UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

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| **In the Matter of:** | ) | **EPA-5-13-113(a)-IL-03** |
| | ) | |
| **SABIC Innovative Plastics US LLC** | ) | **Proceeding Under Sections 113(a)(1)** |
| **Ottawa, Illinois** | ) | **(a)(3), 114(a) (1) of the Clean Air Act** |
| | ) | **42 U.S.C. §§ 7413(a)(1) and (a)(3)** |
| | ) | **and 7414(a)(1)** |
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## I. Administrative Consent Order

1. The Director of the Air and Radiation Division, U.S. Environmental Protection Agency, Region 5, is issuing this Order to SABIC Innovative Plastics US LLC (SABIC) under Sections 113(a)(1), (a)(3) and 114(a)(1) of the Clean Air Act (Act), 42 U.S.C. §§ 7413 (a)(1), (a)(3) and 7414(a)(1).

## II. Statutory and Regulatory Background

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

3. On February 21, 1980, EPA approved Illinois Rule 35 Illinois Administrative Code (IAC) 215 as part of the federally enforceable State Implementation Plan (SIP) for Illinois. 45 Fed. Reg. 11,472.

4. The Illinois State Implementation Plan (Illinois SIP) at Illinois Administrative Code (IAC) 215.301 and 302(a) allows the release of volatile organic material (VOM) waste gas streams containing more than 8 pounds/hour of VOM if such emissions are controlled by one of the following methods: (A) flame, thermal or catalytic incineration so as either to reduce such emissions to 10 ppm equivalent methane (molecular weight 16) or less, or to convert 85 percent of the hydrocarbons to carbon dioxide and water; (B) a vapor recovery system which adsorbs and/or condenses at least 85 percent of the total uncontrolled organic material that would otherwise be emitted to the atmosphere; or (C) any other air pollution control equipment approved by the Agency capable of reducing by 85 percent or more the uncontrolled organic material that would be otherwise emitted to the atmosphere.

5. Equipment within the latex process is subject to National Emissions Standards for Hazardous Air Pollutants (NESHAP) Group IV Polymers and Resins (Subpart JJJ). The

flare is used as a control device to comply with Subpart JJJ, and is required to meet the flare requirements in 40 C.F.R. 63 Subpart A. Specifically, 40 C.F.R. § 63.11(b)(6)(ii) states, "Flares shall be used only with the net heating value [NHV] of the gas being combusted at 11.2 MJ/scm (300 BTU/scf) or greater if the flare is steam-assisted."

6. On March 7, 1995, EPA gave the Illinois Title V Clean Air Act Permit Program (CAAPP) interim approval as a 40 C.F.R. Part 70 permit program under the authority of Section 502 of the Act, 42 U.S.C. § 7661(a) (60 Fed. Reg. 12478). On December 4, 2001, EPA gave the Illinois Title V CAAPP final approval as a 40 C.F.R. Part 70 permit program (66 Fed. Reg. 62946). The regulation at 40 C.F.R. § 70.6(b)(1) specifies that all terms and conditions in a permit issued under a Part 70 program are enforceable by the EPA under the Act. SABIC was issued Title V Permit No. 96010032 for source 099829AAA on November 25, 2003. SABIC appealed the Title V permit in a timely manner, and the Title V permit is currently stayed.

7. Under Section 113(a)(1) of the Act, 42 U.S.C. § 7413(a)(1), the Administrator of EPA may issue an order requiring compliance to any person who has violated or is violating a SIP. Under Section 113(a)(3) of the Act, 42 U.S.C. § 7413(a)(3), the Administrator of EPA may issue an order requiring compliance to any person who has violated or is violating the NSPS regulations. The Administrator has delegated this authority to the Director of the Air and Radiation Division.

8. The Administrator of EPA may require any person who owns or operates an emission source to make reports, install, use and maintain monitoring equipment, sample emissions and provide information required by the Administrator under Section 114(a)(1) of the Act, 42 U.S.C. § 7414(a)(1). The Administrator has delegated this authority to the Director of the Air and Radiation Division.

