile – 75% Reacted; F2 Stability Class; 5 psig and 210°F

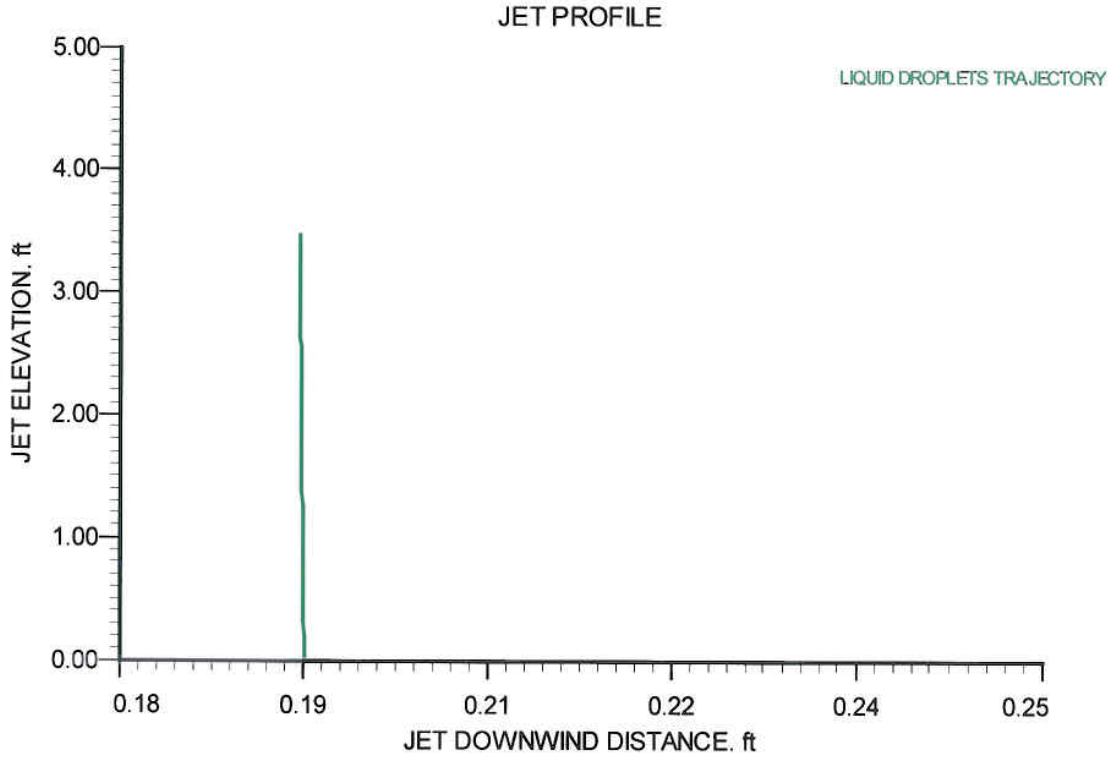


Figure 25: Liquid Release Jet Profile – 100% Reacted; D5 Stability Class; 20 psig and 205°F

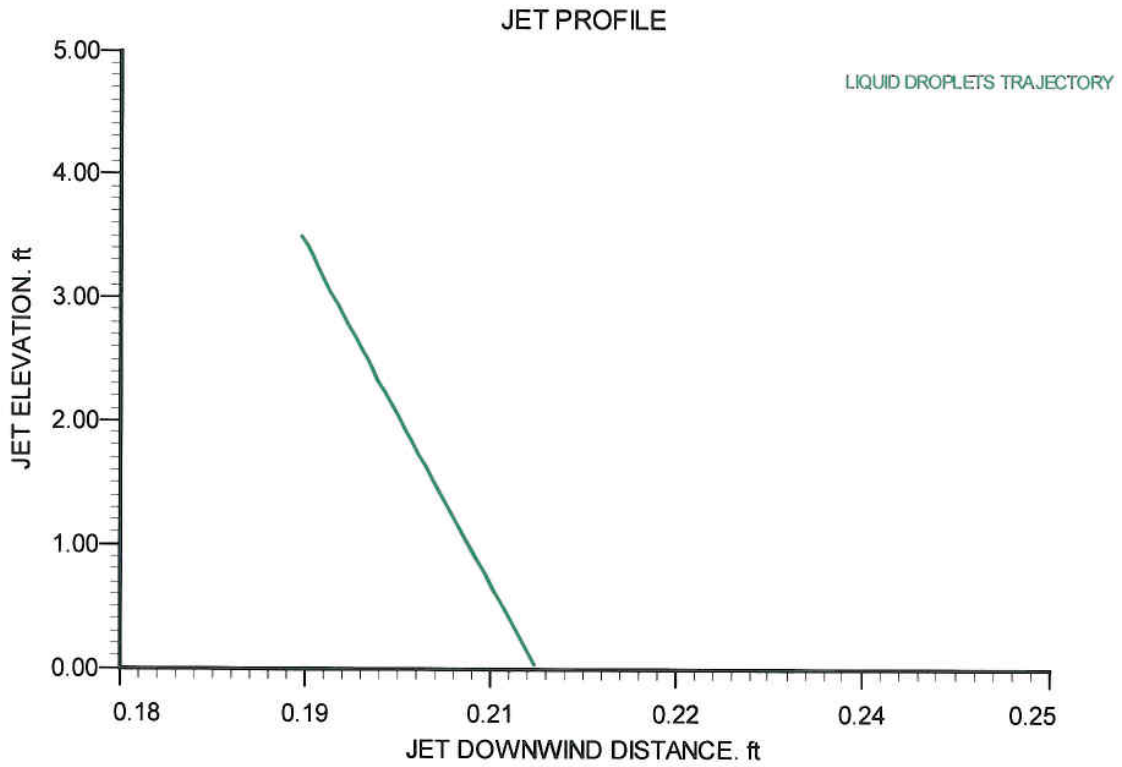


Figure 26: Liquid Release Jet Profile – 100% Reacted; F2 Stability Class; 20 psig and 205°F

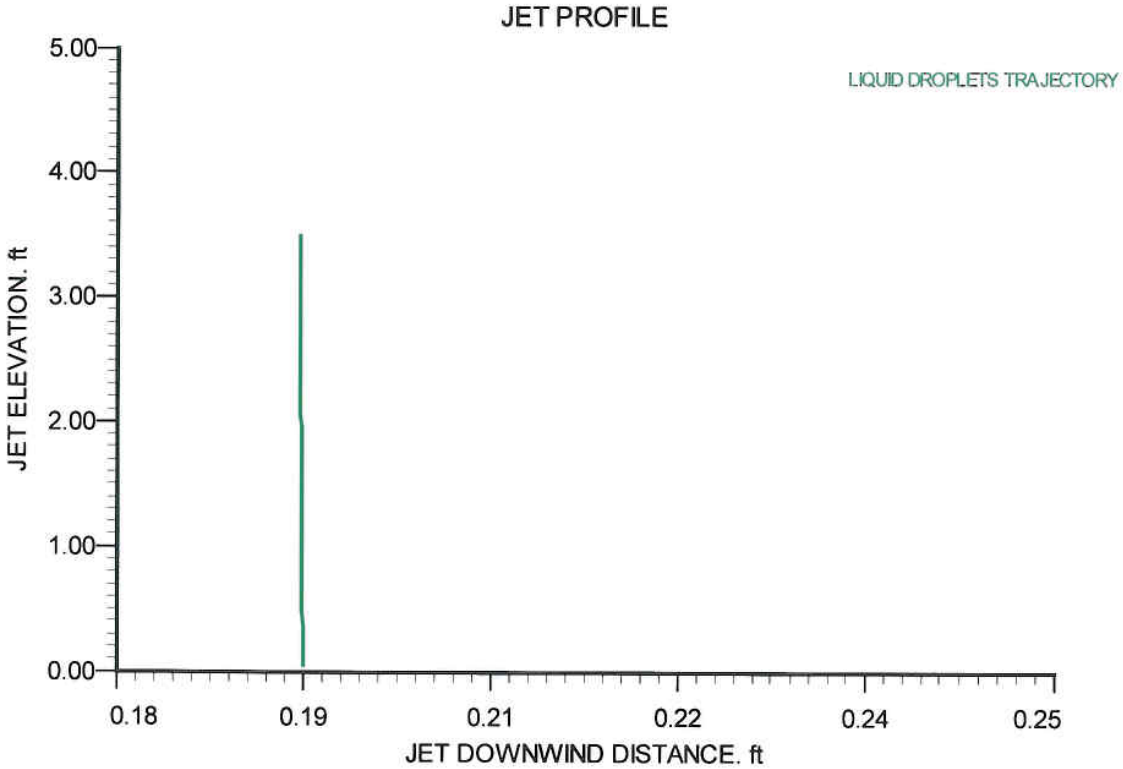


Figure 27: Liquid Release Jet Profile – 100% Reacted; D5 Stability Class; 5 psig and 210°F

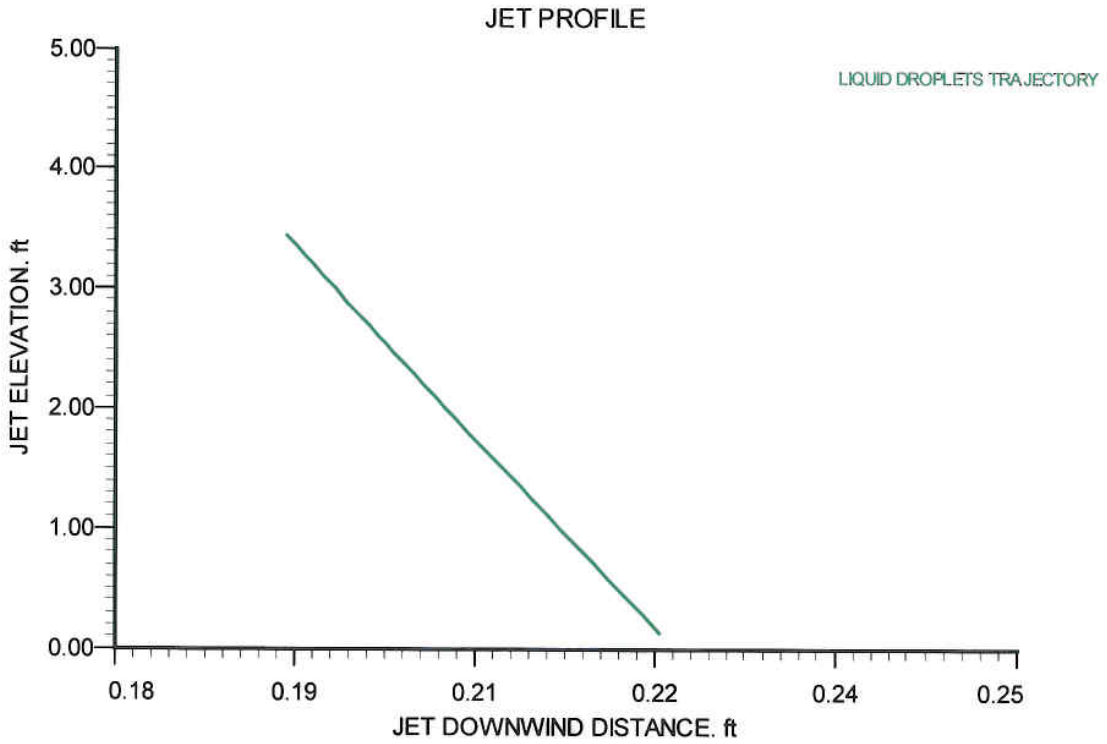
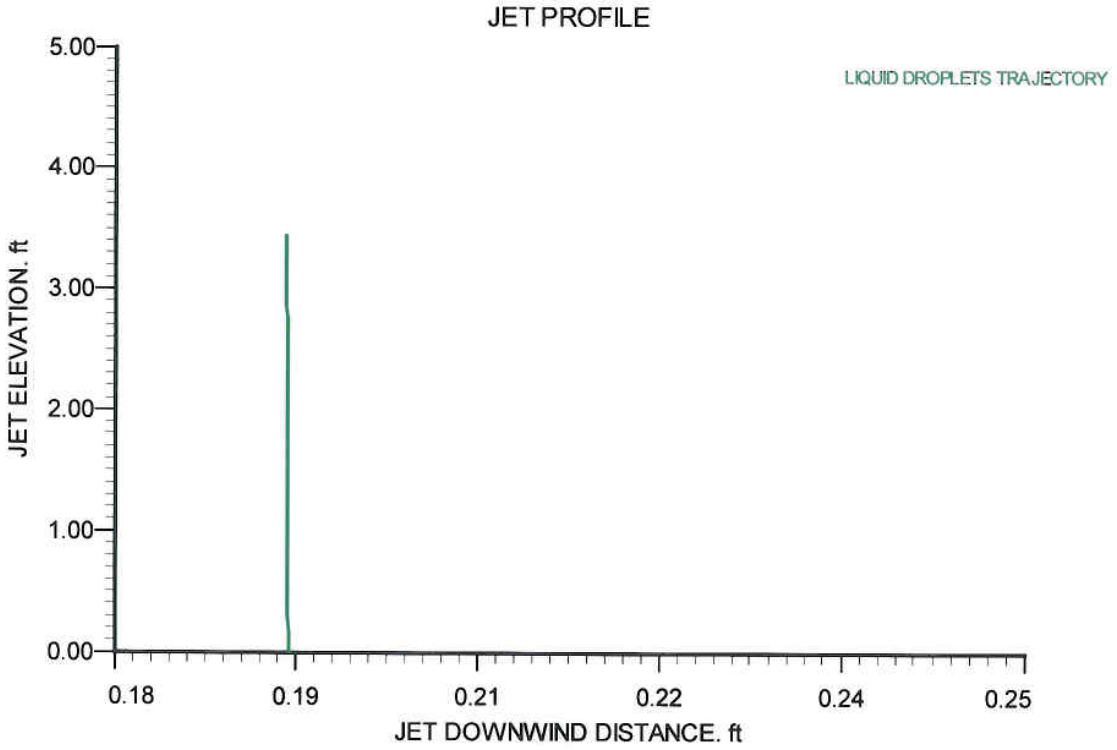


Figure 28: Liquid Release Jet Profile – 100% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix D: Results – Styrene Evaporation Rate

Figure 29: Styrene Evaporation Rate – 0% Reacted; D5 Stability Class; 20 psig and 205°F

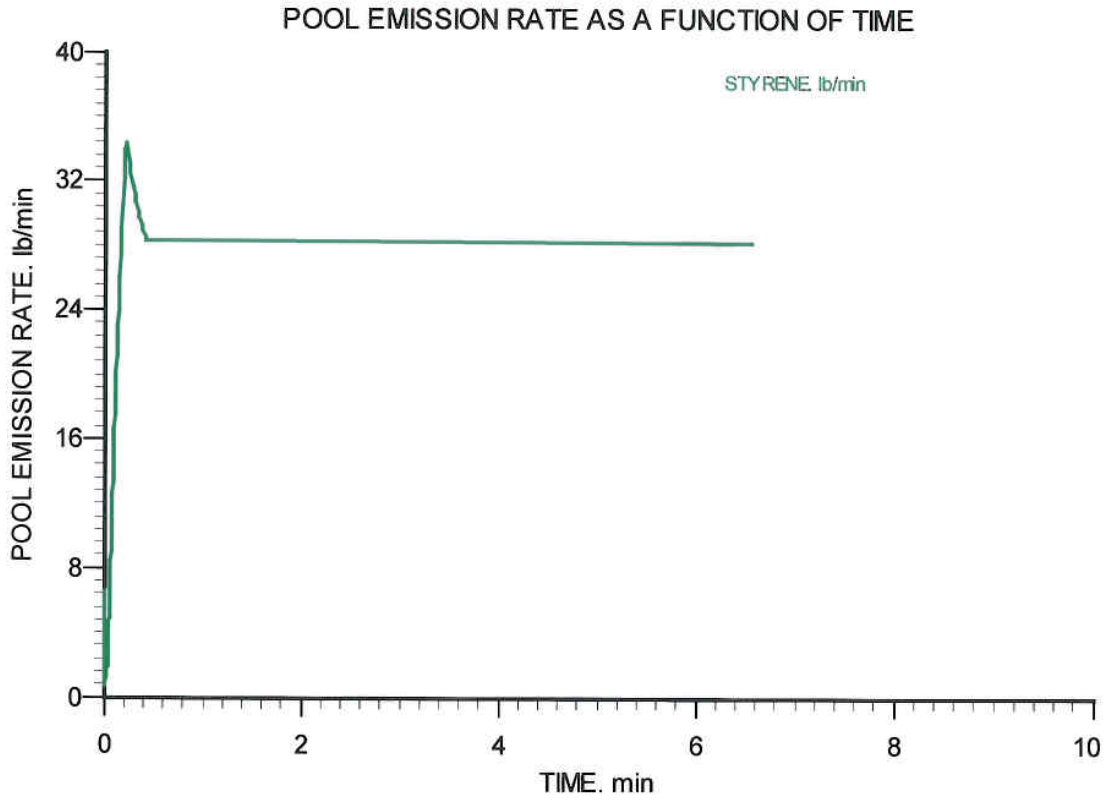


Figure 30: Styrene Evaporation Rate – 0% Reacted; F2 Stability Class; 20 psig and 205°F

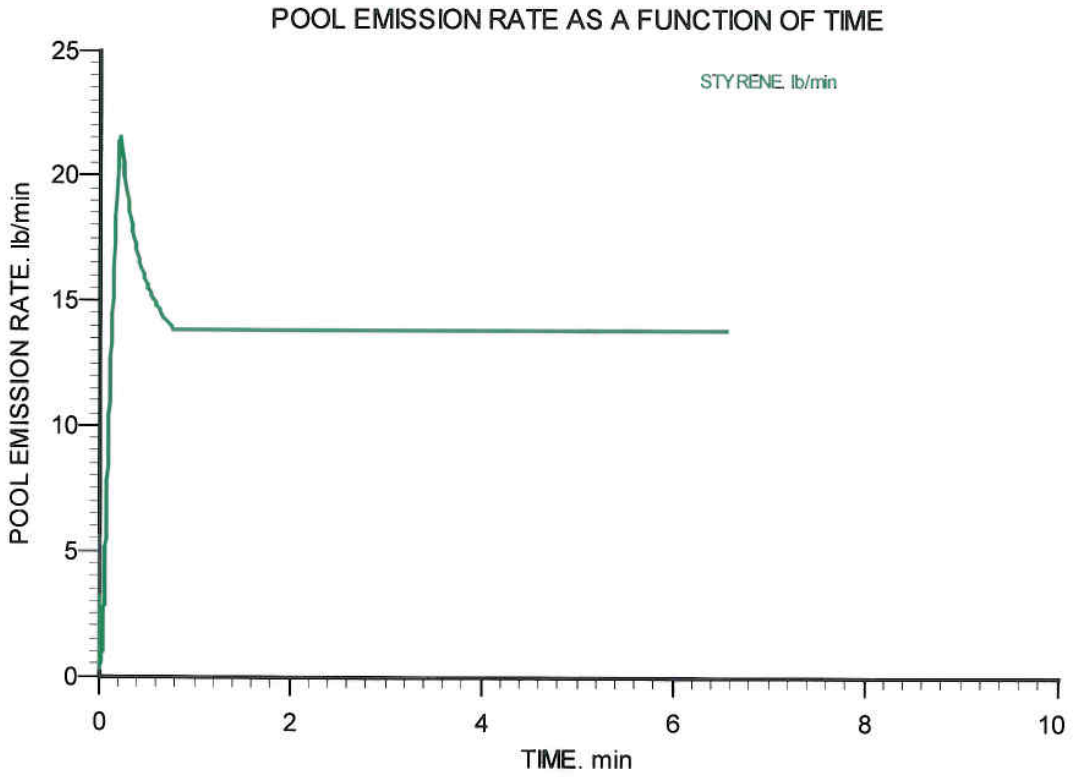


Figure 31: Styrene Evaporation Rate – 0% Reacted; D5 Stability Class; 5 psig and 210°F

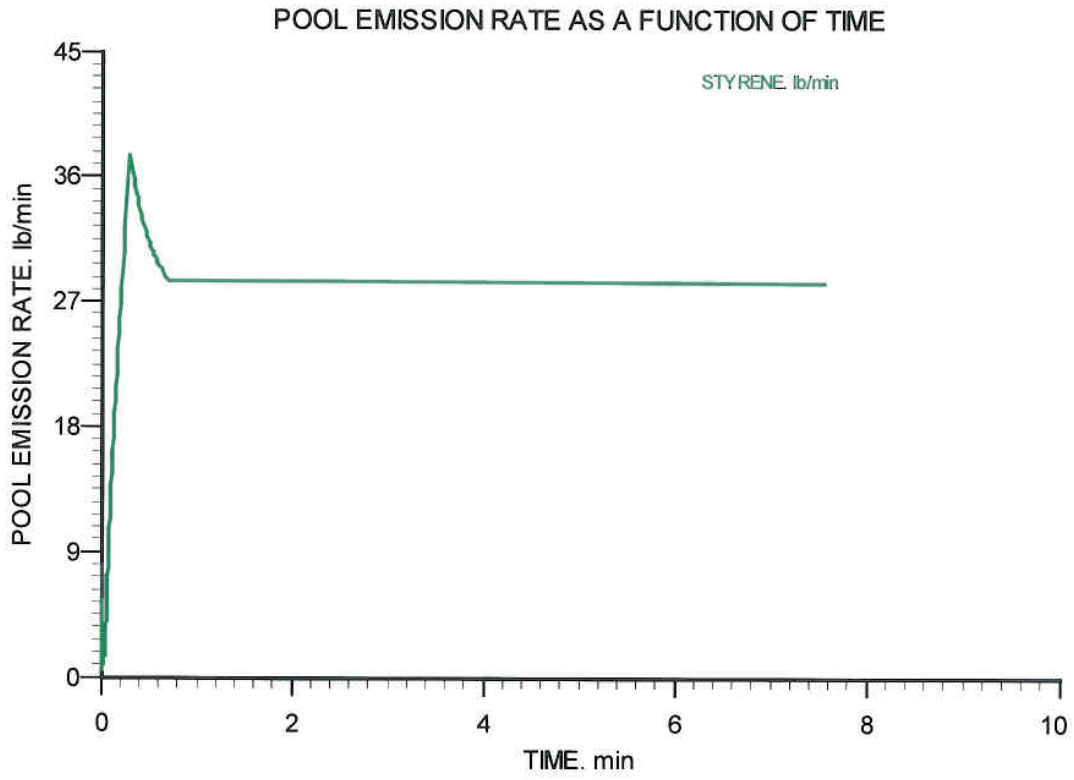


Figure 32: Styrene Evaporation Rate – 0% Reacted; F2 Stability Class; 5 psig and 210°F

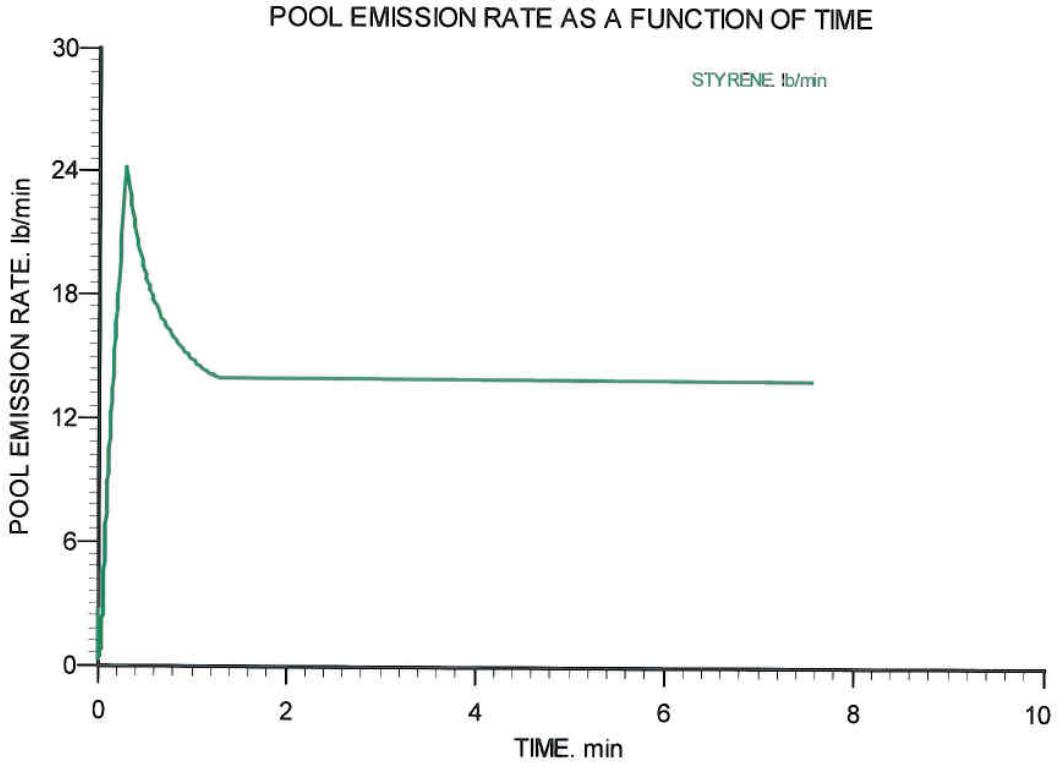


Figure 33: Styrene Evaporation Rate – 25% Reacted; D5 Stability Class; 20 psig and 205°F

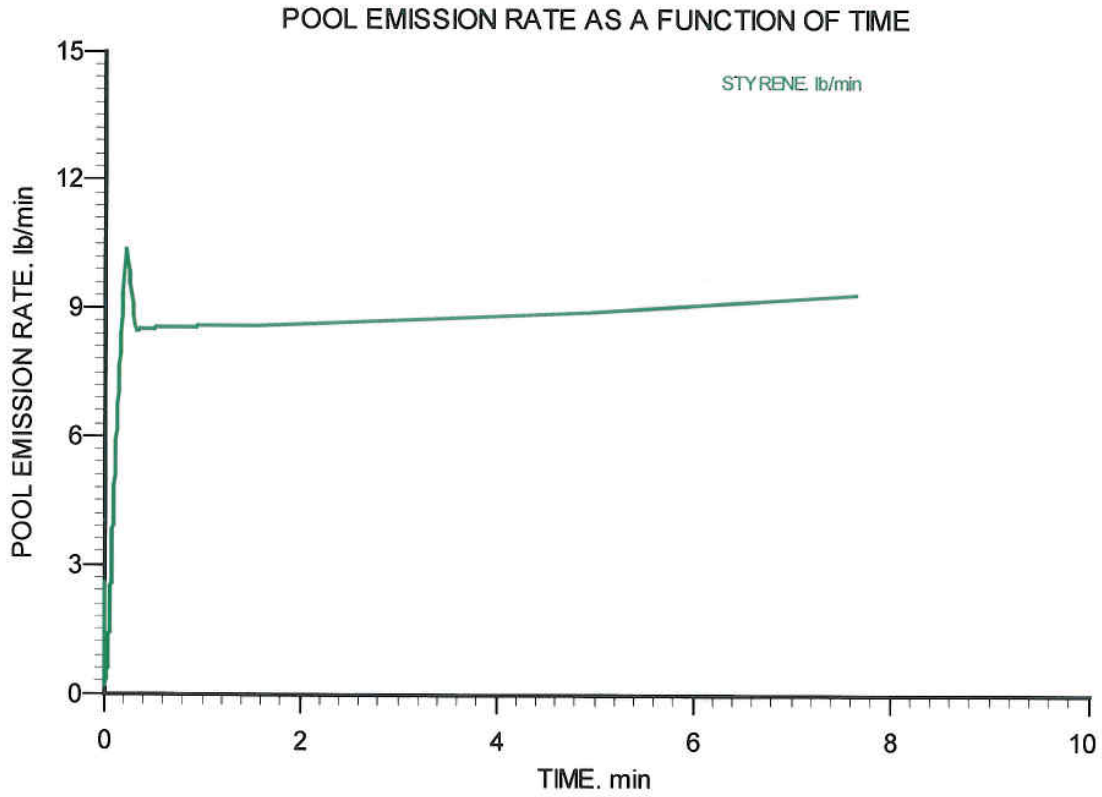


Figure 34: Styrene Evaporation Rate – 25% Reacted; F2 Stability Class; 20 psig and 205°F

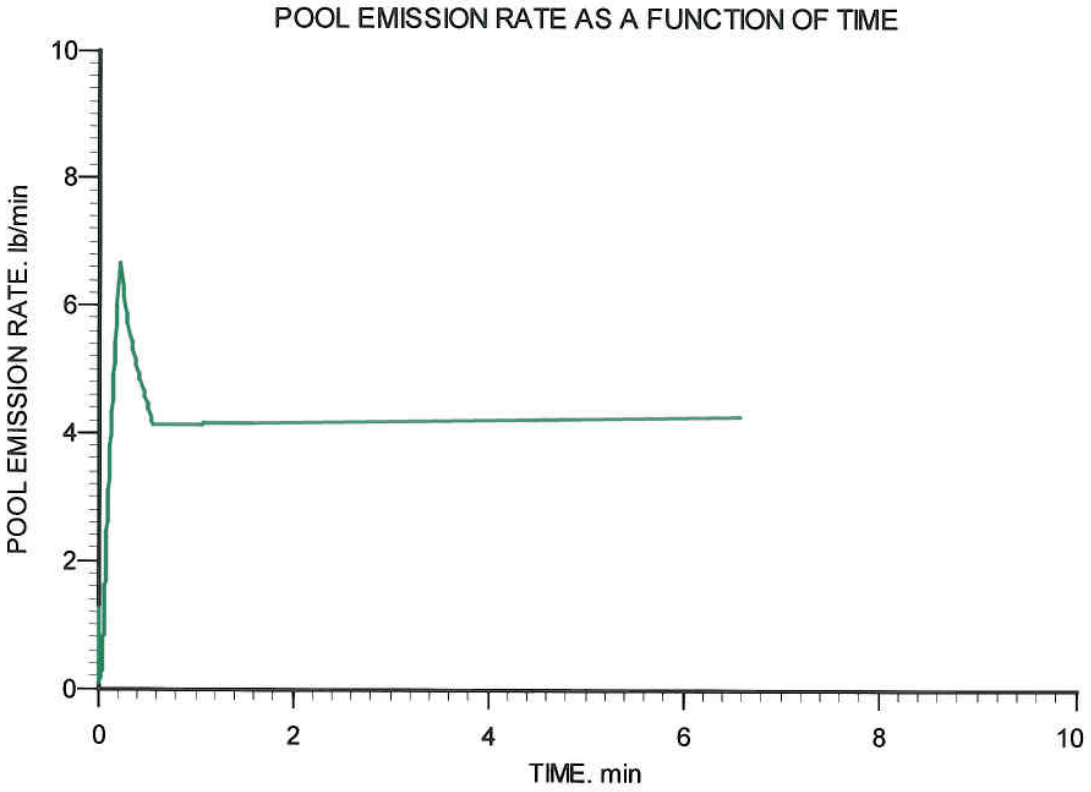


Figure 35: Styrene Evaporation Rate – 25% Reacted; D5 Stability Class; 5 psig and 210°F

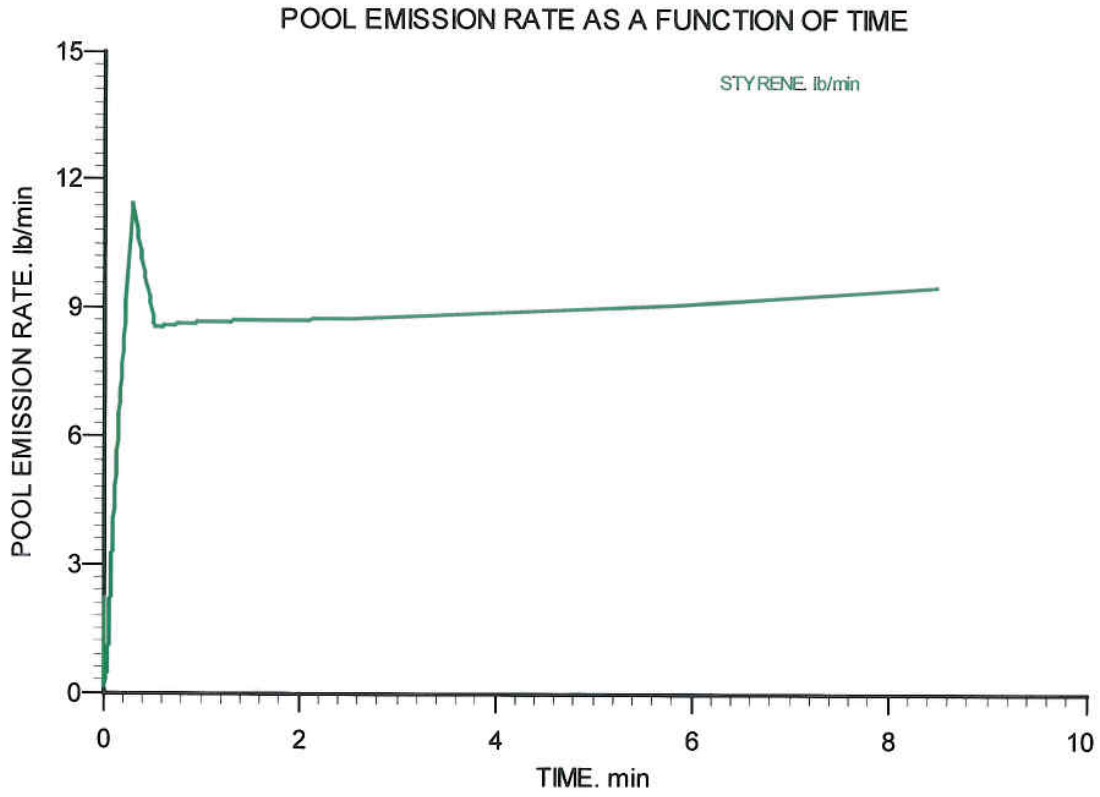


Figure 36: Styrene Evaporation Rate – 25% Reacted; F2 Stability Class; 5 psig and 210°F

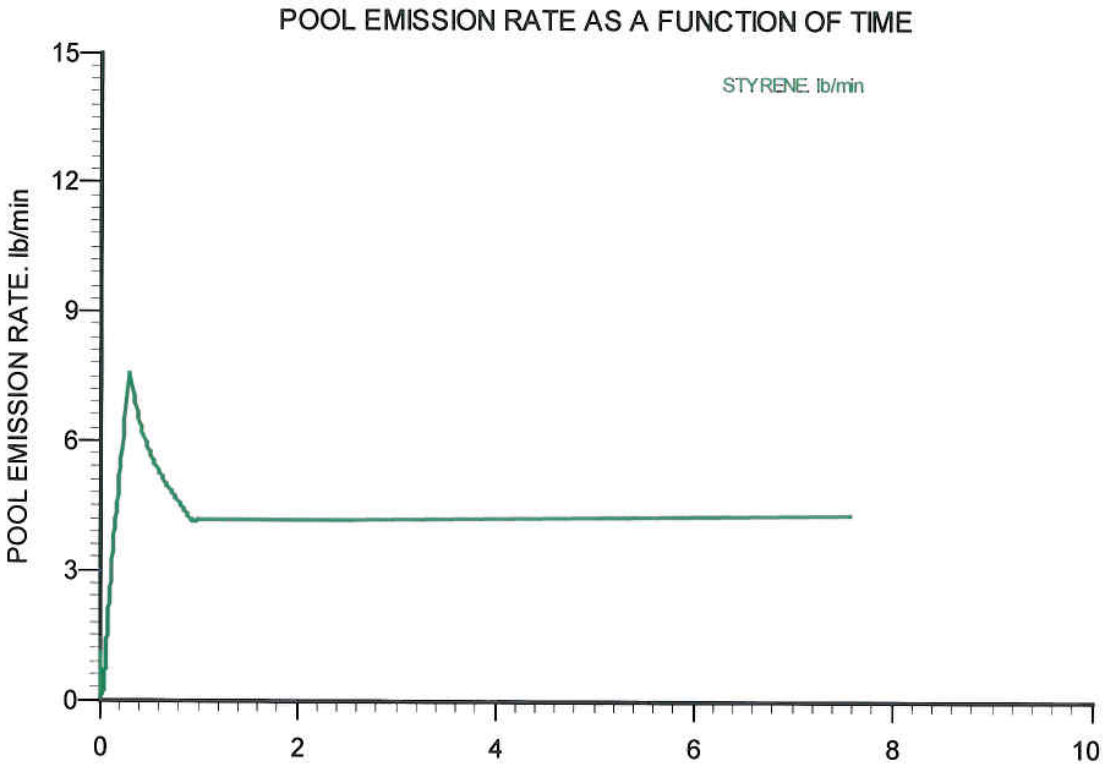


Figure 37: Styrene Evaporation Rate – 50% Reacted; D5 Stability Class; 20 psig and 205°F

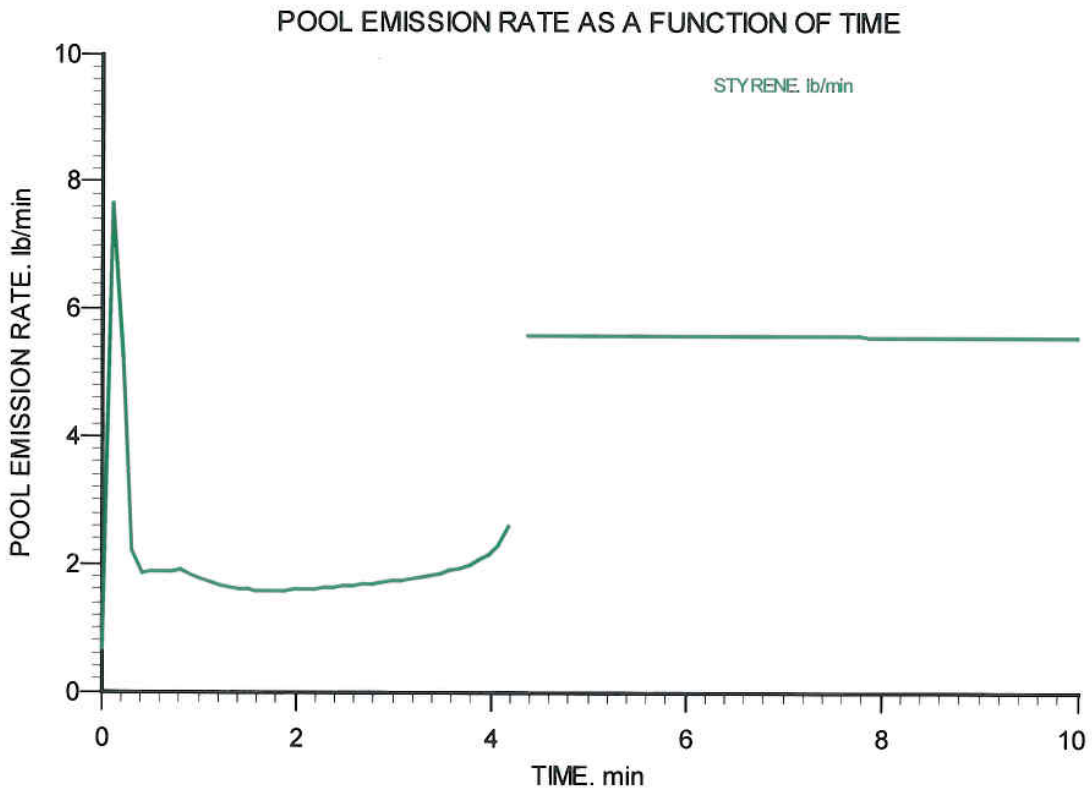


Figure 38: Styrene Evaporation Rate – 50% Reacted; F2 Stability Class; 5 psig and 210°F

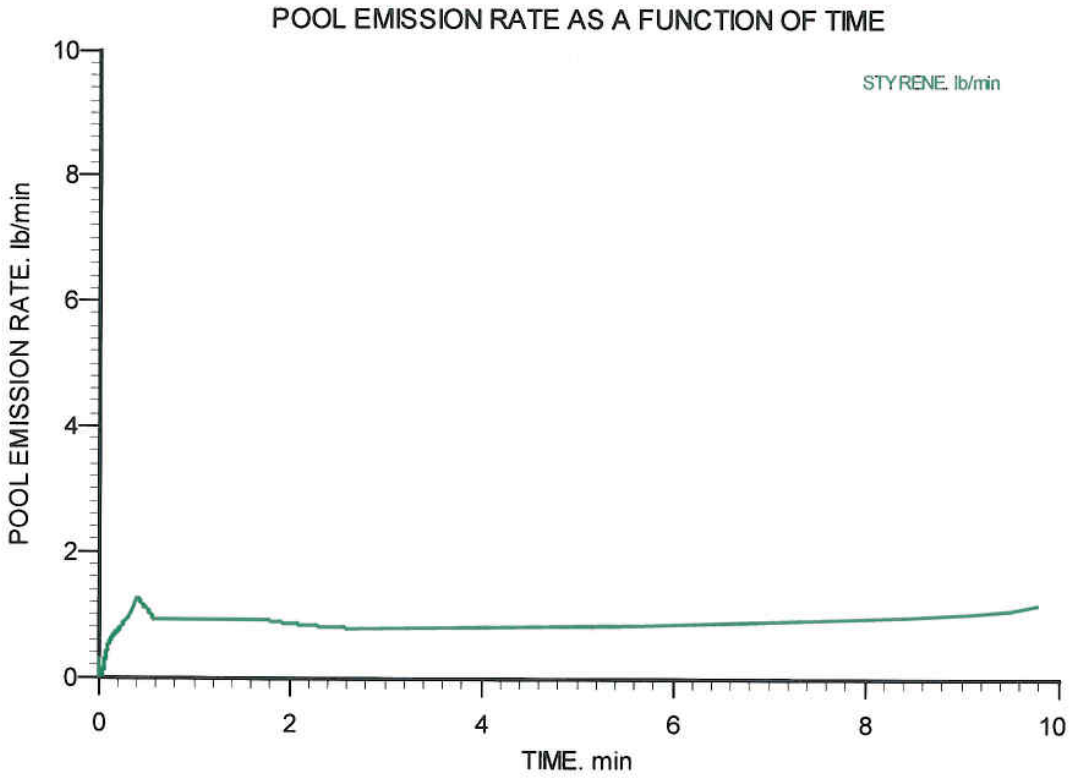


Figure 39: Styrene Evaporation Rate – 75% Reacted; F2 Stability Class; 20 psig and 205°F

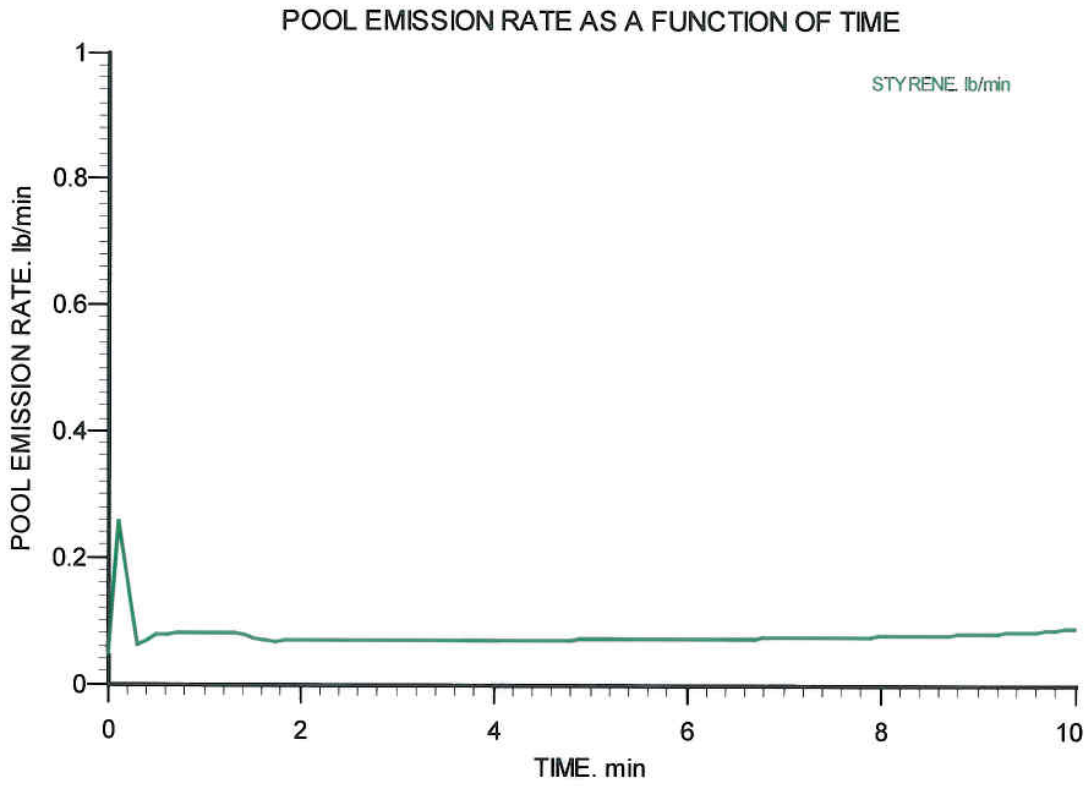
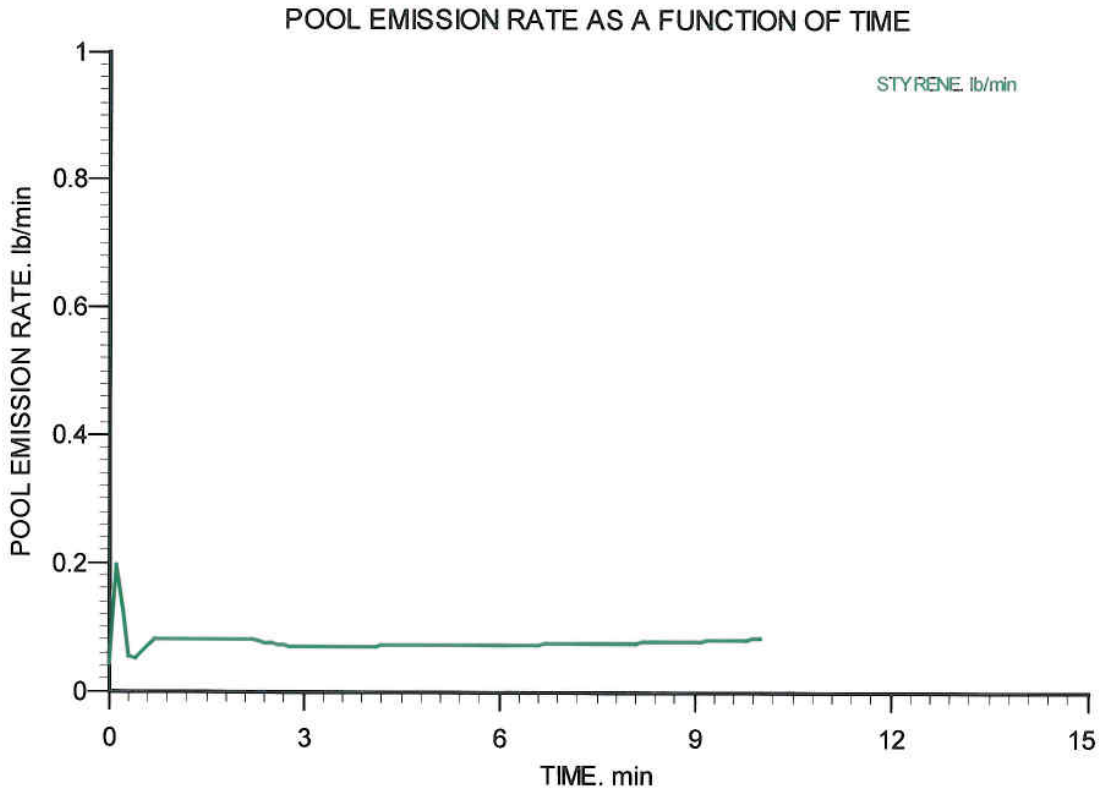


Figure 40: Styrene Evaporation Rate – 75% Reacted; F2 Stability Class; 5 psig and 210°F



Appendix E: Results – Vapor Cloud Dispersion

Figure 41: Vapor Cloud Dispersion – 0% Reacted; D5 Stability Class; 20 psig and 205°F

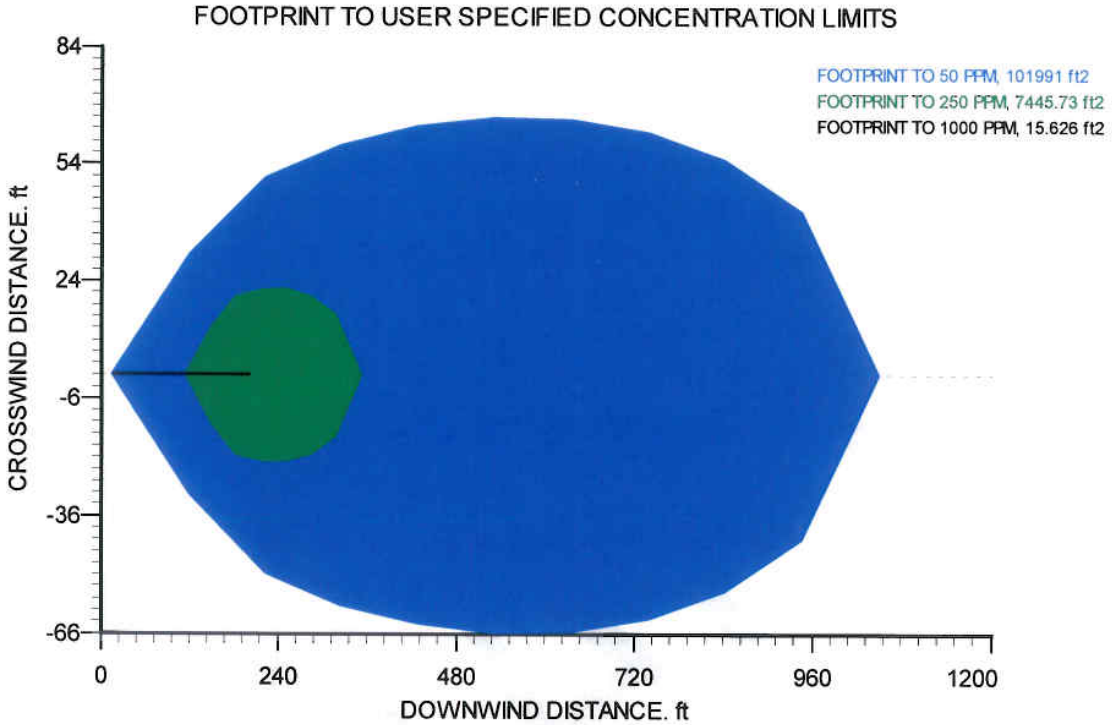


Figure 42: Vapor Cloud Dispersion – 0% Reacted; F2 Stability Class; 20 psig and 205°F

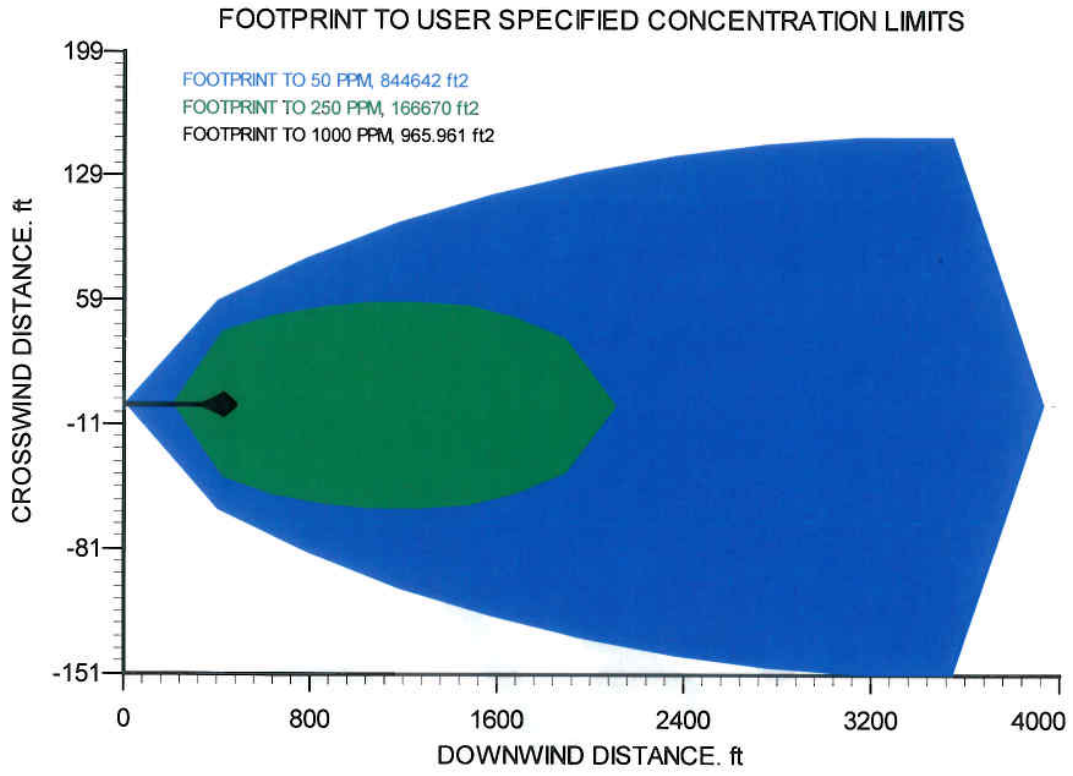


Figure 43: Vapor Cloud Dispersion – 0% Reacted; D5 Stability Class; 5 psig and 210°F