## III. Findings

9. SABIC uses a flare to control emissions from its latex process (latex flare). The latex flare is steam-assisted, which means that steam is added to the waste, or vent gas stream, to enhance combustion and prevent the formation of smoke. Steam is added in proportion to the amount of vent gas. It is common practice to measure the amount of steam as a ratio of the mass of steam per unit mass of vent gas (lb/lb).

10. In July 1983, the EPA released report "EPA 600/2-83-052," titled Flare Efficiency Study (1983 Flare Study). This study, partially funded by EPA and the Chemical Manufacturers Association (CMA), included various tests to determine the combustion efficiency and hydrocarbon destruction efficiency of flares under a variety of operating conditions. Certain tests were conducted on a steam-assisted flare provided by John Zink Company. The tests performed included a wide range of steam flows and steam-to-vent gas ratios. The data collected showed decreasing combustion efficiencies when the steam-to-vent gas ratio was above 3.5. The tests showed the following efficiencies at the following steam-to-vent gas (S/V) ratios:

| Pounds of Steam to One Pound of Vent Gas | Combustion Efficiency (%) |
|---|---|
| 3.45 | 99.7 |
| 5.67 | 82.18 |
| 6.86 | 68.95 |

The report concluded that excessive steam-to-vent gas ratios caused steam quenching of the flame during the tests which resulted in lower combustion efficiency.

11. The EPA has identified other publicly available studies and reports that evaluate how flare combustion efficiency is affected by steam addition. The conclusions of these studies support those of EPA 600/2-83-052.

12. On July 1, 2011, and August 31, 2011, SABIC provided information to the EPA in response to an EPA information request, including design documents and operating data on the latex flare for the period from January 19, 2007, to May 26, 2011. Documents provided by SABIC include the Material Requisition and Operation, Maintenance and Installation Instructions. EPA reviewed all information provided by SABIC.

13. Documents provided by SABIC set forth both steam and vent gas flow rates. These documents indicate an S/V ratio of 0.25 to 0.4. Specifically:

    a. In the Material Requisition from Crawford & Russell dated May 30, 1973, on page 2 in the Design Summary 3.2.D, it calls for "150 psig steam – 0.4 lb steam/lb waste," or an S/V ratio of 0.4;
    b. In the Operating & Installation Instructions (undated), under V – Waste Design Rates, it calls for a Waste Flow Rate of 1275 lb/hr and steam flow rate of 320 lb/hr, providing an S/V ratio of 0.25; and
    c. In the Operating, Maintenance and Installation Instructions for a John Zink ZTOF Ground Flare (undated), on the Specifications Sheet (page 5), under Section A. Waste Data, it indicates a flow rate of 1,275 lb/hr, and under Section C, Purging, it indicates a flow rate of 320 lb/hr of steam. This yields an S/V ratio of 0.25.

    Actual operating information provided by SABIC indicates operation of the flare above an S/V ratio of 0.4 at all times the flare was operated for the period from January 1, 2007 through May 26, 2011. Flare testing data indicates that such operation would have reduced the efficiency of the flare and subsequently increased emissions. Moreover, the flare was operated at an S/V ratio greater than ten times above 0.4 (i.e. an S/V ratio of 4.0) for an estimated 13,990 hours during this period.

14. By supplying excess steam, SABIC reduced the combustion efficiency of the latex flare on a consistent basis below 85% and released a waste gas stream to the environment with an organic material concentration greater than 10 ppm and at a rate exceeding 8 lb/hr.

This constitutes a violation of the Illinois SIP at IAC 215.301 and 302(a). Information provided by SABIC and the 1983 Flare Study suggests this prohibited condition occurs when the S/V ratio exceeds 5.31. SABIC operated in this condition for a total of 13,951 hours for the period of January 1, 2007 through May 26, 2011.

15. SABIC provided NHV values for operating scenarios for the period from January 1, 2007 through May 26, 2011. Some of the NHV values are below the requirement for steam-assisted flares of 300 BTU/scf specified in 40 C.F.R. § 63.11(b)(6)(ii). Based on information provided by SABIC, EPA determined that SABIC violated this condition for a total of 1,035 hours for the period from January 1, 2007 through May 26, 2011.

16. On May 23, 2011, EPA issued SABIC an information request for flare operating data.

17. On January 4, 2012, EPA issued to SABIC a Notice of Violation/Finding of Violation (NOV/FOV) alleging the violations in paragraphs 13 through 15 above.

18. On February 8, 2012, representatives of SABIC and EPA discussed the January 4, 2012 NOV/FOV.

19. SABIC neither admits nor denies the allegations and findings above.

## IV. Compliance Program

20. No later than 12 months from the effective date of this Order, SABIC agrees that it shall achieve compliance with 35 IAC 215.301 and 302(a), and with 40 C.F.R. § 63.11(b)(6)(ii) at its facility in Ottawa, Illinois.

21. Since April 1, 2012, SABIC has minimized the S/VG ratio at the latex flare at all times to the extent possible while still mitigating smoking from the flare. SABIC's actions have included instructing process operators to only use as much steam as is needed to control smoke and to ensure there is a visible flame.

22. This Order sets forth a program of compliance that SABIC agrees it shall follow to correct violations alleged in the January 4, 2012 NOV/FOV. This program consists of:
    a. Installation and start up of a new unassisted flare system (new flare) explained further in paragraph 23 and Appendix A;
    b. Operating limitations and requirements in paragraph 24 and the Instrumentation and Process Control Plan, attached as an Appendix B;
    c. Permit modification described in paragraph 27; and
    d. Recordkeeping described in paragraph 28.

23. SABIC agrees that it shall install the new flare that meets specifications in Appendix A. SABIC also agrees to permanently remove the existing latex flare from service as soon as the new flare becomes fully operational.

24. SABIC agrees that it shall comply with the following operating limitations and requirements at the new flare:
    a. Ensure the new flare complies with all applicable federal, state and local provisions governing flare operation, including, but not limited to, those related to smoke, exit velocity, minimum heating value of the vent gas (NHVvg) (200 BTU/scf), and adhering to the flare's design while using good air pollution control practices;
    b. "One-Hour Rolling Average" shall mean the arithmetic average of 12 consecutive Five-Minute-Operating Averages;
    c. "Five-Minute-Operating Average" shall mean the arithmetic average of data measured during the period of time that waste gas is being vented to the flare, which period of waste gas flow totals 5 minutes in length. Data measured during periods of no waste gas flow (as described in appendix B) shall not be included in the average, and the five-minute period of time shall exclude all periods of no waste gas flow.
    d. "Net Heating Value in the Combustion Zone (NHVcz)" shall mean the net heating value of the combination of waste gas and any supplemental gas and assist gas, but excluding the pilot gas, present at the flare tip;
    e. Ensure NHVcz meets a minimum of 300 BTU/scf on a One-Hour Rolling Average basis whenever the flare is combusting waste gas;
    f. Ensure the addition of supplemental gas required to meet the NHVvg and NHVcz limits above shall be automated to the extent specified in Appendix A;
    g. Whenever the flare is combusting waste gas, measure and record Five-Minute-Operating Averages, and the associated One-Hour Rolling Averages, for the following parameters for the latex flare:
        i. Waste gas flow, supplemental gas flow, and assist gas flow, each in scfm;
        ii. Concentrations of 1,3-butadiene and 2-butene, each in ppmv;
        iii. NHVvg in BTU/scf; and
        iv. NHVcz in BTU/scf.
    h. Maintain records of the following for the latex flare:
        i. Hours each month when a net heating value could not be determined due to downtime of the instruments or control system;
        ii. Hours each month of non-operation of the FTIR, supplemental gas flow meters, assist gas flow meters, and waste gas flow meters, and the reason for the non-operation;
        iii. Hours of operation each month that the NHVvg was below 200 BTU/scf, the cause of each event, and actions SABIC took in response to remedy the low NHVvg; and
        iv. Hours of operation each month that the NHVcz was below 300 BTU/scf, the cause of each event, and actions SABIC took in response to remedy the low NHVcz.