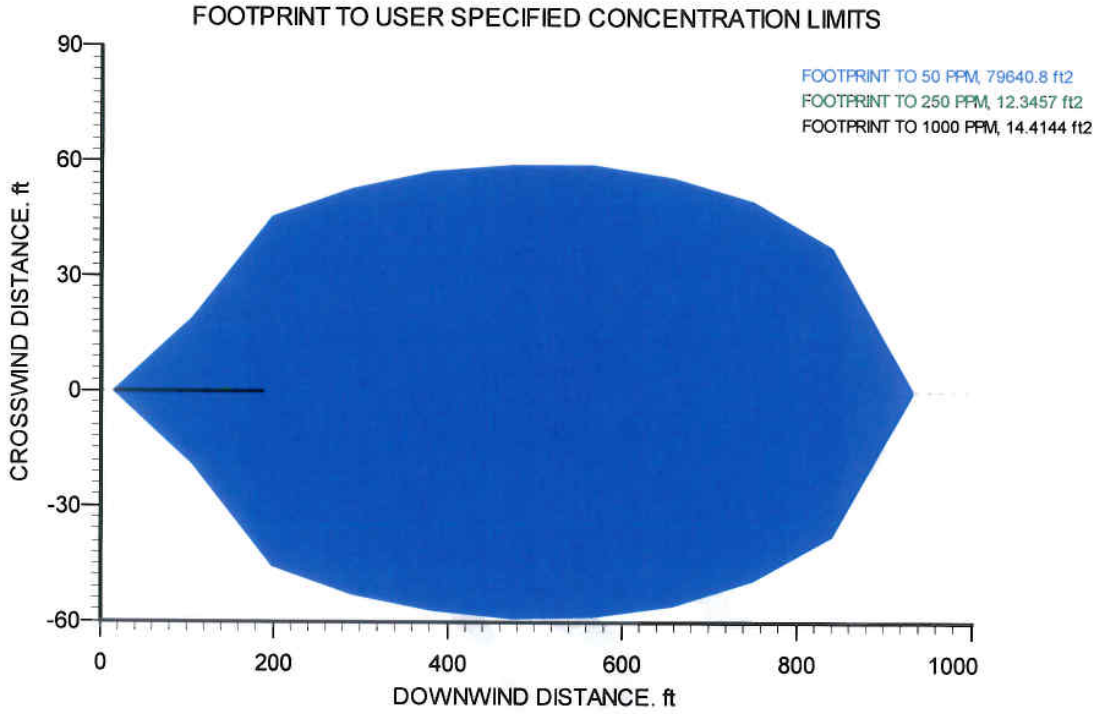


Figure 44: Vapor Cloud Dispersion – 0% Reacted; F2 Stability Class; 5 psig and 210°F

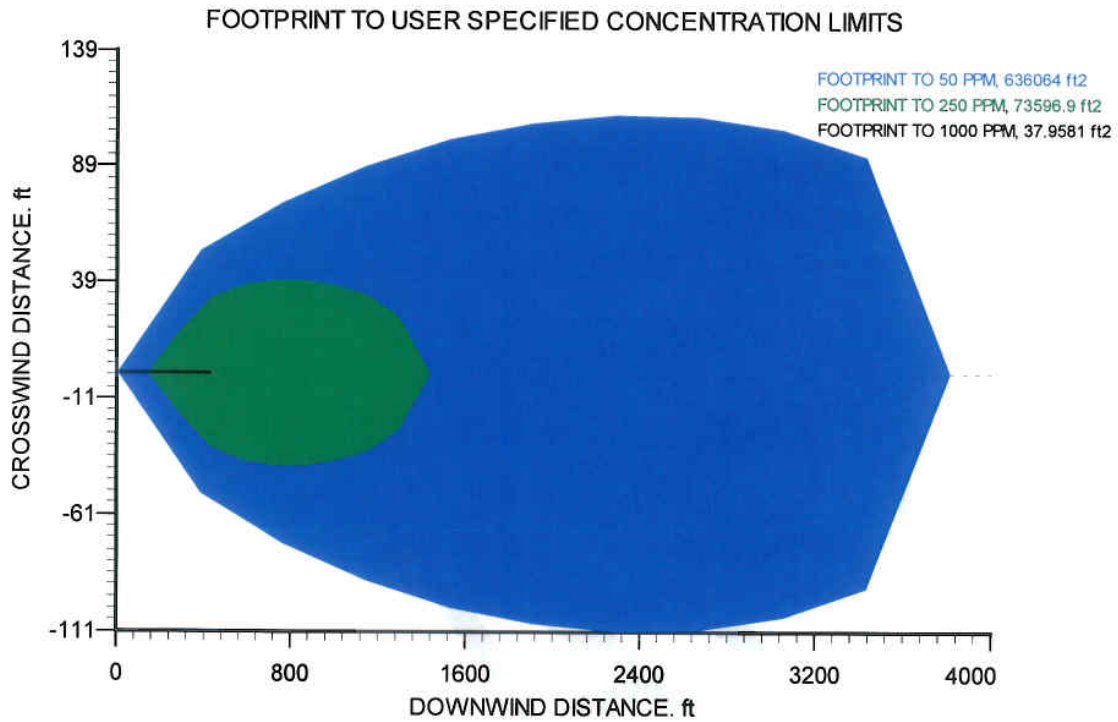


Figure 45: Vapor Cloud Dispersion – 25% Reacted; D5 Stability Class; 20 psig and 205°F

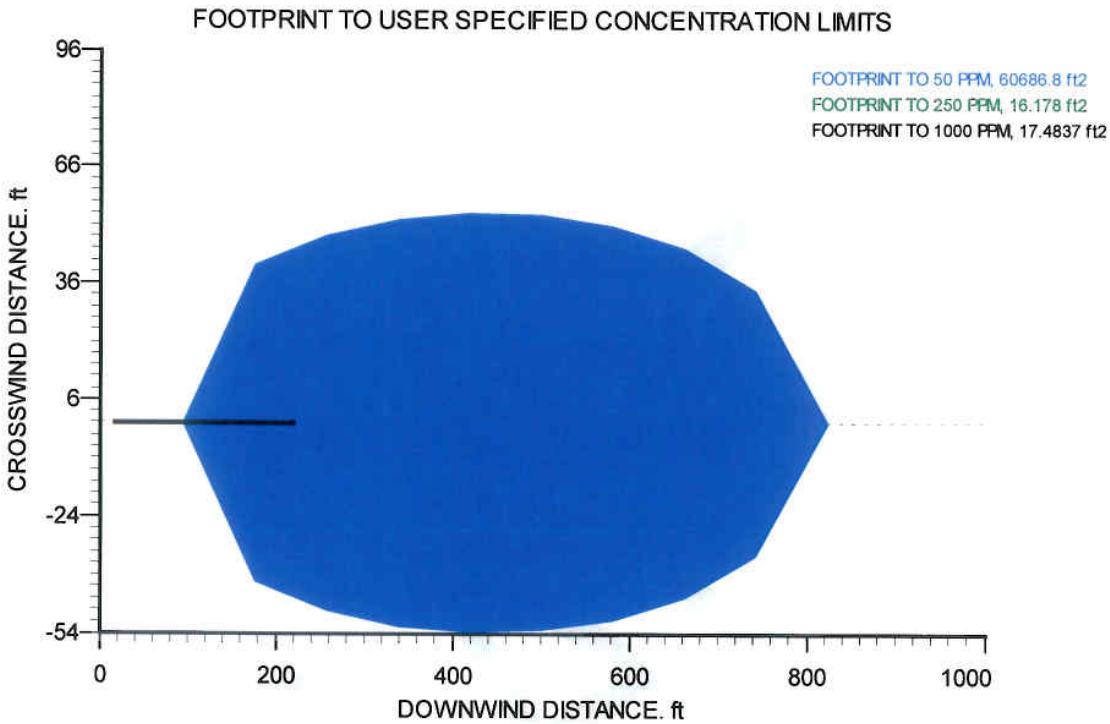


Figure 46: Vapor Cloud Dispersion – 25% Reacted; F2 Stability Class; 20 psig and 205°F

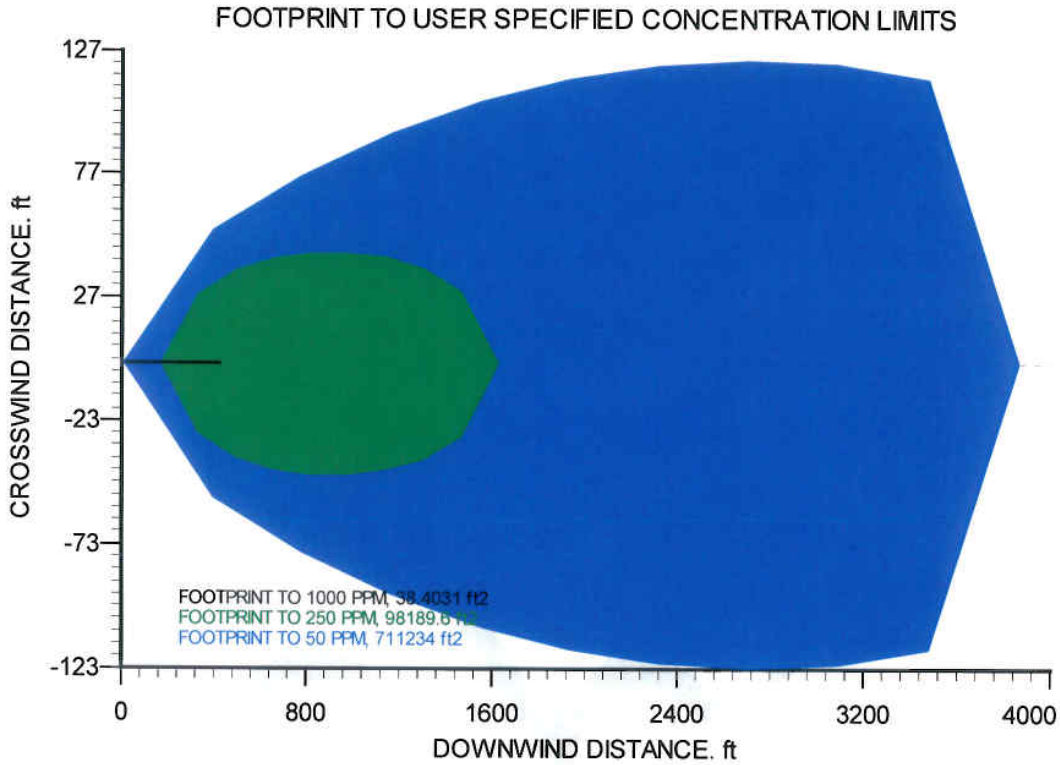


Figure 47: Vapor Cloud Dispersion – 25% Reacted; D5 Stability Class; 5 psig and 210°F

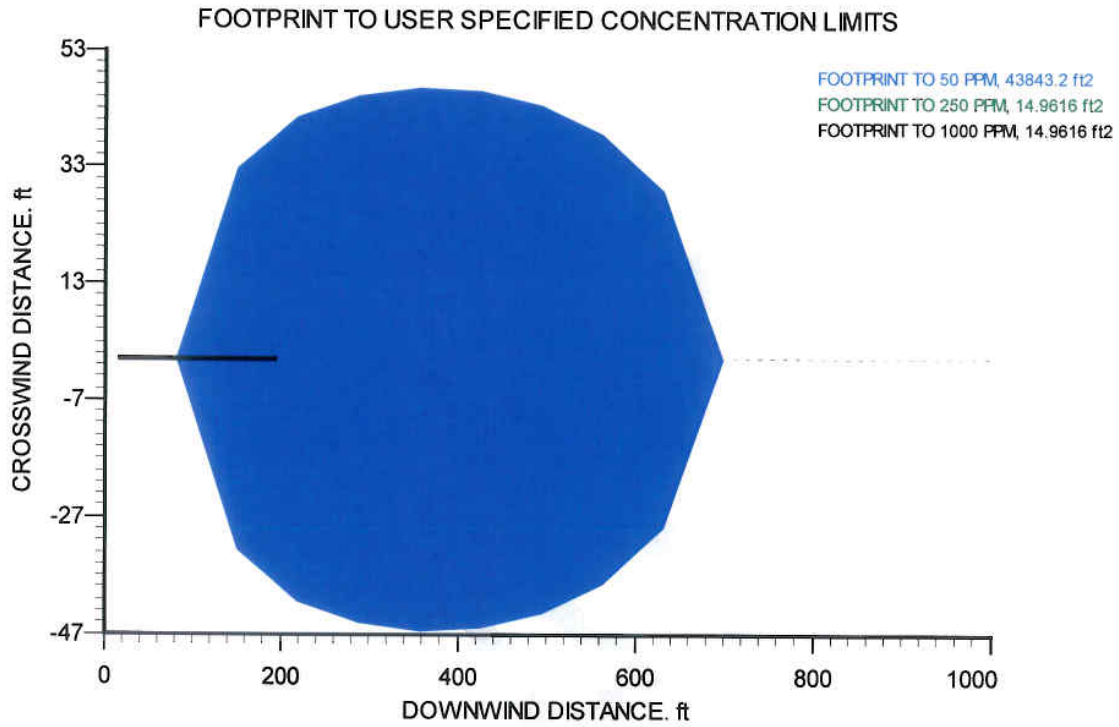


Figure 48: Vapor Cloud Dispersion – 25% Reacted; F2 Stability Class; 5 psig and 210°F

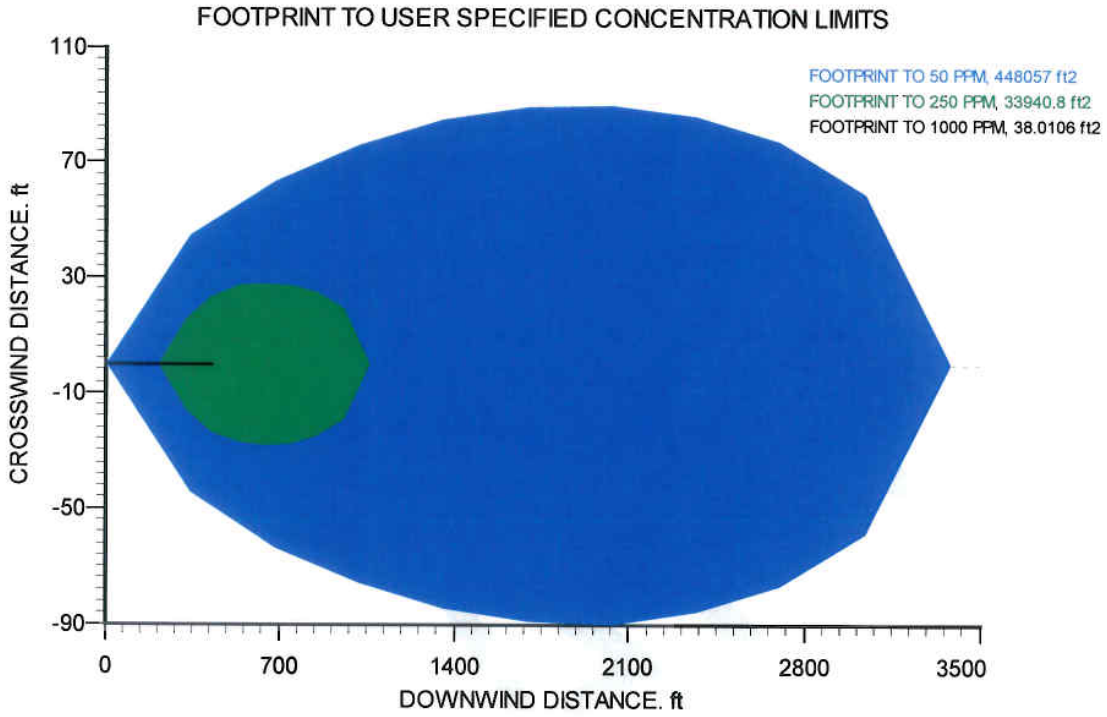


Figure 49: Vapor Cloud Dispersion – 50% Reacted; D5 Stability Class; 20 psig and 205°F

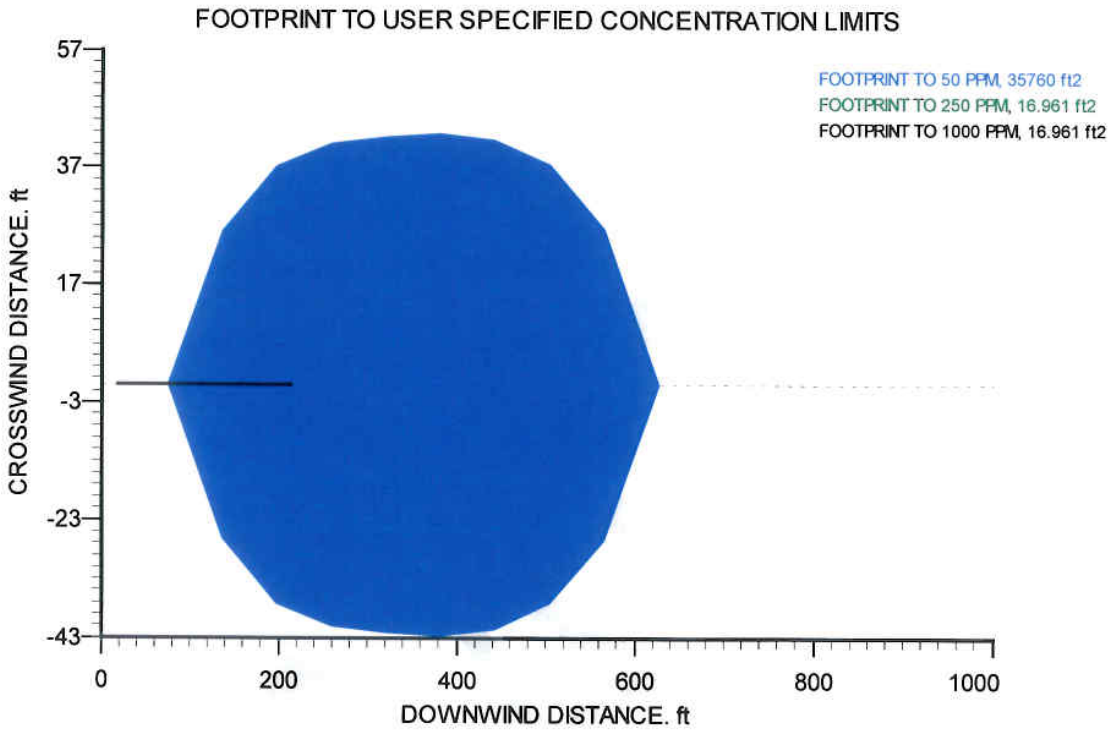


Figure 50: Vapor Cloud Dispersion – 50% Reacted; F2 Stability Class; 5 psig and 210°F

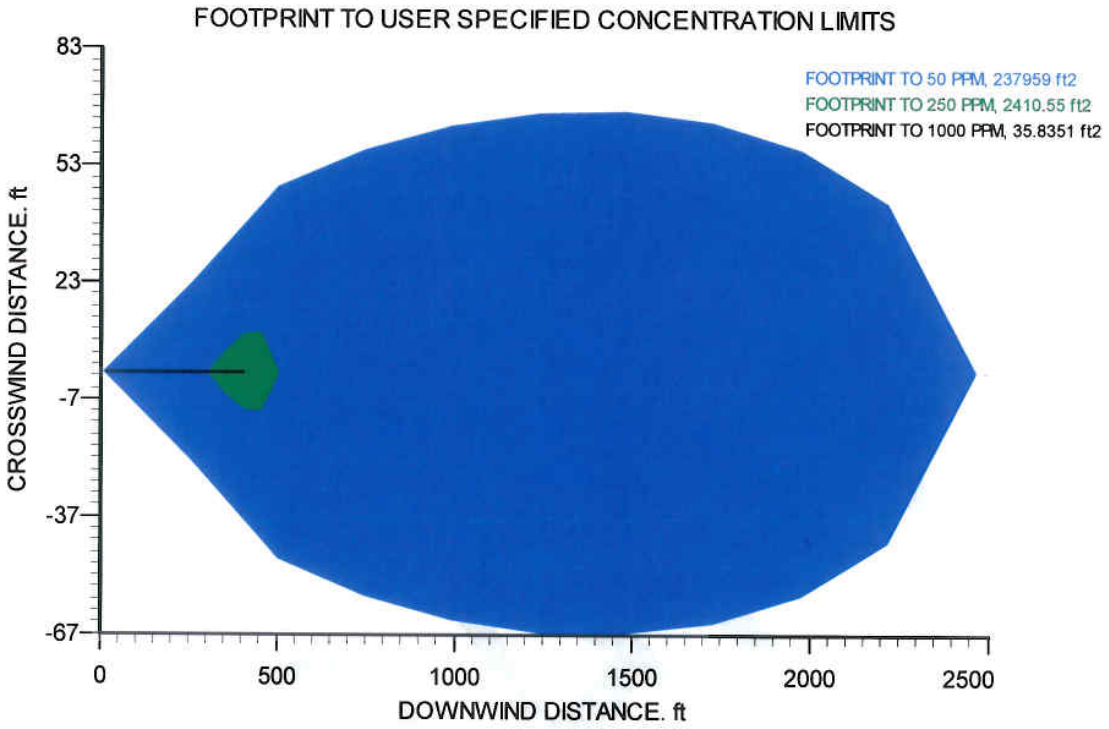
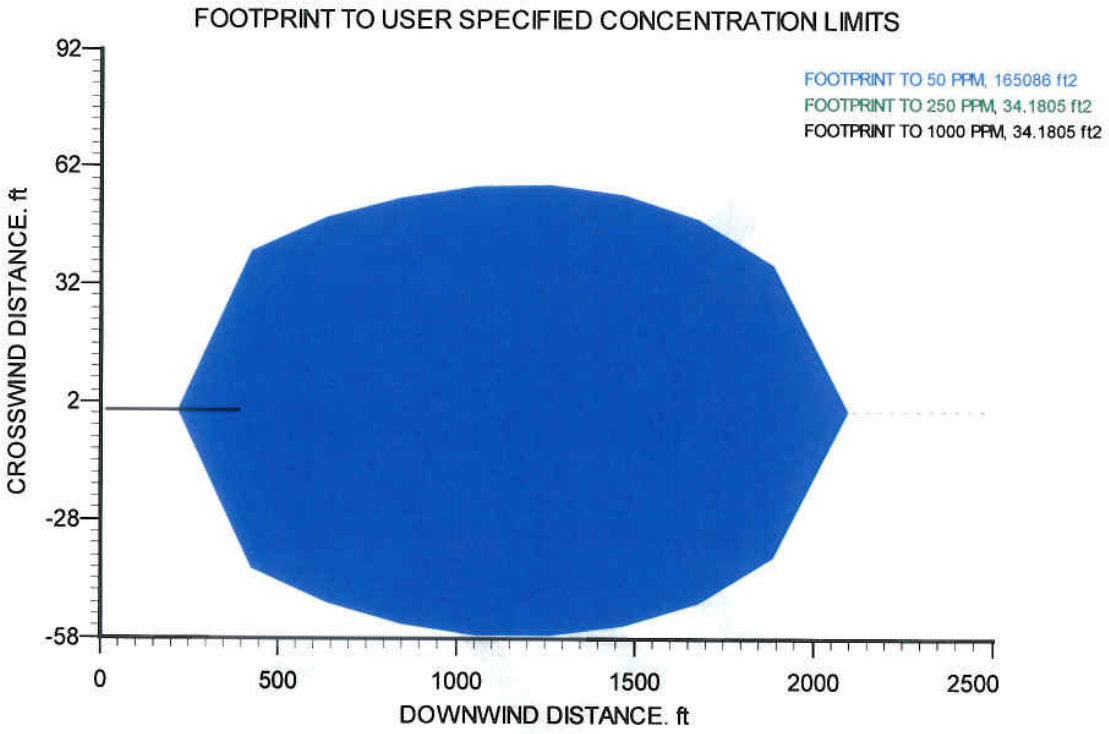


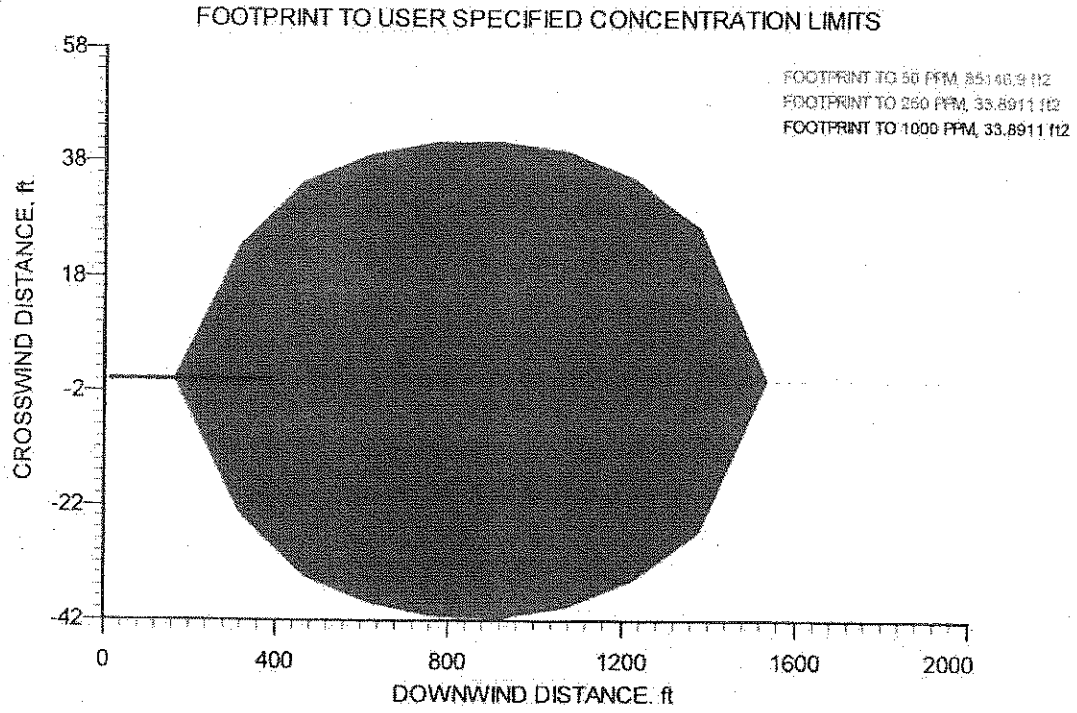
Figure 51: Vapor Cloud Dispersion – 75% Reacted; F2 Stability Class; 20 psig and 205°F



RELEASED
DATE 11/12/19
RIN # 2019-008100
INITIALS JM

PRIVELEGED AND CONFIDENTIAL – PREPARED AT THE REQUEST OF COUNSEL
ATTORNEY-CLIENT PRIVELEGE AND/OR ATTORNEY WORK PRODUCT

Figure 52: Vapor Cloud Dispersion – 75% Reacted; F2 Stability Class; 5 psig and 210°F



FLINT HILLS resources

MANAGEMENT OF CHANGE FORM

(REFER TO PROCEDURE EHS-I-006 FOR EXPLANATION OF THIS FORM)

PROCESS UNIT/AREA: Building 4 contianment pit MOC#: 156665

ORIGINATOR: Angad Singh Chopra DATE: 05/07/2014

SECTION A - TECHNICAL BASIS FOR PROPOSED CHANGE

Purpose and Technical Basis:	Purpose of this MOC is to add corrugated panels on top of the existing containment pit so that in case of a reactor dump, the contents of the reactor do not splash out of the secondary containment.
Description: *Attach additional paper if necessary*	The change involves addition of 60" tall corrugated panel on top of the existing concrete wall along the perimeter of the pit that does not have existing panels. The panels will be bolted on to the existing railing to provide support to the panels. There will be an overhang of the panel on the inside of the concrete contianment pit wall, such that it provides adequate splash protection.
Impact of change On Environmental Health / Safety:	Will allow minimizing environmental events resulting from styrene spills outside of the containment pit.

SECTION B - DOCUMENTATION - *Attach appropriate documentation illustrating proposed changes*

☐	Procedures	☐	Inspections, Testing, PM's	☒	Engineering DWGS	☐	PHA'S
☐	PSM Documentation	☐	CHEMGEMS Specifications	☐	P&ID's	☐	MI Applicability Checklist
☐	MSDS Information	☐	Energy Control Plans	☐	PFD's		
☐	Training/Communication	☐	Floor Plans	☐	LDAR		
☐	Quality Issues	☐	Mechanical Integrity DWGS	☐	Site/Plot Plan	☐	OJT's
☐	Customer Impact	☐	Electrical Schematics	☐	Electrical Single Lines	☐	JSA's
☐	Alarm Response Tables	☐	Loop DWGS	☐	Elect'l Classification	☐	Other

Affected Personnel Needing To Be Informed/Trained On Proposed Change

☐	Operations	☐	I/E Technicians	☐	Community
☐	Production Facilitators	☐	Engineering	☐	Regulatory Entities
☐	Mechanics/Welders	☐	Contractor(s)	☐	Corporate
☐	Electricians	☐	Office Personnel	☐	Other

SECTION C - Is Change Permanent?

☒	YES	Proposed Project Start Date 05/07/2014
☐	NO	Proposed Project Completion Date 05/31/2014

SECTION D - Is Change Temporary ?

☐	YES	From:
☒	NO	To:

SECTION E - Is Change Emergency ?

☐ Yes Start:

☒ NO

Approval Received From:

☐ Ops. Mgr./Designee ☐ Env. Eng./Designee

☐ Plant Mgr./Designee (if requested) ☐ Technical Services Mgr./Designee

☐ H&S Mgr./Specialist ☐ Area Mgr./Designee

Approval Received By:

_____

Signature *Date*

Returned To Original Service: ____/____/____

Area Mgr./Designee

Signature: _____

Extended To: ____/____/____*

Plant Managers Approval:

Plant Mgr./

Signature *Date*

*Note: Temporary MOCAs may be extended up to 6 months at a time

FHRPRU003965

SECTION F - DESIGN SAFETY REVIEW

PHA. Does the proposed change require a PHA? (i.e. What-if/Checklist, Hazop, Revalidation, Review) If yes indicate type of PHA in Action to be Taken section.	☐YES	☒NO
PSSR. Does the proposed change require a Pre-Start-up Safety Review (PSSR)? See EHS-I-067 for Requirements. Mandatory if change involves DCS Interface.	☒YES	☐NO

1. RELIEF AND BLOWDOWN

Does the Proposed Change:	YES	NO
1. Introduce or alter any potential cause of over/under pressurizing of the system?	☐	☒
2. In any way affect existing equipment installed to prevent over/under pressurization?	☐	☒
3. Introduce or alter any potential cause of raising/lowering the system temperature?	☐	☒
4. Introduce a risk of creating/reducing vacuum in the system?	☐	☒
5. Have any critical relief devices been identified for verification of proper rating and installation?	☐	☒

2. AREA CLASSIFICATION

Does the Proposed Change:	YES	NO
1. Introduce or alter the storage of flammable materials?	☐	☒
2. Introduce or alter the location of potential leaks of flammable materials?	☐	☒
3. Introduce new or alter existing electrical equipment?	☐	☒
4. Affect area ventilation?	☐	☒
5. Has the established building electrical classification been changed?	☐	☒

3. SAFETY CONSIDERATIONS

Does the Proposed Change:	YES	NO
1. Require any additional safety equipment or layers of protection?	☐	☒
2. Alter or affect existing safety equipment or means of egress?	☐	☒
3. Require changes to the function or independence of existing equipment or layers of protection?	☐	☒
4. Alter or affect critical safety instrumented functions (SIF's)?	☐	☒
5. Alter the noise level in the surrounding area?	☐	☒
6. Increase the potential for exposure to any chemicals?	☐	☒
7. Introduce a new or previously unused chemical/raw material?	☐	☒
8. Affect de-energization? (able to lock-out, drain materials)	☐	☒
9. Create any ergonomic concerns?	☐	☒
10. Affect the Battery Limit Valves (BLV)?	☐	☒
11. Affect the overall security of the facility?	☐	☒
12. Does this increase the risk of potential impact to plant personnel (employees and contractors)?	☐	☒
13. Does the proposed change affect facility siting relative to both people and equipment in any of the following situations: temporary changes, before startup after a permanent change, or before startup after temporary change has been removed/closed/returned to original condition?	☐	☒
14. If the proposed change affects replacement or demolition of piping or conduit, will the entire run be identified and clearly marked prior to work, to ensure safe work activity?	☐	☒
15. Affect the safe transport of hazardous material? For ex., introducing a new hazardous material for transport or changing the method of transportation of the hazardous material.	☐	☒

4. ENVIRONMENTAL CONSIDERATIONS**

	YES	NO
1. Will there be a potential increase in the maximum production rate, which exceeds the currently permitted design capacity of the facility?	☐	☒
2. Will the replacement or modification change any of the basic parameters of the process unit, such as temperature, pressure, etc?	☐	☒
3. Will the change cause increased emissions of regulated pollutants during installation, implementation, or during operations?	☐	☒
4. Will there be any new vents added?	☐	☒
5. Will the change add, remove or modify any permitted emission units (*Example: reactors, wash tanks, dryers, centrifuges, packout bins, screening towers, or styrene or pentane storage.)*?	☐	☒
6. Will the project include the installation of a stationary engine with a ≤ 500 hp? If so, a non-resettable hour meter shall be installed to record operational hours and PMs shall be consistent with RICE NESHAP regulations and the manufacturer's recommended preventative maintenance.	☐	☒
7. Will the project results in the increase in Facility's total throughput of natural gas?	☐	☒
8. Is there the potential to generate a new waste or increase the quantity of an existing waste?	☐	☒

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SECTION F - DESIGN SAFETY REVIEW -- cont.

4. ENVIRONMENTAL CONSIDERATIONS** - - cont.

9. Will there be a change in the wastewater characteristics? If the project causes an increase to the discharge of wastewater to the Public Sanitary District, provide calculations with the MOC.	☐	☒
10. Does the project add or remove LDAR Components (Pumps, PRVs, Valves, and Connectors) that come in contact with styrene or pentane?	☐	☒
11. Does the project increase risk to off-site residential & environmental receptors?	☐	☒
12. Will the change affect the control of processes?	☐	☒
13. Will the change affect the composition or physical properties of the final product?	☐	☒
14. Will new chemicals be brought onsite anytime during the project?	☐	☒
15. Does an evaluation of chemical compatibility need to be conducted during the project?	☐	☒
16. Will the project involve decommissioning or demolition of equipment or structure?	☐	☒
17. If yes to 16, does National Emissions Standards for Hazardous Air Pollutants (NESHAP) or deconstruction permit apply?	☐	☒
18. Will this project require a portable engine?	☐	☒

** Consult with Environmental Engineer for completion of this section.

5. OPERATION AND DESIGN

Does the Proposed Change:	YES	NO
1. Affect the process or equipment upstream/downstream of the change?	☐	☒
2. Affect access to process or equipment/controls for personnel?	☐	☒
3. Introduce any new or affect existing interlocks or alarms systems?	☐	☒
4. Affect manpower or qualified personnel?	☐	☒
5. Affect the loads/strengths of existing foundations, structures, vessels, or pipe racks?	☐	☒
6. Impact requirements of existing or proposed piping supports? *(Needs to be adequately designed for expected stresses due to pressure and thermal loadings.)*	☐	☒
7. Alter the DCS/Software logic of process operations?	☐	☒
8. Affect process chemistry? (reactivity/compatibility)	☐	☒
9. Affect maximum intended inventory, which would require updating maximum inventory tables?	☐	☒
10. Affect safe upper/lower limits for such items as temperature, process flows or compositions?	☐	☒
11. Affect material/energy balances?	☐	☒
12. Affect plant utility resources? (i.e. steam, water, electricity, etc.)	☐	☒
13. Affect equipment with heat-up/cool-down cycling requiring bolt retightening after start-up?	☐	☒
14. Is an exception/revision to design codes or standards (CHEM-GEMS, etc.) required?	☐	☒

SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION

Will the Proposed Change:	YES	NO
1. Introduce new or impact existing operational procedures? *	☐	☒
2. Introduce new or impact existing maintenance procedures? *	☐	☒
3. Add or Remove equipment/instrumentation? *(Contact MST to assign Equipment/Instrumentation Location Numbers. If equipment/instrumentation is being added, MI Applicability Checklist MNT-F-161 shall be completed by MOC originator, and approval form(s) sent to the MI coordinator.)*	☐	☒
4. Revise equipment preventative maintenance/ inspections, job plans , and/or frequencies?	☐	☒
5. Require additional training for operational or maintenance personnel? *(requires completion of Leaning and Development Job Aid addendum A)*	☐	☒
6. Require additional notification for operational or maintenance personnel?	☐	☒
7. Require updating controlled drawings? * *(PFD'S, LDAR, P&ID's, Floor Plans, Electrical Single Lines, Loop Drawings/Electrical Schematics, MCC arrangement, MI Iso Drawings)*	☒	☐
8. Require updating equipment files? *(Engineering, Maintenance, Manufacturers Inspect/Test results)*	☐	☒
9. Require a spare parts list and inventory to be developed?	☐	☒
10. Require major project spare equipment to be turned over to maintenance?	☐	☒
11. Require equipment labeling in the field?	☐	☒
12. Require updating of Alarm Response Tables? *	☐	☒
13. Require a new/modification of existing energy control plans? *	☐	☒

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SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION –cont'd		
14. Cause any PSM/RMP applicability issues?	☐	☒
15. Cause a change in PSM/RMP program level?	☐	☒
16. Will this change have any effect on the overall plant facility siting issues?	☐	☒
17. Increase or decrease the impact contour for worst-case scenario by a factor of two or more?	☐	☒
18. Will this MOC supersede /interfere with any other Temporary/Emergency/Permanent MOC's?	☐	☒
19. Is there a need to update the EPS-I-004, Chemical Compatibility Matrix?	☐	☒
20. Is a Layer of Protection Analysis (LOPA) study required?	☐	☒
21. Will this affect the Interlock Matrix?	☐	☒
22. Require updating of electrical energy consumption spreadsheet? Update required for any MCC, CB panel or bus bar connection additions or alterations.	☐	☒
23. Will this change impact Proprietary Technology including product, process, equipment, technical data, or other trade secret information licensed to FHR by third parties" If yes, contact the Proprietary Technology Coordinator.	☐	☒

*** NOTE: Refer to Engineering Equipment Location Database for a list of affected documents, sorted by Location Number.**

FHRPRU003968

Any questions with a 'YES' answer, requires follow-up activity.
List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'

Item No.	Action To Be Completed Prior to PSSR	Responsible Party	Target Completion Date
F-PSSR	Perform PSSR	Angad Singh	05/31/2014

FHRPRU003969

Any questions with a 'YES' answer, requires follow-up activity.
List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'

Item No.	Action To Be Completed After PSSR	Responsible Party	Target Completion Date
G7	Update engineering drawings	Lisa G	6/30/2014

FHRPRU003970

MOC APPROVAL FORM

Originator: MOC No. 156665

MOC Packet Completeness Verification Review

Title/Position	Verification Review Signatures	Date
Drafting Tech, or Designee		5-5-14
MI Coordinator, or Designee	Verbally Approved by Dean 5/8/14	5-7-14
Maintenance Tech from appropriate area		5.5.14
Operator from affected area		5-5-14
Area Training Contact, or Designee		5-5-14

Signatures required Prior To Implementation of MOC.

Title/Position	Authorizing Signatures	Date
Area Manager/Facilitator or Designee		5-9-14
Technical Services Manager or Designee		5/7/14
Pilot Plant / QC Manager (If Applicable)		
H&S Specialist or Designee		5-7-14
Operations Manager or Designee		5-9-14
Environment Engineer or Designee		5/9/14

Other Reviewers
(as requested by any of the Authorizing signers)

Title/Position	Review Signature	Date
Plant Manager or Designee		
Electrical Engineer		

VERIFICATION OF MOC CLOSURE

By signing below:

1. The Originator of this MOC confirms that all action items have been completed & that equipment/documentation in this change is set to start up.
2.

MOC closure requires the Originators Signature

MOC Originator: Date:_____

FHRPRU003971

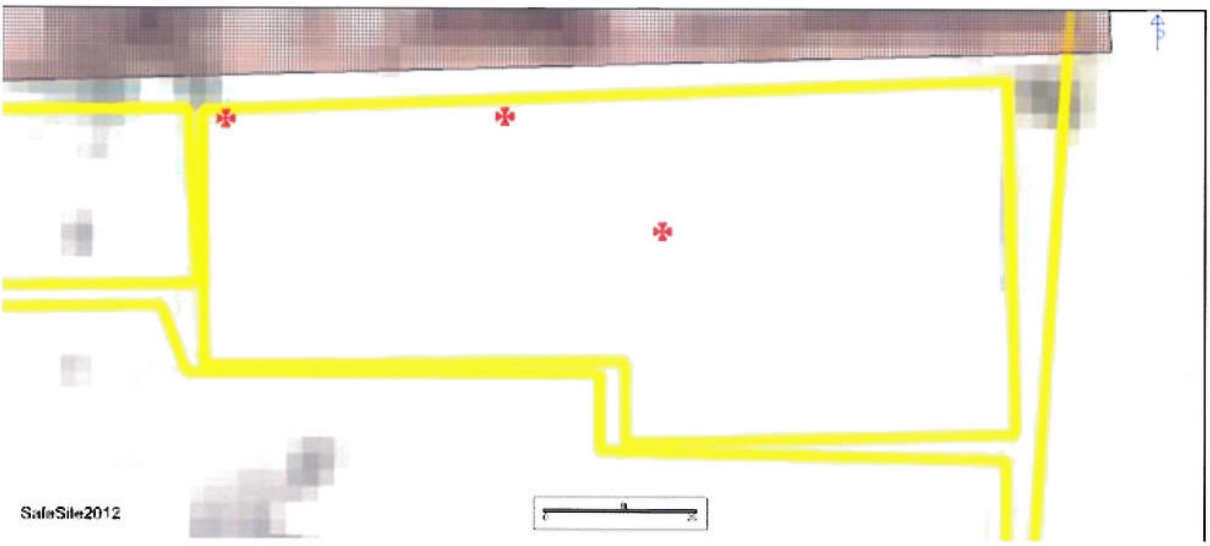
Miller, Phil

From: Moosemiller, Michael <MMoosemiller@BakerRisk.com>
Sent: Tuesday, May 06, 2014 4:50 PM
To: Miller, Phil
Cc: Steinbach, Mary; Rodante, Tom
Subject: Facility Siting Study Modeling of Pit Release

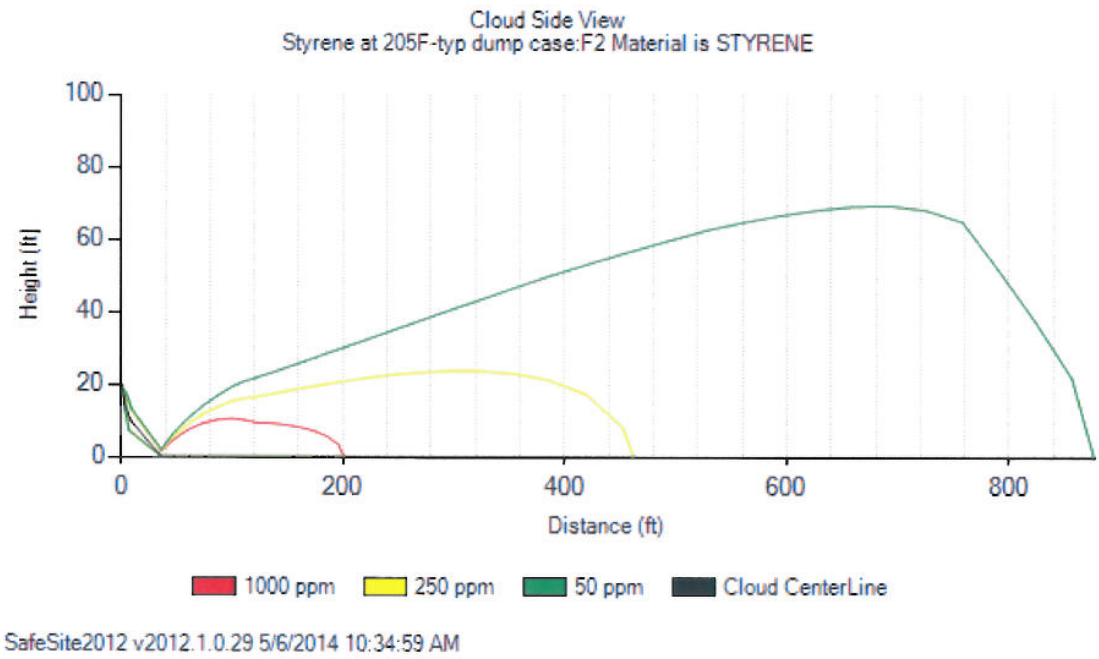
Phil,

To follow up on our conversation from earlier today, this is how the emergency dump case was modeled in the 2009 study. Note that this email contains a little more information than what I showed you during the day today:

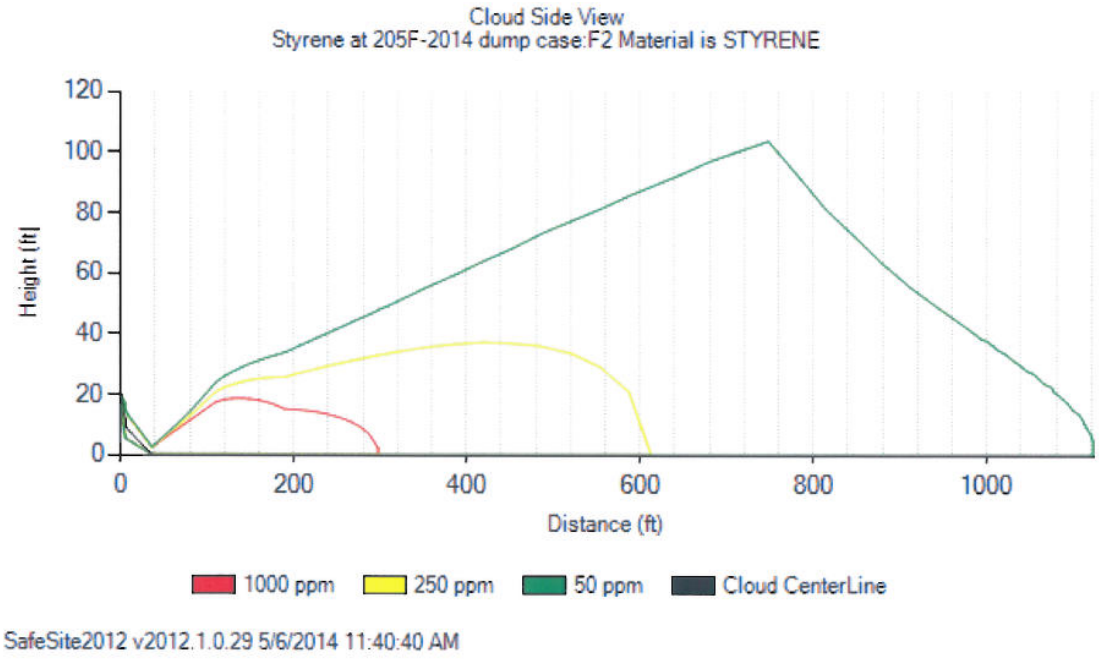
Case Name: "Styrene at 205F-typ dump case"
Case Description: Picked typical dump case, where 43% of styrene is unreacted at the start of dump
Process Temperature: 205F
Process Pressure: 5 psig
Release Geometry: Released via 20 foot, 14" diameter pipe at 45 degree downward angle; discharged at 20-foot elevation
Other Release Modeling: Modeled as 1.8" diameter in order to get desired flow rate of 1100 lb/min (of unreacted styrene)
Destination: Discharged into concrete pit of irregular shape shown in the figure below (area 4075 square feet)



Outcome of modeling: The software predicts the temperature after discharge to be 205F, dropping to 183F by the time it hits the ground. A pool starts to form, building to a maximum size of an equivalent 72 feet diameter after 54 seconds (by which time the pool has cooled to 117F). Although not given in the original report, the ERPG profiles are shown below in side view, assuming the event occurs in calm evening conditions at 70F ambient temperature:



We had a discussion about the possibility that the April 25 event had a higher flow rate of unreacted styrene than what we modeled in the siting study. So I ran another test model in which the release rate was assumed to be 2000 lb/min rather than 1100 lb/min. While using a higher flow rate of unreacted styrene would still result in the same pool size because both events are assumed to be contained in the dump pit, there is enough vaporization as the release travels through the air that the dispersions extend out a bit further than before:



Note that each of the results described above is based on an older version of the software, but the conclusions should be the same regardless of the version used.

To recap, the facility siting did model an event that involved a dump of hot styrene into the pit, and the modeling incorporated the pit dimensions. There are some changes in the modeling that could be done to try to replicate the actual event (e.g. modified outdoor temperature, modified discharge rate, use of most recent software). But to answer your original question, installing higher dike walls will not affect the modeling we performed in the facility siting study – it will actually serve to make what we modeled more correct, since we didn't account for material getting out of the dike as occurred in the April 25 event.

You are welcome to ask any follow-up questions. As I think I mentioned today, it is likely that I won't be able to answer them until next week, however.

Mike

Mike Moosemiller
Sr. Principal Consultant
Baker Engineering and Risk Consultants, Inc.
(630) 414-0868

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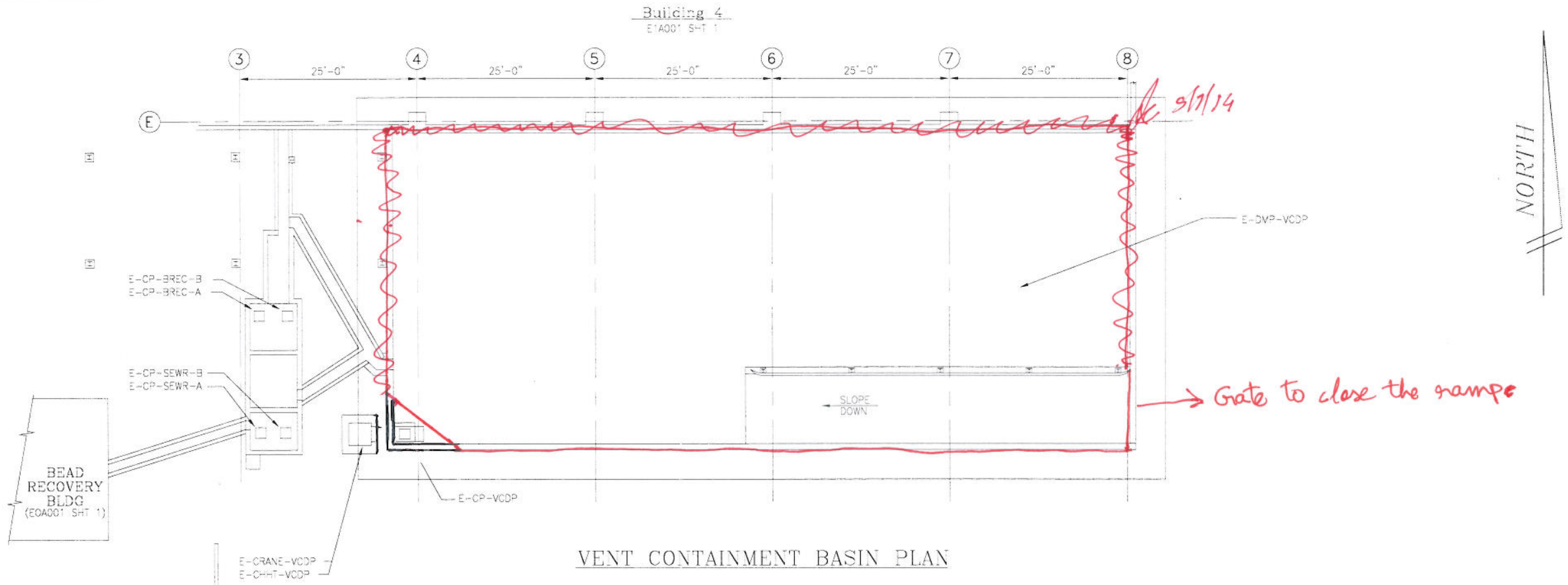

VENT CONTAINMENT BASIN PLAN

VENT CONTAINMENT BASIN ELEVATION

~~Note: 54" ~~ concrete wall~~ 5/7/14

Note: 60" Corrugated panels.