25. A failure to comply with the operating limitations and requirements in paragraph 24 and the Instrumentation and Process Control Plan shall not constitute a violation of this Order if the noncompliance results from downtime of instruments or equipment due to the following:

a. Malfunction of an instrument, for an instrument needed to meet the requirement(s);
b. Maintenance following instrument malfunction, for an instrument needed to meet the requirement(s);
c. Scheduled maintenance of an instrument in accordance with the manufacturer's recommended schedule, for an instrument needed to meet the requirement(s); and
d. Quality Assurance/Quality Control activities on an instrument needed to meet the requirement(s).

However, it shall be a violation of this Order if the sum of the length of these events (a.-d.) exceeds 110 hours in any calendar quarter for any individual instrument. This 110-hour restriction relates only to periods of time during which there is waste gas flow to the flare.

26. SABIC agrees that it shall install the equipment, instrumentation and programming outlined in the Instrumentation and Process Control Plan within 11 months of the effective date of this Order. SABIC agrees that it shall meet all other operating limitations and requirements in Section IV of this Order within 12 months of the effective date of this Order.

27. SABIC shall apply for a modification to its existing federally-enforceable Title V CAA permit No. 96010032 (the Application) so that the permit incorporates the limitations and requirements in Section IV of this Order. The Application shall be made in accordance with applicable State of Illinois regulations. The Application shall be submitted to the Illinois EPA no later than ten months after the effective date of this Order, and a copy shall be provided simultaneously to EPA. SABIC shall make a good faith effort to assist the Illinois EPA in permitting these changes and subsequently incorporating these changes into the Title V permit, where appropriate.

28. Recordkeeping:
   a. SABIC must keep all pertinent records of the implementation of this Order, including purchase records, work orders and instrument calibrations, for at least three years after the termination of this Order unless a longer time is required by permit or regulation; and
   b. SABIC shall keep the records listed in paragraph 24 g. and h. pertaining to the operation of the new flare for a period of three years after termination of this Order unless a longer time is required by permit or regulation.

29. Any submittals required under this Order shall be sent to:

Attention: Compliance Tracker (AE-17J)
Air Enforcement and Compliance Assurance
Branch
U.S. Environmental Protection Agency, Region 5
77 W. Jackson Boulevard
Chicago, Illinois 60604

## V. General Provisions

30. If both parties concur that it is appropriate, specific terms of this compliance program may be revised in writing signed by an authorized representative of EPA and SABIC.

31. This Order does not affect SABIC's responsibility to comply with other federal, state and local laws.

32. This Order does not restrict EPA's authority to enforce the Illinois SIP and Section 111 of the Act, or any other section of the Act.

33. Nothing in this Order limits the EPA's authority to seek appropriate relief, including penalties, under Section 113 of the Act, 42 U.S.C. § 7413, for SABIC's violation of the Illinois SIP, NESHAPs, or Title V of the Act.

34. Failure to comply with this Order may subject SABIC to penalties of up to $37,500 per day for each violation under Section 113 of the Act, 42 U.S.C. § 7413, and 40 C.F.R. Part 19.

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

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

37. This Order is not subject to the Paperwork Reduction Act, 44 U.S.C. § 3501 *et seq.*, because it seeks collection of information by an agency from specific individuals or entities as part of an administrative action or investigation. To aid in our electronic recordkeeping efforts, please furnish an electronic copy on CD or a thumb drive. If not possible, provide your response to this Order without staples; paper clips and binder clips, however, are acceptable.

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

39. SABIC agrees to the terms of this Order. This Order is effective on the date of signature by the Director of the Air and Radiation Division. This Order will terminate one year from the effective date, provided that SABIC has complied with all terms of the Order throughout its duration.