Flint Hills Resources

PERU, ILLINOIS PLANT

REV	DATE	DESCRIPTION
E	5/12	PER DCR 2012-017
D	11/10	PER DCR 2010-036
C	8/01	PER DCR
B	2/01	PER MOC 20082
A	1/01	PER MOC 20043

NAME: BLDG 4 VENT CONTAINMENT BASIN PLAN VIEW

DRAWN BY: TJB | CONTROLLED: YES

DATE: 5/4/99

SCALE: 1/8"=1'-0" | PLOT SCALE: 1=96

VERSION: A | SHT# 2 | REV# E

EOA001

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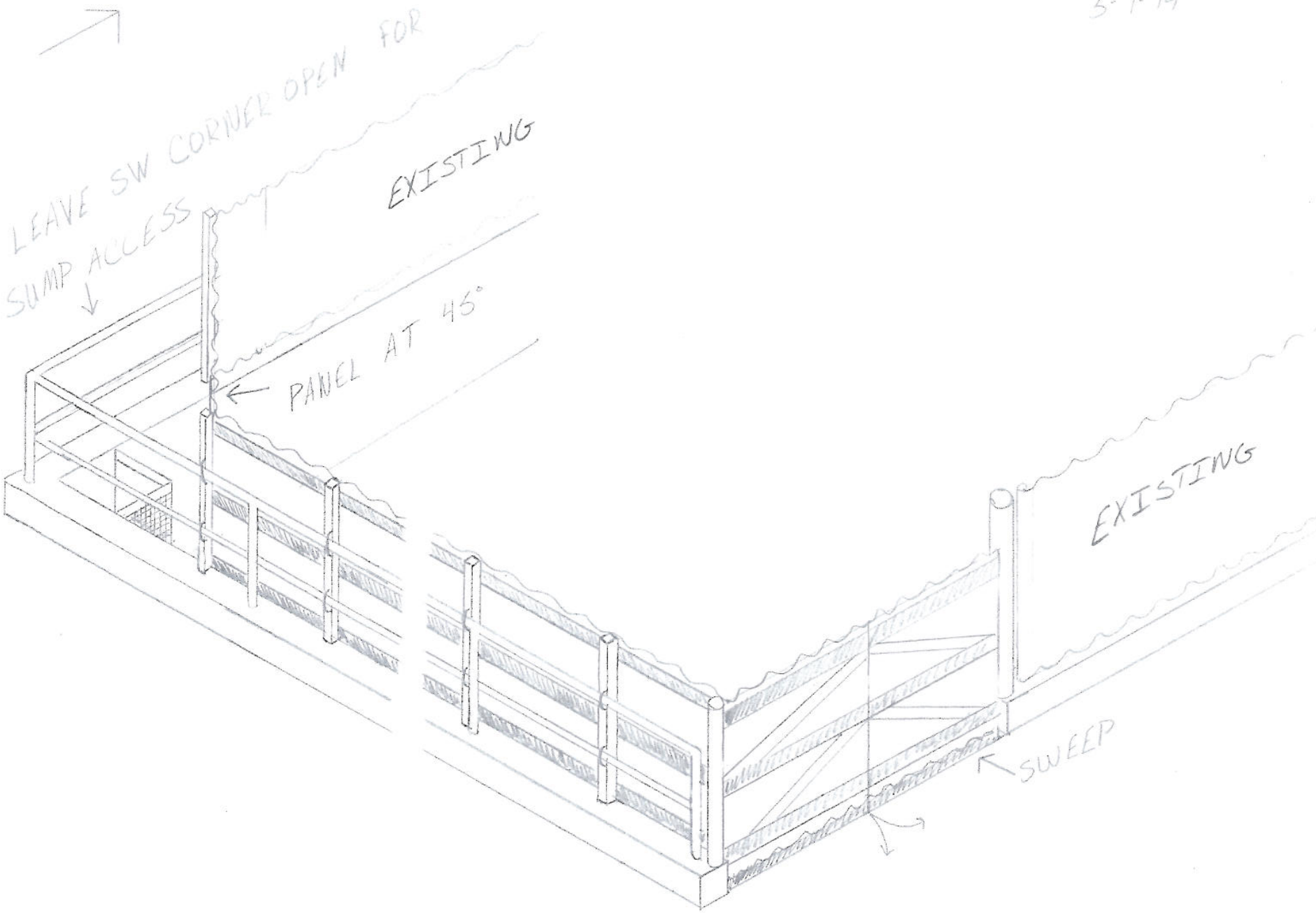
5-7-14



FHRPRU003976

FLINT HILLS resources

ORIGINAL

MANAGEMENT OF CHANGE FORM

(REFER TO PROCEDURE EHS-I-006 FOR EXPLANATION OF THIS FORM)

PROCESS UNIT/AREA: Building 4 containment pit
MOC#: 156666
ORIGINATOR: Steve Emmett
DATE: 05/10/2014

SECTION A - TECHNICAL BASIS FOR PROPOSED CHANGE

Purpose and Technical Basis:	Install a temporary vapor suppression system for buiding 4 containment pit to be used in the event of a reactor dump to the containment area.
Description: *Attach additional paper if necessary*	A temporary system will be installed which consist of 2 remote operated control valves, approximately 500 feet of high pressure hose, 5 way manifold valve, 2 500GPM foam nozzles, and 4 totes of RF-3 foam (265 gallons each) (see attached sketch)
Impact of change On Environmental Health / Safety:	Material will not be pumped to WWT until a waste treatability study has been completed. System should reduce Health + Safety Risks

SECTION B - DOCUMENTATION - *Attach appropriate documentation illustrating proposed changes*

☐	Procedures	☐	Inspections, Testing, PM's	☐	Engineering DWGS	☐	PHA'S
☐	PSM Documentation	☐	CHEMGEMS Specifications	☒	P&ID's	☒	MI Applicability Checklist
☒	MSDS Information	☐	Energy Control Plans	☐	PFD's		
☐	Training/Communication	☐	Floor Plans	☐	LDAR		
☐	Quality Issues	☐	Mechanical Integrity DWGS	☐	Site/Plot Plan	☐	OJT's
☐	Customer Impact	☐	Electrical Schematics	☐	Electrical Single Lines	☐	JSA's
☐	Alarm Response Tables	☐	Loop DWGS	☐	Elect'l Classification	☒	Other MSDS

Affected Personnel Needing To Be Informed/Trained On Proposed Change

☒	Operations	☐	I/E Technicians	☐	Community
☒	Production Facilitators	☒	Engineering	☐	Regulatory Entities
☐	Mechanics/Welders	☐	Contractor(s)	☐	Corporate
☐	Electricians	☐	Office Personnel	☐	Other

SECTION C - Is Change Permanent?

☐	YES	Proposed Project Start Date
☒	NO	Proposed Project Completion Date

SECTION D - Is Change Temporary ?

☒	YES	From: 05/14/2014
☐	NO	To: 11/30/2014

SECTION E - Is Change Emergency ?

☐	Yes	Start:
☒	NO	

Approval Received From:

☐ Ops. Mgr./Designee
☐ Env. Eng./Designee
☐ Plant Mgr./Designee (if requested)
☐ Technical Services Mgr./Designee
☐ H&S Mgr./Specialist
☐ Area Mgr./Designee

Approval Received By:

_____
Signature *Date*

Returned To Original Service: _____/_____/_____

Area Mgr./Designee Signature: _____

Extended To: _____/_____/_____*

Plant Managers Approval:

Plant Mgr./

Signature *Date*

*Note: Temporary MOCAs may be extended up to 6 months at a time

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ORIGINAL

SECTION F - DESIGN SAFETY REVIEW

PHA. Does the proposed change require a PHA? (i.e. What-if/Checklist, Hazop, Revalidation, Review) If yes indicate type of PHA in Action to be Taken section. ☐YES ☒NO

PSSR. Does the proposed change require a Pre-Start-up Safety Review (PSSR)? See EHS-I-067 for Requirements. Mandatory if change involves DCS Interface. ☒YES ☒NO

MS 5/12/14

1. RELIEF AND BLOWDOWN

Does the Proposed Change:	YES	NO
1. Introduce or alter any potential cause of over/under pressurizing of the system?	☐	☒
2. In any way affect existing equipment installed to prevent over/under pressurization?	☐	☒
3. Introduce or alter any potential cause of raising/lowering the system temperature?	☐	☒
4. Introduce a risk of creating/reducing vacuum in the system?	☐	☒
5. Have any critical relief devices been identified for verification of proper rating and installation?	☐	☒

2. AREA CLASSIFICATION

Does the Proposed Change:	YES	NO
1. Introduce or alter the storage of flammable materials?	☐	☒
2. Introduce or alter the location of potential leaks of flammable materials?	☐	☒
3. Introduce new or alter existing electrical equipment?	☐	☒
4. Affect area ventilation?	☐	☒
5. Has the established building electrical classification been changed?	☐	☒

3. SAFETY CONSIDERATIONS

Does the Proposed Change:	YES	NO
1. Require any additional safety equipment or layers of protection?	☐	☒
2. Alter or affect existing safety equipment or means of egress?	☐	☒
3. Require changes to the function or independence of existing equipment or layers of protection?	☐	☒
4. Alter or affect critical safety instrumented functions (SIF's)?	☐	☒
5. Alter the noise level in the surrounding area?	☐	☒
6. Increase the potential for exposure to any chemicals?	☒	☐
7. Introduce a new or previously unused chemical/raw material?	☒	☐
8. Affect de-energization? (able to lock-out, drain materials)	☐	☒
9. Create any ergonomic concerns?	☐	☒
10. Affect the Battery Limit Valves (BLV)?	☐	☒
11. Affect the overall security of the facility?	☐	☒
12. Does this increase the risk of potential impact to plant personnel (employees and contractors)?	☐	☒
13. Does the proposed change affect facility siting relative to both people and equipment in any of the following situations: temporary changes, before startup after a permanent change, or before startup after temporary change has been removed/closed/returned to original condition?	☐	☒
14. If the proposed change affects replacement or demolition of piping or conduit, will the entire run be identified and clearly marked prior to work, to ensure safe work activity?	☒	☒
15. Affect the safe transport of hazardous material? For ex., introducing a new hazardous material for transport or changing the method of transportation of the hazardous material.	☐	☒

4. ENVIRONMENTAL CONSIDERATIONS**

	YES	NO
1. Will there be a potential increase in the maximum production rate, which exceeds the currently permitted design capacity of the facility?	☐	☒
2. Will the replacement or modification change any of the basic parameters of the process unit, such as temperature, pressure, etc?	☐	☒
3. Will the change cause increased emissions of regulated pollutants during installation, implementation, or during operations?	☐	☒
4. Will there be any new vents added?	☐	☒
5. Will the change add, remove or modify any permitted emission units (*Example: reactors, wash tanks, dryers, centrifuges, packout bins, screening towers, or styrene or pentane storage.*)?	☐	☒
6. Will the project include the installation of a stationary engine with a ≤ 500 hp? If so, a non-resettable hour meter shall be installed to record operational hours and PMs shall be consistent with RICE NESHAP regulations and the manufacturer's recommended preventative maintenance.	☐	☒
7. Will the project results in the increase in Facility's total throughput of natural gas?	☐	☒
8. Is there the potential to generate a new waste or increase the quantity of an existing waste?	☒	☒

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ORIGINAL

SECTION F - DESIGN SAFETY REVIEW -- cont.

4. ENVIRONMENTAL CONSIDERATIONS** - - cont.

9. Will there be a change in the wastewater characteristics? If the project causes an increase to the discharge of wastewater to the Public Sanitary District, provide calculations with the MOC.	☒	☒
10. Does the project add or remove LDAR Components (Pumps, PRVs, Valves, and Connectors) that come in contact with styrene or pentane?	☐	☒
11. Does the project increase risk to off-site residential & environmental receptors?	☐	☒
12. Will the change affect the control of processes?	☐	☒
13. Will the change affect the composition or physical properties of the final product?	☐	☒
14. Will new chemicals be brought onsite anytime during the project?	☒	☐
15. Does an evaluation of chemical compatibility need to be conducted during the project?	☐	☒
16. Will the project involve decommissioning or demolition of equipment or structure?	☐	☒
17. If yes to 16, does National Emissions Standards for Hazardous Air Pollutants (NESHAP) or deconstruction permit apply?	☐	☒
18. Will this project require a portable engine?	☐	☒

** Consult with Environmental Engineer for completion of this section.

5. OPERATION AND DESIGN

Does the Proposed Change:	YES	NO
1. Affect the process or equipment upstream/downstream of the change?	☒	☒
2. Affect access to process or equipment/controls for personnel?	☐	☒
3. Introduce any new or affect existing interlocks or alarms systems?	☐	☒
4. Affect manpower or qualified personnel?	☐	☒
5. Affect the loads/strengths of existing foundations, structures, vessels, or pipe racks?	☐	☒
6. Impact requirements of existing or proposed piping supports? *(Needs to be adequately designed for expected stresses due to pressure and thermal loadings.)*	☐	☒
7. Alter the DCS/Software logic of process operations?	☐	☒
8. Affect process chemistry? (reactivity/compatibility)	☐	☒
9. Affect maximum intended inventory, which would require updating maximum inventory tables?	☐	☒
10. Affect safe upper/lower limits for such items as temperature, process flows or compositions?	☐	☒
11. Affect material/energy balances?	☐	☒
12. Affect plant utility resources? (i.e. steam, water, electricity, etc.)	☒	☒
13. Affect equipment with heat-up/cool-down cycling requiring bolt retightening after start-up?	☐	☒
14. Is an exception/revision to design codes or standards (CHEM-GEMS, etc.) required?	☐	☒

SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION

Will the Proposed Change:	YES	NO
1. Introduce new or impact existing operational procedures? *	☒	☐
2. Introduce new or impact existing maintenance procedures? *	☐	☒
3. Add or Remove equipment/instrumentation? *(Contact MST to assign Equipment/Instrumentation Location Numbers. If equipment/instrumentation is being added, MI Applicability Checklist MNT-F-161 shall be completed by MOC originator, and approval form(s) sent to the MI coordinator.)*	☒	☒
4. Revise equipment preventative maintenance/ inspections, job plans , and/or frequencies?	☐	☒
5. Require additional training for operational or maintenance personnel? *(requires completion of Leaning and Development Job Aid addendum A)*	☒	☐
6. Require additional notification for operational or maintenance personnel?	☒	☐
7. Require updating controlled drawings? * *(PFD'S, LDAR, P&ID's, Floor Plans, Electrical Single Lines, Loop Drawings/Electrical Schematics, MCC arrangement, MI Iso Drawings)*	☐	☒
8. Require updating equipment files? *(Engineering, Maintenance, Manufacturers Inspect/Test results)*	☐	☒
9. Require a spare parts list and inventory to be developed?	☐	☒
10. Require major project spare equipment to be turned over to maintenance?	☐	☒
11. Require equipment labeling in the field?	☐	☒
12. Require updating of Alarm Response Tables? *	☐	☒
13. Require a new/modification of existing energy control plans? *	☒	☒

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SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION –cont'd

14. Cause any PSM/RMP applicability issues?	☐	☒
15. Cause a change in PSM/RMP program level?	☐	☒
16. Will this change have any effect on the overall plant facility siting issues?	☐	☒
17. Increase or decrease the impact contour for worst-case scenario by a factor of two or more?	☐	☒
18. Will this MOC supersede /interfere with any other Temporary/Emergency/Permanent MOC's?	☐	☒
19. Is there a need to update the EPS-I-004, Chemical Compatibility Matrix?	☐	☒
20. Is a Layer of Protection Analysis (LOPA) study required?	☐	☒
21. Will this affect the Interlock Matrix?	☐	☒
22. Require updating of electrical energy consumption spreadsheet? Update required for any MCC, CB panel or bus bar connection additions or alterations.	☐	☒
23. Will this change impact Proprietary Technology including product, process, equipment, technical data, or other trade secret information licensed to FHR by third parties" If yes, contact the Proprietary Technology Coordinator.	☐	☒

*** NOTE: Refer to Engineering Equipment Location Database for a list of affected documents, sorted by Location Number.**

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ORIGINAL

Any questions with a 'YES' answer, requires follow-up activity.
List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'

MCS 5/13/2014

Item No.	Action To Be Completed Prior to PSSR	Responsible Party	Target Completion Date
3-6	Approve New chemical request form	Miller/Schmidt	5-13-14
3-7	" "	"	"
4-14	" "	"	"
5-1	Determine affects on WWT	Mike Schmidt	5-13-14
5-12	" "	" "	" "
6-5	Train all operations personnel	Shea	5-25-14
6-6	" "	" "	" "
6-1	CREATE PROCEDURE		
SECTION F	PSSR	EMMETT	5-16/-14
F-3-14			
	Phil M[illegible] 5-13-14		

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ORIGINAL

Any questions with a 'YES' answer, requires follow-up activity.
List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'

Item No.	Action To Be Completed After PSSR	Responsible Party	Target Completion Date
G-5	Train all operations personnel	M. Shea	5-25-14
G-6	Train all operations personnel	M. Shea	5-25-14
G-1	Create Procedure	M. Shea	5-25-14
	[illegible] 5-13-14		

MES 05/13/14

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ORIGINAL

MOC APPROVAL FORM

Originator: Steve Emmett **MOC No.** 156666

MOC Packet Completeness Verification Review

Title/Position	Verification Review Signatures	Date
Drafting Tech, or Designee	Lisa [illegible]	5-12-14
MI Coordinator, or Designee	Dean [illegible]	5-12-14
Maintenance Tech from appropriate area	Ryan Williams	5-12-14
Operator from affected area	Ti Stibane	5-12-14
Area Training Contact, or Designee	[illegible]	05/12/14

Signatures required Prior To Implementation of MOC.

Title/Position	Authorizing Signatures	Date
Area Manager/Facilitator or Designee	[illegible]	05/13/14
Technical Services Manager or Designee	[illegible]	5/13/14
Pilot Plant / QC Manager (If Applicable)	N/A	
H&S Specialist or Designee	Phil Mill[illegible]	5-13-14
Operations Manager or Designee	[illegible]	5-10-14
Environment Engineer or Designee	[illegible]	5/14/2014

Other Reviewers
(as requested by any of the Authorizing signers)

Title/Position	Review Signature	Date
Plant Manager or Designee		
Electrical Engineer		

VERIFICATION OF MOC CLOSURE

By signing below:

1. The Originator of this MOC confirms that all action items have been completed & that equipment/documentation in this change is set to start up.
2.

MOC closure requires the Originators Signature

MOC Originator: Date:_____

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Tom Moeller
630-738-2555

ORIGINAL

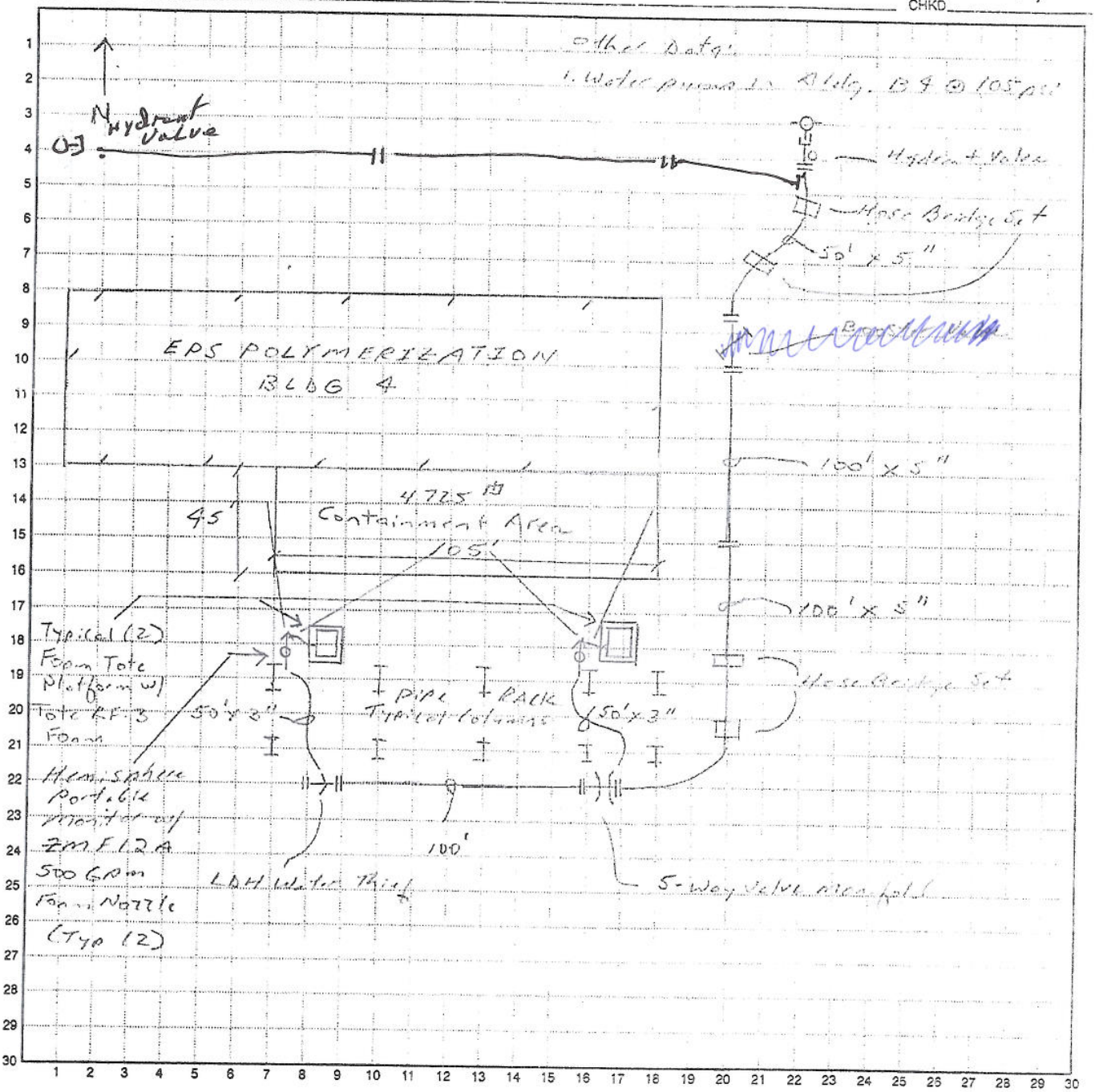
HAYDEN AND COMPANY
2604-B WEST 83rd STREET
DARIEN, ILLINOIS 60561
TEL: (630) 910.6244
FAX: (630) 910.6245
Email: info@haydencompany.com

CALCULATIONS AND SKETCHES

PROFESSIONAL, VALUE ADDED SERVICES SINCE 1947

SUBJECT
SHEET 1 OF 1
JOB NO.
BY JPM
CHKD 5-2-14

SUBJECT Temporary Fire Protection Plan - FHR Peru IL
Styrene Protection



Any questions with a 'YES' answer, requires follow-up activity. List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'			
Item No.	**Action To Be Completed Prior to PSSR**	**Responsible Party**	**Target Completion Date**
F3-6	Conduct Area Air Monitoring	Phil Miller	5-21-14
	during commissioning	— —	— —
F3-7	Approve MSDS	Phil Miller &	5-14-14
F3-7	Approve MSDS	M. Schmidt	5-14-14
~~G-B~~	~~Complete MNT-F-161~~	~~[illegible]~~	
G-B	Develop ECP	~~M. Shea~~ S. Emmett, M. Shea	5-23-14
G-5	Train all Operations Personnel PSM 5-14-14	M. Shea S. Emmett	5-23-14
~~G-6~~	~~Train all Operations Personnel~~ PSM 5-14-14	~~M. Shea~~	5-23-14
G-1	Develop written Procedure	M. Shea	5-23-14
G-3	Review & implement MNT-F-161	Dean T	5-23-14
F-PSSR	Conduct PSSR	Steve Emmett	5-23-14
PSM 5-14-14			
G-6	Notify Maintenance	S. Emmett	5-23-14

Any questions with a 'YES' answer, requires follow-up activity. List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'			
Item No.	**Action To Be Completed <u>After PSSR</u>**	**Responsible Party**	**Target Completion Date**
F-4-9	Conduct waste water treatability study.	M. Schmidt	11-13-14
F-4-8 ~~F8~~-	Profile waste with TSD	M. Schmidt	6/13/2014
TEMP1	Return to Original Service	Steve Emmett	11-30-2014

ORIGINAL

RE-HEALING™ RF3, 3% FOAM CONCENTRATE

MATERIAL SAFETY DATA SHEET

Section 1: Chemical product and company identification

Product Name:	RE-HEALING™ RF3, 3% Foam Concentrate
Synonym:	RE-HEALING RF3 or RF3
Chemical Name:	N/A This product is a mixture
C.A.S No.:	N/A This product is a mixture
Chemical Formula:	N/A This product is a mixture
EINECS Number:	N/A This product is a mixture

Use of this product: The intended use of this product is as a fire extinguishing agent.

Company / Undertaking Identification:

Americas	Europe/Middle East/Africa	Asia-Pacific
The Solberg Company 1520 Brookfield Avenue Green Bay, WI 54313 United States	Solberg Scandinavian AS Radøyvegen 721 - Olsvollstranda N-5938 Sæbøvågen Norway	Solberg Asia Pacific Pty Ltd 3 Charles Street St. Marys NSW 2760 Australia
Tel: +1 920 593 9445	Tel: +47 56 34 97 00	Tel: +61 2 9673 5300

Telephone:	(920) 593-9445
Emergency Contacts:	Chemtrec: (800) 424-9300 or (703) 527-3887
Revised:	February, 2012

Section 2: Hazard identification and emergency overview

Human Exposure:
Product:

EU Classification:	Xi	Irritant
R Phrases:	36	Irritating to eyes
S Phrases:	2	Keep out of reach of children
	24	Avoid contact with skin
	26	In case of contact with eyes, rinse immediately with copious amounts of water and seek medical advice.

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Components:
Diethylene Glycol Monobutyl Ether:

EU Classification	Xi	Irritant
R Phrases	36	Irritating to eyes
S Phrases	2	Keep out of reach of children
	24	Avoid skin contact
	26	In case of contact with eyes, rinse immediately with copious amounts of water and seek medical advice

Limit Values for Exposure:
Diethylene Glycol Monobutyl Ether:
OSHA PEL (General Industry) 8 hour TWA: None established
MAK (DE) Limit Value: 100 mg/m^3
Short term exposure limit value
(8 times, 5 minutes): 200mg/m^3

Neither this product nor any of the ingredients contained in it have been listed as carcinogenic by the National Toxicology Program IARC, or OSHA. As part of good industrial and personal hygiene and safety procedure, avoid all unnecessary exposure to chemical substances and ensure prompt removal from skin, eyes, and clothing

Signs and Symptoms:

Acute Exposure:	
Eye Contact:	May cause mild to moderate transient irritation
Skin Contact:	May cause mild transient irritation and/or dermatitis
Inhalation:	Not a normal route of entry
Ingestion:	Irritating to mucous membranes
Chronic Overexposure:	Possible systemic and motor disorders, diethethylene glycol monobutyl ether did not interfere with reproduction; however, body weights of newborn animals were decreased.

Medical conditions generally aggravated by exposure: Diseases of the kidney and liver.

For Environment: As much as possible, keep from being washed into surface water.

Section 3. Composition/information on ingredients

Ingredient Name:	Proprietary mixture consisting of hydrocarbon surfactants, complex carbohydrates, inorganic salts, solvent and water
Chemical Formula:	N/A - This is a mixture
C.A.S. No.:	N/A - This is a mixture
EINECS Number:	N/A - This is a mixture
Concentration, Wt. %:	<40%
Hazard Classification:	See section 2
Ingredient Name:	**Diethylene Glycol Monobutyl Ether** (a)
Chemical Formula:	$C_4H_9O(CH_2CH_2O)_2H$

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SOLBERG

C.A.S. No.:	112-35-5
EINECS Number:	230-961-6
Concentration, Wt.%:	12%
Hazard Classification:	See section 2

(a) This chemical is subject to reporting requirements of SARA Title III Section 313 and 40CFR Section 372

Section 4. First aid measures

Eye Exposure:	Irrigate eyes at eye wash station and repeat until pain free. Seek medical attention immediately.
Skin Exposure:	In case of contact, wash with plenty of soap and water. If irritation persists seek medical attention.
Inhalation:	If respiratory irritation or distress occurs remove victim to fresh air. Provide oxygen if breathing is difficult. Seek medical attention if irritation develops or persists.
Ingestion:	Do not induce vomiting. If victim is alert, give liquids such as milk or water. Seek immediate medical attention. Do not leave victim unattended. To prevent aspiration of swallowed product, lay victim on side with head lower than waist.

Medical conditions possibly aggravated by exposure: Inhalation of product may aggravate existing chronic respiratory conditions.

Section 5. Firefighting measures

This product is an extinguishing media. No special protective equipment is required for fire fighters. Insensitive to mechanical impact or static discharge.

HMIS (hazardous materials identification system) rankings (as liquid): health = 3, flammability = 0, reactivity = 0, personal protective equipment: eye and skin protection (see Section 8).

Section 6: Accidental release measures

For personal protection: Prevent skin and eye contact, see Heading 8
Clean up: Use an absorbent material, to include but not be limited to, diatomaceous earth, kitty litter, or saw dust, and sweep up. See Heading 12

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Section 7: Handling and storage

Avoid eye, respiratory, and skin exposure. Use appropriate PPE (personal protective equipment) when handling, and wash thoroughly after handling (Section 8). Keep product in original container until packaging for use as extinguisher. Clean used equipment before storage. Use this product only in well ventilated areas. Do not mix with other extinguishing agents.

Section 8: Exposure controls/ personal protection

Respiratory protection: None expected to be needed, mechanical ventilation is recommended

Hand Protection: Use chemical resistant gloves when handling the product

Eye protection: Chemical goggles are recommended

Skin protection: Standard fire-fighting equipment should provide all necessary protection

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Section 9: Physical and chemical properties

Appearance: Liquid light brown color; mild sweet odor
Solubility: Completely soluble in water
Flammability: Non -flammable
Flash point: Does not flash
Vapor density (Air = 1): Not determined, but <1
Explosive properties: Not explosive
Oxidizing properties: Not an oxidizer
Relative density: 1.06 (Water = 1)
pH: 7.0 to 8.5
Boiling point: ~ 220° F

Section 10: Stability and reactivity

Stability: stable

Incompatibles: Reactive metals, electrically energized equipment, any material reactive with water and strong oxidizers.

Conditions to avoid: There are no known conditions which may cause a dangerous reaction.

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Section 11: Toxicological Information

Product: The toxicity of the product mixture has not been determined

Components:

Diethylene Glycol Monobutyl Ether

Toxicity Data: Oral (rat) LD_{50} 5,660 mg/kg
Oral (rat) LD_{50} 9,626 mg/kg (EINECS ESIS)
Dermal (rabbit) LD_{50} 4,000 mg/kg
Dermal (rabbit) LD_{50} 2,764 mg/kg (EINECS ESIS)

Irritation Data: Eye (rabbit) 20 mg/day Moderate (EINECS ESIS)
Eye (rabbit) Highly-irritating (EINECS ESIS)
Skin (rabbit) 1000 mg/kg/day Moderate with edema, fissuring, leathery appearance (EINECS ESIS)

Target organs: Kidney, blood, liver, lungs, gastrointestinal, spleen

---

Section 12: Ecological information

Ecotoxicity:

Components:

Diethylene Glycol Monobutyl Ether

Fish Lepomis marcrochinus: LC_{50} (96 hrs.) 1,300 mg/L
Carassius auratus: LC_{50} (24 hrs.) 2,700 mg/L
Daphnids, Daphnia magna: EC_{50} 24 hrs.) 3,184 mg/L
Algae, Scenedesmus subspicatus: EC_{50} (96 hrs.) >100 mg/L

Mobility

Diethylene Glycol Monobutyl Ether

Should not partition from a water column to organic matter contained in sediments and suspended solids.

Persistence/ Degradability:

Diethylene Glycol Monobutyl Ether:

Indirect photodegradation is about 50% in 3.5 hours
Aerobic degradation with adapted activated sludge is 60% after 28 days
COD = 2080 mg/g of substance
BOD_5 = 250 mg O_2/g substance
Theoretical oxygen demand = 2.17 mg/mg

Bioaccumulation:

Diethylene Glycol Monobutyl Ether

Should not bioaccumulate

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Section 13: Disposal considerations

As much as possible, keep from being washed into surface water, see Heading 12. Dispose of in compliance with national, regional, and local provisions that may be in force.

Section 14: Transportation information

This product is not a hazardous material under U.S. Department of Transportation (DOT) 49 CFR 172, and is not regulated by the DOT, IMO, IATA, RID/ADR, or Canada's TDG.

Section 15: Regulatory information

Product:

EU Classification:	Xi	Irritant
R Phrases:	36	Irritating to eyes
S Phrases:	2	Keep out of reach of children
	24	Avoid contact with skin
	26	In case of contact with eyes, rinse immediately with copious amounts of water and seek medical advice.

Limit Values for Exposure:
Diethylene Glycol Monobutyl Ether:
OSHA PEL (General Industry) 8 hour TWA: None established
MAK (DE) Limit Value: 100 mg/m^3
Short term exposure limit value
(8 times, 5 minutes): 200mg/m^3

State regulatory information:
Chemicals in this product under specific State regulations, as denoted below:

California - Permissible Exposure Limits for Chemical Contaminants: None
Florida – Substance List: None
Massachusetts - Substance List: None
Minnesota - List of Hazardous Substances: None
New Jersey - Right to Know Hazardous Substance List: None
Pennsylvania: Hazardous Substance List: None

California Proposition 65: No component is listed on the California Proposition 65 list or the No Significant Risk Level List.

Section 16. Other information

This MSDS conforms to requirements under U.S., U.K., Canadian, Australian, and EU regulations or standards, and conforms to the 2003 ANSI Z400.1 format.

The information herein is given in good faith to be correct but does not claim to be all inclusive and shall be used only as a guide. Solberg or Amerex Corporation shall not be held liable for any damage resulting from handling or from contact with the above product.

FHRPRU003992

German Hygiene Institute Test Results

TEST		RESULT	
		RF3	3% RF3 in Fresh water
		Concentrate	3%
Bacterial toxicity		0.00565	0.188
Fish toxicity	LC 50	23	767
Daphnia toxicity	EC 50	50	1667
Algae toxicity	EC 50	150	5000
Oral mammal toxicity	(limit concentration of 2000)	> 2000	> 2000
Biodegradability	COD	560000	560000
	BOD 5 day's	240000	240000
	Biodegradability 5 day's	42.9	42.9
	Biodegradability 28 day's	93.2	93.2
Biological Soil testing			
Inhibition of Germination of plants	EC50 Barley	1000	> 10000
	EC 50 cress	6000	> 10000
	EC 50 radish	> 10000	> 10000
Inhibition of Growth of plants	EC50 Barley	300	> 10000
	EC 50 cress	800	> 10000
	EC 50 radish	500	> 10000
Toxicity for Earthworms	EC 50	5500	> 10000
Recomendations on Soil	No significant effect	100	3333
	NOEC	< 100	< 3300
Skin irritation	erythema and scab	1	NA
	formation of oedema	0	NA
According to the hazardeous substance law		NON	NON
Eye irritation	cornea	0	NA
	iris	1	NA
	conjunctiva	1	NA
According to the hazardeous substance law		NON	NON

Mechanical Integrity Applicability Checklist

Project Number: PE 52690 MOC Number: 156666 Date: 05/13/2014
Project Description: Short-term foam application system for B4 discharge pit
Equipment Number: _____ Equipment Description: Remote control hydrant slide valves (2)

		Yes	No	If yes, Why
1.	Is the equipment/process PSM/RMP covered per EHS-I-105?	☐	☒	
2.	Do jurisdictional requirements mandate MI coverage? (Federal, state, local law or regulations)	☒	☐	NFPA 1962 Section 8.2
3.	Is a transportation container being used as a storage tank?	☐	☐	
4.	Is equipment part of an environmental permit?	☐	☐	
5.	Should equipment/process be MI covered due to Good Engineering Practice?	☒	☐	Equipment critical to mitigate reactor batch discharges

Completed By: Phil Mill Date: 5-13-14
Technical Services Manager Approval: _____ Date: _____

If yes is answered to any of the above questions:

- Forward the completed ITPM frequency change request form (MIP-F-100) to the Mechanical Integrity Coordinator with PM requirements.
- MI Coordinator signature required once ITPM task has been created.

MI Coordinator: _____ Date: _____

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FLINT HILLS resources

ORIGINAL

MANAGEMENT OF CHANGE FORM

(REFER TO PROCEDURE EHS-I-006 FOR EXPLANATION OF THIS FORM)

PROCESS UNIT/AREA: Building #4 Containment Pit MOC#: 156681

ORIGINATOR: G.Medley DATE: 05/13/2014

SECTION A - TECHNICAL BASIS FOR PROPOSED CHANGE

Purpose and Technical Basis:	reroute 8" drain lines that are affected by the new wall extension. Extend 3" fogger lines 18" so there is no interference with new piping.
Description: *Attach additional paper if necessary*	See attached drawings & photos of changes.
Impact of change On Environmental Health / Safety:	None.

SECTION B - DOCUMENTATION - *Attach appropriate documentation illustrating proposed changes*

☐	Procedures	☐	Inspections, Testing, PM's	☐	Engineering DWGS	☐	PHA'S
☐	PSM Documentation	☒	CHEMGEMS Specifications	☒	P&ID's	☐	MI Applicability Checklist
☐	MSDS Information	☐	Energy Control Plans	☐	PFD's		
☐	Training/Communication	☐	Floor Plans	☐	LDAR		
☐	Quality Issues	☐	Mechanical Integrity DWGS	☐	Site/Plot Plan	☐	OJT's
☐	Customer Impact	☐	Electrical Schematics	☐	Electrical Single Lines	☐	JSA's
☐	Alarm Response Tables	☐	Loop DWGS	☐	Elect'l Classification	☐	Other

Affected Personnel Needing To Be Informed/Trained On Proposed Change

☐	Operations	☐	I/E Technicians	☐	Community
☐	Production Facilitators	☐	Engineering	☐	Regulatory Entities
☐	Mechanics/Welders	☐	Contractor(s)	☐	Corporate
☐	Electricians	☐	Office Personnel	☐	Other

SECTION C - Is Change Permanent?

☒	YES	Proposed Project Start Date 05/14/2014
☐	NO	Proposed Project Completion Date 06/30/2014

SECTION D - Is Change Temporary ?

☐	YES	From:
☒	NO	To:

SECTION E - Is Change Emergency ?

☐	Yes	Start:
☒	NO	

Approval Received From:

☐ Ops. Mgr./Designee ☐ Env. Eng./Designee

☐ Plant Mgr./Designee (if requested) ☐ Technical Services Mgr./Designee

☐ H&S Mgr./Specialist ☐ Area Mgr./Designee

Approval Received By:

_____

Signature *Date*

Returned To Original Service: _____/_____/_____

Area Mgr./Designee

Signature: _____

Extended To: _____/_____/_____*

Plant Managers Approval:

Plant Mgr./

Signature *Date*

*Note: Temporary MOCAs may be extended up to 6 months at a time

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SECTION F - DESIGN SAFETY REVIEW

PHA. Does the proposed change require a PHA? (i.e. What-if/Checklist, Hazop, Revalidation, Review) If yes indicate type of PHA in Action to be Taken section.	☐YES	☒NO
PSSR. Does the proposed change require a Pre-Start-up Safety Review (PSSR)? See EHS-I-067 for Requirements. Mandatory if change involves DCS Interface.	☒YES	☐NO

1. RELIEF AND BLOWDOWN

Does the Proposed Change:	YES	NO
1. Introduce or alter any potential cause of over/under pressurizing of the system?	☐	☒
2. In any way affect existing equipment installed to prevent over/under pressurization?	☐	☒
3. Introduce or alter any potential cause of raising/lowering the system temperature?	☐	☒
4. Introduce a risk of creating/reducing vacuum in the system?	☐	☒
5. Have any critical relief devices been identified for verification of proper rating and installation?	☐	☒

2. AREA CLASSIFICATION

Does the Proposed Change:	YES	NO
1. Introduce or alter the storage of flammable materials?	☐	☒
2. Introduce or alter the location of potential leaks of flammable materials?	☐	☒
3. Introduce new or alter existing electrical equipment?	☐	☒
4. Affect area ventilation?	☐	☒
5. Has the established building electrical classification been changed?	☐	☒

3. SAFETY CONSIDERATIONS

Does the Proposed Change:	YES	NO
1. Require any additional safety equipment or layers of protection?	☐	☒
2. Alter or affect existing safety equipment or means of egress?	☐	☒
3. Require changes to the function or independence of existing equipment or layers of protection?	☐	☒
4. Alter or affect critical safety instrumented functions (SIF's)?	☐	☒
5. Alter the noise level in the surrounding area?	☐	☒
6. Increase the potential for exposure to any chemicals?	☐	☒
7. Introduce a new or previously unused chemical/raw material?	☐	☒
8. Affect de-energization? (able to lock-out, drain materials)	☐	☒
9. Create any ergonomic concerns?	☐	☒
10. Affect the Battery Limit Valves (BLV)?	☐	☒
11. Affect the overall security of the facility?	☐	☒
12. Does this increase the risk of potential impact to plant personnel (employees and contractors)?	☐	☒
13. Does the proposed change affect facility siting relative to both people and equipment in any of the following situations: temporary changes, before startup after a permanent change, or before startup after temporary change has been removed/closed/returned to original condition?	☐	☒
14. If the proposed change affects replacement or demolition of piping or conduit, will the entire run be identified and clearly marked prior to work, to ensure safe work activity?	☐	☒
15. Affect the safe transport of hazardous material? For ex., introducing a new hazardous material for transport or changing the method of transportation of the hazardous material.	☐	☒

4. ENVIRONMENTAL CONSIDERATIONS**

	YES	NO
1. Will there be a potential increase in the maximum production rate, which exceeds the currently permitted design capacity of the facility?	☐	☒
2. Will the replacement or modification change any of the basic parameters of the process unit, such as temperature, pressure, etc?	☐	☒
3. Will the change cause increased emissions of regulated pollutants during installation, implementation, or during operations?	☐	☒
4. Will there be any new vents added?	☐	☒
5. Will the change add, remove or modify any permitted emission units (*Example: reactors, wash tanks, dryers, centrifuges, packout bins, screening towers, or styrene or pentane storage.)*?	☐	☒
6. Will the project include the installation of a stationary engine with a ≤ 500 hp? If so, a non-resettable hour meter shall be installed to record operational hours and PMs shall be consistent with RICE NESHAP regulations and the manufacturer's recommended preventative maintenance.	☐	☒
7. Will the project results in the increase in Facility's total throughput of natural gas?	☐	☒
8. Is there the potential to generate a new waste or increase the quantity of an existing waste?	☐	☒

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ORIGINAL

SECTION F - DESIGN SAFETY REVIEW -- cont.

4. ENVIRONMENTAL CONSIDERATIONS** - - cont.

9. Will there be a change in the wastewater characteristics? If the project causes an increase to the discharge of wastewater to the Public Sanitary District, provide calculations with the MOC.	☐	☒
10. Does the project add or remove LDAR Components (Pumps, PRVs, Valves, and Connectors) that come in contact with styrene or pentane?	☐	☒
11. Does the project increase risk to off-site residential & environmental receptors?	☐	☒
12. Will the change affect the control of processes?	☐	☒
13. Will the change affect the composition or physical properties of the final product?	☐	☒
14. Will new chemicals be brought onsite anytime during the project?	☐	☒
15. Does an evaluation of chemical compatibility need to be conducted during the project?	☐	☒
16. Will the project involve decommissioning or demolition of equipment or structure?	☐	☒
17. If yes to 16, does National Emissions Standards for Hazardous Air Pollutants (NESHAP) or deconstruction permit apply?	☐	☒
18. Will this project require a portable engine?	☐	☒

** Consult with Environmental Engineer for completion of this section.

5. OPERATION AND DESIGN

Does the Proposed Change:	YES	NO
1. Affect the process or equipment upstream/downstream of the change?	☐	☒
2. Affect access to process or equipment/controls for personnel?	☐	☒
3. Introduce any new or affect existing interlocks or alarms systems?	☐	☒
4. Affect manpower or qualified personnel?	☐	☒
5. Affect the loads/strengths of existing foundations, structures, vessels, or pipe racks?	☐	☒
6. Impact requirements of existing or proposed piping supports? *(Needs to be adequately designed for expected stresses due to pressure and thermal loadings.)*	☐	☒
7. Alter the DCS/Software logic of process operations?	☐	☒
8. Affect process chemistry? (reactivity/compatibility)	☐	☒
9. Affect maximum intended inventory, which would require updating maximum inventory tables?	☐	☒
10. Affect safe upper/lower limits for such items as temperature, process flows or compositions?	☐	☒
11. Affect material/energy balances?	☐	☒
12. Affect plant utility resources? (i.e. steam, water, electricity, etc.)	☐	☒
13. Affect equipment with heat-up/cool-down cycling requiring bolt retightening after start-up?	☐	☒
14. Is an exception/revision to design codes or standards (CHEM-GEMS, etc.) required?	☐	☒

SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION

Will the Proposed Change:	YES	NO
1. Introduce new or impact existing operational procedures? *	☐	☒
2. Introduce new or impact existing maintenance procedures? *	☐	☒
3. Add or Remove equipment/instrumentation? *(Contact MST to assign Equipment/Instrumentation Location Numbers. If equipment/instrumentation is being added, MI Applicability Checklist MNT-F-161 shall be completed by MOC originator, and approval form(s) sent to the MI coordinator.)*	☐	☒
4. Revise equipment preventative maintenance/ inspections, job plans , and/or frequencies?	☐	☒
5. Require additional training for operational or maintenance personnel? *(requires completion of Leaning and Development Job Aid addendum A)*	☐	☒
6. Require additional notification for operational or maintenance personnel?	☐	☒
7. Require updating controlled drawings? * *(PFD'S, LDAR, P&ID's, Floor Plans, Electrical Single Lines, Loop Drawings/Electrical Schematics, MCC arrangement, MI Iso Drawings)*	☒	☐
8. Require updating equipment files? *(Engineering, Maintenance, Manufacturers Inspect/Test results)*	☐	☒
9. Require a spare parts list and inventory to be developed?	☐	☒
10. Require major project spare equipment to be turned over to maintenance?	☐	☒
11. Require equipment labeling in the field?	☐	☒
12. Require updating of Alarm Response Tables? *	☐	☒
13. Require a new/modification of existing energy control plans? *	☐	☒

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ORIGINAL

SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION –cont'd

14. Cause any PSM/RMP applicability issues?	☐	☒
15. Cause a change in PSM/RMP program level?	☐	☒
16. Will this change have any effect on the overall plant facility siting issues?	☐	☒
17. Increase or decrease the impact contour for worst-case scenario by a factor of two or more?	☐	☒
18. Will this MOC supersede /interfere with any other Temporary/Emergency/Permanent MOC's?	☐	☒
19. Is there a need to update the EPS-I-004, Chemical Compatibility Matrix?	☐	☒
20. Is a Layer of Protection Analysis (LOPA) study required?	☐	☒
21. Will this affect the Interlock Matrix?	☐	☒
22. Require updating of electrical energy consumption spreadsheet? Update required for any MCC, CB panel or bus bar connection additions or alterations.	☐	☒
23. Will this change impact Proprietary Technology including product, process, equipment, technical data, or other trade secret information licensed to FHR by third parties" If yes, contact the Proprietary Technology Coordinator.	☐	☒

*** NOTE: Refer to Engineering Equipment Location Database for a list of affected documents, sorted by Location Number.**

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ORIGINAL

Any questions with a 'YES' answer, requires follow-up activity.
List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'

Item No.	Action To Be Completed Prior to PSSR	Responsible Party	Target Completion Date
F-PSSR	Perform PSSR	G.Medley	06/30/2014
G-7a	Redline Drawings	G.Medley	06/30/2014

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ORIGINAL

Any questions with a 'YES' answer, requires follow-up activity. List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'			
Item No.	**Action To Be Completed <u>After PSSR</u>**	**Responsible Party**	**Target Completion Date**
G-7b	Revise P&ID's	L.Grant	09/30/2014

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ORIGINAL

MOC APPROVAL FORM

Originator: Greg Medley **MOC No.** 156681

MOC Packet Completeness Verification Review

Title/Position	Verification Review Signatures	Date
Drafting Tech, or Designee	Lisa [illegible]	5-13-14
MI Coordinator, or Designee	Dean [illegible]	5-13-14
Maintenance Tech from appropriate area	Jon D. Duff	5-13-14
Operator from affected area	MIKE WILKE	5-13-14
Area Training Contact, or Designee	[illegible]	5/13/14

Signatures required Prior To Implementation of MOC.

Title/Position	Authorizing Signatures	Date
Area Manager/Facilitator or Designee	[illegible]	5/13/14
Technical Services Manager or Designee	[illegible]	5/13/14
Pilot Plant / QC Manager (If Applicable)	N/A	
H&S Specialist or Designee	Phil M[illegible]	5-13-14
Operations Manager or Designee	PER STEVE EMMETT [illegible]	05/13/14
Environment Engineer or Designee	[illegible]	05/13/14

Other Reviewers

(as requested by any of the Authorizing signers)

Title/Position	Review Signature	Date
Plant Manager or Designee		
Electrical Engineer		

VERIFICATION OF MOC CLOSURE

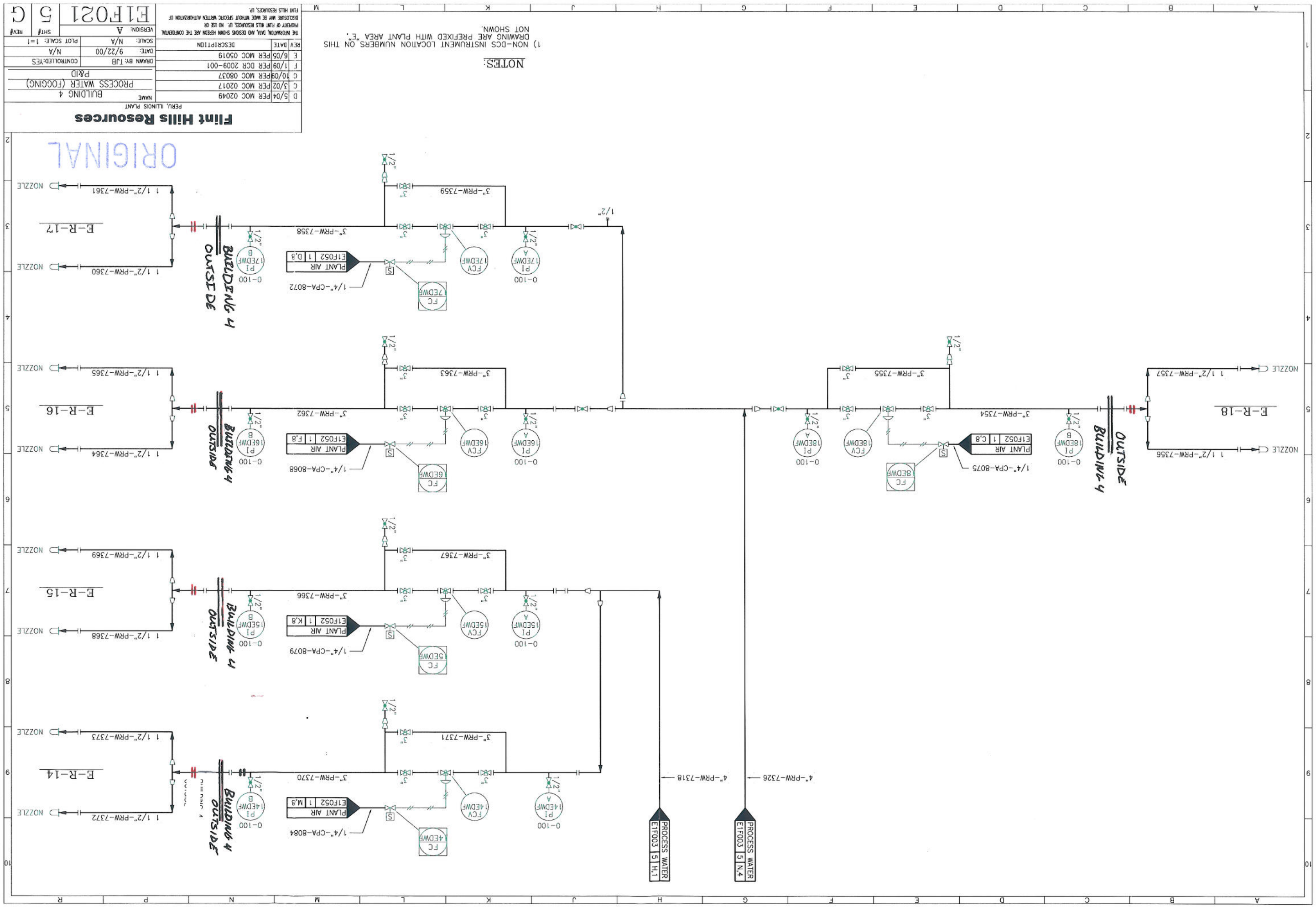
By signing below:

1. The Originator of this MOC confirms that all action items have been completed & that equipment/documentation in this change is set to start up.
2.

MOC closure requires the Originators Signature

MOC Originator: Date:_____

FHRPRU004001



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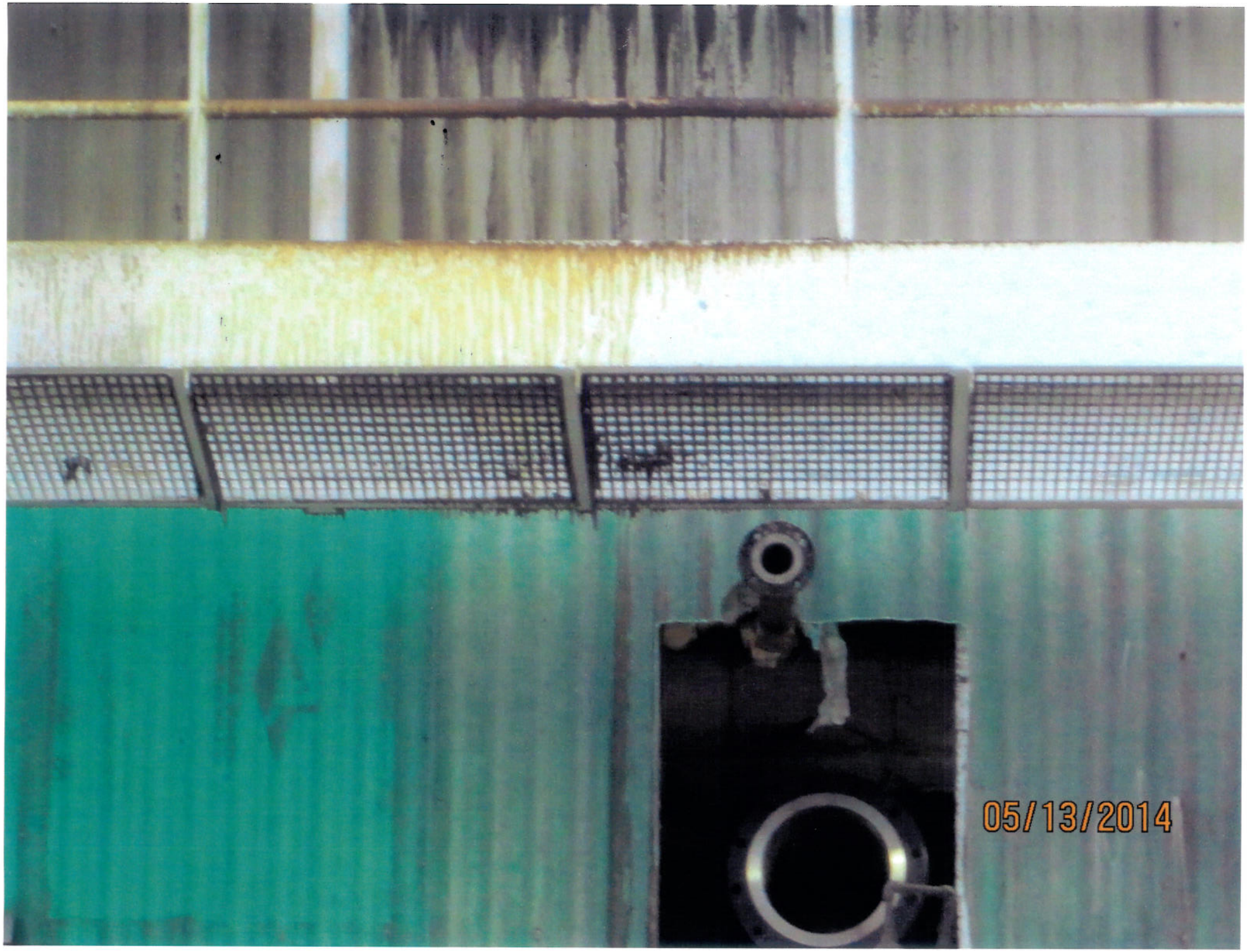
05/13/2014



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05/13/2014

FHRPRU004006

SERVICE: STYRENE, DEMINERALIZED WATER

RATING:	CORR. ALLOWANCE:	MATERIAL:	VALVE TRIM:
ASME B16.5 CLASS 150,RF	0.000 INCH	304L SS	316L SS

ITEM	NOTES	SIZE (NPS)	SCH/RAT	ENDS	DESCRIPTION	STOCK CODE
PIPE	AAA, N, 11, 69					
		1/2 – 1 1/2	40S	PLAIN	SS,EFW,ASTM A312-TP 304L	
		2 - 12	10S	BEVELED	SS,EFW,ASTM A312-TP 304L	
		14 - 24	10S	BEVELED	SS,EFW,ASTM A358-304L CL.2	
NIPPLES						
IN-LINE	14,100	1/2 – 1 1/2	80S		SS,EFW,ASTM A312-TP 304L	
BRANCH	14,100	1/2 – 1 1/2	80S		SS,EFW,ASTM A312-TP 304L	
SWAGE(CONC)	14,101	1/2 – 1 1/2	80S		SS,ASTM A403-WP304L-W,MSS SP-95	
SWAGE(ECC)	14,101	1/2 – 1 1/2	80S		SS,ASTM A403-WP304L-W,MSS SP-95	
FITTINGS	AAA,69,104					
UNION-X		UNIONS NOT ALLOWED (USE FLANGES)				
90 ELL		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
45 ELL		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
TEE		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
TEE(RED)		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
PLUG	D	1/2 – 1 1/2		THRD	SS,ASTM A182-F304L,ROUND HEAD,ASME B16.11	
COUPLING		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
COUPLING	D	1/2 – 1 1/2	300 LB	THRD	SS,ASTM A182-F304L,ASME B16.11	
COUPLING(RED)		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
CAP		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
CAP	D	1/2 – 1 1/2	300 LB	THRD	SS,ASTM A182-F304L,ASME B16.11	
SOCKOLET		1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
THREADOLET	74	1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
SW LATROLET		1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
SW ELBOWLET		1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
REDUCER(CONC)		1 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
REDUCER(ECC)		1 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
WELDOLET		2 - 6		WELD	SS,STM A182-F304L,LIGHT WEIGHT	
CAP		2 - 24		WELD	SS,ASTM A403-WP304L-S,ASME B16.9	
90 LR ELL		2 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
45 ELL		2 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
TEE		2 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
VALVES	AAA,10,46					
GATE		1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM	V1R36
GATE	46	1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM,F.P.	V1R32
GATE	50	1/2 - 2	800 LB	T/SW	316L SS EXTENDED BODY W/316 SS TRIM,MPE X FNPT	V1R38
GATE		1/2 – 2	800 LB	T/SW	316L SS BODY W/316 SS TRIM	V1R34
GATE	43	3/4 – 2	150 LB	RF	316 SS BODY W/316 SS TRIM	V1R33
GATE	43,86	3/4 – 2	300 LB	RF	316 SS BODY W/316 SS TRIM	V1R3
GATE	57	1	800 LB	T/SW	316L SS BODY W/316 SS TRIM,F.P.	V1R68
GATE	57	1 1/2 – 2	150 LB	RF	316 SS BODY W/316 SS TRIM,F.P.	V1R67
GATE		3 - 24	150 LB	RF	316 SS BODY W/316 SS TRIM,F.P.	V1R49
GLOBE		1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM	
GLOBE		3 - 12	150 LB	RF	316 SS BODY W/316 SS TRIM	V2R1
CHECK		1 1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM,PISTON H ONLY	V3R42
CHECK		1 1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM,PISTON V ONLY	V3R44
CHECK		1/2 - 12	150 LB	RF	316 SS BODY W/316 SS TRIM,F.P.,SWING,H OR V	V3R3
WAFER CHECK	77	14 - 24	150 LB	RF	316 SS BODY W/316 SS DISC/ST,DUAL PLT,H OR V	V3R25
FLG'D BUTTERFLY		3 - 24	150 LB	RF	316 SS BODY W/316 SS DISC,316 SS LAMINAT SEAL,P.O.	V5R27
BALL		1/2 – 2	300 LB	RF	316 SS BODY W/316 SS TRIM,F.S.,F.P.	V5R39
BALL		3 - 24	150 LB	RF	316 SS BODY W/316 SS TRIM,I.F.S.,F.P.	V5R31
PLUG	47	1/2 – 1	300 LB	SOCW	316L SS BODY W/TS&D,316 SS PLUG,F.S.	V4R6
PLUG	47	1 1/2 – 3	150 LB	RF	316 SS BODY W/TS&D,316 SS PLUG,F.S.	
PLUG	47	4 - 12	150 LB	RF	316 SS BODY W/TS&D,316 SS PLUG,F.S.,G.O.	

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FLANGES AAA,104,116

SOCKET WELD	1/2 – 1 1/2	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SOCKET WELD 84	1/2 – 1 1/2	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SOCKET WELD 86	1/2 – 1 1/2	300 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
BLIND	1/2 – 24	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
BLIND	1/2 – 24	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
BLIND 86	1/2 – 24	300 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
WELD NECK82	1 1/2 - 24	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
WELD NECK82,84	1 1/2 - 24	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
WELD NECK86	2 - 24	300 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SLIP-ON	2 - 24	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SLIP-ON 84	2 - 24	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
STUB END-LAP JOINT	1/2 - 24		LJ	SS,ASTM A403-WP304L-W,ASME B16.9,TYPE A,SHORT,SF
PAIR WN ORIFICE 87	2 - 24	300 LB	RF	SS,ASTM A182-F304L,ASME B16.36,1/2" SW TAPS,STD FIN

GASKETS

FULL FACE 90	1/2 – 24	FF1	1/16" FLEX GRAPH W/316 SS TANGED INSERT,ASME B16.21
		FR1	1/16" FLAT RING,ARAMID FIBER W/NBR BINDER (GARLOCK STYLE 3000)
SPIRAL WOUND 88	1/2 – 24	RF	316L SS WINDING W/FLEX GRAPH FILL,ASME B16.20
		RF	304 OR 316L SS WINDING W/GRAFOIL® GRADE GT™ B OR GT™ K FILLER,CS OR SS CENTERING RING,304 OR 316 SS SOLID
INNER			RING,FLEXITALLIC STYLE CGI,LAMONS STYLE WRI,FURON STYLE RWI OR APPROVED EQUAL,ASME B16.20
		(GRAFOIL IS A REGISTERED TRADEMARK OF UNION CARBIDE	
CORPORATION)			

BOLTING B

STUD BOLTS	1/2 – 24	ASME A320 GR B8 CL 2 STUD WITH ASTM A194 GR 8 NUTS ASME A193 BR B7 STUD WITH ASTM A194 GR 2H NUTS

MISCELLANEOUS

Y-STRAINER 96	1/2 – 1 1/2	600 LB	SOCW	304L SS BODY W/304 SS SCREEN (100 MESH,0.0045" WIRE)
Y-STRAINER 97	1/2 – 1 1/2	600 LB	SOCW	304L SS BODY W/304 SS SCREEN (20 MESH,0.016" WIRE)
FIGURE 8 62,86	1/2 – 12	300 LB	RF	304 SS,PER API 590,STD.FIN
FIGURE 8 62	1/2 – 18	150 LB	RF	304 SS,PER API 590,STD.FIN
STRAINER(PUMP)	1 1/2 – 24	150 LB	RF	304 SS,3/16" DIA PERF & 1/4" ON CNETERS(150% BASK)

PRESSURE – TEMPERATURE LIMITATIONS: ASME B16.5 – GROUP 2.3

TEMPERATURE	PRESSURE
-20F (-29C)	
TO 100F (38C)	230 PSIG
200F (93C)	195 PSIG

HYDROSTATIC TEST:
300 PSIG MAX.

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SPECIFIC PIPING NOTES

AAA. SPECIAL REQUIREMENTS FOR PIPING CLASSES WITH **SUFFIX "S"**
- (1) ONLY VALVE TAG NOS. WITH SUFFIX "S"(CERTIFIED SILICON FREE)SHALL BE USED.
- (2) PIPING IN THE PO PURIFICATION AND STORAGE AREAS SHALL BE THOROUGHLY CLEANED TO REMOVE ANY TRACE OF SILICONE AFTER FABRICATION,ASSEMBLY & BEFORE STARTUP. PIPING INCLUDES BLIND FLANGES,STRAINERS,BOLTING,ETC.
- (3) CLEANING METHOD AND PROCEDURE SHALL BE SUBMITTED FOR REVIEW AND APPROVAL.
- (4) ALL GASKETS SHALL BE CERTIFIED SILICONE FREE.

10. VALVES TO BE ORDERED WITH CHEM-GEMS J-1M AND COMPLETE VALVE SPECIFICATION SHEET FROM CHEM GEMS J-2M.
11. MINIMUM LINE SIZE SHALL BE 3/4". SIZE SMALLER THAN 3/4" IS ONLY FOR INSTRUMENTS CONNECTIONS AND OTHER SPECIAL APPLICATIONS.
14. THREADED JOINTS ARE ONLY PERMITTED AT TERMINAL POINTS.
43. TO BE USED AGAINST FLANGED EQUIPMENT (I.E. STORAGE TANKS,VESSELS,LEVEL GAGES,ETC.).
46. USE FULL PRT VALVES AT INLET AND DISCHARGE OF PSV'S AND IN PUMP SUCTIONS WHERE PRESSURE DROP IS CRITICAL.
47. THIS VALVE IS RESTRICTED TO A MAX SERVICE TEMPERATURE OF 300F (149C). 150 FB,FBS,FF NO.28. & DEMINERALIZED WATER.
50. USE EXTENDED BODY VALVE AT VENT,DRAIN,AND INSTRUMENT CONNECTIONS. WHEN THICKNESS OF HEADER INSULATION WILL COVER THE VALVE BODY,USE STANDARD NON-EXTENDED BODY VALVE WITH PROPER LENGTH OF PIPE NIPPLE.
57. USE FULL PORT VALVES AT SAMPLE PROBE CONNECTIONS. REFER TO DRAWING NOS. A14-18-129/130 FOR DETAILS.
62. USE OF FIGURE 8 BLINDS SHALL BE LIMITED TO THE SIZES LISTED DUE TO LIMITATION ON WEIGHT OF 150 POUNDS MAXIMUM:
    CLASS 150:18 INCH;CLASS 300:12 INCH;CLASS 600:10 INCH;CLASS 900:8 INCH;CLASS 1500:6INCH. FIGURE 8 GLINDS, SPACERS,AND BLANKS LARGER THAN 24" OR WHEN NOT COVERED BY THE SIZE RANGE IN THE SPECS SHALL BE DESIGNED BY PIPING MECHANICAL.
69. DO NOT BEND OR THREAD SCHEDULE 10S PIPE. WHERE THREADING OR BENDING IS REQUIRED,USE SCHEDULE 40S MINIMUM.
74. THREADED OUTLET REINFORCED BRANCH WELD FITTINGS TO BE USED ONLY FOR HYDROSTATIC TEST CONNECTIONS.
77. THESE VALVES HAVE NO FLANGES BUT ARE INSTALLED BETWEEN LINE FLANGES WITH EXTRA LENGTH BOLTS.
82. WELD NECK FLANGES SHALL BE USED AGAINST BUTT WELD FITTINGS.
84. PROVIDE FLAT FACE FLANGES ADJACENT TO FLAT FACE CAST IRON VALVES,FLANGES,AND EQUIPMENT NOZZLES.
86. TO BE USED ONLY TO MATCH CLASS 300 RATED FLANGE CONNECTIONS AT CONTROL VALVES AND SPECIAL EQUIPMENT.
87. INSTALL ORIFICE FLANGES PER DRAWING D-J-111.
88. ALLOW 1/8" BETWEEN FLANGES FOR GASKETS.
90. USE FULL FACE GASKETS AT FLAT FACED FLANGES.
96. TO BE USED FOR AIR,GAS,OR STEAM SERVICE.
97. TO BE USED FOR LIQUID SERVICE.
100. NIPPLES (IN-LINE OR BRANCH),SHALL BE PROVIDED WITH BOTH ENDS BEVELED. WHERE REQUIRED,NIPPLES MAY BE PROVIDED WITH ONE END THREADED.
101. SWAGE NIPPLES SHALL BE PROVIDED WITH BOTH ENDS BEVELED. WHERE REQUIRED SWAGE NIPPLES MAY BE PROVIDED WITH LARGE END BEVELED X SMALL END THREADED,OR WITH LARGE END THREADED X SMALL END BEVELED.
104. BUTTWELDING FITTINGS/FLANGES THICKNESS SHALL MATCH PIPE THICKNESS.
116. SEE CHEMGEMS K-9D FOR SELECTION,CONSTRUCTION,AND INSTALLATION OF TEMPERATURE INSTRUMENTS.
B. CADMIUM PLATED FOR ASME 150 & 300 SERVICES.
N. TUBING IS ALLOWED,USE PLS MISC.C1FA.

FHRPRU004009

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BRANCH CONNECTION
      LEGEND, NOTES & CHART                      24   T
LEGEND                                           20   C T
 C - TO BE CALCULATED (SEE J-2D)          B      16   C C T
 E - REDUCING TEE                         R      16   C C C T
 S - SOCKOLET                             A      14   C C C C T
 T - TEE                                  N      12   C C C C C T
 W - WELDOLET                             C      10   C C C C C C T
 X - NOT PERMITTED          11            H       8   C C C C C C C T
                                            6   W W W W W W W W T
                                          S       4   W W W W W W W W W T
                                          I       3   W W W W W W W W W W T
                                          Z       2   W W W W W W W W W W W T
                                          E     1.5   S S S S S S S S S S S T
                                                  1   S S S S S S S S S S S E T
                                               0.75   S S S S S S S S S S S E E T
                                                0.5   S S S S S S S S S S S E E E X