9/11/2013
Date

Michael Walsh
Vice President
SABIC Innovative Plastics US LLC

Date

George T. Czerniak
Director
Air and Radiation Division

## CERTIFICATE OF MAILING

I, Loretta Shaffer, certify that I sent the Administrative Consent Order, EPA Order No. EPA-5-13-113(a)-IL-03, by certified mail, return receipt requested, to:

Alphonse McMahon
Senior Counsel, EHSS
Saudi Basic Industries Corporation
1 Lexan Lane
Mount Vernon, IN 47620

I also certify that I sent a copy of the Administrative Consent Order, EPA Order No. EPA-5-13-113(a)-IL-03, by first-class mail to:

Ray Pilapil, Manager
Compliance and Enforcement Section
Illinois Environmental Protection Agency
1012 North Grand Avenue East
Springfield, Illinois 62702

On the 20 day of September 2013

Loretta Shaffer

Loretta Schaffer
AECAB, Planning and Administration Section

CERTIFIED MAIL RECEIPT NUMBER: 7009 1680 0000 7669 5701

Standard bcc's: Official File Copy w/Attachment (s)
Originating Organization Reading File w/Attachment(s)

Other bcc's:

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# <u>APPENDIX A</u>

Flare Specifications

**GENERAL FLARE DESIGN:**

The flare will be a gas-assisted enclosed flare of John Zink Company (JZ) design. The flare will contain 3 burners. The first burner will be designed to handle the Butadiene Recovery System venting (Case 1). The first burner will operate independently of the other two burners, including the instrumentation and controls. The second and third burners will be identical to the first burner but they will work in parallel and will handle all of the other venting conditions (Cases 2-6). These two burners will have instrumentation and controls separate from the first burner.

**I. SCOPE OF SUPPLY**

<u>Complete Flare System</u>:

**One (1) John Zink Enclosed Flare System, including:**

- Flare Enclosure with support structure, 42' OAH (A36 carbon steel) with exterior surface prep and coating per JZ standard paint specs, ceramic fiber lining, ladder and platform mounting brackets (ladders and platforms not included), and nozzles described below.
- Three (3) GKEC Gas-Assisted Burners, 310 SS
- Three (3) KEP Pilots with electronic spark igniter and flame ionization pilot flame detection, 310 SS
- KEP Auto/Manual NEMA 7 Electronic Pilot Ignition Control Panel, with alarm contacts for DCS.
- Rack-mounted pilot fuel strainer, pressure regulator, manual block valve, and pressure gauge.
- Four (4) 4" sample ports
- Three (3) 2" scanner ports (scanners not included)
- One (1) 4" x 6" sight glass assembly with internal flapper-style closure and pull handle
- Engineering design for ladders, one (1) 360° platform, and one (1) step-off platform. Mounting hardware for ladders and platforms will be provided and installed on the flare enclosure, but actual ladders and platforms will not be supplied.

**Note**: JZ will provide basic engineering support for the following items, but these items are not included in JZ scope of supply:

- Waste gas control system
- Supplemental gas control system
- Assist gas control system
- Purge gas control system
- Pilot fuel gas control system
- Engineering logic and controls diagram
- PLC and/or changes to DCS for pilot ignition control
- Knockout drum
- Foundation design
- Wind Fence
- Ladders and platforms
- Flame arrestors
- Scanners

**II. DESIGN CRITERIA: Design shall be in accordance with 40 CFR 63.11(b)**

**Waste Gas Design Case:**

| | |
|---|---|
| Composition: | 0-100% Butadiene, with balance N2 (0-25% of the butadiene may consist of butenes) |
| Flow Rate: | Case 1: 0-500 lb/hr<br>Cases 2-6: 0-1,000 lb/hr total |
| Calculated Heating Value: | 0 to 2,789 Btu/scf (see Note) |
| Molecular Weight: | 28 to 54 |
| Temperature: | 140°F |
| Pressure Required: | 23 in. w.c. |

**Utilities:**

| | |
|---|---|
| Pilot Fuel: | Natural Gas - 100 SCFH per pilot @ 15 psig |
| Electricity: | 110V/60HZ/1PH |
| Assist Gas: | Natural Gas - 0 to 600 lb/hr |
| Supplemental Gas: | Natural Gas - 0 to 630 lb/hr (See Note) |

**Enclosed Ground Flare Specifications:**

| | |
|---|---|
| Height: | 42' Overall Height (37' enclosure) |
| Diameter: | 7'-6" OD with 3" thick ceramic fiber lining |
| Maximum Capacity: | 42 MM Btu/hr |

**Note:** Each flare burner will be designed to handle 500 lb/hr of zero BTU waste gas (N2) plus sufficient supplemental gas to enrich the vent gas (i.e., combination of waste gas and supplemental gas) up to 350 BTU/scf.