                                                      2 2 1 1 1 1 1 8 6 4 3 2 1 1 0 0
                                                      4 0 8 6 4 2 0           . . .
                                                                              5 7 5
                                                                                5
                                                        H E A D E R   S I Z E
```

Revision Log		
Distribution Date	Deviation #	Brief Description of Change
1/28/14	089	Allow use of 150# ball valve ½"-2"
4/20/10	068	Allow 150# flanges around reactors for ½"-2" valves.
2/5/09	065	Allow Sch40 CS Pipe, Sch40 Weld Fittings and 150# RF CS Flanges.
8/11/08	063	Allow use of 150# RF Ball Valve
7/11/07	058	150# ball valves ½"-8"
2/1/06	-	Change 150# RF flanged check valve size to ½"-12" from 3"-12"
4/25/05	053	Allow use of 1" flanged check valve on BA line
7/2/04	050	Styrene/Pentane Filter Rupture Disc
1/13/04	-	Correct typographical error
08/18/03	048	Direct Pentane Project Deviation
02/19/03	-	Correct note on plug valves from #48 to #47
02/19/03	046	SA/CAT tank slurry piping improvement at Building 4
1/26/01	041	Use of Threaded Fittings and Ball Valves on Reactor Vent Condensor Project
4/6/01	036	No X-Rays for Di Filters Project
4/6/01	035	Threaded Fittings and Valves on Drain Line for DI Filters Project
2/26/01	-	Remove Valve Specification
1/12/01	-	Add Styrene to Service, Change 3000 lb Fittings to 300 lb, Add SS Material to Spiral Wound Centering Ring, Change Hydrostatic Test Pressure to 300 psig Max.
12/28/00	-	Peru On-Line System
9/6/00	019	Allow Swing Check Valve in Horizontal Plane for SGS Circuit Modification Project
1/14/99	006	Add Bolting Specification

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FHRPRU004011

FLINT HILLS resources

MANAGEMENT OF CHANGE FORM

(REFER TO PROCEDURE EHS-I-006 FOR EXPLANATION OF THIS FORM)

PROCESS UNIT/AREA: B4 MOC#: 156706

ORIGINATOR: Chad Holman DATE: 05/12/2014

SECTION A - TECHNICAL BASIS FOR PROPOSED CHANGE

Purpose and Technical Basis:	Improve DCS programming to remove logic that could lead to a reactor release, improve visibility of information to operators, and make the program more robust.
Description: *Attach additional paper if necessary*	1. Revise DCS code so that reactor M1 valve will not open if reactor is not lined up to flare. 2. Modify graphics on reactor pages to show valve position of Rx jacket steam and back pressure valves. 3. Remove backpressure valve low limit setpoint criteria during M1 addition 4. Simplify programming for water and styrene charging to make it more robust and better able to handlenon-standard operations.
Impact of change On Environmental Health / Safety:	Reduce risk of environmental or safety event

SECTION B - DOCUMENTATION - *Attach appropriate documentation illustrating proposed changes*

☐	Procedures	☐	Inspections, Testing, PM's	☐	Engineering DWGS	☐	PHA'S
☐	PSM Documentation	☐	CHEMGEMS Specifications	☐	P&ID's	☐	MI Applicability Checklist
☐	MSDS Information	☐	Energy Control Plans	☐	PFD's		
☐	Training/Communication	☐	Floor Plans	☐	LDAR		
☐	Quality Issues	☐	Mechanical Integrity DWGS	☐	Site/Plot Plan	☐	OJT's
☐	Customer Impact	☐	Electrical Schematics	☐	Electrical Single Lines	☐	JSA's
☐	Alarm Response Tables	☐	Loop DWGS	☐	Elect'l Classification	☒	Other DCS Screen shots

Affected Personnel Needing To Be Informed/Trained On Proposed Change

☒	Operations	☐	I/E Technicians	☐	Community
☒	Production Facilitators	☐	Engineering	☐	Regulatory Entities
☐	Mechanics/Welders	☐	Contractor(s)	☐	Corporate
☐	Electricians	☐	Office Personnel	☐	Other

SECTION C - Is Change Permanent?

☒	**YES**	**Proposed Project Start Date** **05/13/2014**
☐	**NO**	**Proposed Project Completion Date** **06/30/2014**

SECTION D - Is Change Temporary ?

☐	**YES**	**From:**
☒	**NO**	**To:**

SECTION E - Is Change Emergency ?

☐	**Yes**	**Start:**
☒	**NO**	

Approval Received From:

☐ Ops. Mgr./Designee ☐ Env. Eng./Designee

☐ Plant Mgr./Designee (if requested) ☐ Technical Services Mgr./Designee

☐ H&S Mgr./Specialist ☐ Area Mgr./Designee

Approval Received By:

_____

Signature *Date*

Returned To Original Service: _____/_____/_____

Area Mgr./Designee

Signature: _____

Extended To: _____/_____/_____*

Plant Managers Approval:

Plant Mgr./

Signature *Date*

*Note: Temporary MOCAs may be extended up to 6 months at a time

SECTION F - DESIGN SAFETY REVIEW

PHA. Does the proposed change require a PHA? (i.e. What-if/Checklist, Hazop, Revalidation, Review) If yes indicate type of PHA in Action to be Taken section.	☐YES	☒NO
PSSR. Does the proposed change require a Pre-Start-up Safety Review (PSSR)? See EHS-I-067 for Requirements. Mandatory if change involves DCS Interface.	☒YES	☐NO

1. RELIEF AND BLOWDOWN

Does the Proposed Change:	YES	NO
1. Introduce or alter any potential cause of over/under pressurizing of the system?	☐	☒
2. In any way affect existing equipment installed to prevent over/under pressurization?	☐	☒
3. Introduce or alter any potential cause of raising/lowering the system temperature?	☒	☐
4. Introduce a risk of creating/reducing vacuum in the system?	☐	☒
5. Have any critical relief devices been identified for verification of proper rating and installation?	☐	☒

2. AREA CLASSIFICATION

Does the Proposed Change:	YES	NO
1. Introduce or alter the storage of flammable materials?	☐	☒
2. Introduce or alter the location of potential leaks of flammable materials?	☐	☒
3. Introduce new or alter existing electrical equipment?	☐	☒
4. Affect area ventilation?	☐	☒
5. Has the established building electrical classification been changed?	☐	☒

3. SAFETY CONSIDERATIONS

Does the Proposed Change:	YES	NO
1. Require any additional safety equipment or layers of protection?	☐	☒
2. Alter or affect existing safety equipment or means of egress?	☐	☒
3. Require changes to the function or independence of existing equipment or layers of protection?	☐	☒
4. Alter or affect critical safety instrumented functions (SIF's)?	☐	☒
5. Alter the noise level in the surrounding area?	☐	☒
6. Increase the potential for exposure to any chemicals?	☐	☒
7. Introduce a new or previously unused chemical/raw material?	☐	☒
8. Affect de-energization? (able to lock-out, drain materials)	☐	☒
9. Create any ergonomic concerns?	☐	☒
10. Affect the Battery Limit Valves (BLV)?	☐	☒
11. Affect the overall security of the facility?	☐	☒
12. Does this increase the risk of potential impact to plant personnel (employees and contractors)?	☐	☒
13. Does the proposed change affect facility siting relative to both people and equipment in any of the following situations: temporary changes, before startup after a permanent change, or before startup after temporary change has been removed/closed/returned to original condition?	☐	☒
14. If the proposed change affects replacement or demolition of piping or conduit, will the entire run be identified and clearly marked prior to work, to ensure safe work activity?	☐	☒
15. Affect the safe transport of hazardous material? For ex., introducing a new hazardous material for transport or changing the method of transportation of the hazardous material.	☐	☒

4. ENVIRONMENTAL CONSIDERATIONS**

	YES	NO
1. Will there be a potential increase in the maximum production rate, which exceeds the currently permitted design capacity of the facility?	☐	☒
2. Will the replacement or modification change any of the basic parameters of the process unit, such as temperature, pressure, etc?	☐	☒
3. Will the change cause increased emissions of regulated pollutants during installation, implementation, or during operations?	☐	☒
4. Will there be any new vents added?	☐	☒
5. Will the change add, remove or modify any permitted emission units (*Example: reactors, wash tanks, dryers, centrifuges, packout bins, screening towers, or styrene or pentane storage.*)?	☐	☒
6. Will the project include the installation of a stationary engine with a ≤ 500 hp? If so, a non-resettable hour meter shall be installed to record operational hours and PMs shall be consistent with RICE NESHAP regulations and the manufacturer's recommended preventative maintenance.	☐	☒
7. Will the project results in the increase in Facility's total throughput of natural gas?	☐	☒
8. Is there the potential to generate a new waste or increase the quantity of an existing waste?	☐	☒

SECTION F - DESIGN SAFETY REVIEW -- cont.

4. ENVIRONMENTAL CONSIDERATIONS** - - cont.

9. Will there be a change in the wastewater characteristics? If the project causes an increase to the discharge of wastewater to the Public Sanitary District, provide calculations with the MOC.	☐	☒
10. Does the project add or remove LDAR Components (Pumps, PRVs, Valves, and Connectors) that come in contact with styrene or pentane?	☐	☒
11. Does the project increase risk to off-site residential & environmental receptors?	☐	☒
12. Will the change affect the control of processes?	☒	☐
13. Will the change affect the composition or physical properties of the final product?	☐	☒
14. Will new chemicals be brought onsite anytime during the project?	☐	☒
15. Does an evaluation of chemical compatibility need to be conducted during the project?	☐	☒
16. Will the project involve decommissioning or demolition of equipment or structure?	☐	☒
17. If yes to 16, does National Emissions Standards for Hazardous Air Pollutants (NESHAP) or deconstruction permit apply?	☐	☒
18. Will this project require a portable engine?	☐	☒

** Consult with Environmental Engineer for completion of this section.

5. OPERATION AND DESIGN

Does the Proposed Change:	YES	NO
1. Affect the process or equipment upstream/downstream of the change?	☐	☒
2. Affect access to process or equipment/controls for personnel?	☐	☒
3. Introduce any new or affect existing interlocks or alarms systems?	☐	☒
4. Affect manpower or qualified personnel?	☐	☒
5. Affect the loads/strengths of existing foundations, structures, vessels, or pipe racks?	☐	☒
6. Impact requirements of existing or proposed piping supports? *(Needs to be adequately designed for expected stresses due to pressure and thermal loadings.)*	☐	☒
7. Alter the DCS/Software logic of process operations?	☒	☐
8. Affect process chemistry? (reactivity/compatibility)	☐	☒
9. Affect maximum intended inventory, which would require updating maximum inventory tables?	☐	☒
10. Affect safe upper/lower limits for such items as temperature, process flows or compositions?	☐	☒
11. Affect material/energy balances?	☐	☒
12. Affect plant utility resources? (i.e. steam, water, electricity, etc.)	☐	☒
13. Affect equipment with heat-up/cool-down cycling requiring bolt retightening after start-up?	☐	☒
14. Is an exception/revision to design codes or standards (CHEM-GEMS, etc.) required?	☐	☒

SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION

Will the Proposed Change:	YES	NO
1. Introduce new or impact existing operational procedures? *	☐	☒
2. Introduce new or impact existing maintenance procedures? *	☐	☒
3. Add or Remove equipment/instrumentation? *(Contact MST to assign Equipment/Instrumentation Location Numbers. If equipment/instrumentation is being added, MI Applicability Checklist MNT-F-161 shall be completed by MOC originator, and approval form(s) sent to the MI coordinator.)*	☐	☒
4. Revise equipment preventative maintenance/ inspections, job plans , and/or frequencies?	☐	☒
5. Require additional training for operational or maintenance personnel? *(requires completion of Leaning and Development Job Aid addendum A)*	☐	☒
6. Require additional notification for operational or maintenance personnel?	☒	☐
7. Require updating controlled drawings? * *(PFD'S, LDAR, P&ID's, Floor Plans, Electrical Single Lines, Loop Drawings/Electrical Schematics, MCC arrangement, MI Iso Drawings)*	☐	☒
8. Require updating equipment files? *(Engineering, Maintenance, Manufacturers Inspect/Test results)*	☐	☒
9. Require a spare parts list and inventory to be developed?	☐	☒
10. Require major project spare equipment to be turned over to maintenance?	☐	☒
11. Require equipment labeling in the field?	☐	☒
12. Require updating of Alarm Response Tables? *	☐	☒
13. Require a new/modification of existing energy control plans? *	☐	☒

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SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION –cont'd		
14. Cause any PSM/RMP applicability issues?	☐	☒
15. Cause a change in PSM/RMP program level?	☐	☒
16. Will this change have any effect on the overall plant facility siting issues?	☐	☒
17. Increase or decrease the impact contour for worst-case scenario by a factor of two or more?	☐	☒
18. Will this MOC supersede /interfere with any other Temporary/Emergency/Permanent MOC's?	☐	☒
19. Is there a need to update the EPS-I-004, Chemical Compatibility Matrix?	☐	☒
20. Is a Layer of Protection Analysis (LOPA) study required?	☐	☒
21. Will this affect the Interlock Matrix?	☐	☒
22. Require updating of electrical energy consumption spreadsheet? Update required for any MCC, CB panel or bus bar connection additions or alterations.	☐	☒
23. Will this change impact Proprietary Technology including product, process, equipment, technical data, or other trade secret information licensed to FHR by third parties" If yes, contact the Proprietary Technology Coordinator.	☐	☒

*** NOTE: Refer to Engineering Equipment Location Database for a list of affected documents, sorted by Location Number.**

Any questions with a 'YES' answer, requires follow-up activity. List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'			
Item No.	**Action To Be Completed Prior to PSSR**	**Responsible Party**	**Target Completion Date**
F1.3, F5.7c	Remvoe backpressure valve low limit setpoint criteria during M1 addition	Keith M	06/15/2014
F4.12, F5.7a	Revise DCS logic so that reactor M1 valve does not open unless vent valve lined up to flare	Keith M	06/15/2014
F5.7b	Modify graphics on reactor pages to show valve position of Rx jacket stream and backpressure valve	Keith M	06/15/2014
F5.7d	Simplify programming for water and styrene charging to make it more robust and better able to handle non-standard operations	Keith M	06/15/2014
G6a	Notify operations and facilitors of DCS changes	Mike Shea	06/15/2014
X1	Have someone else (ABB rep) cold-eye/review code changes prior to going "live".	Keith M	06/15/2014
PSSR	PSSR	Chad H	06/15/2014

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Any questions with a 'YES' answer, requires follow-up activity. List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'			
Item No.	**Action To Be Completed <u>After PSSR</u>**	**Responsible Party**	**Target Completion Date**
G6b	Notify any operators/facilitators of DCS changes (as soon as they return next on-shift) that were not notified prior to PSSR	Mike Shea	08/15/2014

FHRPRU004017

MOC APPROVAL FORM

Originator: Chad Holman **MOC No.** 156706

MOC Packet Completeness Verification Review

Title/Position	Verification Review Signatures	Date
Drafting Tech, or Designee		5-13-14
MI Coordinator, or Designee		5-13-14
Maintenance Tech from appropriate area		5-12-14
Operator from affected area		5.13.14
Area Training Contact, or Designee		5/13/14

Signatures required Prior To Implementation of MOC.

Title/Position	Authorizing Signatures	Date
Area Manager/Facilitator or Designee		05/13/14
Technical Services Manager or Designee		5/13/14
Pilot Plant / QC Manager (If Applicable)	N/A	
H&S Specialist or Designee		5-13-14
Operations Manager or Designee	STEVE GIMMETT DELEGATION	05/13/14
Environment Engineer or Designee		5/13/2014

Other Reviewers
(as requested by any of the Authorizing signers)

Title/Position	Review Signature	Date
Plant Manager or Designee		
Electrical Engineer		

VERIFICATION OF MOC CLOSURE

By signing below:

1. The Originator of this MOC confirms that all action items have been completed & that equipment/documentation in this change is set to start up.
2.

MOC closure requires the Originators Signature

MOC Originator: Date:_____

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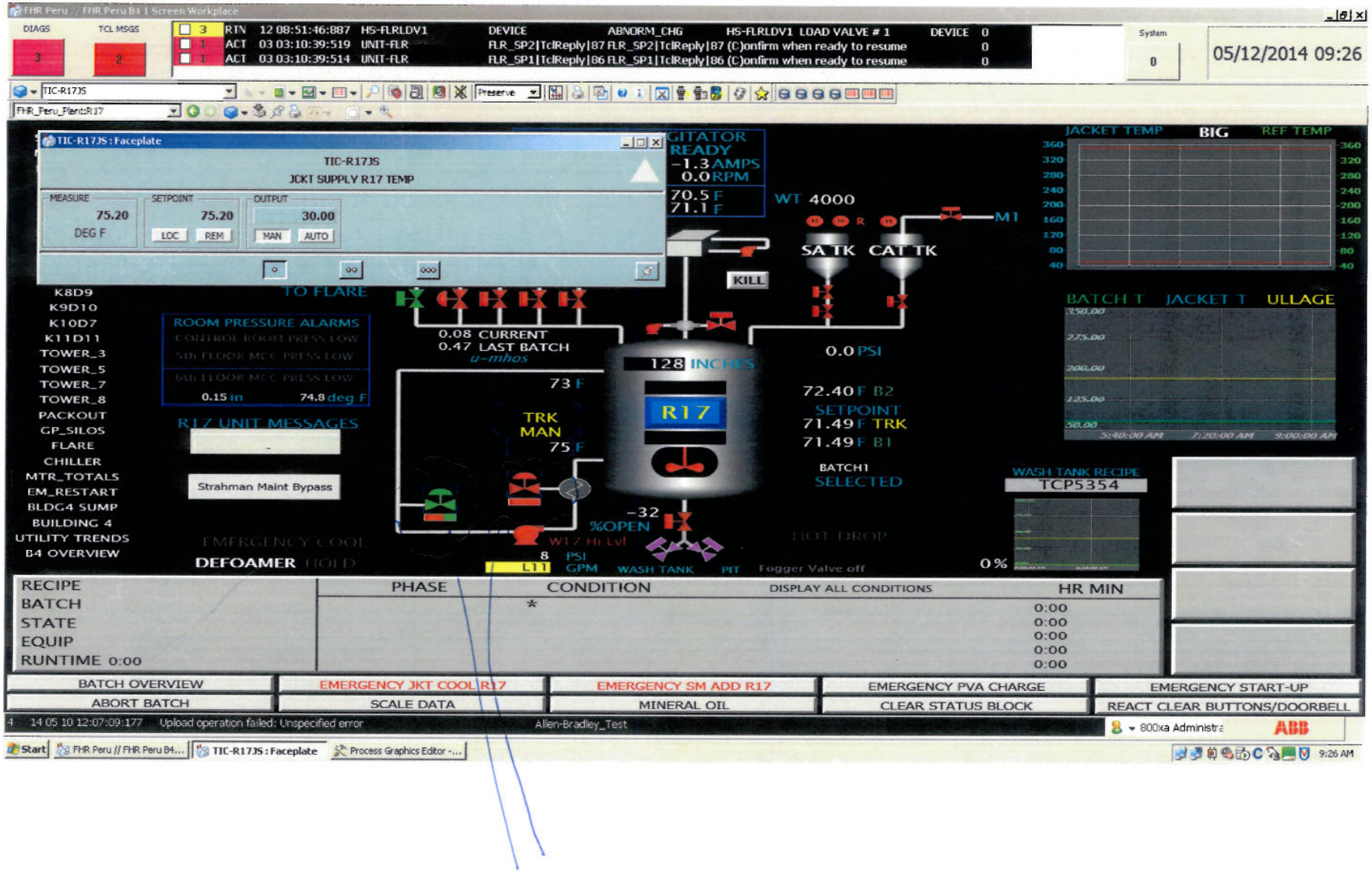
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05/12/2014 09:26
TIC-R17JS
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TIC-R17JS : Faceplate
TIC-R17JS
JCKT SUPPLY R17 TEMP
MEASURE
75.20
DEG F
SETPOINT
75.20
LOC
REM
OUTPUT
30.00
MAN
AUTO
GITATOR
READY
-1.3 AMPS
0.0 RPM
70.5 F
71.1 F
WT 4000
M1
SA TK
CAT TK
KILL
JACKET TEMP
BIG
REF TEMP
BATCH T
JACKET T
ULLAGE
K8D9
K9D10
K10D7
K11D11
TOWER_3
TOWER_5
TOWER_7
TOWER_8
PACKOUT
GP_SILOS
FLARE
CHILLER
MTR_TOTALS
EM_RESTART
BLDG4 SUMP
BUILDING 4
UTILITY TRENDS
B4 OVERVIEW
TO FLARE
ROOM PRESSURE ALARMS
CONTROL ROOM PRESS LOW
5th FLOOR MCC PRESS LOW
6th FLOOR MCC PRESS LOW
0.15 in
74.8 deg F
R17 UNIT MESSAGES
Strahman Maint Bypass
0.08 CURRENT
0.47 LAST BATCH
u-mhos
73 F
TRK
MAN
75 F
128 INCHES
R17
-32
%OPEN
W17 Hi Lvl
8 PSI
L11 GPM
WASH TANK
PIT
Fogger Valve off
0.0 PSI
72.40 F B2
SETPOINT
71.49 F TRK
71.49 F B1
BATCH1
SELECTED
WASH TANK RECIPE
TCP5354
0 %
EMERGENCY COOL
DEFOAMER HOLD
HOT DROP
RECIPE
BATCH
STATE
EQUIP
RUNTIME 0:00
PHASE
CONDITION
DISPLAY ALL CONDITIONS
HR MIN
BATCH OVERVIEW
EMERGENCY JKT COOL R17
EMERGENCY SM ADD R17
EMERGENCY PVA CHARGE
EMERGENCY START-UP
ABORT BATCH
SCALE DATA
MINERAL OIL
CLEAR STATUS BLOCK
REACT CLEAR BUTTONS/DOORBELL
14 05 10 12:07:09:177 Upload operation failed: Unspecified error
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800xa Administra
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Start
FHR Peru // FHR Peru B4...
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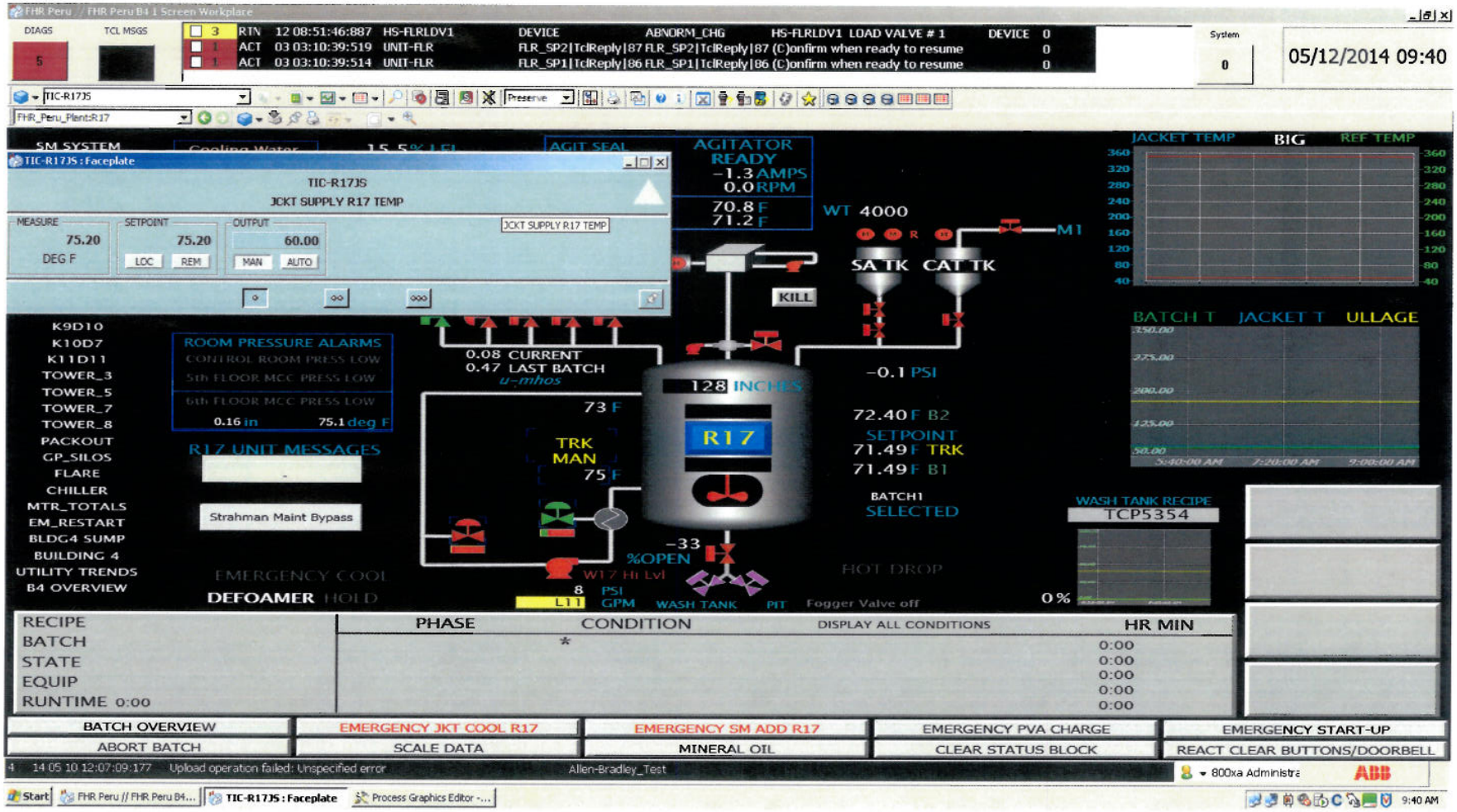
9:26 AM



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FLINT HILLS resources

MANAGEMENT OF CHANGE FORM

(REFER TO PROCEDURE EHS-I-006 FOR EXPLANATION OF THIS FORM)

PROCESS UNIT/AREA: EPS Production/Bldg 4 MOC#: 156735

ORIGINATOR: Greg Medley DATE: 05/15/2014

SECTION A - TECHNICAL BASIS FOR PROPOSED CHANGE

Purpose and Technical Basis:	We are currently implementing a foam system to be activated during a reactor dump to the containment pit and the current fog system will prevent the foam system from working correctly.
Description: *Attach additional paper if necessary*	Remove fog nozzles at the second flange from the nozzle tee just inside of building 4. Install 3 inch 150 pound end of pipe blind flange. Remove code from DCS programming that activates fogger system. This MOC supersedes the fogger extensions in MOC #156681. See revised P&ID for fogger blanks.
Impact of change On Environmental Health / Safety:	None.

SECTION B - DOCUMENTATION - *Attach appropriate documentation illustrating proposed changes*

☐	Procedures	☐	Inspections, Testing, PM's	☐	Engineering DWGS	☐	PHA'S
☐	PSM Documentation	☒	CHEMGEMS Specifications	☒	P&ID's	☐	MI Applicability Checklist
☐	MSDS Information	☐	Energy Control Plans	☐	PFD's		
☐	Training/Communication	☐	Floor Plans	☐	LDAR		
☐	Quality Issues	☐	Mechanical Integrity DWGS	☐	Site/Plot Plan	☐	OJT's
☐	Customer Impact	☐	Electrical Schematics	☐	Electrical Single Lines	☐	JSA's
☐	Alarm Response Tables	☐	Loop DWGS	☐	Elect'l Classification	☐	Other

Affected Personnel Needing To Be Informed/Trained On Proposed Change

☐	Operations	☐	I/E Technicians	☐	Community
☐	Production Facilitators	☐	Engineering	☐	Regulatory Entities
☐	Mechanics/Welders	☐	Contractor(s)	☐	Corporate
☐	Electricians	☐	Office Personnel	☐	Other

SECTION C - Is Change Permanent?

☒	YES	Proposed Project Start Date 05/15/2014
☐	NO	Proposed Project Completion Date 06/30/2014

SECTION D - Is Change Temporary ?

☐	YES	From:
☒	NO	To:

SECTION E - Is Change Emergency ?

☐	Yes	Start:
☒	NO	

Approval Received From:

☐ Ops. Mgr./Designee ☐ Env. Eng./Designee

☐ Plant Mgr./Designee (if requested) ☐ Technical Services Mgr./Designee

☐ H&S Mgr./Specialist ☐ Area Mgr./Designee

Approval Received By:

_____

Signature *Date*

Returned To Original Service: _____/_____/_____

Area Mgr./Designee Signature: _____

Extended To: _____/_____/_____*

Plant Managers Approval:

Plant Mgr./

Signature *Date*

*Note: Temporary MOCAs may be extended up to 6 months at a time

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SECTION F - DESIGN SAFETY REVIEW

PHA. Does the proposed change require a PHA? (i.e. What-if/Checklist, Hazop, Revalidation, Review) If yes indicate type of PHA in Action to be Taken section.	☐YES	☒NO
PSSR. Does the proposed change require a Pre-Start-up Safety Review (PSSR)? See EHS-I-067 for Requirements. Mandatory if change involves DCS Interface.	☒YES	☐NO

1. RELIEF AND BLOWDOWN

Does the Proposed Change:	YES	NO
1. Introduce or alter any potential cause of over/under pressurizing of the system?	☐	☒
2. In any way affect existing equipment installed to prevent over/under pressurization?	☐	☒
3. Introduce or alter any potential cause of raising/lowering the system temperature?	☐	☒
4. Introduce a risk of creating/reducing vacuum in the system?	☐	☒
5. Have any critical relief devices been identified for verification of proper rating and installation?	☐	☒

2. AREA CLASSIFICATION

Does the Proposed Change:	YES	NO
1. Introduce or alter the storage of flammable materials?	☐	☒
2. Introduce or alter the location of potential leaks of flammable materials?	☐	☒
3. Introduce new or alter existing electrical equipment?	☐	☒
4. Affect area ventilation?	☐	☒
5. Has the established building electrical classification been changed?	☐	☒

3. SAFETY CONSIDERATIONS

Does the Proposed Change:	YES	NO
1. Require any additional safety equipment or layers of protection?	☐	☒
2. Alter or affect existing safety equipment or means of egress?	☐	☒
3. Require changes to the function or independence of existing equipment or layers of protection?	☐	☒
4. Alter or affect critical safety instrumented functions (SIF's)?	☐	☒
5. Alter the noise level in the surrounding area?	☐	☒
6. Increase the potential for exposure to any chemicals?	☐	☒
7. Introduce a new or previously unused chemical/raw material?	☐	☒
8. Affect de-energization? (able to lock-out, drain materials)	☐	☒
9. Create any ergonomic concerns?	☐	☒
10. Affect the Battery Limit Valves (BLV)?	☐	☒
11. Affect the overall security of the facility?	☐	☒
12. Does this increase the risk of potential impact to plant personnel (employees and contractors)?	☐	☒
13. Does the proposed change affect facility siting relative to both people and equipment in any of the following situations: temporary changes, before startup after a permanent change, or before startup after temporary change has been removed/closed/returned to original condition?	☐	☒
14. If the proposed change affects replacement or demolition of piping or conduit, will the entire run be identified and clearly marked prior to work, to ensure safe work activity?	☐	☒
15. Affect the safe transport of hazardous material? For ex., introducing a new hazardous material for transport or changing the method of transportation of the hazardous material.	☐	☒

4. ENVIRONMENTAL CONSIDERATIONS**

	YES	NO
1. Will there be a potential increase in the maximum production rate, which exceeds the currently permitted design capacity of the facility?	☐	☒
2. Will the replacement or modification change any of the basic parameters of the process unit, such as temperature, pressure, etc?	☐	☒
3. Will the change cause increased emissions of regulated pollutants during installation, implementation, or during operations?	☐	☒
4. Will there be any new vents added?	☐	☒
5. Will the change add, remove or modify any permitted emission units (*Example: reactors, wash tanks, dryers, centrifuges, packout bins, screening towers, or styrene or pentane storage.)*?	☐	☒
6. Will the project include the installation of a stationary engine with a ≤ 500 hp? If so, a non-resettable hour meter shall be installed to record operational hours and PMs shall be consistent with RICE NESHAP regulations and the manufacturer's recommended preventative maintenance.	☐	☒
7. Will the project results in the increase in Facility's total throughput of natural gas?	☐	☒
8. Is there the potential to generate a new waste or increase the quantity of an existing waste?	☐	☒

SECTION F - DESIGN SAFETY REVIEW -- cont.

4. ENVIRONMENTAL CONSIDERATIONS** - - cont.

9. Will there be a change in the wastewater characteristics? If the project causes an increase to the discharge of wastewater to the Public Sanitary District, provide calculations with the MOC.	☐	☒
10. Does the project add or remove LDAR Components (Pumps, PRVs, Valves, and Connectors) that come in contact with styrene or pentane?	☐	☒
11. Does the project increase risk to off-site residential & environmental receptors?	☐	☒
12. Will the change affect the control of processes?	☐	☒
13. Will the change affect the composition or physical properties of the final product?	☐	☒
14. Will new chemicals be brought onsite anytime during the project?	☐	☒
15. Does an evaluation of chemical compatibility need to be conducted during the project?	☐	☒
16. Will the project involve decommissioning or demolition of equipment or structure?	☐	☒
17. If yes to 16, does National Emissions Standards for Hazardous Air Pollutants (NESHAP) or deconstruction permit apply?	☐	☒ CH 5/8/14
18. Will this project require a portable engine?	☐	☒

** Consult with Environmental Engineer for completion of this section.

5. OPERATION AND DESIGN

Does the Proposed Change:	YES	NO
1. Affect the process or equipment upstream/downstream of the change?	☐	☒
2. Affect access to process or equipment/controls for personnel?	☐	☒
3. Introduce any new or affect existing interlocks or alarms systems?	☐	☒
4. Affect manpower or qualified personnel?	☐	☒
5. Affect the loads/strengths of existing foundations, structures, vessels, or pipe racks?	☐	☒
6. Impact requirements of existing or proposed piping supports? *(Needs to be adequately designed for expected stresses due to pressure and thermal loadings.)*	☐	☒
7. Alter the DCS/Software logic of process operations?	☒	☐
8. Affect process chemistry? (reactivity/compatibility)	☐	☒
9. Affect maximum intended inventory, which would require updating maximum inventory tables?	☐	☒
10. Affect safe upper/lower limits for such items as temperature, process flows or compositions?	☐	☒
11. Affect material/energy balances?	☐	☒
12. Affect plant utility resources? (i.e. steam, water, electricity, etc.)	☐	☒
13. Affect equipment with heat-up/cool-down cycling requiring bolt retightening after start-up?	☐	☒
14. Is an exception/revision to design codes or standards (CHEM-GEMS, etc.) required?	☐	☒

SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION

Will the Proposed Change:	YES	NO
1. Introduce new or impact existing operational procedures? *	☐	☒
2. Introduce new or impact existing maintenance procedures? *	☐	☒
3. Add or Remove equipment/instrumentation? *(Contact MST to assign Equipment/Instrumentation Location Numbers. If equipment/instrumentation is being added, MI Applicability Checklist MNT-F-161 shall be completed by MOC originator, and approval form(s) sent to the MI coordinator.)*	☒	☐
4. Revise equipment preventative maintenance/ inspections, job plans , and/or frequencies?	☐	☒
5. Require additional training for operational or maintenance personnel? *(requires completion of Leaning and Development Job Aid addendum A)*	☐	☒
6. Require additional notification for operational or maintenance personnel?	☒	☐
7. Require updating controlled drawings? * *(PFD'S, LDAR, P&ID's, Floor Plans, Electrical Single Lines, Loop Drawings/Electrical Schematics, MCC arrangement, MI Iso Drawings)*	☒	☐
8. Require updating equipment files? *(Engineering, Maintenance, Manufacturers Inspect/Test results)*	☐	☒
9. Require a spare parts list and inventory to be developed?	☐	☒
10. Require major project spare equipment to be turned over to maintenance?	☐	☒
11. Require equipment labeling in the field?	☐	☒
12. Require updating of Alarm Response Tables? *	☐	☒
13. Require a new/modification of existing energy control plans? *	☐	☒

SECTION G - AFFECTS ON PROCEDURES, TRAINING, AND DOCUMENTATION –cont'd

14. Cause any PSM/RMP applicability issues?	☐	☒
15. Cause a change in PSM/RMP program level?	☐	☒
16. Will this change have any effect on the overall plant facility siting issues?	☐	☒
17. Increase or decrease the impact contour for worst-case scenario by a factor of two or more?	☐	☒
18. Will this MOC supersede /interfere with any other Temporary/Emergency/Permanent MOC's?	☒	☐
19. Is there a need to update the EPS-I-004, Chemical Compatibility Matrix?	☐	☒
20. Is a Layer of Protection Analysis (LOPA) study required?	☐	☒
21. Will this affect the Interlock Matrix?	☐	☒
22. Require updating of electrical energy consumption spreadsheet? Update required for any MCC, CB panel or bus bar connection additions or alterations.	☐	☒
23. Will this change impact Proprietary Technology including product, process, equipment, technical data, or other trade secret information licensed to FHR by third parties" If yes, contact the Proprietary Technology Coordinator.	☐	☒

*** NOTE: Refer to Engineering Equipment Location Database for a list of affected documents, sorted by Location Number.**

Any questions with a 'YES' answer, requires follow-up activity. List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'			
Item No.	**Action To Be Completed Prior to PSSR**	**Responsible Party**	**Target Completion Date**
F-PSSR	Perform PSSR.	Medley	06/30/2014
F-5-7	Remove all fogger operations from DCS program.	Marshall	06/30/2014
G-3	Remove fogger nozzles.	Medley	06/30/2014
G-7a	Redline drawing.	Medley	06/30/2014
G-18	Cancel Lynx action items for G-7(Redline drawings) and G-7(Revise P&ID's) for MOC #156681.	Christmann	06/30/2014
G-6a	Notify operations of change	Steve Emmett	06-30-2014
G-6b	Notify maintenance of change	Mark Stoneking	06-30-2014

Any questions with a 'YES' answer, requires follow-up activity. List the action(s) to be taken to resolve any issues identified in 'Section F' and 'Section G'			
Item No.	**Action To Be Completed <u>After PSSR</u>**	**Responsible Party**	**Target Completion Date**
~~G-6~~	~~Notify operations of change.~~	~~Shea~~	~~06/30/2014~~
~~G-6~~	~~Notify maintenance of change.~~	~~Stoneking~~	~~06/30/2014~~
G-7b	Revise P&ID.	Grant	09/30/2014

MOC APPROVAL FORM

Originator: Greg Medley **MOC No.** 156735

MOC Packet Completeness Verification Review

Title/Position	Verification Review Signatures	Date
Drafting Tech, or Designee		5-15-14
MI Coordinator, or Designee		5-15-14
Maintenance Tech from appropriate area		5-15-14
Operator from affected area		5/15/14
Area Training Contact, or Designee		5/15/14

Signatures required Prior To Implementation of MOC.

Title/Position	Authorizing Signatures	Date
Area Manager/Facilitator or Designee		05/15/14
Technical Services Manager or Designee		5/15/14
Pilot Plant / QC Manager (If Applicable)	N/A	
H&S Specialist or Designee		5-15-14
Operations Manager or Designee		5-15-14
Environment Engineer or Designee		5/15/2014

Other Reviewers

(as requested by any of the Authorizing signers)

Title/Position	Review Signature	Date
Plant Manager or Designee		
Electrical Engineer		

VERIFICATION OF MOC CLOSURE

By signing below:

1. The Originator of this MOC confirms that all action items have been completed & that equipment/documentation in this change is set to start up.
2.

MOC closure requires the Originators Signature

MOC Originator: Date:_____

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SERVICE: STYRENE, DEMINERALIZED WATER

RATING:	CORR. ALLOWANCE:	MATERIAL:	VALVE TRIM:
ASME B16.5 CLASS 150,RF	0.000 INCH	304L SS	316L SS

ITEM	NOTES	SIZE (NPS)	SCH/RAT	ENDS	DESCRIPTION	STOCK CODE
PIPE	AAA, N, 11, 69					
		1/2 – 1 1/2	40S	PLAIN	SS,EFW,ASTM A312-TP 304L	
		2 - 12	10S	BEVELED	SS,EFW,ASTM A312-TP 304L	
		14 - 24	10S	BEVELED	SS,EFW,ASTM A358-304L CL.2	
NIPPLES						
IN-LINE	14,100	1/2 – 1 1/2	80S		SS,EFW,ASTM A312-TP 304L	
BRANCH	14,100	1/2 – 1 1/2	80S		SS,EFW,ASTM A312-TP 304L	
SWAGE(CONC)	14,101	1/2 – 1 1/2	80S		SS,ASTM A403-WP304L-W,MSS SP-95	
SWAGE(ECC)	14,101	1/2 – 1 1/2	80S		SS,ASTM A403-WP304L-W,MSS SP-95	
FITTINGS	AAA,69,104					
UNION-X		UNIONS NOT ALLOWED (USE FLANGES)				
90 ELL		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
45 ELL		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
TEE		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
TEE(RED)		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
PLUG	D	1/2 – 1 1/2		THRD	SS,ASTM A182-F304L,ROUND HEAD,ASME B16.11	
COUPLING		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
COUPLING	D	1/2 – 1 1/2	300 LB	THRD	SS,ASTM A182-F304L,ASME B16.11	
COUPLING(RED)		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
CAP		1/2 – 1 1/2	300 LB	SOCW	SS,ASTM A182-F304L,ASME B16.11	
CAP	D	1/2 – 1 1/2	300 LB	THRD	SS,ASTM A182-F304L,ASME B16.11	
SOCKOLET		1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
THREADOLET	74	1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
SW LATROLET		1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
SW ELBOWLET		1/2 – 1 1/2	300 LB	WELD	SS,ASTM A182-F304L,LIGHT WEIGHT	
REDUCER(CONC)		1 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
REDUCER(ECC)		1 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
WELDOLET		2 - 6		WELD	SS,STM A182-F304L,LIGHT WEIGHT	
CAP		2 - 24		WELD	SS,ASTM A403-WP304L-S,ASME B16.9	
90 LR ELL		2 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
45 ELL		2 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
TEE		2 - 24		WELD	SS,ASTM A403-WP304L-W,ASME B16.9	
VALVES	AAA,10,46					
GATE		1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM	V1R36
GATE	46	1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM,F.P.	V1R32
GATE	50	1/2 - 2	800 LB	T/SW	316L SS EXTENDED BODY W/316 SS TRIM,MPE X FNPT	V1R38
GATE		1/2 – 2	800 LB	T/SW	316L SS BODY W/316 SS TRIM	V1R34
GATE	43	3/4 – 2	150 LB	RF	316 SS BODY W/316 SS TRIM	V1R33
GATE	43,86	3/4 – 2	300 LB	RF	316 SS BODY W/316 SS TRIM	V1R3
GATE	57	1	800 LB	T/SW	316L SS BODY W/316 SS TRIM,F.P.	V1R68
GATE	57	1 1/2 – 2	150 LB	RF	316 SS BODY W/316 SS TRIM,F.P.	V1R67
GATE		3 - 24	150 LB	RF	316 SS BODY W/316 SS TRIM,F.P.	V1R49
GLOBE		1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM	
GLOBE		3 - 12	150 LB	RF	316 SS BODY W/316 SS TRIM	V2R1
CHECK		1 1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM,PISTON H ONLY	V3R42
CHECK		1 1/2 – 2	800 LB	SOCW	316L SS BODY W/316 SS TRIM,PISTON V ONLY	V3R44
CHECK		1/2 - 12	150 LB	RF	316 SS BODY W/316 SS TRIM,F.P.,SWING,H OR V	V3R3
WAFER CHECK	77	14 - 24	150 LB	RF	316 SS BODY W/316 SS DISC/ST,DUAL PLT,H OR V	V3R25
FLG'D BUTTERFLY		3 - 24	150 LB	RF	316 SS BODY W/316 SS DISC,316 SS LAMINAT SEAL,P.O.	V5R27
BALL		1/2 – 2	300 LB	RF	316 SS BODY W/316 SS TRIM,F.S.,F.P.	V5R39
BALL		3 - 24	150 LB	RF	316 SS BODY W/316 SS TRIM,I.F.S.,F.P.	V5R31
PLUG	47	1/2 – 1	300 LB	SOCW	316L SS BODY W/TS&D,316 SS PLUG,F.S.	V4R6
PLUG	47	1 1/2 – 3	150 LB	RF	316 SS BODY W/TS&D,316 SS PLUG,F.S.	
PLUG	47	4 - 12	150 LB	RF	316 SS BODY W/TS&D,316 SS PLUG,F.S.,G.O.	

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FLANGES AAA,104,116

SOCKET WELD	1/2 – 1 1/2	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SOCKET WELD 84	1/2 – 1 1/2	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SOCKET WELD 86	1/2 – 1 1/2	300 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
BLIND	1/2 – 24	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
BLIND	1/2 – 24	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
BLIND 86	1/2 – 24	300 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
WELD NECK82	1 1/2 - 24	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
WELD NECK82,84	1 1/2 - 24	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
WELD NECK86	2 - 24	300 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SLIP-ON	2 - 24	150 LB	RF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
SLIP-ON 84	2 - 24	150 LB	FF	SS,ASTM A182-F304L,ASME B16.5,STD FIN
STUB END-LAP JOINT	1/2 - 24		LJ	SS,ASTM A403-WP304L-W,ASME B16.9,TYPE A,SHORT,SF
PAIR WN ORIFICE 87	2 - 24	300 LB	RF	SS,ASTM A182-F304L,ASME B16.36,1/2" SW TAPS,STD FIN

GASKETS

FULL FACE 90	1/2 – 24	FF1	1/16" FLEX GRAPH W/316 SS TANGED INSERT,ASME B16.21
		FR1	1/16" FLAT RING,ARAMID FIBER W/NBR BINDER (GARLOCK STYLE 3000)
SPIRAL WOUND 88	1/2 – 24	RF	316L SS WINDING W/FLEX GRAPH FILL,ASME B16.20
		RF	304 OR 316L SS WINDING W/GRAFOIL® GRADE GT™ B OR GT™ K FILLER,CS OR SS CENTERING RING,304 OR 316 SS SOLID
INNER			RING,FLEXITALLIC STYLE CGI,LAMONS STYLE WRI,FURON STYLE RWI OR APPROVED EQUAL,ASME B16.20
		(GRAFOIL IS A REGISTERED TRADEMARK OF UNION CARBIDE	
CORPORATION)			

BOLTING B

STUD BOLTS	1/2 – 24	ASME A320 GR B8 CL 2 STUD WITH ASTM A194 GR 8 NUTS ASME A193 BR B7 STUD WITH ASTM A194 GR 2H NUTS

MISCELLANEOUS

Y-STRAINER 96	1/2 – 1 1/2	600 LB	SOCW	304L SS BODY W/304 SS SCREEN (100 MESH,0.0045" WIRE)
Y-STRAINER 97	1/2 – 1 1/2	600 LB	SOCW	304L SS BODY W/304 SS SCREEN (20 MESH,0.016" WIRE)
FIGURE 8 62,86	1/2 – 12	300 LB	RF	304 SS,PER API 590,STD.FIN
FIGURE 8 62	1/2 – 18	150 LB	RF	304 SS,PER API 590,STD.FIN
STRAINER(PUMP)	1 1/2 – 24	150 LB	RF	304 SS,3/16" DIA PERF & 1/4" ON CNETERS(150% BASK)

PRESSURE – TEMPERATURE LIMITATIONS: ASME B16.5 – GROUP 2.3

TEMPERATURE	PRESSURE
-20F (-29C)	
TO 100F (38C)	230 PSIG
200F (93C)	195 PSIG

HYDROSTATIC TEST:
300 PSIG MAX.

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SPECIFIC PIPING NOTES

AAA. SPECIAL REQUIREMENTS FOR PIPING CLASSES WITH **SUFFIX "S"**
- (1) ONLY VALVE TAG NOS. WITH SUFFIX "S"(CERTIFIED SILICON FREE)SHALL BE USED.
- (2) PIPING IN THE PO PURIFICATION AND STORAGE AREAS SHALL BE THOROUGHLY CLEANED TO REMOVE ANY TRACE OF SILICONE AFTER FABRICATION,ASSEMBLY & BEFORE STARTUP. PIPING INCLUDES BLIND FLANGES,STRAINERS,BOLTING,ETC.
- (3) CLEANING METHOD AND PROCEDURE SHALL BE SUBMITTED FOR REVIEW AND APPROVAL.
- (4) ALL GASKETS SHALL BE CERTIFIED SILICONE FREE.

10. VALVES TO BE ORDERED WITH CHEM-GEMS J-1M AND COMPLETE VALVE SPECIFICATION SHEET FROM CHEM GEMS J-2M.
11. MINIMUM LINE SIZE SHALL BE 3/4". SIZE SMALLER THAN 3/4" IS ONLY FOR INSTRUMENTS CONNECTIONS AND OTHER SPECIAL APPLICATIONS.
14. THREADED JOINTS ARE ONLY PERMITTED AT TERMINAL POINTS.
43. TO BE USED AGAINST FLANGED EQUIPMENT (I.E. STORAGE TANKS,VESSELS,LEVEL GAGES,ETC.).
46. USE FULL PRT VALVES AT INLET AND DISCHARGE OF PSV'S AND IN PUMP SUCTIONS WHERE PRESSURE DROP IS CRITICAL.
47. THIS VALVE IS RESTRICTED TO A MAX SERVICE TEMPERATURE OF 300F (149C). 150 FB,FBS,FF NO.28. & DEMINERALIZED WATER.
50. USE EXTENDED BODY VALVE AT VENT,DRAIN,AND INSTRUMENT CONNECTIONS. WHEN THICKNESS OF HEADER INSULATION WILL COVER THE VALVE BODY,USE STANDARD NON-EXTENDED BODY VALVE WITH PROPER LENGTH OF PIPE NIPPLE.
57. USE FULL PORT VALVES AT SAMPLE PROBE CONNECTIONS. REFER TO DRAWING NOS. A14-18-129/130 FOR DETAILS.
62. USE OF FIGURE 8 BLINDS SHALL BE LIMITED TO THE SIZES LISTED DUE TO LIMITATION ON WEIGHT OF 150 POUNDS MAXIMUM:
    CLASS 150:18 INCH;CLASS 300:12 INCH;CLASS 600:10 INCH;CLASS 900:8 INCH;CLASS 1500:6INCH. FIGURE 8 GLINDS, SPACERS,AND BLANKS LARGER THAN 24" OR WHEN NOT COVERED BY THE SIZE RANGE IN THE SPECS SHALL BE DESIGNED BY PIPING MECHANICAL.
69. DO NOT BEND OR THREAD SCHEDULE 10S PIPE. WHERE THREADING OR BENDING IS REQUIRED,USE SCHEDULE 40S MINIMUM.
74. THREADED OUTLET REINFORCED BRANCH WELD FITTINGS TO BE USED ONLY FOR HYDROSTATIC TEST CONNECTIONS.
77. THESE VALVES HAVE NO FLANGES BUT ARE INSTALLED BETWEEN LINE FLANGES WITH EXTRA LENGTH BOLTS.
82. WELD NECK FLANGES SHALL BE USED AGAINST BUTT WELD FITTINGS.
84. PROVIDE FLAT FACE FLANGES ADJACENT TO FLAT FACE CAST IRON VALVES,FLANGES,AND EQUIPMENT NOZZLES.
86. TO BE USED ONLY TO MATCH CLASS 300 RATED FLANGE CONNECTIONS AT CONTROL VALVES AND SPECIAL EQUIPMENT.
87. INSTALL ORIFICE FLANGES PER DRAWING D-J-111.
88. ALLOW 1/8" BETWEEN FLANGES FOR GASKETS.
90. USE FULL FACE GASKETS AT FLAT FACED FLANGES.
96. TO BE USED FOR AIR,GAS,OR STEAM SERVICE.
97. TO BE USED FOR LIQUID SERVICE.
100. NIPPLES (IN-LINE OR BRANCH),SHALL BE PROVIDED WITH BOTH ENDS BEVELED. WHERE REQUIRED,NIPPLES MAY BE PROVIDED WITH ONE END THREADED.
101. SWAGE NIPPLES SHALL BE PROVIDED WITH BOTH ENDS BEVELED. WHERE REQUIRED SWAGE NIPPLES MAY BE PROVIDED WITH LARGE END BEVELED X SMALL END THREADED,OR WITH LARGE END THREADED X SMALL END BEVELED.
104. BUTTWELDING FITTINGS/FLANGES THICKNESS SHALL MATCH PIPE THICKNESS.
116. SEE CHEMGEMS K-9D FOR SELECTION,CONSTRUCTION,AND INSTALLATION OF TEMPERATURE INSTRUMENTS.
B. CADMIUM PLATED FOR ASME 150 & 300 SERVICES.
N. TUBING IS ALLOWED,USE PLS MISC.C1FA.

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BRANCH CONNECTION
LEGEND, NOTES & CHART

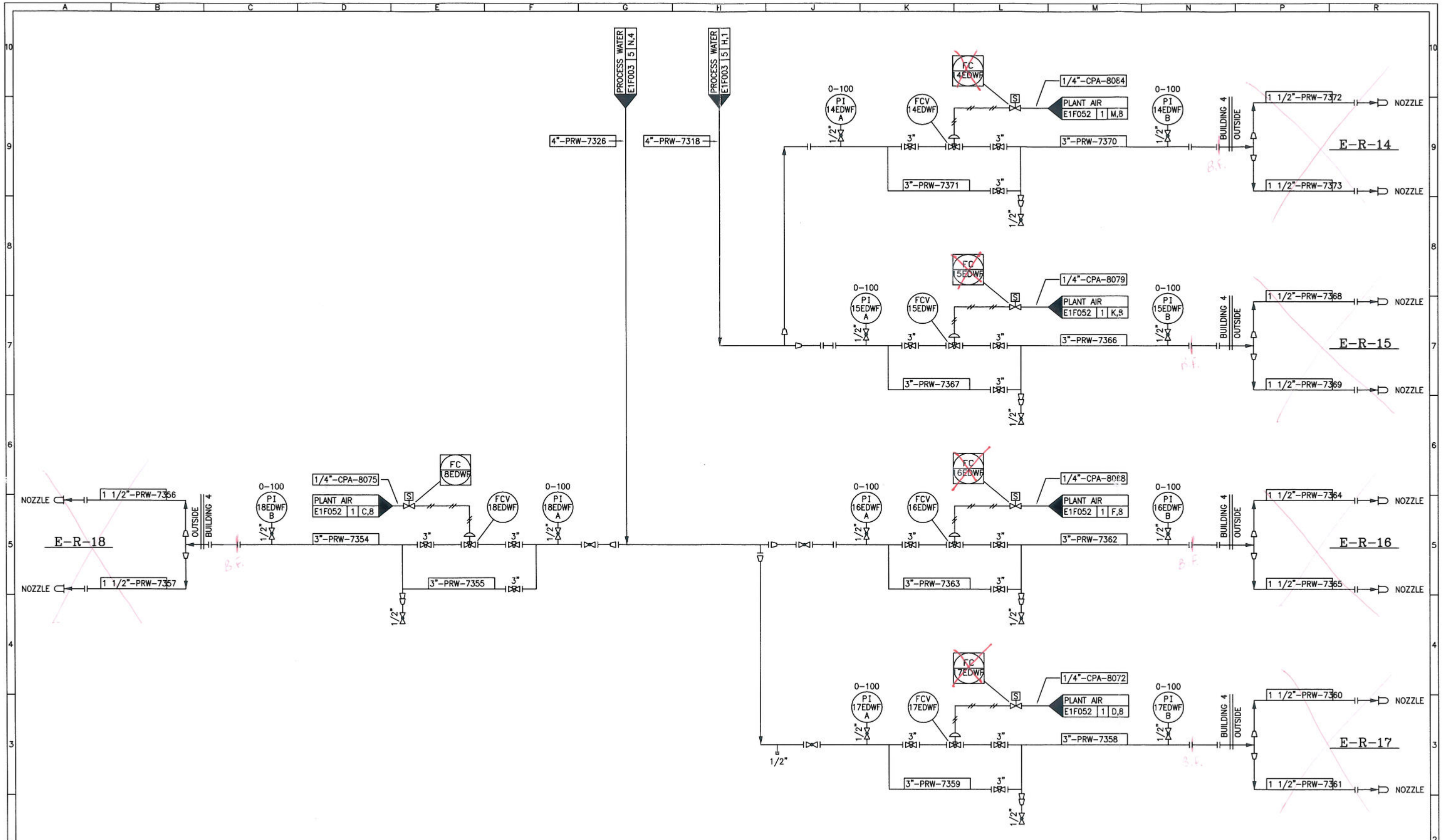
LEGEND
- C - TO BE CALCULATED (SEE J-2D)
- E - REDUCING TEE
- S - SOCKOLET
- T - TEE
- W - WELDOLET
- X - NOT PERMITTED 11

BRANCH SIZE	24	20	18	16	14	12	10	8	6	4	3	2	1.5	1	0.75	0.5
24	T															
20	C	T														
18	C	C	T													
16	C	C	C	T												
14	C	C	C	C	T											
12	C	C	C	C	C	T										
10	C	C	C	C	C	C	T									
8	C	C	C	C	C	C	C	T								
6	W	W	W	W	W	W	W	W	T							
4	W	W	W	W	W	W	W	W	W	T						
3	W	W	W	W	W	W	W	W	W	W	T					
2	W	W	W	W	W	W	W	W	W	W	W	T				
1.5	S	S	S	S	S	S	S	S	S	S	S	S	T			
1	S	S	S	S	S	S	S	S	S	S	S	S	E	T		
0.75	S	S	S	S	S	S	S	S	S	S	S	S	E	E	T	
0.5	S	S	S	S	S	S	S	S	S	S	S	S	E	E	E	X
HEADER SIZE	24	20	18	16	14	12	10	8	6	4	3	2	1.5	1	0.75	0.5

Revision Log		
Distribution Date	Deviation #	Brief Description of Change
1/28/14	089	Allow use of 150# ball valve ½"-2"
4/20/10	068	Allow 150# flanges around reactors for ½"-2" valves.
2/5/09	065	Allow Sch40 CS Pipe, Sch40 Weld Fittings and 150# RF CS Flanges.
8/11/08	063	Allow use of 150# RF Ball Valve
7/11/07	058	150# ball valves ½"-8"
2/1/06	-	Change 150# RF flanged check valve size to ½"-12" from 3"-12"
4/25/05	053	Allow use of 1" flanged check valve on BA line
7/2/04	050	Styrene/Pentane Filter Rupture Disc
1/13/04	-	Correct typographical error
08/18/03	048	Direct Pentane Project Deviation
02/19/03	-	Correct note on plug valves from #48 to #47
02/19/03	046	SA/CAT tank slurry piping improvement at Building 4
1/26/01	041	Use of Threaded Fittings and Ball Valves on Reactor Vent Condensor Project
4/6/01	036	No X-Rays for Di Filters Project
4/6/01	035	Threaded Fittings and Valves on Drain Line for DI Filters Project
2/26/01	-	Remove Valve Specification
1/12/01	-	Add Styrene to Service, Change 3000 lb Fittings to 300 lb. Add SS Material to Spiral Wound Centering Ring, Change Hydrostatic Test Pressure to 300 psig Max.
12/28/00	-	Peru On-Line System
9/6/00	019	Allow Swing Check Valve in Horizontal Plane for SGS Circuit Modification Project
1/14/99	006	Add Bolting Specification

FHRPRU004031

FHRPRU004032



NOTES:

1) NON-DCS INSTRUMENT LOCATION NUMBERS ON THIS DRAWING ARE PREFIXED WITH PLANT AREA "E", NOT SHOWN.

Flint Hills Resources

PERU, ILLINOIS PLANT

REV	DATE	DESCRIPTION
D	5/04	PER MOC 02049
C	3/02	PER MOC 02017
G	10/09	PER MOC 08037
F	1/09	PER DCR 2009-001
E	6/05	PER MOC 05019

NAME: BUILDING 4 PROCESS WATER (FOGGING) P&ID

DRAWN BY: TJB | CONTROLLED: YES

DATE: 9/22/00 | N/A

SCALE: N/A | PLOT SCALE: 1=1

VERSION: A

THE INFORMATION, DATA, AND DESIGNS SHOWN HEREON ARE THE CONFIDENTIAL PROPERTY OF FLINT HILLS RESOURCES, LP. NO USE OR DISCLOSURE MAY BE MADE WITHOUT SPECIFIC WRITTEN AUTHORIZATION OF FLINT HILLS RESOURCES, LP.

E1F021 | SHT# 5 | REV# G

Prairie Analytical Systems, Inc. **Date:** 5/7/2014

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Haz Waste Analysis & RCRA TCLP Metals **Lab Order:** 14E0066
Client Sample ID: SCS4 **Lab ID:** 14E0066-04
Collection Date: 5/5/14 13:21 **Matrix:** Solid

Analyses	Result	Limit	Qual	Units	DF	Date Prepared	Date Analyzed	Method	Analyst
TCLP Metals by ICP-MS									
*Mercury	U	0.0200		mg/L	100	5/6/14 10:29	5/7/14 8:14	SW 6020A	JTC
*Selenium	U	0.500		mg/L	100	5/6/14 10:29	5/7/14 8:14	SW 6020A	JTC
*Silver	U	0.500		mg/L	100	5/6/14 10:29	5/7/14 8:14	SW 6020A	JTC
TCLP Metals by ICP									
*Arsenic	U	0.0100		mg/L	1	5/6/14 10:29	5/6/14 17:55	SW 6010B	CEP
*Barium	U	1.00		mg/L	1	5/6/14 10:29	5/6/14 17:55	SW 6010B	CEP
*Cadmium	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:55	SW 6010B	CEP
*Chromium	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:55	SW 6010B	CEP
*Lead	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:55	SW 6010B	CEP

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Haz Waste Analysis & RCRA TCLP Metals **Lab Order:** 14E0066

Notes and Definitions

S1	Analyte exceeds the laboratory control sample acceptance criteria, but there is no observable concentration in the sample.
P1	Pass
B	Analyte detected in the associated method blank.
*	NELAC certified compound.
U	Analyte not detected (i.e. less than RL or MDL).

Chain of Custody Record

Central IL- 1210 Capital Airport Drive - Springfield, IL 62707-8490 - Phone (217) 753-1148 - Facsimile (217) 753-1152
Chicago Office - PO Box 2116 - Crystal Lake, IL 60039-2116 - Phone (847) 651-2604 - Facsimile (847) 458-9680
www.prairieanalytical.com

Prairie Analytical Systems, INCORPORATED

Client	Flint Hills
Address	
City, State Zip Code	
Phone / Facsimile No.	/
Client Project	
Location	
Sampler(s) / Phone	/
Turnaround Time	Standard [ ] Rush [X] Date Required: 5-7-14
P.O. # or Invoice To	
Contact Person	

Analysis and/or method Requested: Haz Waste Analysis; RCRA & TCLP metals

Reporting: TACO ___ Resid ___ Ind/Comm; CALM __ A __ B __ C; RISC ___ Resid ___ Indust

	Sample Description	Sampling Date	Sampling Time	Matrix Code[1]	Total # of Containers	Sample Comp	Sample Grab	Haz Waste Analysis	RCRA & TCLP metals	Laboratory Comments
SCS1+2	Polystyrene SS	5/5/14	1:21	S	2	X		X		
SCS-3	Polystyrene EC	5/5/14	1:21	S	1	X		X		
SCS-4	WW Sludge	5/5/14	1:21		1		X		X	

[1] M = Matrix Code: A - Aqueous; DW - Drinking Water; GW - Groundwater; NA - Non-aqueous Liquid; S - Solids; O - Other (Specify)

Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment
M. McSchol	5/5/14	1:23PM	[signature]	5/5/14	13:23	hand

Special Instructions:

Q/C Level: 1 X 2 __ 3 __ 4 __

On Wet Ice: Y / N

Proper Preservation: Y / N

Temperature (°C)

Page 1 of 1

Copies: White - Client Yellow - PAS, Inc. Pink - Sampler

Analytical Report
Lab Order: 14D0614

Summary

Analytical report came from samples collected from two roll-off boxes that contained CA-7 crushed limestone ("CA-7"). The CA-7 came from the remediated area on the south side of Building 4's Emergency Containment Pit. This is the area that came into contact with styrene during the April 25, 2014 release. Samples were collected on April 30, 2014 by Prairie Analytical Systems, Incorporated employee.

Analytical: Total styrene, RCRA-8 Metals TCLP, Ignitability, and Paint Filter

Sample ID RF26-01 – refers to a roll off box that contained remediated CA-7

Sample ID RF26-02 - refers to a roll off box that contained remediated CA-7

Sample ID PS26-01 – refers to a waste pile that was in the soil staging area (Case Narrative refers to this soil staging area as containment area.). This waste pile was onsite before the April 25, 2014 release. It was unknown whether or not this pile had come in contact with any remediated CA-7, so samples were collected from the pile.

PS26-02 – refers to a pile of remediated CA-7 in soil staging area.

*Analytical Report contains a more details Case Narrative

Friday, May 2, 2014

Michael Schmidt

Flint Hills Resources
501 Brunner Street
Peru, IL 61354

TEL: (815) 224-5451

FAX: NA

RE: Styrene Analysis PAS WO: 14D0614

Prairie Analytical Systems, Inc. received 4 sample(s) on 4/30/2014 for the analyses presented in the following report.

All applicable quality control procedures met method specific acceptance criteria unless otherwise noted.

This report shall not be reproduced, except in full, without the prior written consent of Prairie Analytical Systems, Inc.

If you have any questions, please feel free to contact me at (217) 753-1148.

Respectfully submitted,

Ana L. Jensen
Project Manager

Certifications: NELAP/NELAC - IL #100323

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Styrene Analysis **Lab Order:** 14D0614

Case Narrative

FIELD NARRATIVE

Sample RF26-01 refers to the roll-off box located to the east. The box was marked off and 5 samples were taken from randomly appointed locations and composited.

Sample RF26-02 refers to the roll-off box located to the west. The box was marked off and 5 samples were taken from randomly appointed locations and composited.

Sample PS26-01 refers to the large waste pile located to the north of the containment area. The pile was irregularly shaped an measured approximately 47.5'x17'x7.5'. 5 samples were taken from random points throughout the pile and composited to comprise the sample. All of the samples were taken from the dirt/gravel portion of the pile and none from the large asphalt pieces on the west side of the pile.

Sample PS26-02 refers to the smaller waste pile located on the east side of the containment area. The pile was irregularly shaped and measured approximately 15'x18'x5'. 5 samples were taken from random points throughout the pile and composited to comprise the sample.

LAB NARRATIVE

The percent moisure test was not performed due to the high styrene level detected in the samples and therefore for safety reasons. Samples are reported on a wet weight basis.

Sample RF26-02 required a 50,000X dilution factor for Styrene analysis. With that magnitude of dilution, the final result is estimated.

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Styrene Analysis **Lab Order:** 14D0614
Client Sample ID: RF26-01 **Lab ID:** 14D0614-01
Collection Date: 4/30/14 11:15 **Matrix:** Solid

Analyses	Result	Limit	Qual	Units	DF	Date Prepared	Date Analyzed	Method	Analyst
Volatile Organic Compounds by GC-MS									
***Styrene**	**760000**	50000		µg/Kg wet	10000	5/1/14 10:54	5/1/14 13:03	SW 8260B Re	BDP
TCLP Metals by ICP-MS									
*Mercury	U	0.0200		mg/L	100	5/1/14 12:17	5/2/14 0:05	SW 6020A	JTC
*Selenium	U	0.500		mg/L	100	5/1/14 12:17	5/2/14 0:05	SW 6020A	JTC
*Silver	U	0.500		mg/L	100	5/1/14 12:17	5/2/14 0:05	SW 6020A	JTC
TCLP Metals by ICP									
*Arsenic	U	0.0100		mg/L	1	5/1/14 12:17	5/1/14 23:36	SW 6010B	CEP
*Barium	U	1.00		mg/L	1	5/1/14 12:17	5/1/14 23:36	SW 6010B	CEP
*Cadmium	U	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:36	SW 6010B	CEP
*Chromium	U	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:36	SW 6010B	CEP
*Lead	U	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:36	SW 6010B	CEP
Conventional Chemistry Parameters									
*Ignitability (Flash Point)	>200	50.0		°F	1	5/1/14 12:39	5/1/14 12:42	SW 1010 (M)	CCD
*Paint Filter	Pass			P/F	1	5/1/14 12:39	5/1/14 12:42	SW 9095A	CCD

Client Sample ID: RF26-02 **Lab ID:** 14D0614-02
Collection Date: 4/30/14 11:28 **Matrix:** Solid

Analyses	Result	Limit	Qual	Units	DF	Date Prepared	Date Analyzed	Method	Analyst
Volatile Organic Compounds by GC-MS									
***Styrene**	**13600000**	250000	E	µg/Kg wet	50000	5/2/14 10:26	5/2/14 11:22	SW 8260B Re	BDP
TCLP Metals by ICP-MS									
*Mercury	U	0.0200		mg/L	100	5/1/14 12:17	5/2/14 0:14	SW 6020A	JTC
*Selenium	U	0.500		mg/L	100	5/1/14 12:17	5/2/14 0:14	SW 6020A	JTC
*Silver	U	0.500		mg/L	100	5/1/14 12:17	5/2/14 0:14	SW 6020A	JTC
TCLP Metals by ICP									
*Arsenic	U	0.0100		mg/L	1	5/1/14 12:17	5/1/14 23:41	SW 6010B	CEP
*Barium	U	1.00		mg/L	1	5/1/14 12:17	5/1/14 23:41	SW 6010B	CEP
*Cadmium	U	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:41	SW 6010B	CEP
*Chromium	U	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:41	SW 6010B	CEP
*Lead	U	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:41	SW 6010B	CEP
Conventional Chemistry Parameters									
*Ignitability (Flash Point)	>200	50.0		°F	1	5/1/14 12:39	5/1/14 12:42	SW 1010 (M)	CCD
*Paint Filter	Pass			P/F	1	5/1/14 12:39	5/1/14 12:42	SW 9095A	CCD

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Styrene Analysis **Lab Order:** 14D0614
Client Sample ID: PS26-01 **Lab ID:** 14D0614-03
Collection Date: 4/30/14 12:00 **Matrix:** Solid

Analyses	Result	Limit	Qual	Units	DF	Date Prepared	Date Analyzed	Method	Analyst
Volatile Organic Compounds by GC-MS									
***Styrene**	**3360**	250		µg/Kg wet	50	5/1/14 10:54	5/1/14 17:59	SW 8260B Re	BDP
TCLP Metals by ICP-MS									
*Mercury	U	0.0200		mg/L	100	5/1/14 12:17	5/2/14 0:22	SW 6020A	JTC
*Selenium	U	0.500		mg/L	100	5/1/14 12:17	5/2/14 0:22	SW 6020A	JTC
*Silver	U	0.500		mg/L	100	5/1/14 12:17	5/2/14 0:22	SW 6020A	JTC
TCLP Metals by ICP									
*Arsenic	U	0.0100		mg/L	1	5/1/14 12:17	5/1/14 23:46	SW 6010B	CEP
*Barium	U	1.00		mg/L	1	5/1/14 12:17	5/1/14 23:46	SW 6010B	CEP
***Cadmium**	**0.253**	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:46	SW 6010B	CEP
*Chromium	U	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:46	SW 6010B	CEP
***Lead**	**0.286**	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:46	SW 6010B	CEP
Conventional Chemistry Parameters									
*Ignitability (Flash Point)	>200	50.0		°F	1	5/1/14 12:39	5/1/14 12:42	SW 1010 (M)	CCD
*Paint Filter	Pass			P/F	1	5/1/14 12:39	5/1/14 12:42	SW 9095A	CCD

Client Sample ID: PS26-02 **Lab ID:** 14D0614-04
Collection Date: 4/30/14 12:12 **Matrix:** Solid

Analyses	Result	Limit	Qual	Units	DF	Date Prepared	Date Analyzed	Method	Analyst
Volatile Organic Compounds by GC-MS									
***Styrene**	**694000**	50000		µg/Kg wet	10000	5/1/14 10:54	5/1/14 14:32	SW 8260B Re	BDP
TCLP Metals by ICP-MS									
*Mercury	U	0.0200		mg/L	100	5/1/14 12:17	5/2/14 0:31	SW 6020A	JTC
*Selenium	U	0.500		mg/L	100	5/1/14 12:17	5/2/14 0:31	SW 6020A	JTC
*Silver	U	0.500		mg/L	100	5/1/14 12:17	5/2/14 0:31	SW 6020A	JTC
TCLP Metals by ICP									
*Arsenic	U	0.0100		mg/L	1	5/1/14 12:17	5/1/14 23:52	SW 6010B	CEP
*Barium	U	1.00		mg/L	1	5/1/14 12:17	5/1/14 23:52	SW 6010B	CEP
*Cadmium	U	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:52	SW 6010B	CEP
*Chromium	U	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:52	SW 6010B	CEP
*Lead	U	0.00500		mg/L	1	5/1/14 12:17	5/1/14 23:52	SW 6010B	CEP
Conventional Chemistry Parameters									
*Ignitability (Flash Point)	>200	50.0		°F	1	5/1/14 12:39	5/1/14 12:42	SW 1010 (M)	CCD
*Paint Filter	Pass			P/F	1	5/1/14 12:39	5/1/14 12:42	SW 9095A	CCD

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Styrene Analysis **Lab Order:** 14D0614

Notes and Definitions

P1	Pass
E	Result above quantitation range.
*	NELAC certified compound.
U	Analyte not detected (i.e. less than RL or MDL).

Chain of Custody Record

Central IL - 1210 Capital Airport Drive - Springfield, IL 62707-8490 - Phone (217) 753-1148 - Facsimile (217) 753-1152
Chicago IL Office - 9114 Virginia Rd., Ste 112 - Lake in the Hills, IL 60156 - Phone (847) 651-2604 - Facsimile (847) 458-9680
Central/Southern IL Office - Phone (217) 414-7762 - Facsimile (217) 223-7922

Prairie Analytical Systems, INCORPORATED
www.prairieanalytical.com

Client	Flint hills
Address	
City, State, Zip Code	
Phone / Facsimile	
Project Name / Number	
Project Location	
P.O. # or Invoice To	
Contact Person	Mike Schmidt

Reporting: TACO ☐ Resid ☐ Ind/Comm; CALM ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F; RISC ☐ Resid ☐ Indust

Sample Description	Sampling Date	Sampling Time	Matrix Code	Preserv Code	No. of Containers	Sample Type Comp	Sample Type Grab	Styrene	TCLP metals	flash point	paint filter						Sampler Comments
RF26-01	4-30-14	11:15						X	X	X	X						
RF26-02	4-30-14	11:28						X	X	X	X						
PS26-01	4-30-14	12:00						X	X	X	X						
PS26-02	4-30-14	12:12						X	X	X	X						

Matrix Code	A - Aqueous	DW - Drinking Water	GW - Ground Water	NA - Non-Aqueous Liquid	S - Solid	O - Oil	X - Other (Specify)
Preserv Code	0 - None	1 - HCl	2 - H2SO4	3 - HNO3	4 - NaOH	5 - 5035 Kit	X - Other (Specify)

Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment
[signature]	4-30-14	14:40	PAS	4-30-14	14:40	hand

Special Instructions:

Turnaround Time: Standard ☐ Rush ☒
Date Required: 5-2-14 AM

QC Level: 1 ☒ 2 ☐ 3 ☐ 4 ☐

On wet ice? Yes No

Temperature (°C): 5.6

Page 6 of 6

FHRPRU004043

Copies: White - Client / Yellow - PAS, Inc. / Pink - Sampler

Analytical Report
Lab Order: 14E0066

Summary

Analytical report came from samples collected from 3 piles of waste that was generated during the release of material from reactor 17. Two piles were staged at the Facility's soil staging area and one pile remained in the Building 4's Emergency Containment Pit.

Analytical Ran on All 3 Samples: VOC TCLP, Semi VOC TCLP, RCRA 8 Metals TCLP, Reactive Cyanide, Ignitability, Paint filter, pH, and Reactive Sulfide.

Sample ID SCS1 – refers to the southeast pile. A total of 7 samples were collected randomly from the pile and composited into a 1 liter sample container.

Sample ID SCS2– refers to the northwest pile. A total of 7 samples were collected randomly and composited into a 1 liter sample container

Sample ID SCS3 – refers to the in Building 4's Emergency Containment Pit. The number of random samples was not documented. Smaller samples were collected and later composited into a 1 liter sample container

*No Case Narrative with Analytical Report

Wednesday, May 7, 2014

Michael Schmidt

Flint Hills Resources
501 Brunner Street
Peru, IL 61354

TEL: (815) 224-5451

FAX: NA

RE: Haz Waste Analysis & RCRA TCLP Metals PAS WO: 14E0066

Prairie Analytical Systems, Inc. received 4 sample(s) on 5/5/2014 for the analyses presented in the following report.

All applicable quality control procedures met method specific acceptance criteria unless otherwise noted.

This report shall not be reproduced, except in full, without the prior written consent of Prairie Analytical Systems, Inc.

If you have any questions, please feel free to contact me at (217) 753-1148.

Respectfully submitted,

Kristen A. Potter For Ana L. Jensen
Project Manager

Certifications: NELAP/NELAC - IL #100323

Prairie Analytical Systems, Inc. **Date:** 5/7/2014

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Haz Waste Analysis & RCRA TCLP Metals **Lab Order:** 14E0066
Client Sample ID: SCS1 **Lab ID:** 14E0066-01
Collection Date: 5/5/14 13:21 **Matrix:** Solid

Analyses	Result	Limit	Qual	Units	DF	Date Prepared	Date Analyzed	Method	Analyst
TCLP Volatile Organic Compounds by GC-MS									
*Benzene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
*2-Butanone	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
*Carbon tetrachloride	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
*Chlorobenzene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
*Chloroform	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
*1,4-Dichlorobenzene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
*1,2-Dichloroethane	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
*1,1-Dichloroethene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
*Tetrachloroethene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
*Trichloroethene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
*Vinyl chloride	U	200		µg/L	10	5/6/14 10:13	5/6/14 19:29	SW 8260B Re	BDP
TCLP Semi-Volatile Organic Compounds by GC-MS									
*1,4-Dichlorobenzene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
*2,4-Dinitrotoluene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
*Hexachlorobenzene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
*Hexachlorobutadiene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
***Hexachloroethane**	**19.1**	10.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
***2-Methylphenol**	**188**	10.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
3 & 4-Methylphenol	**91.8**	20.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
*Nitrobenzene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
*Pentachlorophenol	U	50.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
Pyridine	U	50.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
*2,4,5-Trichlorophenol	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
*2,4,6-Trichlorophenol	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 20:28	SW 8270C	BDP
TCLP Metals by ICP-MS									
*Mercury	U	0.0200		mg/L	100	5/6/14 10:29	5/7/14 7:57	SW 6020A	JTC
*Selenium	U	0.500		mg/L	100	5/6/14 10:29	5/7/14 7:57	SW 6020A	JTC
*Silver	U	0.500		mg/L	100	5/6/14 10:29	5/7/14 7:57	SW 6020A	JTC
TCLP Metals by ICP									
*Arsenic	U	0.0100		mg/L	1	5/6/14 10:29	5/6/14 17:40	SW 6010B	CEP
*Barium	U	1.00		mg/L	1	5/6/14 10:29	5/6/14 17:40	SW 6010B	CEP
*Cadmium	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:40	SW 6010B	CEP
***Chromium**	**0.00637**	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:40	SW 6010B	CEP
*Lead	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:40	SW 6010B	CEP
Conventional Chemistry Parameters									
*Reactive Cyanide	U	1.25		mg/Kg wet	1	5/7/14 9:14	5/7/14 10:17	SW 9014	CCD
*Ignitability (Flash Point)	>200	50.0		°F	1	5/6/14 14:22	5/6/14 14:23	SW 1010 (M)	CCD
*Paint Filter	Pass			P/F	1	5/6/14 14:22	5/6/14 14:23	SW 9095A	CCD
***pH**	**5.4**	0.010		pH Units	1	5/6/14 9:25	5/6/14 10:52	SW 9045C	JLS
*Reactive Sulfide	U	9.50		mg/Kg wet	1	5/6/14 8:44	5/6/14 10:39	SW 9034	CCD

Prairie Analytical Systems, Inc. **Date:** 5/7/2014

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Haz Waste Analysis & RCRA TCLP Metals **Lab Order:** 14E0066
Client Sample ID: SCS2 **Lab ID:** 14E0066-02
Collection Date: 5/5/14 13:21 **Matrix:** Solid

Analyses	Result	Limit	Qual	Units	DF	Date Prepared	Date Analyzed	Method	Analyst
TCLP Volatile Organic Compounds by GC-MS									
*Benzene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
*2-Butanone	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
*Carbon tetrachloride	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
*Chlorobenzene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
*Chloroform	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
*1,4-Dichlorobenzene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
*1,2-Dichloroethane	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
*1,1-Dichloroethene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
*Tetrachloroethene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
*Trichloroethene	U	250		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
*Vinyl chloride	U	200		µg/L	10	5/6/14 10:13	5/6/14 19:58	SW 8260B Re	BDP
TCLP Semi-Volatile Organic Compounds by GC-MS									
*1,4-Dichlorobenzene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
*2,4-Dinitrotoluene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
*Hexachlorobenzene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
*Hexachlorobutadiene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
***Hexachloroethane**	**55.9**	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
***2-Methylphenol**	**213**	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
3 & 4-Methylphenol	**94.7**	20.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
*Nitrobenzene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
*Pentachlorophenol	U	50.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
Pyridine	U	50.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
*2,4,5-Trichlorophenol	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
*2,4,6-Trichlorophenol	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:01	SW 8270C	BDP
TCLP Metals by ICP-MS									
*Mercury	U	0.0200		mg/L	100	5/6/14 10:29	5/7/14 8:03	SW 6020A	JTC
*Selenium	U	0.500		mg/L	100	5/6/14 10:29	5/7/14 8:03	SW 6020A	JTC
*Silver	U	0.500		mg/L	100	5/6/14 10:29	5/7/14 8:03	SW 6020A	JTC
TCLP Metals by ICP									
*Arsenic	U	0.0100		mg/L	1	5/6/14 10:29	5/6/14 17:45	SW 6010B	CEP
*Barium	U	1.00		mg/L	1	5/6/14 10:29	5/6/14 17:45	SW 6010B	CEP
*Cadmium	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:45	SW 6010B	CEP
***Chromium**	**0.00589**	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:45	SW 6010B	CEP
*Lead	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:45	SW 6010B	CEP
Conventional Chemistry Parameters									
*Reactive Cyanide	U	1.23		mg/Kg wet	1	5/7/14 9:14	5/7/14 10:17	SW 9014	CCD
*Ignitability (Flash Point)	>200	50.0		°F	1	5/6/14 14:22	5/6/14 14:23	SW 1010 (M)	CCD
*Paint Filter	Pass			P/F	1	5/6/14 14:22	5/6/14 14:23	SW 9095A	CCD
***pH**	**4.9**	0.010		pH Units	1	5/6/14 9:25	5/6/14 10:52	SW 9045C	JLS
*Reactive Sulfide	U	9.19		mg/Kg wet	1	5/6/14 8:44	5/6/14 10:39	SW 9034	CCD

Prairie Analytical Systems, Inc. **Date:** 5/7/2014

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Haz Waste Analysis & RCRA TCLP Metals **Lab Order:** 14E0066
Client Sample ID: SCS3 **Lab ID:** 14E0066-03
Collection Date: 5/5/14 13:21 **Matrix:** Solid

Analyses	Result	Limit	Qual	Units	DF	Date Prepared	Date Analyzed	Method	Analyst
TCLP Volatile Organic Compounds by GC-MS									
*Benzene	U	250		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
*2-Butanone	U	250		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
*Carbon tetrachloride	U	250		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
*Chlorobenzene	U	250		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
*Chloroform	U	250		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
*1,4-Dichlorobenzene	U	250		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
*1,2-Dichloroethane	U	250		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
*1,1-Dichloroethene	U	250		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
*Tetrachloroethene	U	250		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
*Trichloroethene	U	250		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
*Vinyl chloride	U	200		µg/L	10	5/6/14 10:13	5/6/14 20:28	SW 8260B Re	BDP
TCLP Semi-Volatile Organic Compounds by GC-MS									
*1,4-Dichlorobenzene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
*2,4-Dinitrotoluene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
*Hexachlorobenzene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
*Hexachlorobutadiene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
***Hexachloroethane**	**34.6**	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
***2-Methylphenol**	**252**	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
3 & 4-Methylphenol	**106**	20.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
*Nitrobenzene	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
*Pentachlorophenol	U	50.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
Pyridine	U	50.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
*2,4,5-Trichlorophenol	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
*2,4,6-Trichlorophenol	U	10.0		µg/L	1	5/6/14 15:00	5/6/14 21:34	SW 8270C	BDP
TCLP Metals by ICP-MS									
*Mercury	U	0.0200		mg/L	100	5/6/14 10:29	5/7/14 8:09	SW 6020A	JTC
*Selenium	U	0.500		mg/L	100	5/6/14 10:29	5/7/14 8:09	SW 6020A	JTC
*Silver	U	0.500		mg/L	100	5/6/14 10:29	5/7/14 8:09	SW 6020A	JTC
TCLP Metals by ICP									
***Arsenic**	**0.0245**	0.0100		mg/L	1	5/6/14 10:29	5/6/14 17:50	SW 6010B	CEP
*Barium	U	1.00		mg/L	1	5/6/14 10:29	5/6/14 17:50	SW 6010B	CEP
*Cadmium	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:50	SW 6010B	CEP
*Chromium	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:50	SW 6010B	CEP
*Lead	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:50	SW 6010B	CEP
Conventional Chemistry Parameters									
*Reactive Cyanide	U	1.24		mg/Kg wet	1	5/7/14 9:14	5/7/14 10:17	SW 9014	CCD
*Ignitability (Flash Point)	>200	50.0		°F	1	5/6/14 14:22	5/6/14 14:23	SW 1010 (M)	CCD
*Paint Filter	Pass			P/F	1	5/6/14 14:22	5/6/14 14:23	SW 9095A	CCD
***pH**	**5.4**	0.010		pH Units	1	5/6/14 9:25	5/6/14 10:52	SW 9045C	JLS
*Reactive Sulfide	U	9.50		mg/Kg wet	1	5/6/14 8:44	5/6/14 10:39	SW 9034	CCD

Prairie Analytical Systems, Inc. **Date:** 5/7/2014

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Haz Waste Analysis & RCRA TCLP Metals **Lab Order:** 14E0066
Client Sample ID: SCS4 **Lab ID:** 14E0066-04
Collection Date: 5/5/14 13:21 **Matrix:** Solid

Analyses	Result	Limit	Qual	Units	DF	Date Prepared	Date Analyzed	Method	Analyst
TCLP Metals by ICP-MS									
*Mercury	U	0.0200		mg/L	100	5/6/14 10:29	5/7/14 8:14	SW 6020A	JTC
*Selenium	U	0.500		mg/L	100	5/6/14 10:29	5/7/14 8:14	SW 6020A	JTC
*Silver	U	0.500		mg/L	100	5/6/14 10:29	5/7/14 8:14	SW 6020A	JTC
TCLP Metals by ICP									
*Arsenic	U	0.0100		mg/L	1	5/6/14 10:29	5/6/14 17:55	SW 6010B	CEP
*Barium	U	1.00		mg/L	1	5/6/14 10:29	5/6/14 17:55	SW 6010B	CEP
*Cadmium	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:55	SW 6010B	CEP
*Chromium	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:55	SW 6010B	CEP
*Lead	U	0.00500		mg/L	1	5/6/14 10:29	5/6/14 17:55	SW 6010B	CEP

LABORATORY RESULTS

Client: Flint Hills Resources
Project: Haz Waste Analysis & RCRA TCLP Metals **Lab Order:** 14E0066

Notes and Definitions

S1	Analyte exceeds the laboratory control sample acceptance criteria, but there is no observable concentration in the sample.
P1	Pass
B	Analyte detected in the associated method blank.
*	NELAC certified compound.
U	Analyte not detected (i.e. less than RL or MDL).

Chain of Custody Record

Central IL- 1210 Capital Airport Drive - Springfield, IL 62707-8490 - Phone (217) 753-1148 - Facsimile (217) 753-1152
Chicago Office - PO Box 2116 - Crystal Lake, IL 60039-2116 - Phone (847) 651-2604 - Facsimile (847) 458-9680
www.prairieanalytical.com

Prairie Analytical Systems, INCORPORATED

Client	Flint Hills
Address	
City, State Zip Code	
Phone / Facsimile No.	/
Client Project	
Location	
Sampler(s) / Phone	/
Turnaround Time	Standard [ ] Rush [X] Date Required: 5-7-14
P.O. # or Invoice To	
Contact Person	

Analysis and/or method Requested: Haz Waste Analysis; RCRA 8 TCLP metals

Reporting: TACO ___ Resid ___ Ind/Comm; CALM __ A __ B __ C; RISC ___ Resid ___ Indust

	Sample Description	Sampling Date	Sampling Time	Matrix Code[1]	Total # of Containers	Sample Comp	Sample Grab	Haz Waste Analysis	RCRA 8 TCLP metals							Laboratory Comments
SCS1+2	Polystyrene SS	5/5/14	1:21	S	2	X		X								
SCS-3	Polystyrene EC	5/5/14	1:21	S	1	X		X								
SCS-4	WW Sludge	5/5/14	1:21		1		X		X							

[1] M = Matrix Code: A - Aqueous; DW - Drinking Water; GW - Groundwater; NA - Non-aqueous Liquid; S - Solids; O - Other (Specify)

Relinquished By	Date	Time	Received By	Date	Time	Method of Shipment
M. McSold	5/5/14	1:23PM	[signature]	5/5/14	13:23	hand

Special Instructions:

Q/C Level: 1 X 2 __ 3 __ 4 __

On Wet Ice: Y / N

Proper Preservation: Y / N

Temperature (°C)

Page 1 of 1

Copies: White - Client Yellow - PAS, Inc. Pink - Sampler

INCIDENT INVESTIGATION FINAL REPORT

Final Report
May 23, 2014

Prepared for:
Flint Hills Resources

POLYSTYRENE REACTOR RELEASE - PERU, IL APRIL 25, 2014

Prepared by:
Thomas V. Rodante, P.E., CFEI, CFII

STATE OF TEXAS
THOMAS V. RODANTE
97699
LICENSED
PROFESSIONAL ENGINEER

BakerRisk Project No.
01-04869-001-14

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Notice

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EXECUTIVE SUMMARY

On April 25, 2014 Reactor R17 in Building No. 4 experienced a Safety Instrumented System (SIS) reactor release into the primary containment pit. During this release, some quantity of mixed water and monomer (styrene) flowed over the pit wall onto the adjacent plant road. The only offsite detection was one odor complaint resulting from vaporization within the emergency containment area.

The reactor released in response to the correct and appropriate automatic activation of the SIS over-temperature protection function. Under Digital (AKA Distributed) Control System (DCS) commands, the reactor temperature began to rise in preparation for the React phase of the batch process. When the batch temperature exceeded 200 °F, the SIS initiated a high temperature alarm and subsequently automatically released the reactor contents into the emergency containment area when the temperature reached 210 °F. The SIS functioned as designed.

The DCS had executed an emergency cooling function prior to the SIS alarm, but was ineffective in halting the temperature rise. It was concluded that the chain of events between the initial Charge phase and preparation for React phase had resulted in the DCS command logic becoming out of sequence with the actual physical conditions at the time of the temperature rise. Specifically, DCS logic code restricted maximum cooling during execution of the Emergency Cooling command. This restriction had not been cleared from the DCS program after the operators had halted and subsequently resumed the Charge phase of the batch process. This condition was not normal and the need to halt and resume a batch phase during mid-phase had never been previously experienced at this facility. Consequently, an operating procedure for such an occurrence had never been prepared. The removal of DCS limits on maximum cooling and the preparation of operating procedures for mid-phase process disruption could have prevented the chain of events that led to the SIS activation.

The cause for the DCS becoming out of sequence started during the initial reactor Charge phase. Under DCS commands, monomer flow into reactor R17 had commenced while the reactor vent to atmosphere valve was closing and the vent to flare valve was opening. The transitioning of these two vent valves did not complete within the programmed time allowance and thus the DCS issued an operator alarm. Appropriately, the operators then manually intervened, and halted automatic DCS controlled monomer flow into R17. Interlocking the two vent valve positions as a precursor to DCS executing the monomer flow command could have prevented the initiator of the chain of events.

The overall system operation and resultant outcome was actually a demonstration of the system's designed safety, reliability, and performance. While automatic DCS functions and manual

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operator intervention were ultimately ineffective in preventing the activation of the SIS automatic over-ride, nevertheless, the SIS did perform its primary function. The result was a safe release into the primary containment pit, and the SIS averted conditions that could have resulted in the activation of the system's last independent Layer of Protection (LOP), i.e. the reactor's burst disk.

The investigation team's initial responsibility was to provide corrective actions to prevent the reoccurrence of the incident. Given that the root cause was the activation of a safety system, it was deemed counterintuitive to attempt to prevent a safety system from activating. The investigative team then modified its objective to providing suggested actions that would lessen the likelihood, and/or mitigate the consequence, of a SIS reactor release.

The suggested actions include:

- Removing all DCS code logic that would place restrictions on maximum cooling;
- Interlocking the reactor vent valves with the monomer charge valve so that vent valve full transition validation is a permissive condition prior to opening the monomer charge valve;
- Preparing a standard operating procedure for mid-phase batch resumption, including a reactor condition confirmation step prior to restart after extended batch holds;
- Analyzing all DCS and SIS operator interface displays/options and ensure that condition recognition and providing code enhancements will ensure more reliable batch and phase restarts;
- Providing operator training that covers all implemented modifications;
- Assessing the feasibility of installing a closed additive and sample port system; and
- Modifying the emergency containment area to reduce release splashing over the pit wall and minimizing vapor migration.

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1 INTRODUCTION

1.1 Situation

An SIS-initiated reactor R17 dump occurred at 20:46 hrs CDT on April 25, 2014. At the time of the release, plant personnel were engaged in recovering from a manual halt in the DCS programmed batch process. The ensuing dump released approximately 56,000 pounds of partially reacted styrene monomer plus water into the emergency containment area.

This report documents the investigation process, discovered evidence, cause and origin opinions, analytical results, and recommendations.

1.2 Investigative Team

- Thomas V. Rodante, BakerRisk – Lead Investigator
- FHR Participants:
  - Mary Steinbach, – Health & Safety Manger
  - Keith Marshall, – Process Control Engineer
  - Chad Holman, – Process Engineer
  - Devin Moss, – Process Engineer
  - Mike Shea, – Building No.4 Production Facilitator

1.3 Methodology

The primary FHR investigative team was first assembled and met the day after the incident on April 26, 2014.

BakerRisk was commissioned to lead continuing investigative efforts and first arrived on-site May 5, 2014.

The investigation objectives were to:

- Conduct a root cause and origin investigation;
- Document all conditions, equipment, records, etc. associated with the incident;
- Determine one or more probable causes for the initiation of the incident, and of these, identify the root cause(s) and causal factor(s);
- Utilize Root Cause Analysis (RCA) methodology;
- Utilize the TapRooT® technique in executing the RCA;
- Determine recommendations to prevent the occurrence of, and/or to mitigate the consequences of, similar incidents.

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To date, the following activities have been either directly conducted by the team or commissioned under the team's supervision:

- Conduct personnel interviews;
- Inspect and document the site;
- Analyze process data, documentation, and other physical evidence;
- Develop a photo log;
- Develop a sequence of events (TapRooT® SnapChart);
- Identify Causal Factors (TapRooT® Root Cause Tree);
- Define root causes for each Causal Factor (TapRooT® Root Cause Tree);
- Categorize each root cause by basic generic causes (TapRooT® Root Cause Tree Worksheet);
- Prepare a final report.

1.3.1 Site Investigation

All areas related to the incident were inspected for potential physical evidence such as piping, controls, fluid levels, valve positions, etc. Any reported condition, witness statement, and condition verifications pertaining to possible release scenarios were documented.

1.3.2 Root Cause Analysis (RCA)

The TapRoot® technique and software tool was used to document the RCA. A summary combined event tree (presented in time line sequence) and root cause tree (containing identified causal factors) is provided in the appendix to this report.

Root cause results and basic cause characterizations are contained in Section 3.3 of this report.

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2 BACKGROUND

2.1 Process Description

The expandable polystyrene (EPS) made at the Peru facility is a polystyrene bead that has been heated in the presence of vaporized pentane (the "blowing agent") to form a cellular bead structure. Building No.4 has five reactors for the production of expandable polystyrene (EPS) using a batch polymerization process. The EPS batch process consists of the suspension of styrene monomer in water, which is then polymerized with heat in the presence of catalyst to form polystyrene beads. Once initiated ("Trip" temperature), this reaction is exothermic in nature (i.e. the polymerization reaction releases sufficient energy to continue the reaction on its own). After the majority of the polymerization reaction has taken place, pentane is added and the polymerization reaction is completed. The contents of the reactor containing the encapsulated (expanded) beads are then cooled, and the reactor is emptied into a dedicated wash tank. The finished wash tank pellets are pumped downstream for drying and packaging as polystyrene beads.

The EPS batch process is divided into six phases (see Figure 1) as follows:

1. Charge:
   Raw materials (water, styrene monomer, and catalyst) are loaded and heated up in preparation for the React phase. The reactor contents are heated until reaching the "trip" temperature of 190.7 °F.

2. React:
   At "Trip," the batch goes into the react phase (time = 0). During this phase, the batch is held at its react temperature and styrene is polymerized into polystyrene. More specialized additives are loaded into the reactor and suspension samples are taken at specified times.

3. Heat-up:
   At the batch-specific designated time, pentane is added to the reactor and the reactor temperature is ramped to the specified cure temperature.

4. Cure:
   The batch is held at the higher, designated cure temperature for its designated time period. The higher temperature converts any un-reacted monomer to complete the polymerization reaction and allows the pentane to fully impregnate the polystyrene to make the EPS beads.

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5. Cool (also known as "Cool 1"):
   After the designated cure time, the batch is cooled to a temperature at which it is safe to drop to the wash tank, removing the beads from the reactor.

6. Drop (also known as "Cool 2"):
   The batch is cooled and then dropped to the dedicated wash tank underneath the reactor. The reactor is flushed and power washed with process water using a high-pressure cleaning lance. When the flush is complete, the reactor is ready for the next batch charge.

The reactor and wash tank vent vapors to the Flare System via a flare header, and under certain conditions, to the atmosphere. For example, when the reactor is loading water or being opened to take a sample, the vent to flare valve (FV-R17-VFLA) is closed and the vent to atmosphere (FV-R17-VFLB) is opened. Also, the reactor is ultimately protected from overpressure by a rupture disk (PSE-R17-A&-B) that releases to atmosphere. This rupture disk is mechanical in nature (does not require any power or instrument signal) and as such is totally independent from the DCS and SIS respective normal and safety controls.

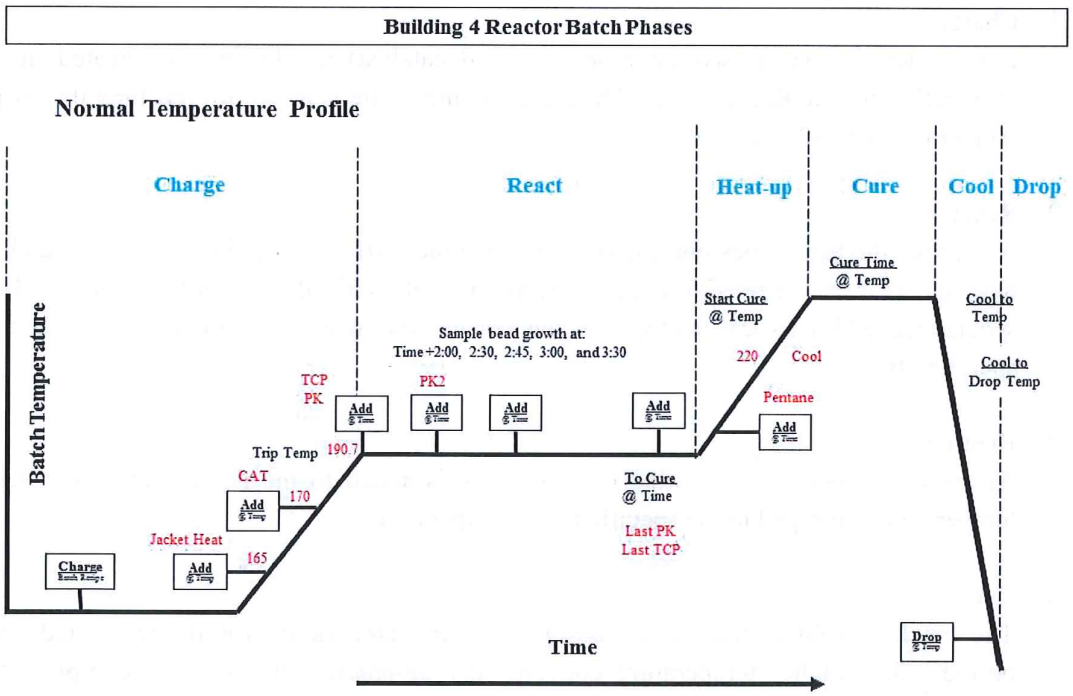

Figure 1. Batch Reactor Phases & Normal Temperature Profile

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The process control, safety systems, and batch phases pertinent to the RCA are further described in the following sub-sections.

2.1.1 Process Control and Safety Functions

The batch phase sequencing and process control is primarily done by the DCS with manual acknowledgement prompts and initiation commands, required by and from the operator at various stages. Within predefined authority limits, operator over-ride of some DCS controls is permitted.

The primary process safety system is a totally independent (separate data communication and instrument transmitters) SIS with assigned Safety Integrity Levels (SIL). Operator over-ride of SIS functions is not possible.

The final safety Layer of Protection (LOP) is a totally automatic and mechanical overpressure rupture burst disk.

2.1.2 Charge Phase

The raw materials are supplied to the Building No.4 reactors through dedicated piping to the reactor, to mixing tanks above the reactor which are piped to the reactor, or are added manually using pre-measured, batch-specific quantities based off each product recipe. The raw materials are charged at the top of the reactor as follows:

1) The process water – supplied through dedicated piping by the Water Treatment Plant (WTP).
2) The styrene monomer and pentane – supplied through dedicated piping from the storage tanks in the Tank Farm. The monomer Charge pumps are designated CP-400a-A&B.
3) The suspending agent and catalyst – supplied from the SA and CAT tanks, respectively, and are pre-mixed as needed during the Charge phase, and
4) Other batch-specific ingredients – directly supplied from the Catalyst Shack or staged in Building No.4 as needed.

The flow of the water, styrene, and pentane are controlled through the DCS, with manual acknowledgement prompts required by the operator before the batch phase continues.

At the start of the Charge Phase, the reactor vent to flare valve (VFL-A) is closed to prevent flare header back-flow into the reactor. The reactor vent to atmosphere valve (VFL-B) is opened to allow reactor head space displacement by the incoming water, and the water flow valve is

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opened. Once the water loading is complete, operator acknowledgement allows the DCS to concurrently open the monomer to reactor inlet valve (FV-R17-M1V) and reverse the positions of the two vent valves (i.e. close the vent to atmosphere and open the vent to flare). Reversing the vent valves is done so as to safely provide a styrene vapor path to the flare rather than directly to the atmosphere.

Once monomer charge has completed, the M1V valve is closed and reactor heat is added by increasing the jacket temperature. During this process, the DCS limits available maximum jacket cooling in preference to heating the reactor charge in preparation for the next React Phase.

2.2 Incident

2.2.1 Incident Time Line

A graphical representation of the incident time line is depicted in the combined TapRooT® SnapChart and Root Cause Tree provided in the appendix material to this report. Valve nomenclatures contained in the cause tree relate to those described in Section 2.1 of this report. Events are enclosed by rectangular boxes, conditions associated with an event are enclosed by oval boxes, precursor and post primary incidents are enclosed by orange circles, the primary incident is enclosed by a red circle, and all Causal Factors are identified with a triangle in the upper right corner of the corresponding chart symbol.

"Causal Factors" are normally defined as conditions, actions, occurrences, etc. that, had they not existed, could have prevented the primary incident from occurring or significantly reduced its consequences. Since the primary incident was in fact the inherent action of a SIS function, it would be counterintuitive to prevent such a function. Therefore the investigation team revised its scope and thus definition of Causal Factor to "issues that could have lessened the likelihood and/or mitigated the consequence of the primary incident" (i.e. in this instance, a SIS initiated reactor release).

2.2.2 Event Sequence Discussion

Note: The time stamps discussed in this report and in the TapRooT® cause tree were corrected to DCS time. The DCS clock was approximately 2 minutes behind CDT and the SIS clock was correct for CDT. The following event summary highlights those events and conditions that led to Causal Factors.

The first occurring deviation from normal operations occurred at approximately 10:59 when the board operator noticed that the vent valves VFL-A&B were still transitioning while the reactor monomer charge had already started. In such a condition, styrene vapors could have been vented through the still open VFL-B valve to the atmosphere. In response to this condition, at 11:04 the

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board operator issued a "Batch Hold" command to the DCS. The DCS then stopped the monomer charge pump CP-4000-A/B and closed the monomer reactor inlet valve M1V.

The next deviation occurred at approximately 11:06 when, after confirming the vent valves had completed their transition and were now in the correct position, the board operator issued the command to "Restart" the monomer charge pump. The deviation was that the charge pump did not start and concurrently the SIS issued a "Command Lock – M1V" alarm. The SIS alarm was the result of two valve position indicators not agreeing on the status of the reactor inlet valve M1V's position (i.e. if it had opened, was still closed, or still transitioning). In such a condition, the DCS interlock will not permit the monomer charge pump to start so as to prevent "dead heading" the pump. Another attempted monomer pump start was made at approximately 11:09 with similar negative results. A contributing condition to this sequence was determined to be the lack of a standard operating procedure detailing how to resume a batch process that had been placed on hold after the batch phase started but before it completed (i.e. a resume during mid-phase procedure). All witnesses' (including one operator with over 40 years of experience in this plant) statements were consistent in stating such a condition had never previously been experienced in this facility.

The operators then issued a Work Order request to have the Maintenance Electrical Technician trouble-shoot the monomer charge valve M1V. In preparation for a potential extended delay in the batch process, the operators then attempted to command the DCS to hold the reactor temperature at 90 °F. Several attempts were made to lower the DCS temperature set point, all of which were unsuccessful. At 11:16, the board operator issued an "Emergency Cool" command to the DCS. At that time, the reactor temperature was approximately 181 °F. While the reactor temperature eventually lowered (at 12:35 the temperature was 161 °F), the delta change per unit of time was not characteristic of an Emergency Cooling situation. Investigation of this condition determined that the DCS programming logic placed a restriction on maximum cooling during the Charge phase. No plant personnel were aware of this restriction and surmised it was placed in the DCS code so as to favor the reactor pre-heating required for the upcoming React phase.

After the Maintenance Electrical Technician confirmed the reactor monomer charge valve M1V was operating properly, the board operator once again attempted to start the monomer charge pump. Approximately seven unsuccessful attempts were made between 13:30 and 15:12. The Shift Supervisor then went to the Motor Control Center and found that the monomer charge pump electrical breaker had tripped out. Once this breaker was reset (approximately 15:45), operators were able to continue the reactor Charge phase which completed at 16:04.

Before process control could be transferred back to the DCS, the Process Control Engineer had to confirm that the DCS logic had kept pace with the manual advances and changes that were

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input by the board operator. Upon arrival at the plant (approximately 16:35), the process control engineer began manually entering the current process conditions and advancing the DCS code so as to synchronize the DCS with the actual physical conditions. The investigation determined that the unknown DCS logic placing a restriction on maximum cooling during Charge phase was not cleared (i.e. reset to allow maximum cooling) either by the automatic DCS code advancement or manually by the Process Control Engineer. The existence of this restriction therefore remained in effect when the reactor batch React phase was eventually continued at 20:02 under DCS process control.

When the reactor React phase commenced, the reactor temperature was 151 °F and then rose to 188 °F at 20:30. At that time, DCS logic placed the reactor into a cooling cycle and one minute later the reactor charge reached the "Trip" (reaction begins) temperature of 191 °F and the SIS is fully armed.

At 20:36, the outside operator opened the reactor sample port (located on the 5th floor) to add an additive to the batch. While doing so, he witnessed some frothing released as he opened the port. The operator concluded that the reactor level must have been higher than normal. In response to his observation and assessment, he notified the board operator that he was on his way to the reactor dump valve (FV-R17-DV) located on the second floor. The outside operator intended to correct the situation by manually releasing a small quantity of the reactor contents to the emergency containment area and then closing the dump valve. This action requires Shift Supervisor authorization. Both the Shift Supervisor and board operator were focused on this request when the DCS automatically initiated "Emergency Cooling" at 20:39 (reactor temperature 200 °F) and the SIS issued a reactor high temperature alarm at 20:40 (reactor temperature 202 °F). The Shift Supervisor enabled the "Hot Drop" function at 20:40. The outside operator manually activated the reactor dump valve (DV) actuator at 20:45 and the SIS initiated a full emergency reactor release at 20:46 (reactor temperature 210 °F). The outside operator then left the second floor to manually open the cooling line valve that by-passes the DCS operated cooling flow control valve.

It is likely that had the operators focused on the reactor rising temperature rather than being diverted by the reactor unconfirmed high level, manual intervention could have negated the still-in-place DCS restriction on maximum cooling. Immediately placing the cooling line into full cooling by-pass most likely would have provided enough reactor cooling to prevent the SIS activation.

Subsequent to the release, the reactor content flow had sufficient momentum to hit the emergency containment area floor and a portion flowed over the pit wall. Impacted soil and gravel adjacent to the emergency containment area was removed for remediation.

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3 INVESTIGATION AND ROOT CAUSE ANALYSIS

3.1 Damage

3.1.1 Personnel Injury

No injuries were reported during the release.

3.1.2 Fire

No ignition resulted from this release.

3.1.3 Overpressure

No evidence of a blast wave was observed.

3.1.4 Mechanical

No equipment physical damage was observed.

3.1.5 Environmental

One offsite odor complaint was received. The release into the emergency containment area was reported to the authorities. The released material was primarily a combination of process water, un-reacted styrene monomer, and reacted polystyrene. Most released materials were contained within the primary emergency containment area; however, a minor portion did flow over the pit wall onto the adjacent plant roadway. No other released materials encroached offsite surface waters. The impacted plant roadway bed soil and gravel was removed.

A detailed environmental impact assessment was not completed at the time of this report's preparation. Confirmatory sampling related to the removal of impacted soil and gravel will be performed.

3.2 Personnel Interviews

Interviews of FHR personnel were conducted by the investigation team. Results of these interviews were incorporated into an investigation time line represented by the TapRooT® Root Cause Tree provided in Appendix B of this report. Interview notes and/or witness prepared statements were also used to develop the sequence of events contained in Section 2.2.1.

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3.3 Root Cause Analysis

The results of the TapRoot® RCA technique are contained in Appendix A and graphically shown in Appendix B.

TapRoot® Worksheets are provided in Appendix C.

A summary of Corrective Actions, listed by type, along with the associated Root Causes and Causal Factors addressed by the Corrective Action, are provided in Appendix D.

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4 FINDINGS

4.1 Summary

The reactor safety SIS function, design, and reliability performed as expected and achieved its primary function. Further, the activation and performance of the SIS averted what, while improbable, potentially could have been a release via the reactor burst disk (last protective layer).

The combination of DCS and SIS controls limited the reactor temperature to 211°F and pressure between 2 to 2.5psig. This condition is less than what would cause water to boil at sea level. The reactor design working temperature is 400°F and 150psig.

While the safety system did perform its primary function, several recommendations were identified that could lessen the likelihood, and/or mitigate the consequence, of a SIS reactor release.

4.2 Recommendations

- 1A – Provide a sequencing code in the DCS batch logic that executes vent valve line-up prior to monomer charge.
- 1B – Interlock the monomer charge M1 valve to vent valve position.
- 2A – Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action.
- 2B – Prior to Restart, analyze all changes and new additions to the Operator Procedures Manual and train each operator accordingly.
- 3A – Remove the DCS coding that restricts maximum cooling from any phase of the batch process control logic.
- 3B – Review / analyze all DCS batch code control logic to ascertain potential downstream effects and interactions with other batch phases and SIS.
- 4A – Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.
- 4B – Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).

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- 6A – Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.

- 6B – Revise Operating Procedures to include a reactor temperature, pressure, and level confirmation step before re-start after any extended batch hold.

- 6C – Consider lowering the reactor pressure set point limit that activates the warning light adjacent to the sample port.

- 7A – Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.

- 8A – Extend outside perimeter pit wall height so as to reduce the likelihood of flow wave splash over.

- 8B – Extend the reactor dump line to within the emergency containment area wall.

- 8C – Install a vapor suppression and firefighting foam system to cover the emergency containment area surface area.

- 8D – Discontinue use of water spray dispersion system (water nozzle at reactor dump line outlet) once the foam system is activated.

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APPENDIX A. TAPROOT® INVESTIGATION FINAL REPORT

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TapRooT® Investigation Report

NUMBER:	01-04869-001-14
TITLE:	FHR Peru, IL Polystyrene Reactor
DATE AND TIME OF INCIDENT:	25/04/2014 08:47 PM
DATE AND TIME INVESTIGATION	05/05/2014
LOCATION:	Peru, IL
CLASSIFICATION(S):	Environmental Spill - open
INVESTIGATION TEAM MEMBERS:	Thomas V. Rodante, BakerRisk – Lead Investigator Mary Steinbach, FHR – Participant Keith Marshall, FHR – Participant Chad Holman, FHR – Participant Devin Moss, FHR – Participant Mike Shea, FHR – Participant

DESCRIPTION:
On April 25, 2014 at approximately 20:47 hours, reactor R17 within Building No.4 experienced an automatic dump into an open air retention pit. The dump was initiated by the Safety Instrumented System in response to elevated temperature rise within the reactor.

INVESTIGATIVE TECHNIQUE:
A Root Cause Analysis (RCA) was conducted by the investigative team. TapRooT® was used as the RCA technique and documentation tool. All headings, Root Cause Basic Categories, Chart symbols, etc. follow the TapRooT® technique conventions.

This FINAL report was generated by the TapRooT® software tool and contains a listing of Causal Factors with each associated Root Cause listed by Basic Category. For each Basic Category, recommended Corrective Actions to address that category are listed. The Corrective Actions are also grouped by the Root Cause assigned to each Causal Factor. Corrective Actions are preceded with an alpha numeric number which matches the Causal Factor number for which the action is intended to mitigate.

Corrective Actions identified as "Prior to Restart" were categorized as such because these have the potential to directly affect the health and safety of personnel and the environment. Those Corrective Actions not categorized as "Prior to Restart" are considered to be further refinements and enhancements to the higher priority items.

CAUSAL FACTOR 1: DCS allows monomer flow before vent valves are lined up correctly			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Hazard analysis NI	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
	1A - DCS - Provide a sequencing code in the DCS batch logic that executes vent valve line-up prior to monomer charge.	Prior to Restart	
	1B - InLok - Interlock monomer charge M1 valve to vent valve position.	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	
	8A - Equip - Extend outside perimeter pit wall height so as to reduce the likelihood of flow wave splash over.	Prior to Restart	
	8C - Equip - Install a vapor suppression and firefighting foam system to cover the emergency containment area	Prior to Restart	
	8D - Equip - Discontinue use of water spray dispersion system (water nozzle at reactor dump line outlet) once the foam system is activated.	Prior to Restart	
Problem Not Anticipated	2A - Op Pr - Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action,	Prior to Restart	
	1A - DCS - Provide a sequencing code in the DCS batch logic that executes vent valve line-up prior to monomer charge.	Prior to Restart	
	1B - InLok - Interlock monomer charge M1 valve to vent valve position.	Prior to Restart	
	3A - DCS - Remove the DCS coding that restricts maximum cooling from any phase of the batch process control logic.	Prior to Restart	

CAUSAL FACTOR 1: DCS allows monomer flow before vent valves are lined up correctly			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
	3B - DCS - Review / analyze all DCS batch code control logic to ascertain potential downstream effects and interactions with other batch phases and SIS.	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	

CAUSAL FACTOR 3: DCS Monomer Charge Phase logic restricts maximum cooling			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Problem Not Anticipated	2A - Op Pr - Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action,	Prior to Restart	
	1A - DCS - Provide a sequencing code in the DCS batch logic that executes vent valve line-up prior to monomer charge.	Prior to Restart	
	1B - InLok - Interlock monomer charge M1 valve to vent valve position.	Prior to Restart	
	3A - DCS - Remove the DCS coding that restricts maximum cooling from any phase of the batch process control logic.	Prior to Restart	
	3B - DCS - Review / analyze all DCS batch code control logic to ascertain potential downstream effects and interactions with other batch phases and SIS inputs.	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	

CAUSAL FACTOR 5: Monomer Charge Phase maximum cooling restriction is not released from DCS logic			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Inspection techniques NI	2A - Op Pr - Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action,	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and after end phase holds).	Prior to Restart	
Problem Not Anticipated	2A - Op Pr - Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action,	Prior to Restart	
	1A - DCS - Provide a sequencing code in the DCS batch logic that executes vent valve line-up prior to monomer charge.	Prior to Restart	
	1B - InLok - Interlock monomer charge M1 valve to vent valve position.	Prior to Restart	
	3A - DCS - Remove the DCS coding that restricts maximum cooling from any phase of the batch process control logic.	Prior to Restart	
	3B - DCS - Review / analyze all DCS batch code control logic to ascertain potential downstream effects and interactions with other batch phases and SIS inputs.	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	

CAUSAL FACTOR 5: Monomer Charge Phase maximum cooling restriction is not released from DCS logic			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Turnover process NI	2A - Op Pr - Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action,	Prior to Restart	

CAUSAL FACTOR 2: Operations Manual doesn't have a mid-phase re-start procedure			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
No procedure	2A - Op Pr - Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action,	Prior to Restart	
Situation not covered	2A - Op Pr - Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action,	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
Task not analyzed	2B - Train - Prior to Restart, analyze all changes and new additions to the Operator Procedures Manual and train each operator accordingly.	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	

CAUSAL FACTOR 7: Operator goes to first floor to manually open Dump Valve by activating MOV switch			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Design Not To Specifications	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
	8A - Equip - Extend outside perimeter pit wall height so as to reduce the likelihood of flow wave splash over.	Prior to Restart	
	8C - Equip - Install a vapor suppression and firefighting foam system to cover the emergency containment area	Prior to Restart	
	8D - Equip - Discontinue use of water spray dispersion system (water nozzle at reactor dump line outlet) once the foam system is activated.	Prior to Restart	
Details NI	6B - Op Pr - Revise Operating Procedures to include a reactor temperature, pressure, and level confirmation step before re-start after any extended batch hold.	Prior to Restart	
	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
Equipment guard NI	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
Knowledge-based decision required	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	
Limits NI	6C - Instr - Consider lowering the reactor pressure set point limit that activates the warning light adjacent to the sample port.	6A +1 month	
	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
	6B - Op Pr - Revise Operating Procedures to include a reactor temperature, pressure, and level confirmation step before re-start after any extended batch hold.	Prior to Restart	

CAUSAL FACTOR 7: Operator goes to first floor to manually open Dump Valve by activating MOV switch			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
Monitoring alertness NI	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
No Checkoff	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
	6B - Op Pr - Revise Operating Procedures to include a reactor temperature, pressure, and level confirmation step before re-start after any extended batch hold.	Prior to Restart	
Upset	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	

CAUSAL FACTOR 6: Operator splashed while opening sample port			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Arrangement / placement	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
Details NI	6B - Op Pr - Revise Operating Procedures to include a reactor temperature, pressure, and level confirmation step before re-start after any extended batch hold.	Prior to Restart	
	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
Equipment guard NI	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
Hazard analysis NI	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 month	
	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
	1A - DCS - Provide a sequencing code in the DCS batch logic that executes vent valve line-up prior to monomer charge.	Prior to Restart	
	1B - InLok - Interlock monomer charge M1 valve to vent valve position.	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	
	8A - Equip - Extend outside perimeter pit wall height so as to reduce the likelihood of flow wave splash over.	Prior to Restart	
	8C - Equip - Install a vapor suppression and firefighting foam system to cover the emergency containment area	Prior to Restart	
	8D - Equip - Discontinue use of water spray dispersion system (water nozzle at reactor dump line outlet) once the foam system is activated.	Prior to Restart	

CAUSAL FACTOR 6: Operator splashed while opening sample port			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Limits NI	6C - Instr - Consider lowering the reactor pressure set point limit that activates the warning light adjacent to the sample port.	6A +1 month	
	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
	6B - Op Pr - Revise Operating Procedures to include a reactor temperature, pressure, and level confirmation step before re-start after any extended batch hold.	Prior to Restart	
	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	

CAUSAL FACTOR 4: Operators choose different options to restart pump that might have disrupted phase sequence logic			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Controls NI	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	
Details NI	6B - Op Pr - Revise Operating Procedures to include a reactor temperature, pressure, and level confirmation step before re-start after any extended batch hold.	Prior to Restart	
	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
Hazard analysis NI	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
	1A - DCS - Provide a sequencing code in the DCS batch logic that executes vent valve line-up prior to monomer charge.	Prior to Restart	
	1B - InLok - Interlock monomer charge M1 valve to vent valve position.	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	
	8A - Equip - Extend outside perimeter pit wall height so as to reduce the likelihood of flow wave splash over.	Prior to Restart	
	8C - Equip - Install a vapor suppression and firefighting foam system to cover the emergency containment area	Prior to Restart	
	8D - Equip - Discontinue use of water spray dispersion system (water nozzle at reactor dump line outlet) once the foam system is activated.	Prior to Restart	

CAUSAL FACTOR 4: Operators choose different options to restart pump that might have disrupted phase sequence logic			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Knowledge-based decision required	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	
Pre-job briefing NI	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
Problem Not Anticipated	2A - Op Pr - Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action,	Prior to Restart	
	1A - DCS - Provide a sequencing code in the DCS batch logic that executes vent valve line-up prior to monomer charge.	Prior to Restart	
	1B - InLok - Interlock monomer charge M1 valve to vent valve position.	Prior to Restart	
	3A - DCS - Remove the DCS coding that restricts maximum cooling from any phase of the batch process control logic.	Prior to Restart	
	3B - DCS - Review / analyze all DCS batch code control logic to ascertain potential downstream effects and interactions with other batch phases and SIS inputs.	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	

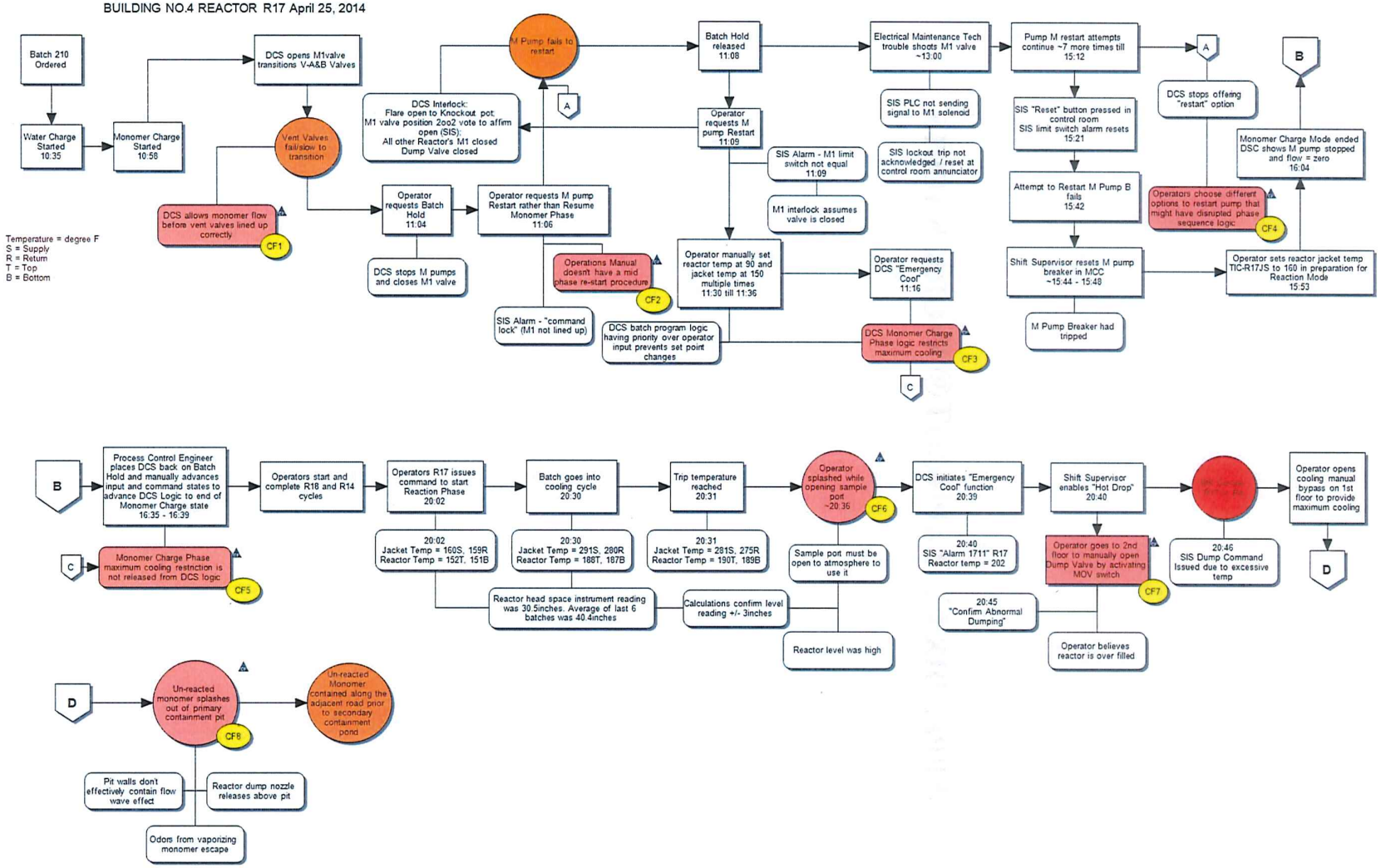
CAUSAL FACTOR 4: Operators choose different options to restart pump that might have disrupted phase sequence logic			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Situation not covered	2A - Op Pr - Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action,	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
Supervision During Work	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
Task not analyzed	2B - Train - Prior to Restart, analyze all changes and new additions to the Operator Procedures Manual and train each operator accordingly.	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	

CAUSAL FACTOR 8: Un-reacted monomer splashes out of primary containment pit			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
Design Not To Specifications	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
	8A - Equip - Extend outside perimeter pit wall height so as to reduce the likelihood of flow wave splash over.	Prior to Restart	
	8C - Equip - Install a vapor suppression and firefighting foam system to cover the emergency containment area	Prior to Restart	
	8D - Equip - Discontinue use of water spray dispersion system (water nozzle at reactor dump line outlet) once the foam system is activated.	Prior to Restart	
Hazard analysis NI	6A - Equip - Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	Restart +3 months	
	7A - DCS - Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	Restart +1 month	
	1A - DCS - Provide a sequencing code in the DCS batch logic that executes vent valve line-up prior to monomer charge.	Prior to Restart	
	1B - InLok - Interlock monomer charge M1 valve to vent valve position.	Prior to Restart	
	4A - DCS - Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	Prior to Restart	
	4B - DCS - Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	Prior to Restart	
	8A - Equip - Extend outside perimeter pit wall height so as to reduce the likelihood of flow wave splash over.	Prior to Restart	
	8C - Equip - Install a vapor suppression and firefighting foam system to cover the emergency containment area	Prior to Restart	
	8D - Equip - Discontinue use of water spray dispersion system (water nozzle at reactor dump line outlet) once the foam system is activated.	Prior to Restart	
Specifications NI	8A - Equip - Extend outside perimeter pit wall height so as to reduce the likelihood of flow wave splash over.	Prior to Restart	

CAUSAL FACTOR 8: Un-reacted monomer splashes out of primary containment pit			
Root Cause	**Corrective Action(s)**	**Priority**	**Due Date**
	8C - Equip - Install a vapor suppression and firefighting foam system to cover the emergency containment area	Prior to Restart	
	8D - Equip - Discontinue use of water spray dispersion system (water nozzle at reactor dump line outlet) once the foam system is activated.	Prior to Restart	

APPENDIX B. TAPROOT® CAUSE TREE

BUILDING NO.4 REACTOR R17 April 25, 2014



APPENDIX C. TAPROOT® WORK SHEETS

TapRooT® Root Cause Tree®

CAUSAL FACTOR 1: DCS allows monomer flow before vent valves lined up correctly

START HERE with each causal factor/ issue and select or eliminate each category to find root causes

- ~~HUMAN PERFORMANCE DIFFICULTY~~
- EQUIPMENT DIFFICULTY
  - *Note: Consider EquifactorTM Analysis
- ~~NATURAL DISASTER/ SABOTAGE~~
- ~~OTHER (Specify)~~

EQUIPMENT DIFFICULTY:

- TOLERABLE FAILURE
- DESIGN
  - DESIGN SPECS
    - Specs NI
    - Design Not To Specs
    - Problem Not Anticipated
      - equipment environment not considered
  - DESIGN REVIEW
    - Independent Review NI
      - management of change (moc) NI
      - ✓ hazard analysis NI
- ~~EQUIPMENT/ PARTS DEFECTIVE~~
  - PROCUREMENT
  - MANUFACTURING
  - HANDLING
  - STORAGE
  - QUALITY CONTROL
  - ...
- PREVENTIVE/ PREDICTIVE MAINTENANCE
  - PM NI
    - No PM for Equip
    - PM for Equip NI
- ~~REPEAT FAILURE~~
  - MANAGEMENT SYSTEM
    - Corrective Action
      - corrective action NI
      - corrective action not yet implemented
      - trending NI

Human Performance Troubleshooting Guide (15 Questions)

NI = Needs Improvement

Individual Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
Was a person excessively fatigued, impaired, upset, bored, distracted, or overwhelmed?	Yes	HUMAN ENGINEERING WORK DIRECTION
Should the person have had and used a written procedure but did not?	Yes	WORK DIRECTION PROCEDURES HUMAN ENGINEERING
Was a mistake made while using a procedure?	Yes	PROCEDURES
Were alarms or displays to recognize or to respond to a condition unavailable or misunderstood?	Yes	HUMAN ENGINEERING
Were displays, alarms, controls, tools, or equipment identified or operated improperly?	Yes	TRAINING PROCEDURES HUMAN ENGINEERING
Did the person need more skill / knowledge to perform the job or to respond to conditions or to understand system response?	Yes	TRAINING WORK DIRECTION
Was work performed in an adverse environment (such as hot, humid, dark, cramped, or hazardous)?	Yes	HUMAN ENGINEERING
Did work involve repetitive motion, uncomfortable positions, vibration, or heavy lifting?	Yes	TRAINING HUMAN ENGINEERING WORK DIRECTION

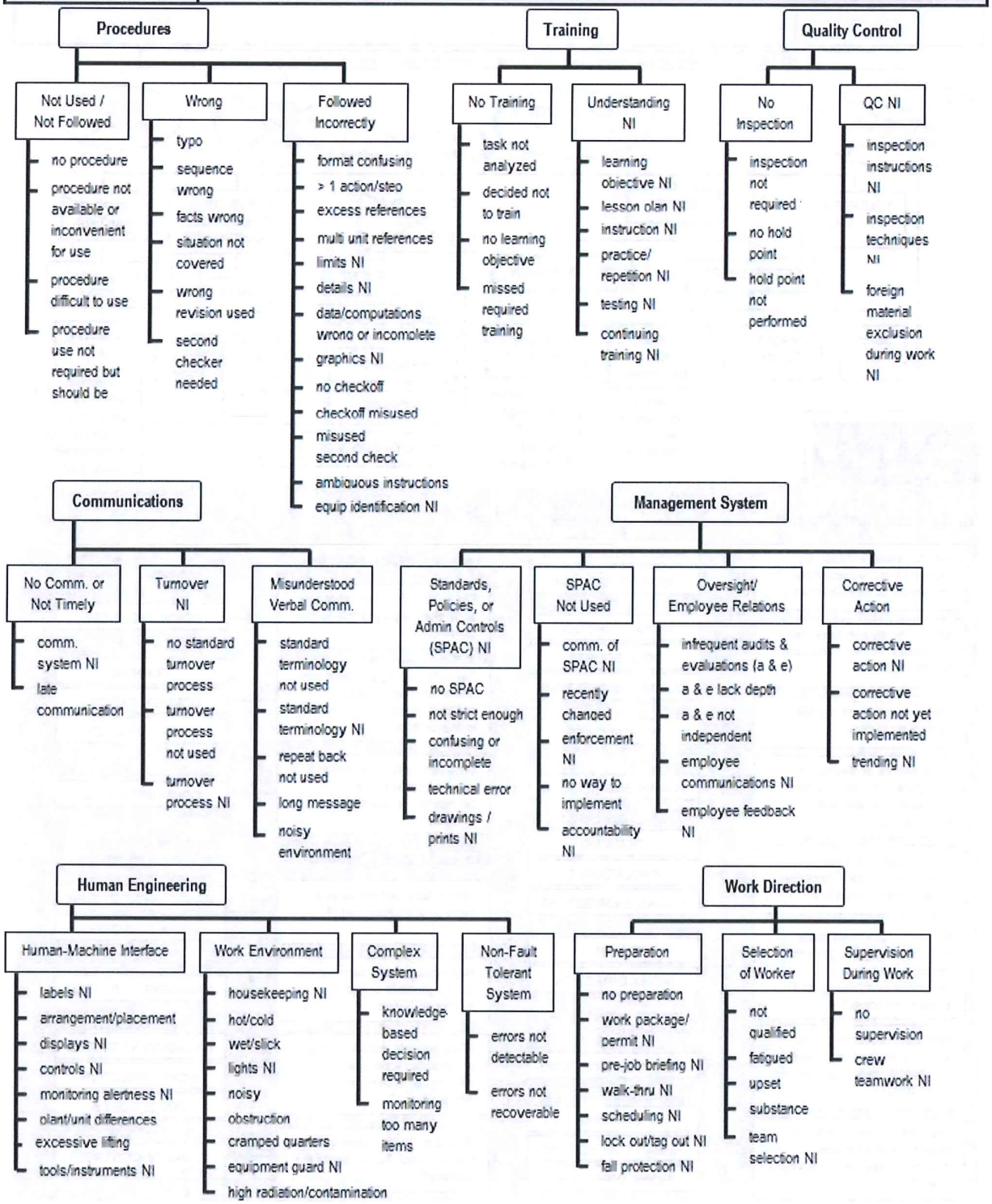
Team Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
Did verbal communications or shift change play a role in this problem?	Yes	COMMUNICATIONS
Did failure to agree about the who/what/when/where of performing the job play a role in this problem?	Yes	TRAINING COMMUNICATIONS WORK DIRECTION
Was communication needed across organizational boundaries or with other facilities?	Yes	COMMUNICATIONS

Management System

Question	Yes	Basic Cause Categories (on back) to Investigate
Was a task performed in a hurry or a shortcut used?	Yes	MANAGEMENT SYSTEM WORK DIRECTION
Had management been warned of this problem or had it happened before?	Yes	MANAGEMENT SYSTEM
Were policies, admin. controls, or procedures not used, missing, or in need of improvement?	Yes	MANAGEMENT SYSTEM WORK DIRECTION PROCEDURES
Should an independent quality control check have caught the problem?	Yes	QUALITY CONTROL

Basic Cause Categories	CAUSAL FACTOR: DCS allows monomer flow before vent valves lined up correctly



TapRooT® Root Cause Tree®

CAUSAL FACTOR 2: Operations Manual doesn't have a mid-phase re-start procedure

START HERE with each causal factor/ issue and select or eliminate each category to find root causes

- HUMAN PERFORMANCE DIFFICULTY
- ~~EQUIPMENT DIFFICULTY~~
- ~~NATURAL DISASTER/ SABOTAGE~~
- ~~OTHER (Specify)~~

*Note: Consider EquifactorTM Analysis

- TOLERABLE FAILURE
- DESIGN
  - DESIGN SPECS
    - Specs NI
    - Design Not To Specs
    - Problem Not Anticipated
      - equipment environment not considered