## III. ENCLOSED FLARE SYSTEM DESCRIPTION

The GKEC Burner assembly is designed for high-temperature corrosion resistance and maximum flame stability through a full range of design flow rates. Gas is injected at the immediate exit of the burner tip assembly for optimum combustion, smokeless, and emissions performance.

The flare enclosure will be sized and designed according to AISC standards, with support structure, ceramic fiber lining, refractory-lined burner floor, and nozzles as described above.

Each of three (3) burners will be fitted with one (1) KEP continuous combustion pilot. The KEP offers reliable spark-ignition and flame ionization detection in the same system. The Automatic/Manual Nema 7 ignition control panel receives a flame-monitoring signal from the flame ionization sensing rod in the pilot. When flame failure is detected, spark ignition using the same rod is initiated. Note: A PLC may be needed, or logic added to the DCS, to manage safe re-ignition of the pilots.

When pilot flame is confirmed, the KEP ignition control system switches to sensing mode using the same rod used for spark ignition.

The KEP ignition control system will be pre-piped, wired, and function-tested to simulate actual operation prior to shipping. The system will include:

1. Panel Power Lamp
2. Pilot Gas Lamps
3. Flame Proved Lamps
4. Rack Mounted Pilot Fuel Gas Strainer, Pressure Regulator, Manual Block Valve and Pressure Indicator. (Note: pilot fuel controls are not included.)

## IV. SPECIFICATION SUMMARY

The following specifications apply to this equipment, except as noted:

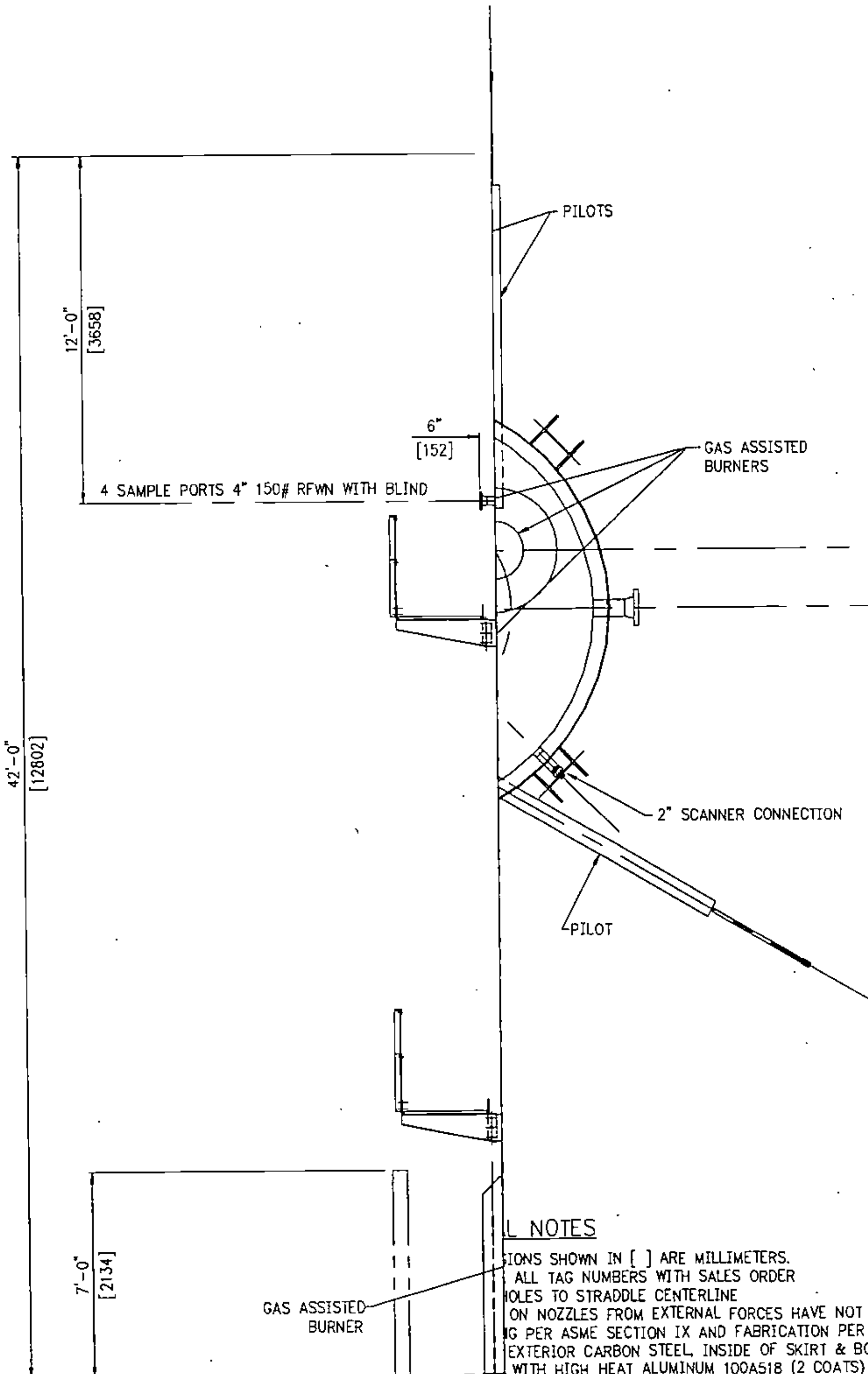
1. Welding – Per AWS and ASME IX (non-stamped)
2. Weld Examination & Testing per AWS
3. All carbon steel surfaces will be painted per SSPC-SP6 surface preparation and coated with 1-2 mils DFT of Sherwin Williams ZincClad II primer, and 1.5 mils DTF of High Heat Alumina.