  - DESIGN REVIEW
    - Independent Review NI
      - management of change (moc) NI
      - hazard analysis NI
- EQUIPMENT/ PARTS DEFECTIVE
  - PROCUREMENT
  - MANUFACTURING
  - HANDLING
  - STORAGE
  - QUALITY CONTROL
- PREVENTIVE/ PREDICTIVE MAINTENANCE
  - PM NI
    - No PM for Equip
    - PM for Equip NI
- REPEAT FAILURE
  - MANAGEMENT SYSTEM
    - Corrective Action
      - corrective action NI
      - corrective action not yet implemented
      - trending NI

Human Performance Troubleshooting Guide (15 Questions)

NI = Needs Improvement

Individual Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
~~Was a person excessively fatigued, impaired, upset, bored, distracted, or overwhelmed?~~	Yes	HUMAN ENGINEERING WORK DIRECTION
Should the person have had and used a written procedure but did not?	Yes	WORK DIRECTION PROCEDURES HUMAN ENGINEERING
~~Was a mistake made while using a procedure?~~	Yes	PROCEDURES
~~Were alarms or displays to recognize or to respond to a condition unavailable or misunderstood?~~	Yes	HUMAN ENGINEERING
Were displays, alarms, controls, tools, or equipment identified or operated improperly?	Yes	TRAINING PROCEDURES HUMAN ENGINEERING
~~Did the person need more skill / knowledge to perform the job or to respond to conditions or to understand system response?~~	Yes	TRAINING WORK DIRECTION
~~Was work performed in an adverse environment (such as hot, humid, dark, cramped, or hazardous)?~~	Yes	HUMAN ENGINEERING
~~Did work involve repetitive motion, uncomfortable positions, vibration, or heavy lifting?~~	Yes	TRAINING HUMAN ENGINEERING WORK DIRECTION

Team Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
~~Did verbal communications or shift change play a role in this problem?~~	Yes	COMMUNICATIONS
~~Did failure to agree about the who/what/when/where of performing the job play a role in this problem?~~	Yes	TRAINING COMMUNICATIONS WORK DIRECTION
~~Was communication needed across organizational boundaries or with other facilities?~~	Yes	COMMUNICATIONS

Management System

Question	Yes	Basic Cause Categories (on back) to Investigate
~~Was a task performed in a hurry or a shortcut used?~~	Yes	MANAGEMENT SYSTEM WORK DIRECTION
~~Had management been warned of this problem or had it happened before?~~	Yes	MANAGEMENT SYSTEM
~~Were policies, admin. controls, or procedures not used, missing, or in need of improvement?~~	Yes	MANAGEMENT SYSTEM WORK DIRECTION PROCEDURES
~~Should an independent quality control check have caught the problem?~~	Yes	QUALITY CONTROL

Basic Cause Categories	CAUSAL FACTOR 2: Operations Manual doesn't have a mid-phase re-start procedure

- **Procedures**
  - Not Used / Not Followed
    - ✓ no procedure
    - procedure not available or inconvenient for use
    - procedure difficult to use
    - procedure use not required but should be
  - Wrong
    - typo
    - sequence wrong
    - facts wrong
    - ✓ situation not covered
    - wrong revision used
    - second checker needed
  - ~~Followed Incorrectly~~
    - format confusing
    - > 1 action/step
    - excess references
    - multi unit references
    - limits NI
    - details NI
    - data/computations wrong or incomplete
    - graphics NI
    - no checkoff
    - checkoff misused
    - misused second check
    - ambiguous instructions
    - equip identification NI
- **Training**
  - No Training
    - ✓ task not analyzed
    - decided not to train
    - no learning objective
    - missed required training
  - Understanding NI
    - learning objective NI
    - lesson plan NI
    - instruction NI
    - practice/ repetition NI
    - testing NI
    - continuing training NI
- **Quality Control**
  - No Inspection
    - inspection not required
    - no hold point
    - hold point not performed
  - QC NI
    - inspection instructions NI
    - inspection techniques NI
    - foreign material exclusion during work NI
- **Communications**
  - No Comm. or Not Timely
    - comm. system NI
    - late communication
  - Turnover NI
    - no standard turnover process
    - turnover process not used
    - turnover process NI
  - Misunderstood Verbal Comm.
    - standard terminology not used
    - standard terminology NI
    - repeat back not used
    - long message
    - noisy environment
- **Management System**
  - Standards, Policies, or Admin Controls (SPAC) NI
    - no SPAC
    - not strict enough
    - confusing or incomplete
    - technical error
    - drawings / prints NI
  - SPAC Not Used
    - comm. of SPAC NI
    - recently changed
    - enforcement NI
    - no way to implement
    - accountability NI
  - Oversight/ Employee Relations
    - infrequent audits & evaluations (a & e)
    - a & e lack depth
    - a & e not independent
    - employee communications NI
    - employee feedback NI
  - Corrective Action
    - corrective action NI
    - corrective action not yet implemented
    - trending NI
- **Human Engineering**
  - ~~Human-Machine Interface~~
    - labels NI
    - arrangement/placement
    - displays NI
    - controls NI
    - monitoring alertness NI
    - plant/unit differences
    - excessive lifting
    - tools/instruments NI
  - ~~Work Environment~~
    - housekeeping NI
    - hot/cold
    - wet/slick
    - lights NI
    - noisy
    - obstruction
    - cramped quarters
    - equipment guard NI
    - high radiation/contamination
  - ~~Complex System~~
    - knowledge based decision required
    - monitoring too many items
  - ~~Non-Fault Tolerant System~~
    - errors not detectable
    - errors not recoverable
- **Work Direction**
  - ~~Preparation~~
    - no preparation
    - work package/ permit NI
    - pre-job briefing NI
    - walk-thru NI
    - scheduling NI
    - lock out/tag out NI
    - fall protection NI
  - ~~Selection of Worker~~
    - not qualified
    - fatigued
    - upset
    - substance
    - team selection NI
  - ~~Supervision During Work~~
    - no supervision
    - crew teamwork NI

TapRooT® Root Cause Tree®

CAUSAL FACTOR 3: DCS Monomer Charge Phase logic restricts maximum cooling

START HERE with each causal factor/ issue and select or eliminate each category to find root causes

- ~~HUMAN PERFORMANCE DIFFICULTY~~
- EQUIPMENT DIFFICULTY
  - *Note: Consider EquifactorTM Analysis
- ~~NATURAL DISASTER/ SABOTAGE~~
- ~~OTHER (Specify)~~

- TOLERABLE FAILURE
- DESIGN
  - DESIGN SPECS
    - Specs NI
    - Design Not To Specs
    - Problem Not Anticipated
      - equipment environment not considered
  - DESIGN REVIEW
    - Independent Review NI
      - management of change (moc) NI
      - hazard analysis NI
- EQUIPMENT/ PARTS DEFECTIVE
  - PROCUREMENT
  - MANUFACTURING
  - HANDLING
  - STORAGE
  - QUALITY CONTROL
  - ...
- PREVENTIVE/ PREDICTIVE MAINTENANCE
  - PM NI
    - No PM for Equip
    - PM for Equip NI
- REPEAT FAILURE
  - MANAGEMENT SYSTEM
    - Corrective Action
      - corrective action NI
      - corrective action not yet implemented
      - trending NI

Human Performance Troubleshooting Guide (15 Questions)

NI = Needs Improvement

Individual Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
Was a person excessively fatigued, impaired, upset, bored, distracted, or overwhelmed?	Yes	HUMAN ENGINEERING; WORK DIRECTION
Should the person have had and used a written procedure but did not?	Yes	WORK DIRECTION; PROCEDURES; HUMAN ENGINEERING
Was a mistake made while using a procedure?	Yes	PROCEDURES
Were alarms or displays to recognize or to respond to a condition unavailable or misunderstood?	Yes	HUMAN ENGINEERING
Were displays, alarms, controls, tools, or equipment identified or operated improperly?	Yes	TRAINING; PROCEDURES; HUMAN ENGINEERING
Did the person need more skill / knowledge to perform the job or to respond to conditions or to understand system response?	Yes	TRAINING; WORK DIRECTION
Was work performed in an adverse environment (such as hot, humid, dark, cramped, or hazardous)?	Yes	HUMAN ENGINEERING
Did work involve repetitive motion, uncomfortable positions, vibration, or heavy lifting?	Yes	TRAINING; HUMAN ENGINEERING; WORK DIRECTION

Team Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
Did verbal communications or shift change play a role in this problem?	Yes	COMMUNICATIONS
Did failure to agree about the who/what/when/where of performing the job play a role in this problem?	Yes	TRAINING; COMMUNICATIONS; WORK DIRECTION
Was communication needed across organizational boundaries or with other facilities?	Yes	COMMUNICATIONS

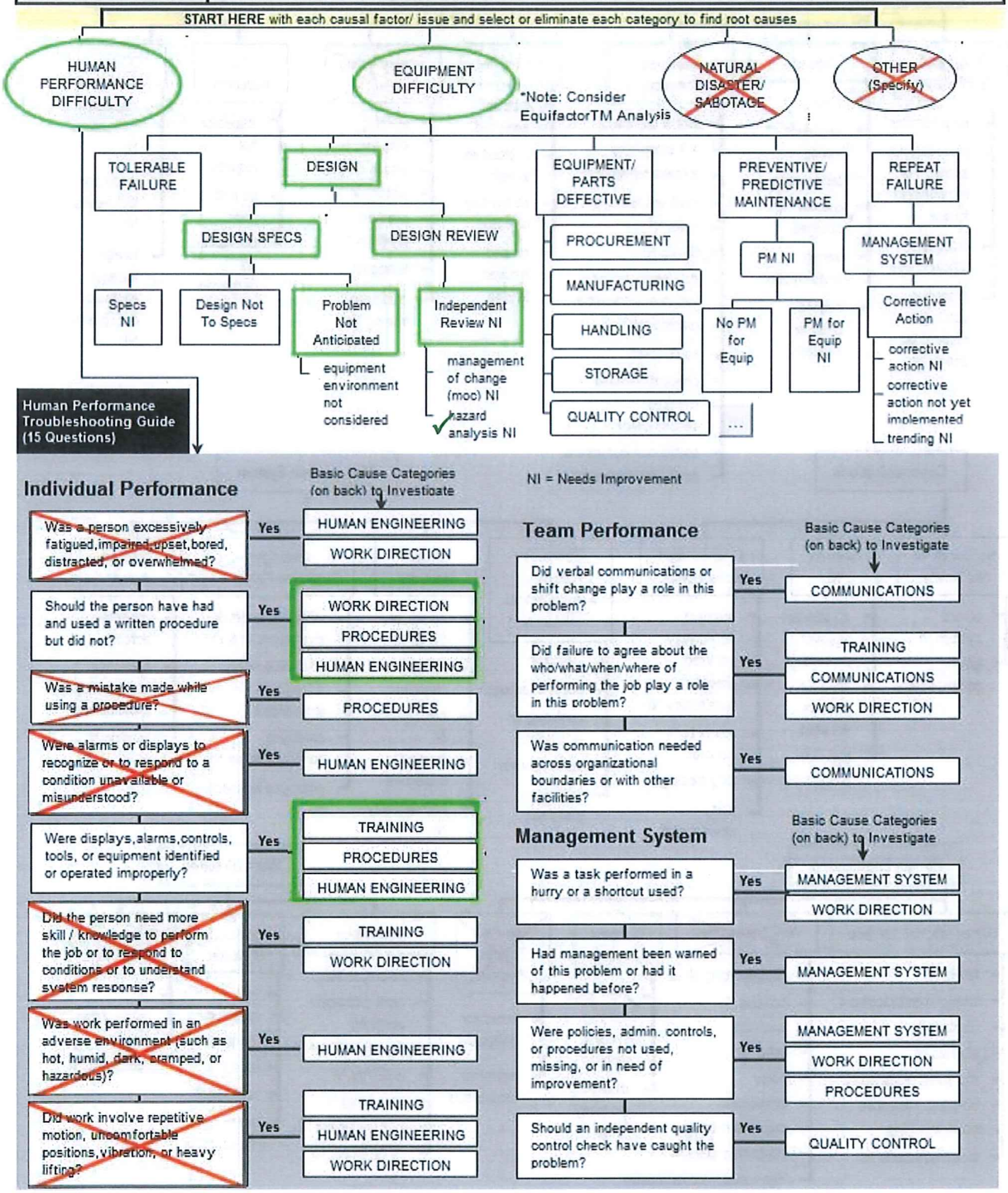
Management System

Question	Yes	Basic Cause Categories (on back) to Investigate
Was a task performed in a hurry or a shortcut used?	Yes	MANAGEMENT SYSTEM; WORK DIRECTION
Had management been warned of this problem or had it happened before?	Yes	MANAGEMENT SYSTEM
Were policies, admin. controls, or procedures not used, missing, or in need of improvement?	Yes	MANAGEMENT SYSTEM; WORK DIRECTION; PROCEDURES
Should an independent quality control check have caught the problem?	Yes	QUALITY CONTROL

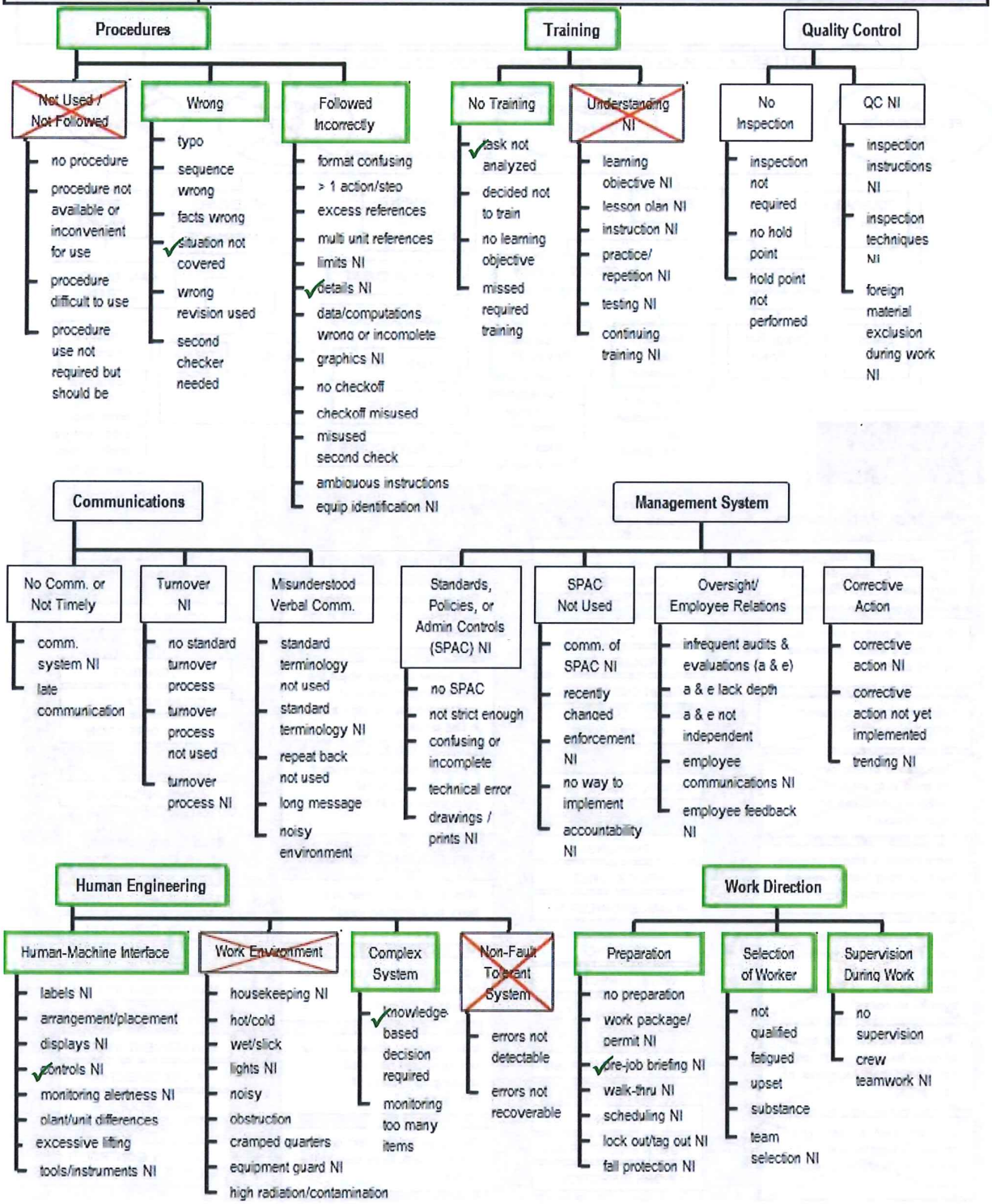
Basic Cause Categories	**CAUSAL FACTOR:** DCS Monomer Charge Phase logic restricts maximum cooling

- **Procedures**
  - Not Used / Not Followed
    - no procedure
    - procedure not available or inconvenient for use
    - procedure difficult to use
    - procedure use not required but should be
  - Wrong
    - typo
    - sequence wrong
    - facts wrong
    - situation not covered
    - wrong revision used
    - second checker needed
  - Followed Incorrectly
    - format confusing
    - > 1 action/step
    - excess references
    - multi unit references
    - limits NI
    - details NI
    - data/computations wrong or incomplete
    - graphics NI
    - no checkoff
    - checkoff misused
    - misused second check
    - ambiguous instructions
    - equip identification NI
- **Training**
  - No Training
    - task not analyzed
    - decided not to train
    - no learning objective
    - missed required training
  - Understanding NI
    - learning objective NI
    - lesson plan NI
    - instruction NI
    - practice/ repetition NI
    - testing NI
    - continuing training NI
- **Quality Control**
  - No Inspection
    - inspection not required
    - no hold point
    - hold point not performed
  - QC NI
    - inspection instructions NI
    - inspection techniques NI
    - foreign material exclusion during work NI
- **Communications**
  - No Comm. or Not Timely
    - comm. system NI
    - late communication
  - Turnover NI
    - no standard turnover process
    - turnover process not used
    - turnover process NI
  - Misunderstood Verbal Comm.
    - standard terminology not used
    - standard terminology NI
    - repeat back not used
    - long message
    - noisy environment
- **Management System**
  - Standards, Policies, or Admin Controls (SPAC) NI
    - no SPAC
    - not strict enough
    - confusing or incomplete
    - technical error
    - drawings / prints NI
  - SPAC Not Used
    - comm. of SPAC NI
    - recently changed
    - enforcement NI
    - no way to implement
    - accountability NI
  - Oversight/ Employee Relations
    - infrequent audits & evaluations (a & e)
    - a & e lack depth
    - a & e not independent
    - employee communications NI
    - employee feedback NI
  - Corrective Action
    - corrective action NI
    - corrective action not yet implemented
    - trending NI
- **Human Engineering**
  - Human-Machine Interface
    - labels NI
    - arrangement/placement
    - displays NI
    - controls NI
    - monitoring alertness NI
    - plant/unit differences
    - excessive lifting
    - tools/instruments NI
  - Work Environment
    - housekeeping NI
    - hot/cold
    - wet/slick
    - lights NI
    - noisy
    - obstruction
    - cramped quarters
    - equipment guard NI
    - high radiation/contamination
  - Complex System
    - knowledge-based decision required
    - monitoring too many items
  - Non-Fault Tolerant System
    - errors not detectable
    - errors not recoverable
- **Work Direction**
  - Preparation
    - no preparation
    - work package/ permit NI
    - pre-job briefing NI
    - walk-thru NI
    - scheduling NI
    - lock out/tag out NI
    - fall protection NI
  - Selection of Worker
    - not qualified
    - fatigued
    - upset
    - substance
    - team selection NI
  - Supervision During Work
    - no supervision
    - crew teamwork NI

TapRooT® Root Cause Tree®	**CAUSAL FACTOR 4:** Operators choose different options to restart pump that might have disrupted phase sequence logic



Basic Cause Categories	CAUSAL FACTOR: Operators choose different options to restart pump that might have disrupted phase sequence logic



TapRooT® Root Cause Tree®

CAUSAL FACTOR 5: Monomer Charge Phase maximum cooling restriction is not released from DCS logic

START HERE with each causal factor/ issue and select or eliminate each category to find root causes

- HUMAN PERFORMANCE DIFFICULTY
- EQUIPMENT DIFFICULTY
  - *Note: Consider EquifactorTM Analysis
- ~~NATURAL DISASTER/ SABOTAGE~~
- ~~OTHER (Specify)~~

- ~~TOLERABLE FAILURE~~
- DESIGN
  - DESIGN SPECS
    - ~~Specs NI~~
    - ~~Design Not To Specs~~
    - Problem Not Anticipated
      - equipment environment not considered
  - ~~DESIGN REVIEW~~
    - Independent Review NI
      - management of change (moc) NI
      - hazard analysis NI
- ~~EQUIPMENT/ PARTS DEFECTIVE~~
  - PROCUREMENT
  - MANUFACTURING
  - HANDLING
  - STORAGE
  - QUALITY CONTROL
  - ...
- ~~PREVENTIVE/ PREDICTIVE MAINTENANCE~~
  - PM NI
    - No PM for Equip
    - PM for Equip NI
- ~~REPEAT FAILURE~~
  - MANAGEMENT SYSTEM
    - Corrective Action
      - corrective action NI
      - corrective action not yet implemented
      - trending NI

Human Performance Troubleshooting Guide (15 Questions)

NI = Needs Improvement

Individual Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
~~Was a person excessively fatigued, impaired, upset, bored, distracted, or overwhelmed?~~	Yes	HUMAN ENGINEERING WORK DIRECTION
~~Should the person have had and used a written procedure but did not?~~	Yes	WORK DIRECTION PROCEDURES HUMAN ENGINEERING
~~Was a mistake made while using a procedure?~~	Yes	PROCEDURES
~~Were alarms or displays to recognize or to respond to a condition unavailable or misunderstood?~~	Yes	HUMAN ENGINEERING
~~Were displays, alarms, controls, tools, or equipment identified or operated improperly?~~	Yes	TRAINING PROCEDURES HUMAN ENGINEERING
~~Did the person need more skill / knowledge to perform the job or to respond to conditions or to understand system response?~~	Yes	TRAINING WORK DIRECTION
~~Was work performed in an adverse environment (such as hot, humid, dark, cramped, or hazardous)?~~	Yes	HUMAN ENGINEERING
~~Did work involve repetitive motion, uncomfortable positions, vibration, or heavy lifting?~~	Yes	TRAINING HUMAN ENGINEERING WORK DIRECTION

Team Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
~~Did verbal communications or shift change play a role in this problem?~~	Yes	COMMUNICATIONS
~~Did failure to agree about the who/what/when/where of performing the job play a role in this problem?~~	Yes	TRAINING COMMUNICATIONS WORK DIRECTION
Was communication needed across organizational boundaries or with other facilities?	Yes	COMMUNICATIONS

Management System

Question	Yes	Basic Cause Categories (on back) to Investigate
~~Was a task performed in a hurry or a shortcut used?~~	Yes	MANAGEMENT SYSTEM WORK DIRECTION
~~Had management been warned of this problem or had it happened before?~~	Yes	MANAGEMENT SYSTEM
~~Were policies, admin. controls, or procedures not used, missing, or in need of improvement?~~	Yes	MANAGEMENT SYSTEM WORK DIRECTION PROCEDURES
Should an independent quality control check have caught the problem?	Yes	QUALITY CONTROL

Basic Cause Categories	**CAUSAL FACTOR:** Monomer Charge Phase maximum cooling restriction is not released from DCS logic

- **Procedures**
  - Not Used / Not Followed
    - no procedure
    - procedure not available or inconvenient for use
    - procedure difficult to use
    - procedure use not required but should be
  - Wrong
    - typo
    - sequence wrong
    - facts wrong
    - situation not covered
    - wrong revision used
    - second checker needed
  - Followed Incorrectly
    - format confusing
    - > 1 action/step
    - excess references
    - multi unit references
    - limits NI
    - details NI
    - data/computations wrong or incomplete
    - graphics NI
    - no checkoff
    - checkoff misused
    - misused second check
    - ambiguous instructions
    - equip identification NI
- **Training**
  - No Training
    - task not analyzed
    - decided not to train
    - no learning objective
    - missed required training
  - Understanding NI
    - learning objective NI
    - lesson plan NI
    - instruction NI
    - practice/ repetition NI
    - testing NI
    - continuing training NI
- **Quality Control**
  - ~~No Inspection~~
    - inspection not required
    - no hold point
    - hold point not performed
  - QC NI
    - inspection instructions NI
    - ✓ inspection techniques NI
    - foreign material exclusion during work NI
- **Communications**
  - ~~No Comm. or Not Timely~~
    - comm. system NI
    - late communication
  - Turnover NI
    - no standard turnover process
    - turnover process not used
    - ✓ turnover process NI
  - ~~Misunderstood Verbal Comm.~~
    - standard terminology not used
    - standard terminology NI
    - repeat back not used
    - long message
    - noisy environment
- **Management System**
  - Standards, Policies, or Admin Controls (SPAC) NI
    - no SPAC
    - not strict enough
    - confusing or incomplete
    - technical error
    - drawings / prints NI
  - SPAC Not Used
    - comm. of SPAC NI
    - recently changed
    - enforcement NI
    - no way to implement
    - accountability NI
  - Oversight/ Employee Relations
    - infrequent audits & evaluations (a & e)
    - a & e lack depth
    - a & e not independent
    - employee communications NI
    - employee feedback NI
  - Corrective Action
    - corrective action NI
    - corrective action not yet implemented
    - trending NI
- **Human Engineering**
  - Human-Machine Interface
    - labels NI
    - arrangement/placement
    - displays NI
    - controls NI
    - monitoring alertness NI
    - plant/unit differences
    - excessive lifting
    - tools/instruments NI
  - Work Environment
    - housekeeping NI
    - hot/cold
    - wet/slick
    - lights NI
    - noisy
    - obstruction
    - cramped quarters
    - equipment guard NI
    - high radiation/contamination
  - Complex System
    - knowledge based decision required
    - monitoring too many items
  - Non-Fault Tolerant System
    - errors not detectable
    - errors not recoverable
- **Work Direction**
  - Preparation
    - no preparation
    - work package/ permit NI
    - pre-job briefing NI
    - walk-thru NI
    - scheduling NI
    - lock out/tag out NI
    - fall protection NI
  - Selection of Worker
    - not qualified
    - fatigued
    - upset
    - substance
    - team selection NI
  - Supervision During Work
    - no supervision
    - crew teamwork NI

TapRooT® Root Cause Tree®

CAUSAL FACTOR 6: Operator splashed while opening sample port

START HERE with each causal factor/ issue and select or eliminate each category to find root causes

- HUMAN PERFORMANCE DIFFICULTY
- EQUIPMENT DIFFICULTY
- ~~NATURAL DISASTER/ SABOTAGE~~
- ~~OTHER (Specify)~~

*Note: Consider EquifactorTM Analysis

- ~~TOLERABLE FAILURE~~
- DESIGN
  - ~~DESIGN SPECS~~
    - Specs NI
    - Design Not To Specs
    - Problem Not Anticipated
      - equipment environment not considered
  - DESIGN REVIEW
    - Independent Review NI
      - management of change (moc) NI
      - ✓ hazard analysis NI
- EQUIPMENT/ PARTS DEFECTIVE
  - PROCUREMENT
  - MANUFACTURING
  - HANDLING
  - STORAGE
  - QUALITY CONTROL
- PREVENTIVE/ PREDICTIVE MAINTENANCE
  - PM NI
    - No PM for Equip
    - PM for Equip NI
- REPEAT FAILURE
  - MANAGEMENT SYSTEM
    - Corrective Action
      - corrective action NI
      - corrective action not yet implemented
      - trending NI

Human Performance Troubleshooting Guide (15 Questions)

NI = Needs Improvement

Individual Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
Was a person excessively fatigued, impaired, upset, bored, distracted, or overwhelmed?	Yes	HUMAN ENGINEERING; WORK DIRECTION
Should the person have had and used a written procedure but did not?	Yes	WORK DIRECTION; PROCEDURES; HUMAN ENGINEERING
Was a mistake made while using a procedure?	Yes	PROCEDURES
Were alarms or displays to recognize or to respond to a condition unavailable or misunderstood?	Yes	HUMAN ENGINEERING
Were displays, alarms, controls, tools, or equipment identified or operated improperly?	Yes	TRAINING; PROCEDURES; HUMAN ENGINEERING
Did the person need more skill / knowledge to perform the job or to respond to conditions or to understand system response?	Yes	TRAINING; WORK DIRECTION
Was work performed in an adverse environment (such as hot, humid, dark, cramped, or hazardous)?	Yes	HUMAN ENGINEERING
Did work involve repetitive motion, uncomfortable positions, vibration, or heavy lifting?	Yes	TRAINING; HUMAN ENGINEERING; WORK DIRECTION

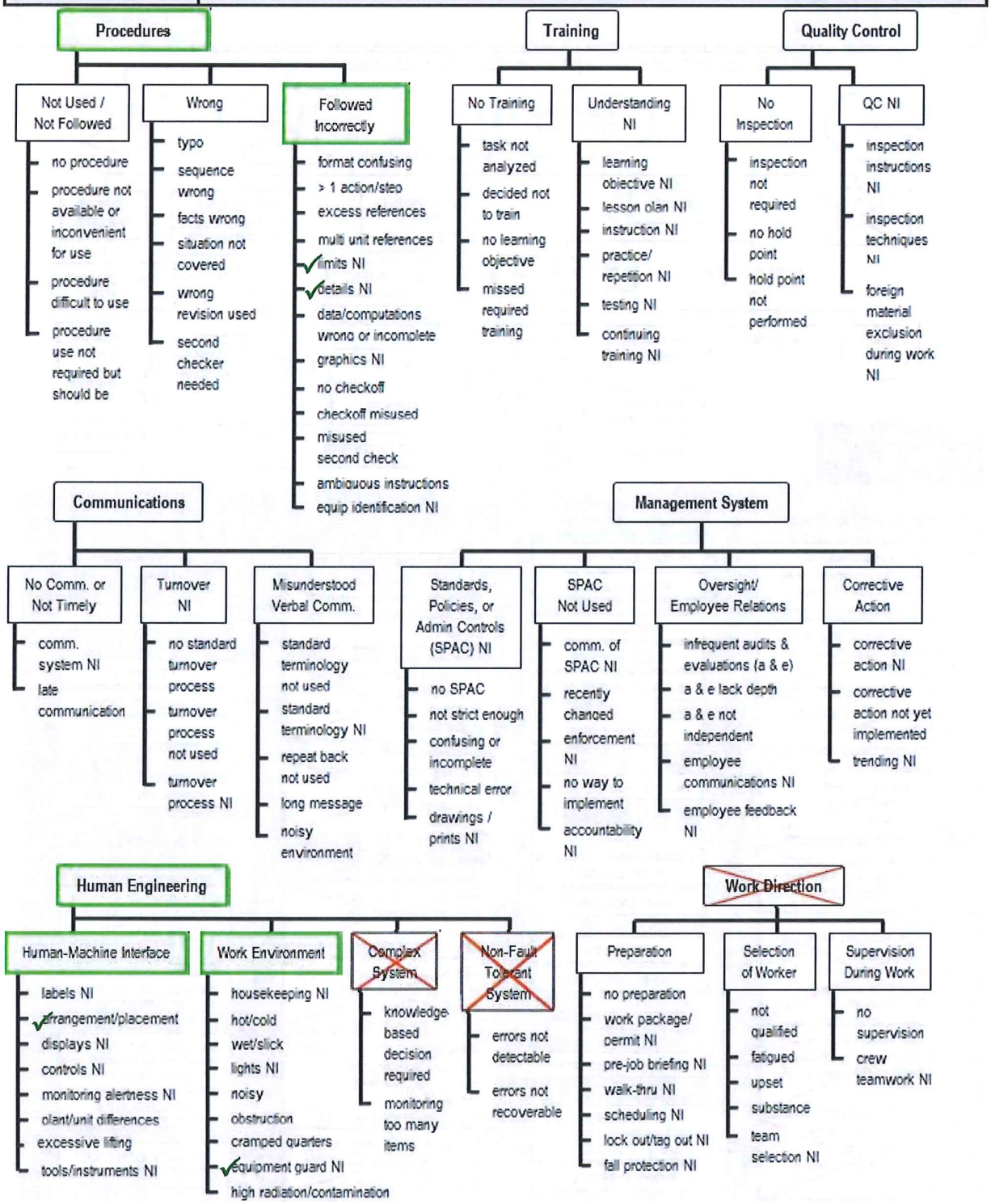
Team Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
Did verbal communications or shift change play a role in this problem?	Yes	COMMUNICATIONS
Did failure to agree about the who/what/when/where of performing the job play a role in this problem?	Yes	TRAINING; COMMUNICATIONS; WORK DIRECTION
Was communication needed across organizational boundaries or with other facilities?	Yes	COMMUNICATIONS

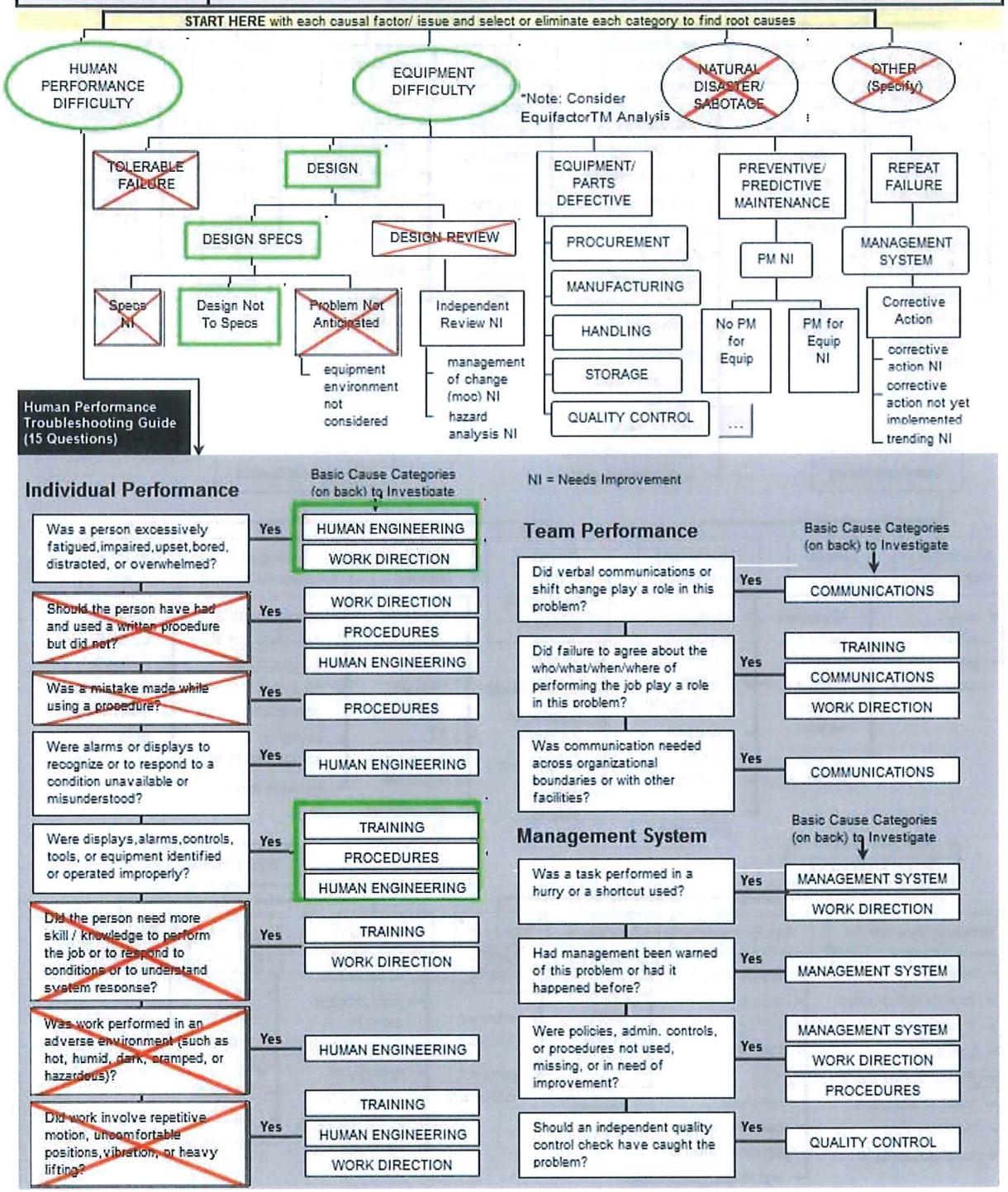
Management System

Question	Yes	Basic Cause Categories (on back) to Investigate
Was a task performed in a hurry or a shortcut used?	Yes	MANAGEMENT SYSTEM; WORK DIRECTION
Had management been warned of this problem or had it happened before?	Yes	MANAGEMENT SYSTEM
Were policies, admin. controls, or procedures not used, missing, or in need of improvement?	Yes	MANAGEMENT SYSTEM; WORK DIRECTION; PROCEDURES
Should an independent quality control check have caught the problem?	Yes	QUALITY CONTROL

Basic Cause Categories	CAUSAL FACTOR: Operator splashed while opening sample port



TapRooT® Root Cause Tree®	**CAUSAL FACTOR 7:** Operator goes to second floor to manually open Dump Valve by activating MOV switch



Basic Cause Categories	CAUSAL FACTOR: Operator goes to first floor to manually open Dump Valve by activating MOV switch

- **Procedures**
  - ~~Not Used / Not Followed~~
    - no procedure
    - procedure not available or inconvenient for use
    - procedure difficult to use
    - procedure use not required but should be
  - ~~Wrong~~
    - typo
    - sequence wrong
    - facts wrong
    - situation not covered
    - wrong revision used
    - second checker needed
  - Followed Incorrectly
    - format confusing
    - > 1 action/step
    - excess references
    - multi unit references
    - ✓ limits NI
    - ✓ details NI
    - data/computations wrong or incomplete
    - graphics NI
    - ✓ no checkoff
    - checkoff misused
    - misused second check
    - ambiguous instructions
    - equip identification NI
- **Training**
  - No Training
    - task not analyzed
    - decided not to train
    - no learning objective
    - missed required training
  - Understanding NI
    - learning objective NI
    - lesson plan NI
    - instruction NI
    - practice/ repetition NI
    - testing NI
    - continuing training NI
- **Quality Control**
  - No Inspection
    - inspection not required
    - no hold point
    - hold point not performed
  - QC NI
    - inspection instructions NI
    - inspection techniques NI
    - foreign material exclusion during work NI
- **Communications**
  - No Comm. or Not Timely
    - comm. system NI
    - late communication
  - Turnover NI
    - no standard turnover process
    - turnover process not used
    - turnover process NI
  - Misunderstood Verbal Comm.
    - standard terminology not used
    - standard terminology NI
    - repeat back not used
    - long message
    - noisy environment
- **Management System**
  - Standards, Policies, or Admin Controls (SPAC) NI
    - no SPAC
    - not strict enough
    - confusing or incomplete
    - technical error
    - drawings / prints NI
  - SPAC Not Used
    - comm. of SPAC NI
    - recently changed
    - enforcement NI
    - no way to implement
    - accountability NI
  - Oversight/ Employee Relations
    - infrequent audits & evaluations (a & e)
    - a & e lack depth
    - a & e not independent
    - employee communications NI
    - employee feedback NI
  - Corrective Action
    - corrective action NI
    - corrective action not yet implemented
    - trending NI
- **Human Engineering**
  - Human-Machine Interface
    - labels NI
    - arrangement/placement
    - displays NI
    - controls NI
    - ✓ monitoring alertness NI
    - plant/unit differences
    - excessive lifting
    - tools/instruments NI
  - Work Environment
    - housekeeping NI
    - hot/cold
    - wet/slick
    - lights NI
    - noisy
    - obstruction
    - cramped quarters
    - ✓ equipment guard NI
    - high radiation/contamination
  - Complex System
    - ✓ knowledge based decision required
    - monitoring too many items
  - ~~Non-Fault Tolerant System~~
    - errors not detectable
    - errors not recoverable
- **Work Direction**
  - ~~Preparation~~
    - no preparation
    - work package/ permit NI
    - pre-job briefing NI
    - walk-thru NI
    - scheduling NI
    - lock out/tag out NI
    - fall protection NI
  - Selection of Worker
    - not qualified
    - fatigued
    - ✓ upset
    - substance
    - team selection NI
  - ~~Supervision During Work~~
    - no supervision
    - crew teamwork NI

TapRooT® Root Cause Tree®

CAUSAL FACTOR 8: Un-reacted monomer splashes out of primary containment pit

START HERE with each causal factor/ issue and select or eliminate each category to find root causes

- ~~HUMAN PERFORMANCE DIFFICULTY~~
- EQUIPMENT DIFFICULTY
  - *Note: Consider EquifactorTM Analysis
  - TOLERABLE FAILURE
  - DESIGN
    - DESIGN SPECS
      - Specs NI
      - Design Not To Specs
      - ~~Problem Not Anticipated~~
        - equipment environment not considered
    - DESIGN REVIEW
      - Independent Review NI
        - management of change (moc) NI
        - ✓ hazard analysis NI
  - EQUIPMENT/ PARTS DEFECTIVE
    - PROCUREMENT
    - MANUFACTURING
    - HANDLING
    - STORAGE
    - QUALITY CONTROL
  - PREVENTIVE/ PREDICTIVE MAINTENANCE
    - PM NI
      - No PM for Equip
      - PM for Equip NI
  - REPEAT FAILURE
    - MANAGEMENT SYSTEM
      - Corrective Action
        - corrective action NI
        - corrective action not yet implemented
        - trending NI
- ~~NATURAL DISASTER/ SABOTAGE~~
- ~~OTHER (Specify)~~

Human Performance Troubleshooting Guide (15 Questions)

NI = Needs Improvement

Individual Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
Was a person excessively fatigued, impaired, upset, bored, distracted, or overwhelmed?	Yes	HUMAN ENGINEERING WORK DIRECTION
Should the person have had and used a written procedure but did not?	Yes	WORK DIRECTION PROCEDURES HUMAN ENGINEERING
Was a mistake made while using a procedure?	Yes	PROCEDURES
Were alarms or displays to recognize or to respond to a condition unavailable or misunderstood?	Yes	HUMAN ENGINEERING
Were displays, alarms, controls, tools, or equipment identified or operated improperly?	Yes	TRAINING PROCEDURES HUMAN ENGINEERING
Did the person need more skill / knowledge to perform the job or to respond to conditions or to understand system response?	Yes	TRAINING WORK DIRECTION
Was work performed in an adverse environment (such as hot, humid, dark, cramped, or hazardous)?	Yes	HUMAN ENGINEERING
Did work involve repetitive motion, uncomfortable positions, vibration, or heavy lifting?	Yes	TRAINING HUMAN ENGINEERING WORK DIRECTION

Team Performance

Question	Yes	Basic Cause Categories (on back) to Investigate
Did verbal communications or shift change play a role in this problem?	Yes	COMMUNICATIONS
Did failure to agree about the who/what/when/where of performing the job play a role in this problem?	Yes	TRAINING COMMUNICATIONS WORK DIRECTION
Was communication needed across organizational boundaries or with other facilities?	Yes	COMMUNICATIONS

Management System

Question	Yes	Basic Cause Categories (on back) to Investigate
Was a task performed in a hurry or a shortcut used?	Yes	MANAGEMENT SYSTEM WORK DIRECTION
Had management been warned of this problem or had it happened before?	Yes	MANAGEMENT SYSTEM
Were policies, admin. controls, or procedures not used, missing, or in need of improvement?	Yes	MANAGEMENT SYSTEM WORK DIRECTION PROCEDURES
Should an independent quality control check have caught the problem?	Yes	QUALITY CONTROL

Basic Cause Categories	CAUSAL FACTOR: Un-reacted monomer splashes out of primary containment pit

- **Procedures**
  - Not Used / Not Followed
    - no procedure
    - procedure not available or inconvenient for use
    - procedure difficult to use
    - procedure use not required but should be
  - Wrong
    - typo
    - sequence wrong
    - facts wrong
    - situation not covered
    - wrong revision used
    - second checker needed
  - Followed Incorrectly
    - format confusing
    - > 1 action/step
    - excess references
    - multi unit references
    - limits NI
    - details NI
    - data/computations wrong or incomplete
    - graphics NI
    - no checkoff
    - checkoff misused
    - misused second check
    - ambiguous instructions
    - equip identification NI
- **Training**
  - No Training
    - task not analyzed
    - decided not to train
    - no learning objective
    - missed required training
  - Understanding NI
    - learning objective NI
    - lesson plan NI
    - instruction NI
    - practice/ repetition NI
    - testing NI
    - continuing training NI
- **Quality Control**
  - No Inspection
    - inspection not required
    - no hold point
    - hold point not performed
  - QC NI
    - inspection instructions NI
    - inspection techniques NI
    - foreign material exclusion during work NI
- **Communications**
  - No Comm. or Not Timely
    - comm. system NI
    - late communication
  - Turnover NI
    - no standard turnover process
    - turnover process not used
    - turnover process NI
  - Misunderstood Verbal Comm.
    - standard terminology not used
    - standard terminology NI
    - repeat back not used
    - long message
    - noisy environment
- **Management System**
  - Standards, Policies, or Admin Controls (SPAC) NI
    - no SPAC
    - not strict enough
    - confusing or incomplete
    - technical error
    - drawings / prints NI
  - SPAC Not Used
    - comm. of SPAC NI
    - recently changed
    - enforcement NI
    - no way to implement
    - accountability NI
  - Oversight/ Employee Relations
    - infrequent audits & evaluations (a & e)
    - a & e lack depth
    - a & e not independent
    - employee communications NI
    - employee feedback NI
  - Corrective Action
    - corrective action NI
    - corrective action not yet implemented
    - trending NI
- **Human Engineering**
  - Human-Machine Interface
    - labels NI
    - arrangement/placement
    - displays NI
    - controls NI
    - monitoring alertness NI
    - plant/unit differences
    - excessive lifting
    - tools/instruments NI
  - Work Environment
    - housekeeping NI
    - hot/cold
    - wet/slick
    - lights NI
    - noisy
    - obstruction
    - cramped quarters
    - equipment guard NI
    - high radiation/contamination
  - Complex System
    - knowledge based decision required
    - monitoring too many items
  - Non-Fault Tolerant System
    - errors not detectable
    - errors not recoverable
- **Work Direction**
  - Preparation
    - no preparation
    - work package/ permit NI
    - pre-job briefing NI
    - walk-thru NI
    - scheduling NI
    - lock out/tag out NI
    - fall protection NI
  - Selection of Worker
    - not qualified
    - fatigued
    - upset
    - substance
    - team selection NI
  - Supervision During Work
    - no supervision
    - crew teamwork NI

APPENDIX D. CORRECTIVE ACTIONS SUMMARY TABLE

Investigation 01-04869-001-14

FHR Peru, IL Polystyrene Reactor

CORRECTIVE ACTION 2A – Operating Procedures		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Prepare/review/modify an operating procedure for mid-phase disruption of each of the standard batch phases. The proposed procedure should be consistent with potential DCS logic improvements resulting from findings of the DCS logic code analysis corrective action.	**Inspection techniques NI (Needs Improvement)**	No.5 - Monomer Charge Phase maximum cooling restriction is not released from DCS logic
	No procedure	No. 2 - Operations Manual doesn't have a mid-phase re-start procedure
	Problem Not Anticipated	No.5 - Monomer Charge Phase maximum cooling restriction is not released from DCS logic
	Situation not covered	No. 2 - Operations Manual doesn't have a mid-phase re-start procedure
	Turnover process NI	No.5 - Monomer Charge Phase maximum cooling restriction is not released from DCS logic

CORRECTIVE ACTION 2B - Training		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Prior to Restart, analyze all changes and new additions to the Operator Procedures Manual and train each operator accordingly.	**Task not analyzed**	No. 2 - Operations Manual doesn't have a mid-phase re-start procedure

CORRECTIVE ACTION 6C – Instruments/Equipment		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Consider lowering the reactor pressure set point limit that activates the warning light adjacent to the sample port.	**Limits NI**	No. 6 - Operator splashed while opening sample port

FHRPRU004105

CORRECTIVE ACTION 6A - Equipment		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Investigate the feasibility of converting the reactor sample port design to one that is closed to the atmosphere during sampling and additive injection. E.G. install an additive pot above the sample port. Provide an isolation valve between the additive pot and sample port.	**Arrangement / placement**	No. 6 - Operator splashed while opening sample port
	Design Not To Specifications	No. 7 - Operator goes to first floor to manually open Dump Valve by activating MOV switch
	Equipment guard NI	No. 6 - Operator splashed while opening sample port
	Equipment guard NI	No. 7 - Operator goes to first floor to manually open Dump Valve by activating MOV switch
	Hazard analysis NI	No. 6 - Operator splashed while opening sample port
	Limits NI	No. 6 - Operator splashed while opening sample port
	No Check off	No. 7 - Operator goes to first floor to manually open Dump Valve by activating MOV switch

CORRECTIVE ACTION 6B – Operating Procedures		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Revise Operating Procedures to include a reactor temperature, pressure, and level confirmation step before re-start after any extended batch hold.	**Details NI**	No. 6 - Operator splashed while opening sample port
	Details NI	No. 7 - Operator goes to first floor to manually open Dump Valve by activating MOV switch
	Limits NI	No. 6 - Operator splashed while opening sample port
	No Check off	No. 7 - Operator goes to first floor to manually open Dump Valve by activating MOV switch

FHRPRU004106

CORRECTIVE ACTION 7A - DCS		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Make the SIS R17 Temperature Alarm more distinctive / noticeable on the operator display console.	**Details NI**	No. 6 - Operator splashed while opening sample port
	Hazard analysis NI	No. 6 - Operator splashed while opening sample port
	Knowledge-based decision required	No. 7 - Operator goes to first floor to manually open Dump Valve by activating MOV switch
	Limits NI	No. 6 - Operator splashed while opening sample port
	Monitoring alertness NI	No. 7 - Operator goes to first floor to manually open Dump Valve by activating MOV switch
	Upset	No. 7 - Operator goes to first floor to manually open Dump Valve by activating MOV switch

CORRECTIVE ACTION 1A - DCS		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Provide a sequencing code in the DCS batch logic that executes vent valve line-up prior to monomer charge.	**Hazard analysis NI**	No. 1 - DCS allows monomer flow before vent valves lined up correctly
	Problem Not Anticipated	No. 1 - DCS allows monomer flow before vent valves lined up correctly

CORRECTIVE ACTION 1B – Inter Locks		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Interlock the monomer charge M1 valve to vent valve position.	**Hazard analysis NI**	No. 1 - DCS allows monomer flow before vent valves lined up correctly
	Problem Not Anticipated	No. 1 - DCS allows monomer flow before vent valves lined up correctly

CORRECTIVE ACTION 3A - DCS		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Remove the DCS coding that restricts maximum cooling from any phase of the batch process control logic.	**Problem Not Anticipated**	No. 3 - DCS Monomer Charge Phase logic restricts maximum cooling

CORRECTIVE ACTION 3B - DCS		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Review / analyze all DCS batch code control logic to ascertain potential downstream effects and interactions with other batch phases and SIS.	**Problem Not Anticipated**	No. 3 - DCS Monomer Charge Phase logic restricts maximum cooling

FHRPRU004108

CORRECTIVE ACTION 4A - DCS		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Analyze the "Resume" and "Restart" options contained in the DCS logic and identify the effects each might have on existing operating procedures, training requirements, and the DCS logic coding to track sequence progression during batch holds and upsets.	**Controls NI**	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Hazard analysis NI	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Inspection techniques NI	No.5 - Monomer Charge Phase maximum cooling restriction is not released from DCS logic
	Knowledge-based decision required	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Pre-job briefing NI	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Problem Not Anticipated	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Problem Not Anticipated	No.5 - Monomer Charge Phase maximum cooling restriction is not released from DCS logic
	Situation not covered	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Supervision During Work	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Task not analyzed	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic

FHRPRU004109

CORRECTIVE ACTION 4B - DCS		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Analyze and provide DCS code enhancements to ensure reliable batch re-starts (both mid-phase, and prior to start of next phase).	**Controls NI**	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Hazard analysis NI	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Inspection techniques NI	No.5 - Monomer Charge Phase maximum cooling restriction is not released from DCS logic
	Knowledge-based decision required	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Problem Not Anticipated	No. 4 - Operators choose different options to restart pump that might have disrupted phase sequence logic
	Problem Not Anticipated	No.5 - Monomer Charge Phase maximum cooling restriction is not released from DCS logic

CORRECTIVE ACTION 8A - Equipment		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Extend outside perimeter pit wall height so as to reduce the likelihood of flow wave splash over.	**Design Not To Specifications**	No. 8 - Un-reacted monomer splashes out of primary containment pit
	Hazard analysis NI	No. 8 - Un-reacted monomer splashes out of primary containment pit
	Specifications NI	No. 8 - Un-reacted monomer splashes out of primary containment pit

CORRECTIVE ACTION 8B - Equipment		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Extend the reactor dump line to within the emergency containment area wall.		

CORRECTIVE ACTION 8C - Equipment		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Install a vapor suppression and firefighting foam system to cover the emergency containment area surface area.	**Design Not To Specifications**	No. 8 - Un-reacted monomer splashes out of primary containment pit
	Hazard analysis NI	No. 8 - Un-reacted monomer splashes out of primary containment pit
	Specifications NI	No. 8 - Un-reacted monomer splashes out of primary containment pit

CORRECTIVE ACTION 8D - Equipment		
Details	**Root Causes Fixed**	**Causal Factors Addressed**
Discontinue use of water spray dispersion system (water nozzle at reactor dump line outlet) once the foam system is activated.	**Design Not To Specifications**	No. 8 - Un-reacted monomer splashes out of primary containment pit
	Hazard analysis NI	No. 8 - Un-reacted monomer splashes out of primary containment pit
	Specifications NI	No. 8 - Un-reacted monomer splashes out of primary containment pit

FHRPRU004111

ILLINOIS Environmental Protection Agency
2014 Hazardous Waste Report
Form GM -- Generation and Management

US EPA ID : **ILD087154555** IL. EPA ID : **0990850005**

SECTION 1. WASTE DESCRIPTION

A. Waste Description: **EPS FEEDSTOCK RELEASE MATERIAL**

B. EPA Hazardous Waste Code(s) : **D001**

C. Source Code : **G32** D. Form Code : **W409** Management Method :

E. Waste Minimization Code: **X**

SECTION 2. QUANTITY GENERATED:

A. UOM : **3. Pounds (lbs)** Density : **10.00** lb/gal .

B. Quantity Generated in Current Reporting Year : **320,560.0**

SECTION 3: QUANTITY MANAGED ON-SITE:

Did this location manage some or all of this waste in RCRA or UIC regulated treatment, recycling, or disposal units at this location? (DO NOT include RCRA exempt processes.) **N**

On-Site System1:Management Method : Quantity managed on-site this year : **0.0**

On-Site System2:Management Method : Quantity managed on-site this year : **0.0**

SECTION 4. OFF-SITE SHIPMENT

A. Was any of this waste shipped off site this reporting year? **Y**

SITE 1.

B. U.S. EPA ID No. of facility waste was shipped to : **TXD055141378**

C.Management method shipped to : **H040**

D. Total quantity shipped in this reporting year : **320,560.0**

SITE 2.

B. U.S. EPA ID No. of facility waste was shipped to :

C. Management method shipped to :

D. Total quantity shipped in this reporting year : **0.0**

SITE 3.

B. U.S. EPA ID No. of facility waste was shipped to :

C. Management method shipped to :

D. Total quantity shipped in this reporting year : **0.0**

SITE 4.

B. U.S. EPA ID No. of facility waste was shipped to :

C. Management method shipped to :

D. Total quantity shipped in this reporting year : **0.0**

SITE 5.

B. U.S. EPA ID No. of facility waste was shipped to :

C. Management method shipped to :

D. Total quantity shipped in this reporting year : **0.0**

COMMENTS : **Y**

1400302429 SC PPW 12/11/2013

BASIN Truck #142

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: ILD087154555
2. Page 1 of: 1
3. Emergency Response Phone: 800-483-3718
4. Manifest Tracking Number: 006051002 FLE

5. Generator's Name and Mailing Address
Flint Hills Resources
501 Brunner Street
Peru, IL 61354
Generator's Phone: 815-224-5451

Generator's Site Address (if different than mailing address): SAME

6. Transporter 1 Company Name: Basin Environmental — U.S. EPA ID Number: OKR000023085

7. Transporter 2 Company Name: Clean Harbors — U.S. EPA ID Number: mad039322050

8. Designated Facility Name and Site Address
Clean Harbors Deer Park, LLC
2027 Independence Parkway south
La Porte, TX 77571
Facility's Phone: 281-930-2300
U.S. EPA ID Number: TXD055141378

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
X	RQ UN 1325 Waste Flammable solids organic NOS (Styrene, Polystyrene), 4.1 PG III (D001)	1	DT	24	T	D001 04 T5409H
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information
CH803730B ERG#133

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Michael C. Schmidt — Signature: [signature] — Month 05 Day 10 Year 14

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: R. McKim — Signature: [signature] — Month 5 Day 10 Year 14
Transporter 2 Printed/Typed Name: Nicole Flores — Signature: Nicole Flores — Month 5 Day 18 Year 14

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator) — U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H040 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Nicole Flores — Signature: Nicole Flores — Month 5 Day 18 Year 14

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Clean Harbors has the appropriate permits for and will accept the waste the generator is shipping

1400302429 SCPPW 12/11/2013

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: IL D087154555
2. Page 1 of: 1
3. Emergency Response Phone: 800-483-3718
4. Manifest Tracking Number: 006051003 FLE

5. Generator's Name and Mailing Address: Flint Hills Resources, 601 Brunner St., Peru, IL 61354
Generator's Phone: (815) 224-5451
Generator's Site Address (if different than mailing address): Same

6. Transporter 1 Company Name: Bulk Transport, Inc.
U.S. EPA ID Number: PAD987347515

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address: Clean Harbors Deer Park, LLC, 2027 Independence Parkway South, LaPorte, TX 77571
Facility's Phone: 291-930-2300
U.S. EPA ID Number: TXD055141378

9a. HM	9b. U.S. DOT Description (Including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
X	RQ, UN 1325 Waste Flammable solids Organic N.O.S (Styrene, Polystyrene), 4.1, PG III (D001)	1	DT	[redacted] ~~est 2.0~~ 4 EB	T	D001 OUT3409H
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information
CHB03730B ERG#133

15. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Michael C. Schmidt
Signature: Michael C. Schmidt
Month 5 Day 10 Year 14

16. International Shipments: ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: [redacted] MCS Todd Stappenbeck
Signature: Todd
Month 05 Day 10 Year 14
Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

18. Discrepancy
18a. Discrepancy Indication Space: ☑ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Per Michael Schmidt Quantity changed
Manifest Reference Number: 5-16-14 EJB
18b. Alternate Facility (or Generator):
U.S. EPA ID Number:
Facility's Phone:
18c. Signature of Alternate Facility (or Generator):
Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H040 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Sandy Beach
Signature: Sandy Beach
Month 5 Day 15 Year 14

GENERATOR | INT'L | TRANSPORTER | DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete. DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Clean Harbors has the appropriate permits for and will accept the waste the Generator is shipping

1400302429 SCPPW 12/11/2013 20478

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: IL D087154555
2. Page 1 of: 1
3. Emergency Response Phone: 800 483 3718
4. Manifest Tracking Number: 006051008 FLE

5. Generator's Name and Mailing Address: Flint Hills Resources, 601 Brunner Street, Peru, IL 61354
Generator's Phone: 815-224-5451
Generator's Site Address (if different than mailing address): SAME

6. Transporter 1 Company Name: Basin Environmental
U.S. EPA ID Number: OKR000023085

7. Transporter 2 Company Name: Clean Harbors
U.S. EPA ID Number: MAD039322250

8. Designated Facility Name and Site Address: Clean Harbors Deer Park, LLC, 2027 Independence Parkway South, La Porte, TX 77571
Facility's Phone: 281-930-2300
U.S. EPA ID Number: TXD055141378

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
X	1. RQ UN1325 Waste Flammable solids Organic NOS (Styrene, Polystyrene) 4.1 PG III (D001)	1	DT	17.81	T	D001 04T5404H
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information

CH803730B ERG#133

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Michael C. Schmidt
Signature: M C Schmidt
Month 05 Day 10 Year 14

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: [illegible]
Signature: Anthony Lynch
Month 5 Day 10 Year 14
Transporter 2 Printed/Typed Name: Nicole Flores
Signature: Nicole Flores
Month 5 Day 19 Year 14

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:

18b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:

18c. Signature of Alternate Facility (or Generator)
Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H040 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Sandy Beck
Signature: Sandy Beck
Month 5 Day 19 Year 14

GENERATOR | INT'L | TRANSPORTER | DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Clean Harbors has the appropriate permits for and will accept the waste the generator is shipping.

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) 1400302429 SC PPW 12/11/2013 Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: ILD087154555
2. Page 1 of: 1
3. Emergency Response Phone: (800) 483-3718
4. Manifest Tracking Number: 007863850 FLE

5. Generator's Name and Mailing Address
Flint Hills Resources
501 Brunner Street
Peru, IL 61354
Generator's Phone: (815) 224-5451

Generator's Site Address (if different than mailing address): SAME

6. Transporter 1 Company Name: Bulk Transport Inc. — U.S. EPA ID Number: PAD987347515

7. Transporter 2 Company Name: Clean Harbors — U.S. EPA ID Number: MAD034327200

8. Designated Facility Name and Site Address
Clean Harbors Deer Park, LLC
2027 Independence Parkway South
La Porte, TX 77571
Facility's Phone: (281) 930-2300
U.S. EPA ID Number: TXD055141378

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
X	1. RO. UN1325. WASTE FLAMMABLE SOLIDS. ORGANIC. N.O.S.. (STYRENE, POLYSTYRENE), 4.1, PG III (D001)	1	DT	22	T	D001 OUTS409H
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information
1.CH803730B ERG#133

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Michael C Schmidt — Signature: M C Sch't — Month 05 Day 08 Year 14

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: RONNIE ANDERSON — Signature: Ronnie Anderson — Month 5 Day 8 Year 14
Transporter 2 Printed/Typed Name: Sonda Mexandy — Signature: SMA — Month 05 Day 12 Year 14

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator) — U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H040 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Sandy Beach — Signature: Sandy Beach — Month 5 Day 12 Year 14

GENERATOR / INT'L / TRANSPORTER / DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Clean Harbors has the appropriate permits for and will accept the waste the generator is shipping.

FHRPRU004117

FHRPRU004118

1400302429 SC PPW 12/11/2013

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: ILD087154555
2. Page 1 of: 1
3. Emergency Response Phone: (800) 483-3718
4. Manifest Tracking Number: 007863851 FLE

5. Generator's Name and Mailing Address
Flint Hills Resources
501 Brunner Street
Peru, IL 61354
Generator's Phone: (815) 224-5451

Generator's Site Address (if different than mailing address): SAME

6. Transporter 1 Company Name: Bulk transport — U.S. EPA ID Number: PAD987347515

7. Transporter 2 Company Name: Clean Harbors — U.S. EPA ID Number: MAD039322250

8. Designated Facility Name and Site Address
Clean Harbors Deer Park, LLC
2027 Independence Parkway South
La Porte, TX 77571
Facility's Phone: (281) 930-2300
U.S. EPA ID Number: TXD055141378

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
X	1. RQ, UN1325, WASTE FLAMMABLE SOLIDS, ORGANIC, N.O.S., (STYRENE, POLYSTYRENE), 4.1, PG III (D001)	1	DT	22	T	D001 OUTS409H
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information
1.CH803730B ERG#133

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Michael C. Schmidt — Signature: [signature] — Month 05 Day 08 Year 14

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Frank Anderson — Signature: [signature] — Month 5 Day 08 Year 14
Transporter 2 Printed/Typed Name: Shea Alexander — Signature: SHA — Month 05 Day 13 Year 14

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator) U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H040 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Sandy Beach — Signature: Sandy Beach — Month 5 Day 13 Year 14

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIR

Clean Harbors has the appropriate permits for and will accept the waste the generator is shipping.

FHRPRU004119

FHRPRU004120

1400302429 SC PPW 12/11/2013

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: ILD087154555
2. Page 1 of 1
3. Emergency Response Phone: (800) 483-3718
4. Manifest Tracking Number: 007863852 FLE

5. Generator's Name and Mailing Address
Flint Hills Resources
501 Brunner Street
Peru, IL 61354
Generator's Phone: (815) 224-5451

Generator's Site Address (if different than mailing address): SAME

6. Transporter 1 Company Name: Bulk Transport, Inc. — U.S. EPA ID Number: PAD987347515

7. Transporter 2 Company Name: Clean Harbors — U.S. EPA ID Number: MAD039322210

8. Designated Facility Name and Site Address
Clean Harbors Deer Park, LLC
2027 Independence Parkway South
La Porte, TX 77571
Facility's Phone: (281) 930-2300
U.S. EPA ID Number: TXD055141378

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
X	1. RQ, UN1325, WASTE FLAMMABLE SOLIDS, ORGANIC, N.O.S., (STYRENE, POLYSTYRENE), 4.1, PG III (D001)	1	DT	23	MST	D001 OUTS409H
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information
1.CH803730B ERG#133

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Michael C. Schmidt — Signature: Michael C. Schmidt — Month 05 Day 09 Year 14

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Les Kramer — Signature: [signature] — Month 5 Day 9 Year 14
Transporter 2 Printed/Typed Name: Shiela McCarthy — Signature: [signature] — Month 05 Day 13 Year 14

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator) U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H040 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Jerry Stoerner — Signature: [signature] — Month 5 Day 14 Year 14

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Clean Harbors has the appropriate permits for and will accept the waste the generator is shipping.

FHRPRU004121

FHRPRU004122

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) 1400302429 SC PPW 12/11/2013 Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: ILD087154555
2. Page 1 of: 1
3. Emergency Response Phone: (800) 483-3718
4. Manifest Tracking Number: 007863853 FLE

5. Generator's Name and Mailing Address
Flint Hills Resources
501 Brunner Street
Peru, IL 61354
Generator's Phone: (815) 224-6451

Generator's Site Address (if different than mailing address): SAME

6. Transporter 1 Company Name: Bulk Transport, Inc — U.S. EPA ID Number: PAD987347515

7. Transporter 2 Company Name: Clean Harbors — U.S. EPA ID Number: MAD039322250

8. Designated Facility Name and Site Address
Clean Harbors Deer Park, LLC
2027 Independence Parkway South
La Porte, TX 77571
Facility's Phone: (281) 930-2300
U.S. EPA ID Number: TXD055141378

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
X	1 RQ, UN1325, WASTE FLAMMABLE SOLIDS, ORGANIC, N.O.S., (STYRENE, POLYSTYRENE), 4.1, PG III (D001)	1	DT	21.28	T	D001 D0TS409H
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information
1.CH803730B ERG#133

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Michael C. Schmidt — Signature: [signature] — Month 05 Day 10 Year 14

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: CLINT HODGE — Signature: [signature] — Month 05 Day 10 Year 14
Transporter 2 Printed/Typed Name: Nicole Jones — Signature: Nicole Jones — Month 5 Day 16 Year 14

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator) U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H040 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Nicole Jones — Signature: Nicole Jones — Month 5 Day 17 Year 14

GENERATOR / INT'L / TRANSPORTER / DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete. DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Clean Harbors has the appropriate permits for and will accept the waste the generator is shipping.

1400302429 SC PPW 12/11/2013

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: ILD087154555
2. Page 1 of 1
3. Emergency Response Phone: (800) 483-3718
4. Manifest Tracking Number: 007863854 FLE

5. Generator's Name and Mailing Address
Flint Hills Resources
501 Brunner Street
Peru, IL 61354
Generator's Phone: (815) 224-5451

Generator's Site Address (if different than mailing address): SAME

6. Transporter 1 Company Name: Bulk Transport, Inc. — U.S. EPA ID Number: PAD987347515

7. Transporter 2 Company Name — U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Clean Harbors Deer Park, LLC
2027 Independence Parkway South
La Porte, TX 77571
Facility's Phone: (281) 930-2300
U.S. EPA ID Number: TXD055141378

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
X	1. RQ, UN1325, WASTE FLAMMABLE SOLIDS, ORGANIC, N.O.S., (STYRENE, POLYSTYRENE), 4.1, PG III (D001)	1	DT	22	T	D001 OUTS409H
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information
1.CH803730B ERG#133

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Michael Schmidt — Signature: M C Schmidt — Month 5 Day 10 Year 14

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Craig Hodge — Signature: — Month 5 Day 10 Year 14
Transporter 2 Printed/Typed Name — Signature — Month Day Year

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:

18b. Alternate Facility (or Generator) — U.S. EPA ID Number
Facility's Phone:

18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H040 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Sandy Beach — Signature: Sandy Beach — Month 5 Day 16 Year 14

GENERATOR | INT'L | TRANSPORTER | DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Clean Harbors has the appropriate permits for and will accept the waste the generator is shipping.

FHRPRU004125

6022

Please print or type. (Form designed for use on elite (12-pitch) typewriter.) 77 1401576006 SC PPW 5/22/2014 Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Manifest Tracking Number
ILD087154555	1	(800) 483-3718	007793861 FLE

5. Generator's Name and Mailing Address
Flint Hills Resources
501 Brunner Street
Peru, IL 61354
Generator's Phone: (815) 224-5451

Generator's Site Address (if different than mailing address)
SAME

6. Transporter 1 Company Name: Clean Harbors Environmental Services Inc — U.S. EPA ID Number: MAD039322250

7. Transporter 2 Company Name: Clean Harbors Environmental Services Inc. — U.S. EPA ID Number: MAD039322250

8. Designated Facility Name and Site Address
Clean Harbors Deer Park, LLC
2027 Independence Parkway South
La Porte, TX 77571
(281) 930-2300
Facility's Phone:
U.S. EPA ID Number: [illegible]

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
X	1. UN1263, WASTE PAINT, 3, PG II	001	DM	55	g	D001 D005 D006 D007 OUTS209H
X	2. UN2055, STYRENE MONOMER, STABILIZED SOLUTION, (POLYSTYRENE, BENTONITE), 3, PG III	003	DM	165	g	OUT511H
X	3. RQ, UN1325, WASTE FLAMMABLE SOLIDS, ORGANIC, N.O.S. MIXTURE, (STYRENE, POLYSTYRENE), 4.1, PG III (D001)	008	DM	440	g	D001 OUT540H
	4.					

14. Special Handling Instructions and Additional Information
1. CH838801 ERG#128 1X55
2. CH849531 ERG#128 3X55
3. CH819759 ERG#133 8X55

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: X Adam Chapman — Signature: X Adam Chap — Month 8 Day 13 Year 14

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Brian Pointer — Signature: Brian Pointer — Month 8 Day 13 Year 14
Transporter 2 Printed/Typed Name: Manuel Guajardo — Signature: Manuel Guajardo — Month 8 Day 31 Year 14

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator) — U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. H040 2. H040 3. H040 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: Shiela Alexander — Signature: SA — Month 09 Day 10 Year 14

GENERATOR / INT'L / TRANSPORTER / DESIGNATED FACILITY

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO GENERATOR

Clean Harbors has the appropriate permits for and will accept the waste the generator is shipping.

FHRPRU004126

Non Haz Soil Manifest

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number	b. Manifest Document Number	c. Page 1 of

d. Generator's Name and Location:	e. Generator's Mailing Address:
Flint Hills Resources 501 Brunner St Peru, IL 61354 f. Phone:815 224 5451	Same g. Phone:
If owner of the generating facility differs from the generator, provide: h. Owner's Name:	i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	Non-Hazardous Soil	1	CM		TN

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

p. Generator Authorized Agent Name (Print)	q. Signature	r. Date
Adam Chapman	Adam Chap	5/5/14

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
Republic Services

b. Phone:

c. Driver Name (Print)	d. Signature	e. Date
Dean Kliéber	Dean Kliéber	5-5-14

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:	c. US EPA Number	d. Discrepancy Indication Space:
LandComp 2840 E 13th Rd Ottawa, IL 61350 b. Phone: 815 434 1808	0990808103	

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print)	f. Signature	g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:	c. Responsible Agency Name and Address:
b. Phone:	d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print)	h. Signature	i. Date

Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is **NOT** asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number	b. Manifest Document Number	c. Page 1 of

d. Generator's Name and Location:	e. Generator's Mailing Address:
Flint Hills Resources 501 Brunner St Peru, IL 61354 f. Phone:815 224 5451	Same g. Phone:
If owner of the generating facility differs from the generator, provide: h. Owner's Name:	i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	Non-Hazardous Soil	1	CM		TN

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

p. Generator Authorized Agent Name (Print)	q. Signature	r. Date
Adam Chapman	Adam Chap	5/5/14

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
Republic Services

b. Phone:

c. Driver Name (Print)	d. Signature	e. Date
Dean Kliehar	Dean Klieh	5-5-14

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:	c. US EPA Number	d. Discrepancy Indication Space:
LandComp 2840 E 13th Rd Ottawa, IL 61350 b. Phone: 815 434 1808	0990808103	

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print)	f. Signature	g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:	c. Responsible Agency Name and Address:
b. Phone:	d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print)	h. Signature	i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number: ILD087154555
b. Manifest Document Number:
c. Page 1 of

d. Generator's Name and Location:
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone:815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide:
h. Owner's Name: Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	NON HAZARDOUS SOIL	1	DM	22	T

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

p. Generator Authorized Agent Name (Print): Adam Chapman
q. Signature: Adam Chap
r. Date: 5/5/14 - 9:15 AM

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555 Special Waste Hauler Number# 3846

c. Driver Name (Print): WAYNE KEITH
d. Signature: Wayne Keith
e. Date: 5 MAY 2014

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL. 61350
b. Phone: 815-434-1808

c. US EPA Number: 0990808103
d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print):
f. Signature:
g. Date:

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:
b. Phone:

c. Responsible Agency Name and Address:
d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print):
h. Signature:
i. Date:

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number: ILD087154555
b. Manifest Document Number:
c. Page 1 of

d. Generator's Name and Location:
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone:815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide:
h. Owner's Name: Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	NON HAZARDOUS SOIL	1	DM	22	T

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

p. Generator Authorized Agent Name (Print): Adam Chapman
q. Signature: Adam Chap
r. Date: 5/5/14

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555 Special Waste Hauler Number# 3846

c. Driver Name (Print): WAYNE KEITH
d. Signature: Wayne Keith
e. Date: 5 MAY 2014

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL. 61350
b. Phone: 815-434-1808

c. US EPA Number: 0990808103
d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print):
f. Signature:
g. Date:

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:
b. Phone:

c. Responsible Agency Name and Address:
d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print):
h. Signature:
i. Date:

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number: ILD087154555
b. Manifest Document Number:
c. Page 1 of

d. Generator's Name and Location:
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone:815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide:

h. Owner's Name: Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	NON HAZARDOUS SOIL	1	DM	22	T

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

Adam Chapman — p. Generator Authorized Agent Name (Print)
Adam Clg — q. Signature
5/5/14 — r. Date

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555 Special Waste Hualer Number# 3846

Robert E Crouch — c. Driver Name (Print)
Robert E Crouch — d. Signature
5-5-14 — e. Date

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL. 61350
b. Phone: 815-434-1808

c. US EPA Number: 0990808103
d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print)
f. Signature
g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:
b. Phone:

c. Responsible Agency Name and Address:
d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print)
h. Signature
i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number ILD087154555
b. Manifest Document Number
c. Page 1 of

d. Generator's Name and Location
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone:815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide

h. Owner's Name: Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	NON HAZARDOUS SOIL	1	DM	22	T

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

Adam Chapman | Adam Chap | 5/5/14
p. Generator Authorized Agent Name (Print) | q. Signature | r. Date

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555 Special Waste Hauler Number# 3846

Robert E Crouch | Robert E Crouch | 5-5-14
c. Driver Name (Print) | d. Signature | e. Date

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL. 61350
b. Phone: 815-434-1808

c. US EPA Number 0990808103
d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print) | f. Signature | g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:

b. Phone:

c. Responsible Agency Name and Address:

d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print) | h. Signature | i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number: ILD087154555
b. Manifest Document Number:
c. Page 1 of

d. Generator's Name and Location:
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone:815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide:

h. Owner's Name: Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	NON HAZARDOUS SOIL	1	DM	22	T

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

Adam Chapman | Adam Chap | 5/5/14
p. Generator Authorized Agent Name (Print) | q. Signature | r. Date

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555
Special Waste Hauler Number# 3846

Ronald O Barkman | Ronald O Barkman | 5-5-14
c. Driver Name (Print) | d. Signature | e. Date

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL. 61350
b. Phone: 815-434-1808

c. US EPA Number
0990808103

d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print) | f. Signature | g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:

b. Phone:

c. Responsible Agency Name and Address:

d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print) | h. Signature | i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number ILD087154555
b. Manifest Document Number
c. Page 1 of

d. Generator's Name and Location:
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone:815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide:

h. Owner's Name: Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	NON HAZARDOUS SOIL	1	DM	22	T

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

Adam Chapman — p. Generator Authorized Agent Name (Print)
Adam Cha — q. Signature
5/5/19 — r. Date

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555
Special Waste Hauler Number# 3846

Doug Brewick — c. Driver Name (Print)
d. Signature
5-5-2017 — e. Date

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL. 61350
b. Phone: 815-434-1808

c. US EPA Number 0990808103
d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print)
f. Signature
g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:

b. Phone:

c. Responsible Agency Name and Address:

d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print)
h. Signature
i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number: ILD087154555
b. Manifest Document Number:
c. Page 1 of

d. Generator's Name and Location:
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone: 815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide:

h. Owner's Name: Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	NON HAZARDOUS SOIL	1	DM	22	T

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

p. Generator Authorized Agent Name (Print) | q. Signature | r. Date

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555 Special Waste Hauler Number# 3846

Adam Chapman | Adam C | 5/5/14 - 9:15 AM

c. Driver Name (Print) | d. Signature | e. Date

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL. 61350
b. Phone: 815-434-1808

c. US EPA Number: 0990808103
d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

Doug Brewick | | MAY 5 2014

e. Name of Authorized Agent (Print) | f. Signature | g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:

b. Phone:

c. Responsible Agency Name and Address:

d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print) | h. Signature | i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number: ILD087154555
b. Manifest Document Number:
c. Page 1 of

d. Generator's Name and Location:
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone:815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide:
h. Owner's Name: Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	NON HAZARDOUS SOIL	1	DM	22	T

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

Adam Chapman — p. Generator Authorized Agent Name (Print)
Adam Cha — q. Signature
5/5/14 — r. Date

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555
Special Waste Hauler Number# 3846

WAYNE KEITH — c. Driver Name (Print)
Wayne Keith — d. Signature
5 MAY 2014 — e. Date

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL 61350
b. Phone: 815-434-1808

c. US EPA Number: 0990808103
d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print)
f. Signature
g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:
b. Phone:

c. Responsible Agency Name and Address:
d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print)
h. Signature
i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number ILD087154555
b. Manifest Document Number
c. Page 1 of

d. Generator's Name and Location:
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone:815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide:
h. Owner's Name. Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	NON HAZARDOUS SOIL	1	DM	22	T

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

Adam Chapman — p. Generator Authorized Agent Name (Print)
Adam Clay — q. Signature
5/5/14 — r. Date

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555
Special Waste Hauler Number# 3846

Robert E Crouch — c. Driver Name (Print)
Robert E. Crouch — d. Signature
5-5-14 — e. Date

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL 61350
b. Phone: 815-434-1808
c. US EPA Number 0990808103
d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print)
f. Signature
g. Date

IV. ASBE[illegible] ompletes IVa-f and Operator complete IVg-i)

c. Responsible Agency Name and Address:

d. Phone:

Information:

% Friable % Non-Friable

e that the contents of this consignment are fully and accurately described above by proper shipping name nd are in all respects in proper condition for transport by highway according to applicable international and

h. Signature
i. Date

s, operates, controls, or supervises the facility being demolished or renovated, or the demolition or

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number	b. Manifest Document Number	c. Page 1 of

d. Generator's Name and Location:	e. Generator's Mailing Address:
Flint Hills Resources 501 Brunner St Peru, IL 61354 f. Phone:815-224-5451	Flint Hills Resources 502 Brunner St Peru, IL 61354 g. Phone:815-224-5451
If owner of the generating facility differs from the generator, provide: h. Owner's Name:	i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
					1	
4170112642	2/17/2014	Potentially Combustible EPS Dust	1	CM	5	Yards

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

Michael Schmidt , Environmental Engineer	M Schmidt	5/05/2013
p. Generator Authorized Agent Name (Print)	q. Signature	r. Date

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
ALLIED WASTE OF OTTAWA
2840 E. THIRTEENTH RD
OTTAWA, IL 61350
b. Phone: 815-434-2036

Dean Klieber	Dean Klieber	5-5-14
c. Driver Name (Print)	d. Signature	e. Date

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:	c. US EPA Number	d. Discrepancy Indication Space:
Land Comp Landfill 2840 E 13th Rd Ottawa, IL 61350 b. Phone: 815-434-1808	0990808103	

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print)	f. Signature	g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:	c. Responsible Agency Name and Address:
b. Phone:	d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print)	h. Signature	i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number: ILD087154555
b. Manifest Document Number:
c. Page 1 of

d. Generator's Name and Location:
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone:815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide:

h. Owner's Name: Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701318025	8/28/2014	NON HAZARDOUS SOIL	1	DM	22	T

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

Adam Chapman | Adam Chap | 5/5/14
p. Generator Authorized Agent Name (Print) | q. Signature | r. Date

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555 Special Waste Hauler Number# 3846

WAYNE KEITH | Wayne Keith | 5 MAY 2014
c. Driver Name (Print) | d. Signature | e. Date

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL. 61350
b. Phone: 815-434-1808

c. US EPA Number
0990808103

d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print) | f. Signature | g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:

b. Phone:

c. Responsible Agency Name and Address:

d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print) | h. Signature | i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

Duck Pond Sediment Manifest

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number	b. Manifest Document Number	c. Page 1 of
ILD087154555		

d. Generator's Name and Location:	e. Generator's Mailing Address:
Flint Hills Resources, LP 501 Brunner Street Peru, IL 61354 f. Phone:815.224.1525	Same as Location g. Phone:
If owner of the generating facility differs from the generator, provide: h. Owner's Name: Koch Industries, Inc.	i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701115215	08/06/2016	STORMWATER SEDIMENT CLEANOUT	1	CM	2	yd3

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

p. Generator Authorized Agent Name (Print)	q. Signature	r. Date
Adam Chapman	Adam Chap	5/8/14

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555 Special Waste Hauler Number# 3846

c. Driver Name (Print)	d. Signature	e. Date
PJ O'Reilly	PJ O'Reilly	5-8-14

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:	c. US EPA Number	d. Discrepancy Indication Space:
LANDCOMP LANDFILL 2840 EAST 13TH RD OTTAWA, IL. 61350 b. Phone: 815-434-1808	0990808103	

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print)	f. Signature	g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:	c. Responsible Agency Name and Address:
b. Phone:	d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print)	h. Signature	i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number	b. Manifest Document Number	c. Page 1 of
ILD087154555		

d. Generator's Name and Location:	e. Generator's Mailing Address:
Flint Hills Resources, LP 501 Brunner Street Peru, IL 61354 f. Phone:815.224.1525	Same as Location g. Phone:
If owner of the generating facility differs from the generator, provide: h. Owner's Name: Koch Industries, Inc.	i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701115215	08/06/2016	STORMWATER SEDIMENT CLEANOUT	1	CM	2	yd3

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

p. Generator Authorized Agent Name (Print)	q. Signature	r. Date
Adam Chapman	Adam Chap	5/8/14

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555 Special Waste Hauler Number# 3846

c. Driver Name (Print)	d. Signature	e. Date
PJ O'Reilly	PJ O'Reilly	5-8-14

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:	c. US EPA Number	d. Discrepancy Indication Space:
LANDCOMP LANDFILL 2840 EAST 13TH RD OTTAWA, IL. 61350 b. Phone: 815-434-1808	0990808103	

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print)	f. Signature	g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:	c. Responsible Agency Name and Address:
b. Phone:	d. Phone:

e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print)	h. Signature	i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both

REPUBLIC SERVICES, INC.

NON-HAZARDOUS SPECIAL WASTE & ASBESTOS MANIFEST

If waste is asbestos waste, complete Sections I, II, III and IV
If waste is NOT asbestos waste, complete Sections I, II and III

I. GENERATOR (Generator completes Ia-r)

a. Generator's US EPA ID Number: ILD087154555
b. Manifest Document Number:
c. Page 1 of

d. Generator's Name and Location:
Flint Hills Resources, LP
501 Brunner Street
Peru, IL 61354
f. Phone:815.224.1525

e. Generator's Mailing Address:
Same as Location
g. Phone:

If owner of the generating facility differs from the generator, provide:
h. Owner's Name: Koch Industries, Inc.
i. Owner's Phone No.:

j. Waste Profile #	k. Exp. Date	l. Waste Shipping Name and Description	m. Containers No.	m. Containers Type	n. Total Quantity	o. Unit Wt/Vol
41701115215	08/06/2016	STORMWATER SEDIMENT CLEANOUT	1	CM	2	yd3

GENERATOR'S CERTIFICATION: I hereby certify that the above named material is not a hazardous waste as defined by 40 CFR 261 or any applicable state law, has been properly described, classified and packaged, and is in proper condition for transportation according to applicable regulations; AND, if this waste is a treatment residue of a previously restricted hazardous waste subject to the Land Disposal Restrictions. I certify and warrant that the waste has been treated in accordance with the requirements of 40 CFR 268 and is no longer a hazardous waste as defined by 40 CFR 261.

p. Generator Authorized Agent Name (Print)	q. Signature	r. Date
Adam Chapman	Adam Chap	5/8/14

II. TRANSPORTER (Generator completes IIa-b and Transporter completes IIc-e)

a. Transporter's Name and Address:
D Construction
1488 S. Broadway
Coal City, Illinois 60416
b. Phone: 815-634-2555

Special Waste Hauler Number# 3846

c. Driver Name (Print)	d. Signature	e. Date
John Swiderski	[illegible]	5-9-14

III. DESTINATION (Generator complete IIIa-c and Destination Site completes IIId-g)

a. Disposal Facility and Site Address:
LANDCOMP LANDFILL
2840 EAST 13TH RD
OTTAWA, IL. 61350
b. Phone: 815-434-1808

c. US EPA Number: 0990808103
d. Discrepancy Indication Space:

I herby certify that the above named material has been accepted and to the best of my knowledge the foregoing is true and accurate.

e. Name of Authorized Agent (Print)	f. Signature	g. Date

IV. ASBESTOS (Generator completes IVa-f and Operator complete IVg-i)

a. Operator's Name and Address:
b. Phone:

c. Responsible Agency Name and Address:
d. Phone:

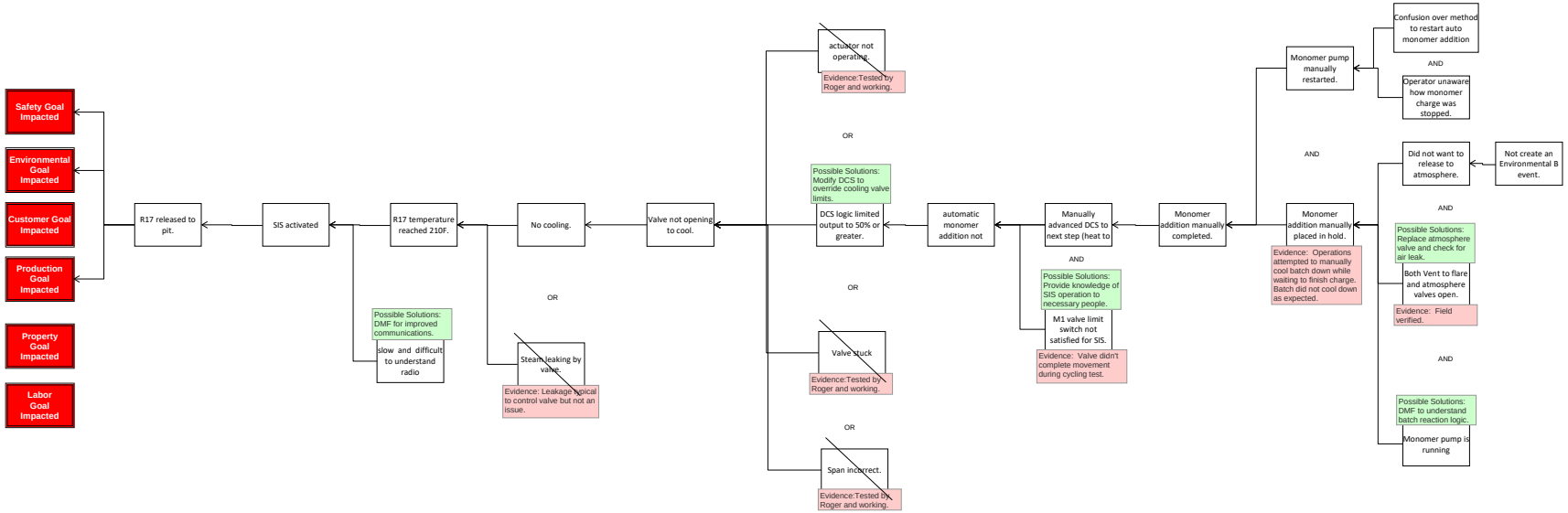
e. Special Handling Instructions and Additional Information:

f. ☐ Friable ☐ Non-Friable ☐ Both % Friable % Non-Friable

OPERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

g. Operator's Name and Title (Print)	h. Signature	i. Date

*Operator refers to the company which owns, leases, operates, controls, or supervises the facility being demolished or renovated, or the demolition or renovation operation or both


Safety Goal Impacted
Environmental Goal Impacted
Customer Goal Impacted
Production Goal Impacted
Property Goal Impacted
Labor Goal Impacted
R17 released to pit.
SIS activated
R17 temperature reached 210F.
Possible Solutions: DMF for improved communications.
slow and difficult to understand radio
No cooling.
OR
Steam leaking by valve.
Evidence: Leakage typical to control valve but not an issue.
Valve not opening to cool.
actuator not operating.
Evidence:Tested by Roger and working.
OR
Possible Solutions: Modify DCS to override cooling valve limits.
DCS logic limited output to 50% or greater.
OR
Valve stuck
Evidence:Tested by Roger and working.
OR
Span incorrect.
Evidence:Tested by Roger and working.
automatic monomer addition not
Manually advanced DCS to next step (heat to
AND
Possible Solutions: Provide knowledge of SIS operation to necessary people.
M1 valve limit switch not satisfied for SIS.
Evidence: Valve didn't complete movement during cycling test.
Monomer addition manually completed.
Monomer pump manually restarted.
Confusion over method to restart auto monomer addition
AND
Operator unaware how monomer charge was stopped.
AND
Monomer addition manually placed in hold.
Evidence: Operations attempted to manually cool batch down while waiting to finish charge. Batch did not cool down as expected.
Did not want to release to atmosphere.
Not create an Environmental B event.
AND
Possible Solutions: Replace atmosphere valve and check for air leak.
Both Vent to flare and atmosphere valves open.
Evidence: Field verified.
AND
Possible Solutions: DMF to understand batch reaction logic.
Monomer pump is running

4040.5

FLINT HILLS
resources®

May 5, 2014

VIA CERTIFIED MAIL
7013 3020 0000 2160 5268

LaSalle County LEPC
711 E. Etna Road
Ottawa, IL 61350

RE: Flint Hills Resources Chemical Intermediates, LLC ("FHR") – Peru Facility
501 Brunner Street, Peru, Illinois
Release Reporting Follow-up – SERC Report #H20140476

To Whom It May Concern:

On behalf of Flint Hills Resources Chemical Intermediates, LLC (FHR), I am re-submitting this follow-up release report for the event that occurred at the FHR Peru Facility on April 25, 2014. The original follow-up release report is postmarked May 2, 2014. The re-submittal is due to the fact that after the May 2, 2014 report was mailed, a typographical error was discovered on the page 2 table that references attachment 1, instead of page 1 of the report. The incident involved a release of styrene (CAS # 100-42-5) to the environment above the Reportable Quantity.

The incident involved reactor R-17, which discharged its batch into the emergency containment area. The discharge into the emergency containment area began at approximately 8:48 pm and ended by approximately 9:15 pm. Notifications to outside agencies of the Reportable Quantity exceedance began with a call to the NRC at 9:23 pm (ID – 1080888), followed by calls to the LaSalle County Emergency Services at 9:35 pm, and the Illinois Emergency Management Agency at 9:43 pm (ID – H201404760).

Some of the discharged material breached the emergency containment area, and Hazardous Materials personnel were called into the facility to respond to the release. Storm water stop gates were closed to prevent material from leaving the site through the storm drains.

Mitigation of the material in the emergency containment area began by adding absorbent to soak up any free liquid. During this process, a skin of polymer formed on the surface. Absorbent material was added to the impacted surfaces outside of the emergency containment area. Storm water was pumped from the retention basin to the facility's wastewater treatment plant. A contractor vacuumed and rinsed the storm sewer that received a small quantity of the discharged material. The contractor removed all absorbent material and the styrene/water mixture from the vacuum and rinse response activities.

A contractor removed impacted material outside of the emergency containment area. This removal was completed when the photoionization detector no longer detected the presence of styrene in the materials. Removed materials have been sampled and will be disposed of once characterization is complete.

All of the above response activities were completed in less than 24 hours of the incident. The facility's reactors are currently shut down pending an independent investigation of the incident.

FHR is providing this written follow-up as required by 40 CFR 355.40(b) and 29 Ill. Admin. Code 430.70. The citations below follow the federal requirements, which mirror the Illinois requirements. The following information

is provided based upon information obtained to date. As noted, FHR has engaged a third party to perform an independent investigation of the incident and may obtain new or different information as a result.

Regulation	Description of Required Information	FHR Response
40 CFR 355.40(a)(1)	Material released	Styrene. The original release notifications reported 56,000 pounds of styrene based on the amount of styrene added to the reactor to make the batch. It is estimated at this time that 52,400 pounds of styrene/polystyrene material was discharged to the emergency containment area.
40 CFR 355.40(a)(2)	Extremely Hazardous Substance (Y/N)	No
40 CFR 355.40(a)(3)	Estimated Quantity Released to Gravel/Asphalt	2,820 pounds of styrene
	Estimated Quantity Released to Air	796 pounds of styrene
40 CFR 355.40(a)(4)	Date	4/25/2014
	Time	The release began at approximately 8:47 PM, when the contents of Reactor 17 were released to the emergency containment area.
	Duration	The discharge to the emergency containment area lasted approximately 26 minutes. Emissions from the material in the emergency containment area continued for approximately 17 hours.
40 CFR 355.40(a)(5)	Medium or media of release	Soil and Air
40 CFR 355.40(a)(6)	Known or anticipated acute or chronic health risks associated with release	Enclosed is the Material Safety Data Sheet (MSDS) for styrene that outlines the acute and chronic health risks for styrene monomer.
40 CFR 355.40(a)(7)	Proper precautions to take as a result of the release, including evacuation (unless such information is readily available to the community emergency coordinator pursuant to the emergency plan).	A verbal assembly was communicated over the intercom informing all employees to assemble at designated assembly areas due to a discharge from Reactor 17 to the emergency containment area. The Hazmat team was notified to assemble for spill mitigation at 9:27 PM.
40 CFR 355.40(a)(8)	The name and telephone number of the individual (or individuals) to be contacted for further information	Brian Marcinkus 815-224-5232
40 CFR 355.40(b)(1)	Actions taken to respond to and contain the release	See Page 1.

Flint Hills Resources Chemical Intermediates, LLC ("FHR") – Peru Facility
501 Brunner Street, Peru, Illinois
Release Reporting Follow-up – SERC Report #H20140476

Regulation	Description of Required Information	FHR Response
40 CFR 355.40(b)(2)	Any known or anticipated acute or chronic health risks associated with the release	See enclosed MSDS.
40 CFR 355.40(b)(3)	Where appropriate, advice regarding medical attention necessary for exposed individuals	There were no reports of exposed individuals requiring medical attention as a result of the release.

If you have any question concerning this notification, please contact me at 815-224-5232.

Sincerely,

Brian Marcinkus
Plant Manager
Flint Hills Resources Chemical Intermediates, LLC

cc:

Illinois Emergency Management Agency
1035 Outer Park Drive
Springfield, IL 62704-4462

VIA CERTIFIED MAIL
7013 3020 0000 2160 5251

Illinois Environmental Protection Agency
Regional Field Office
9511 W. Harrison Street
DesPlaines, IL 60016
Attn: Emilo Salis

VIA CERTIFIED MAIL
7013 3020 0000 2160 5213

Illinois Environmental Protection Agency
Regional Field Office
412 SW Washington, Suite D
Peoria, Illinois 61602
Attn: Rizwan Syed

VIA CERTIFIED MAIL
7013 3020 0000 2160 5220

Illinois Environmental Protection Agency
Regional Field Office
4302 North Main Street
Rockford, Illinois 61103
Attn: Thomas Williams

VIA CERTIFIED MAIL
7013 3020 0000 2160 5337

AmericasStyrenics

Material Safety Data Sheet

Americas Styrenics LLC

Product Name: Styrene Monomer - AS

Issue Date: 12/08/2011
Print Date: 24 May 2012

Americas Styrenics LLC encourages and expects you to read and understand the entire (M)SDS, as there is important information throughout the document. We expect you to follow the precautions identified in this document unless your use conditions would necessitate other appropriate methods or actions.

1. Product and Company Identification

Product Name
Styrene Monomer - AS

COMPANY IDENTIFICATION
Americas Styrenics LLC
Suite 1200
24 Waterway Avenue
The Woodlands, TX 77380
United States

Customer Information Number: 888-552-6789
PSCS@amstyrenics.com

EMERGENCY TELEPHONE NUMBER

24-Hour Emergency Contact: 800-424-9300
Local Emergency Contact: 989-636-4400

2. Hazards Identification

Emergency Overview
Color: Colorless
Physical State: Liquid.
Odor: Sweet
Hazards of product:

WARNING! Flammable liquid and vapor. Causes eye irritation. May cause skin irritation. May be harmful if inhaled. May cause anesthetic effects. Aspiration hazard. Can enter lungs and cause damage. Vapor explosion hazard. Vapors may travel a long distance; ignition and/or flash back may occur. Isolate area. Keep upwind of spill. Stay out of low areas. Warn public of downwind explosion hazard. Eliminate ignition sources. Suspect cancer hazard. May cause cancer.

OSHA Hazard Communication Standard
This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

®(TM)*Trademark

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Potential Health Effects

Eye Contact: May cause moderate eye irritation. May cause moderate corneal injury. Vapor may cause eye irritation experienced as mild discomfort and redness. Vapor may cause lacrimation (tears).
Skin Contact: Prolonged contact may cause skin irritation with local redness. Repeated contact may cause skin burns. Symptoms may include pain, severe local redness, swelling, and tissue damage. May cause drying and flaking of the skin.
Skin Absorption: Prolonged skin contact is unlikely to result in absorption of harmful amounts.
Inhalation: Vapor concentrations are attainable which could be hazardous on single exposure. Excessive exposure may cause irritation to upper respiratory tract (nose and throat). Symptoms of excessive exposure may be anesthetic or narcotic effects; dizziness and drowsiness may be observed.
Ingestion: Very low toxicity if swallowed. Small amounts swallowed incidentally as a result of normal handling operations are not likely to cause injury; however, swallowing larger amounts may cause injury. Swallowing may result in irritation of the mouth, throat, and gastrointestinal tract.
Aspiration hazard: Aspiration into the lungs may occur during ingestion or vomiting, causing lung damage or even death due to chemical pneumonia.
Effects of Repeated Exposure: In animals, effects have been reported on the following organs: Central nervous system. Kidney. Liver. Respiratory tract. Lung effects have been observed in mice following repeated exposure to styrene. Styrene is reported to have caused hearing loss in laboratory animals upon exposure to high concentrations (>800 ppm); however, the relevance of this to humans is unknown. Some studies in humans allege that repeated exposure to styrene may result in minor, subclinical decreases in the ability to discriminate between colors.
Cancer Information: An increased incidence of lung tumors was observed in mice from an inhalation study on styrene. The relevance of this finding to humans is uncertain since data from mode of action investigations of mouse lung tumors coupled with other long-term animal studies and epidemiology studies of workers exposed to styrene do not provide a basis to conclude that styrene is carcinogenic.
Birth Defects/Developmental Effects: Has been toxic to the fetus in laboratory animals at doses toxic to the mother.

3. Composition Information

Component	CAS #	Amount
Styrene	100-42-5	>= 99.9 %

4. First-aid measures

Description of first aid measures

General advice: First Aid responders should pay attention to self-protection and use the recommended protective clothing (chemical resistant gloves, splash protection). If potential for exposure exists refer to Section 8 for specific personal protective equipment.
Inhalation: Move person to fresh air. If not breathing, give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask, etc). If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.
Skin Contact: Wash skin with plenty of water.
Eye Contact: Immediately flush eyes with water; remove contact lenses, if present, after the first 5 minutes, then continue flushing eyes for at least 15 minutes. Obtain medical attention without delay, preferably from an ophthalmologist. Suitable emergency eye wash facility should be immediately available.
Ingestion: Do not induce vomiting. Call a physician and/or transport to emergency facility immediately.

Most important symptoms and effects, both acute and delayed

Aside from the information found under Description of first aid measures (above) and Indication of immediate medical attention and special treatment needed (below), no additional symptoms and effects are anticipated.

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Indication of immediate medical attention and special treatment needed

Maintain adequate ventilation and oxygenation of the patient. If burn is present, treat as any thermal burn, after decontamination. Because rapid absorption may occur through the lungs if aspirated and cause systemic effects, the decision of whether to induce vomiting or not should be made by a physician. If lavage is performed, suggest endotracheal and/or esophageal control. Danger from lung aspiration must be weighed against toxicity when considering emptying the stomach. No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.
Skin contact may aggravate preexisting dermatitis.

5. Fire Fighting Measures

Suitable extinguishing media

Water fog or fine spray. Dry chemical fire extinguishers. Carbon dioxide fire extinguishers. Foam. General purpose synthetic foams (including AFFF type) or protein foams are preferred if available. Alcohol resistant foams (ATC type) may function.
Extinguishing Media to Avoid: Do not use direct water stream. Straight or direct water streams may not be effective to extinguish fire.

Special hazards arising from the substance or mixture

Hazardous Combustion Products: During a fire, smoke may contain the original material in addition to combustion products of varying composition which may be toxic and/or irritating. Combustion products may include and are not limited to: Carbon monoxide. Carbon dioxide.
Unusual Fire and Explosion Hazards: Container may rupture from polymerization. Violent steam generation or eruption may occur upon application of direct water stream to hot liquids. Electrically ground and bond all equipment. Flammable mixtures of this product are readily ignited even by static discharge. Vapors are heavier than air and may travel a long distance and accumulate in low lying areas. Ignition and/or flash back may occur. Flammable mixtures may exist within the vapor space of containers at room temperature. Flammable concentrations of vapor can accumulate at temperatures above flash point; see Section 9. Dense smoke is produced when product burns.

Advice for firefighters

Fire Fighting Procedures: Keep people away. Isolate fire and deny unnecessary entry. Stay upwind. Keep out of low areas where gases (fumes) can accumulate. Water may not be effective in extinguishing fire. Use water spray to cool fire exposed containers and fire affected zone until fire is out and danger of reignition has passed. Fight fire from protected location or safe distance. Consider the use of unmanned hose holders or monitor nozzles. Do not use direct water stream. May spread fire. Eliminate ignition sources. Move container from fire area if this is possible without hazard. Burning liquids may be moved by flushing with water to protect personnel and minimize property damage. Avoid accumulation of water. Product may be carried across water surface spreading fire or contacting an ignition source. Contain fire water run-off if possible. Fire water run-off, if not contained, may cause environmental damage. Review the "Accidental Release Measures" and the "Ecological Information" sections of this (M)SDS.
Special Protective Equipment for Firefighters: Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers, boots, and gloves). Avoid contact with this material during fire fighting operations. If contact is likely, change to full chemical resistant fire fighting clothing with self-contained breathing apparatus. If this is not available, wear full chemical resistant clothing with self-contained breathing apparatus and fight fire from a remote location. For protective equipment in post-fire or non-fire clean-up situations, refer to the relevant sections.

6. Accidental Release Measures

Personal precautions, protective equipment and emergency procedures: Isolate area. Keep unnecessary and unprotected personnel from entering the area. Keep personnel out of low areas.

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Keep upwind of spill. Ventilate area of leak or spill. Refer to Section 7, Handling, for additional precautionary measures. No smoking in area. Vapor explosion hazard. Keep out of sewers. For large spills, warn public of downwind explosion hazard. Check area with combustible gas detector before reentering area. Ground and bond all containers and handling equipment. Eliminate all sources of ignition in vicinity of spill or released vapor to avoid fire or explosion. See Section 10 for more specific information. Use appropriate safety equipment. For additional information, refer to Section 8, Exposure Controls and Personal Protection.

Environmental precautions: Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. See Section 12, Ecological Information.

Methods and materials for containment and cleaning up: Contain spilled material if possible. Pump with explosion-proof equipment. If available, use foam to smother or suppress. Collect in suitable and properly labeled containers. See Section 13, Disposal Considerations, for additional information.

7. Handling and Storage

Handling

General Handling: Keep away from heat, sparks and flame. Avoid contact with eyes, skin, and clothing. Do not swallow. Avoid breathing vapor. Wash thoroughly after handling. Use only with adequate ventilation. Keep container closed. No smoking, open flames or sources of ignition in handling and storage area. Electrically bond and ground all containers and equipment before transfer or use of material. Use of non-sparking or explosion-proof equipment may be necessary, depending upon the type of operation. Containers, even those that have been emptied, can contain vapors. Do not cut, drill, grind, weld, or perform similar operations on or near empty containers. Vapors are heavier than air and may travel a long distance and accumulate in low lying areas. Ignition and/or flash back may occur. Never use air pressure for transferring product. See Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION.
Other Precautions: Spills of these organic materials on hot fibrous insulations may lead to lowering of the autoignition temperatures possibly resulting in spontaneous combustion.

Storage

Minimize sources of ignition, such as static build-up, heat, spark or flame. Keep container closed. Maintain inhibitor and dissolved oxygen level. Do not purge containers of this material with nitrogen. Flammable mixtures may exist within the vapor space of containers at room temperature. See Section 10 for more specific information. Do not store in: Copper. Copper alloys. Shelf life is dependent on storage temperature and inhibitor level.

Shelf life: Use within 3 - 6 Months

8. Exposure Controls / Personal Protection

Exposure Limits

Component	List	Type	Value
Styrene	ACGIH	TWA	20 ppm BEI
	ACGIH	STEL	40 ppm BEI
	OSHA/Z2	TWA	100 ppm
	OSHA/Z2	Ceiling	200 ppm
	OSHA/Z2	MAX. CONC	600 ppm 5 minutes in any 3 hours

A BEI notation following the exposure guideline refers to a guidance value for assessing biological monitoring results as an indicator of the uptake of a substance from all routes of exposures.

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Personal Protection

Eye/Face Protection: Use chemical goggles. If exposure causes eye discomfort, use a full-face respirator.

Skin Protection: When prolonged or frequently repeated contact could occur, use protective clothing chemically resistant to this material. Selection of specific items such as faceshield, boots, apron, or full-body suit will depend on the task.

Hand protection: Use gloves chemically resistant to this material when prolonged or frequently repeated contact could occur. Examples of preferred glove barrier materials include: Polyethylene. Ethyl vinyl alcohol laminate ("EVAL"). Polyvinyl alcohol ("PVA"). Polyvinyl chloride ("PVC" or "vinyl"). Styrene/butadiene rubber. Viton. Examples of acceptable glove barrier materials include: Butyl rubber. Chlorinated polyethylene. Natural rubber ("latex"). Neoprene. Nitrile/butadiene rubber ("nitrile" or "NBR"). NOTICE: The selection of a specific glove for a particular application and duration of use in a workplace should also take into account all relevant workplace factors such as, but not limited to: Other chemicals which may be handled, physical requirements (cut/puncture protection, dexterity, thermal protection), potential body reactions to glove materials, as well as the instructions/specifications provided by the glove supplier.

Respiratory Protection: Respiratory protection should be worn when there is a potential to exceed the exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive-pressure supplied-air will depend on the specific operation and the potential airborne concentration of the material. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus. In confined or poorly ventilated areas, use an approved self-contained breathing apparatus or positive pressure air line with auxiliary self-contained air supply. The following should be effective types of air-purifying respirators: Organic vapor cartridge.

Ingestion: Avoid ingestion of even very small amounts; do not consume or store food or tobacco in the work area; wash hands and face before smoking or eating.

Engineering Controls

Ventilation: Use engineering controls to maintain airborne level below exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, use only with adequate ventilation. Local exhaust ventilation may be necessary for some operations.

9. Physical and Chemical Properties

Appearance	
Physical State	Liquid.
Color	Colorless
Odor	Sweet
Odor Threshold	0.1 ppm *Literature*
pH	*Not applicable*
Melting Point	Not applicable to liquids
Freezing Point	-30.6 °C (-23.1 °F) *Literature*
Boiling Point (760 mmHg)	145 °C (293 °F) Literature.
Flash Point - Closed Cup	31 °C (88 °F) *Literature*
Evaporation Rate (Butyl Acetate = 1)	< 1 *Literature*
Flammability (solid, gas)	No
Flammable Limits In Air	**Lower:** 1.1 %(V) *Literature* **Upper:** 6.1 %(V) *Literature*
Vapor Pressure	0.67 kPa @ 20 °C *Literature*
Vapor Density (air = 1)	3.6 @ 20 °C *Literature*
Specific Gravity (H2O = 1)	0.91 *Literature*
Solubility in water (by weight)	0.03 g/l @ 20 °C *Literature*
Partition coefficient, n-octanol/water (log Pow)	2.95 *Measured*
Autoignition Temperature	490 °C (914 °F) *Literature*
Decomposition Temperature	No test data available

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Kinematic Viscosity	0.8 cSt @ 20 °C *Literature*
Liquid Density	0.9050 g/cm3 @ 20 °C
Molecular Weight	104.14 g/mol
Henry's Law Constant (H)	2.75E-03 atm*m3/mole Measured

10. Stability and Reactivity

Reactivity
No dangerous reaction known under conditions of normal use.

Chemical stability
Stable under recommended storage conditions. See Storage, Section 7.

Possibility of hazardous reactions
Can occur. Maintain inhibitor and dissolved oxygen level. Do not purge containers of this material with nitrogen. Polymerization can be catalyzed by: Absence of air. Metal salts. Peroxides. Rust. This product is inhibited with: p-Tertiary butylcatechol. Uninhibited monomer vapors can polymerize and plug relief devices.

Conditions to Avoid: Avoid temperatures above 30°C (86°F) Exposure to elevated temperatures can cause product to decompose. Avoid static discharge. Do not blanket or purge with an inert gas to avoid depleting the oxygen concentration. Avoid direct sunlight.
Inhibitor: 4-tert-Butylcatechol.
Incompatible Materials: Avoid contact with oxidizing materials. Avoid contact with: Acids. Caustic potash. Caustic soda. Metal halides. Avoid contact with absorbent materials such as: Cellulose. Clay-based absorbents. Sawdust. Avoid unintended contact with peroxides.

Hazardous decomposition products
Decomposition products depend upon temperature, air supply and the presence of other materials.

11. Toxicological Information

Acute Toxicity
Ingestion
LD50, rat 5,000 mg/kg
Dermal
The dermal LD50 has not been determined.
Inhalation
LC50, 4 h, Vapor, rat 11.8 mg/l
Eye damage/eye irritation
May cause moderate eye irritation. May cause moderate corneal injury. Vapor may cause eye irritation experienced as mild discomfort and redness. Vapor may cause lacrimation (tears).
Skin corrosion/irritation
Prolonged contact may cause skin irritation with local redness. Repeated contact may cause skin burns. Symptoms may include pain, severe local redness, swelling, and tissue damage. May cause drying and flaking of the skin.
Sensitization
Skin
No relevant data found.
Respiratory
No relevant data found.
Repeated Dose Toxicity
In animals, effects have been reported on the following organs: Central nervous system. Kidney. Liver. Respiratory tract. Lung effects have been observed in mice following repeated exposure to styrene. Styrene is reported to have caused hearing loss in laboratory animals upon exposure to high

FHRPRU004154

concentrations (>800 ppm); however, the relevance of this to humans is unknown. Some studies in humans allege that repeated exposure to styrene may result in minor, subclinical decreases in the ability to discriminate between colors.

Chronic Toxicity and Carcinogenicity

An increased incidence of lung tumors was observed in mice from an inhalation study on styrene. The relevance of this finding to humans is uncertain since data from mode of action investigations of mouse lung tumors coupled with other long-term animal studies and epidemiology studies of workers exposed to styrene do not provide a basis to conclude that styrene is carcinogenic.

Carcinogenicity Classifications:

Component	List	Classification
Styrene	IARC	Possibly carcinogenic to humans.; 2B
	NTP	Reasonably anticipated to be a human carcinogen.

Developmental Toxicity

Has been toxic to the fetus in laboratory animals at doses toxic to the mother. Did not cause birth defects in laboratory animals.

Reproductive Toxicity

In animal studies, did not interfere with reproduction.

Genetic Toxicology

In vitro genetic toxicity studies were inconclusive. Animal genetic toxicity studies were inconclusive

12. Ecological Information

Toxicity

Material is moderately toxic to aquatic organisms on an acute basis (LC50/EC50 between 1 and 10 mg/L in the most sensitive species tested).

Fish Acute & Prolonged Toxicity
LC50, Oncorhynchus mykiss (rainbow trout), static test, 96 h: 4.1 mg/l
Aquatic Invertebrate Acute Toxicity
LC50, Daphnia magna (Water flea), static test, 48 h, survival: 23 mg/l
EC50, Daphnia magna (Water flea), flow-through test, 48 h, immobilization: 4.7 mg/l
Aquatic Plant Toxicity
ErC50, Pseudokirchneriella subcapitata (green algae), static test, Growth rate inhibition, 72 h: 4.9 mg/l
Toxicity to Soil Dwelling Organisms
LC50, Eisenia fetida (earthworms), 14 d: 120 mg/kg

Persistence and Degradability

Material is ultimately biodegradable (reaches > 70% biodegradation in OECD test(s) for inherent biodegradability). Biodegradation under aerobic static laboratory conditions is high (BOD20 or BOD28/ThOD > 40%). Material is expected to be readily biodegradable.

OECD Biodegradation Tests:

Biodegradation	Exposure Time	Method	10 Day Window
87 %	28 d	OECD 301F Test	pass

Indirect Photodegradation with OH Radicals

Rate Constant	Atmospheric Half-life	Method
5.3E-11 cm3/s	3.5 h	Estimated.

Biological oxygen demand (BOD):

BOD 5	BOD 10	BOD 20	BOD 28
34 %	47 %	54 %	

Chemical Oxygen Demand: 2.89 mg/mg
Theoretical Oxygen Demand: 3.08 mg/mg

Bioaccumulative potential

Bioaccumulation: Bioconcentration potential is low (BCF < 100 or Log Pow < 3).
Partition coefficient, n-octanol/water (log Pow): 2.95 Measured

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Bioconcentration Factor (BCF): 13.5; Fish; Measured

Mobility in soil

Mobility in soil: Potential for mobility in soil is low (Koc between 500 and 2000).
Partition coefficient, soil organic carbon/water (Koc): 520 - 920 Estimated.
Henry's Law Constant (H): 2.75E-03 atm*m3/mole Measured

13. Disposal Considerations

DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. All disposal practices must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. AS YOUR SUPPLIER, WE HAVE NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION: Composition Information. FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: Incinerator or other thermal destruction device.

14. Transport Information

DOT Non-Bulk

Proper Shipping Name: STYRENE MONOMER, STABILIZED
Hazard Class: 3 **ID Number:** UN2055 **Packing Group:** PG III

DOT Bulk

Proper Shipping Name: STYRENE MONOMER, STABILIZED
Hazard Class: 3 **ID Number:** UN2055 **Packing Group:** PG III

IMDG

Proper Shipping Name: STYRENE MONOMER, STABILIZED
Hazard Class: 3 **ID Number:** UN2055 **Packing Group:** PG III
EMS Number: F-E,S-D
Marine pollutant.: No

ICAO/IATA

Proper Shipping Name: STYRENE MONOMER, STABILIZED
Hazard Class: 3 **ID Number:** UN2055 **Packing Group:** PG III
Cargo Packing Instruction: 366
Passenger Packing Instruction: 355
Additional Information

Reportable quantity: 1,000 lb – STYRENE

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product. Additional transportation system information can be obtained through an authorized sales or customer service representative. It is the responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.

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15. Regulatory Information

OSHA Hazard Communication Standard
This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Sections 311 and 312

Immediate (Acute) Health Hazard	Yes
Delayed (Chronic) Health Hazard	Yes
Fire Hazard	Yes
Reactive Hazard	No
Sudden Release of Pressure Hazard	No

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Section 313
This product contains the following substances which are subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and which are listed in 40 CFR 372.

Component	CAS #	Amount
Styrene	100-42-5	99.9%

Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Hazardous Substances List and/or Pennsylvania Environmental Hazardous Substance List:
The following product components are cited in the Pennsylvania Hazardous Substance List and/or the Pennsylvania Environmental Substance List, and are present at levels which require reporting.

Component	CAS #	Amount
Styrene	100-42-5	99.9%

Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Special Hazardous Substances List:
To the best of our knowledge, this product does not contain chemicals at levels which require reporting under this statute.

California Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986)
WARNING: This product contains a chemical(s) known to the State of California to cause cancer.

Component	CAS #	Amount
Benzene	71-43-2	<= 1.0 PPM
Ethylbenzene	100-41-4	<= 0.0085 %

However, please note that there is inadequate evidence of ethylbenzene causing cancer in humans. Ethylbenzene has not been classified as a carcinogen by the International Agency for Research on Cancer (IARC), US Environmental Protection Agency (EPA) or the National Toxicology Program (NTP).

In March 2008, the Office of Environmental Health Hazard Assessment's (OEHHA) Proposition 65 department proposed an NSRL of 54 µg/day (inhalation) for ethylbenzene. The objective of the above warning statement is to comply with the Prop 65 statute.

For guidance on Prop 65 labeling requirements for your products, please refer to the workbook published by the Plastics Packaging Council (PPC) available by calling the Customer Information number found on page 1 of this MSDS.

California Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986)
WARNING: This product contains a chemical(s) known to the State of California to cause birth defects or other reproductive harm.

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Component	CAS #	Amount
Benzene	71-43-2	<= 1.0 PPM

US. Toxic Substances Control Act
All components of this product are on the TSCA Inventory or are exempt from TSCA Inventory requirements under 40 CFR 720.30
CEPA - Domestic Substances List (DSL)
All substances contained in this product are listed on the Canadian Domestic Substances List (DSL) or are not required to be listed.

16. Other Information

Recommended Uses and Restrictions
Identified uses
For industrial use. We recommend that you use this product in a manner consistent with the listed use. If your intended use is not consistent with the stated use, please contact your sales or technical service representative.

Revision
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Most recent revision(s) are noted by the bold, double bars in left-hand margin throughout this document.

Legend

N/A	Not available
W/W	Weight/Weight
OEL	Occupational Exposure Limit
STEL	Short Term Exposure Limit
TWA	Time Weighted Average
ACGIH	American Conference of Governmental Industrial Hygienists, Inc.
DOW IHG	Dow Industrial Hygiene Guideline
WEEL	Workplace Environmental Exposure Level
HAZ_DES	Hazard Designation
Action Level	A value set by OSHA that is lower than the PEL which will trigger the need for activities such as exposure monitoring and medical surveillance if exceeded.

Americas Styrenics LLC urges each customer or recipient of this (M)SDS to study it carefully and consult appropriate expertise, as necessary or appropriate, to become aware of and understand the data contained in this (M)SDS and any hazards associated with the product. The information herein is provided in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ between various locations. It is the buyer's/user's responsibility to ensure that his activities comply with all federal, state, provincial or local laws. The information presented here pertains only to the product as shipped. Since conditions for use of the product are not under the control of the manufacturer, it is the buyer's/user's duty to determine the conditions necessary for the safe use of this product. Due to the proliferation of sources for information such as manufacturer-specific (M)SDSs, we are not and cannot be responsible for (M)SDSs obtained from any source other than ourselves. If you have obtained an (M)SDS from another source or if you are not sure that the (M)SDS you have is current, please contact us for the most current version.

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