All dimensions, material thickness, etc. in this proposal are preliminary and subject to modification, in compliance with specifications, after final engineering.

Unless specifically defined in this proposal, all nozzles on vessels, stacks, etc. will not be designed to accept loads from piping, or other external forces.

**Quality Control:**

The following specifications apply to this equipment.
1. 100% Visual/Dimensional Inspection
2. 10% Dye Pen Testing
3. 5% X-ray of linear welds (burners only)
3. WPQR and welder qualification records
4. NDE Personnel Performance records
5. MTRs




## L NOTES

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ALL TAG NUMBERS WITH SALES ORDER
HOLES TO STRADDLE CENTERLINE
ON NOZZLES FROM EXTERNAL FORCES HAVE NOT BEEN CONSIDERED IN THE DESIGN
G PER ASME SECTION IX AND FABRICATION PER JOHN ZINK STANDARDS.
EXTERIOR CARBON STEEL, INSIDE OF SKIRT & BOTTOM OF FLOOR PLATE PER SSPC-SP10 AND
WITH HIGH HEAT ALUMINUM 100A518 (2 COATS) 1.0 ~1.2 MDFT PER COAT



| | | | |
|---|---|---|---|
| FOR: SABIC INNOVATIVE PLASTICS US LLC | | JOHN ZINK | |
| USER: | | JOHN ZINK COMPANY LLC | |
| JOBSITE: OTTAWA, IL | | PARTS AND SERVICE, PHONE 1-800-755-4252, FAX (918) 234-5705 | |
| | | 7'-6" O.D. x 42'-0" TALL ZTOF WITH | |
| S.O. NO: QUOTE #11-18562 | | 3 GAS ASSISTED BURNERS | |
| P.O. NO: | | | |
| DR: D.L.B. | DATE: 4-23-13 | CERTIFIED | DRAWING NUMBER B-F-11-18562-301 REV. 0 |
| CK: D.L.B. | DATE: 4-23-13 | | |
| APP: G.S. | DATE: 4-23-13 | DATE: | SCALE NONE 1 OF 1 |

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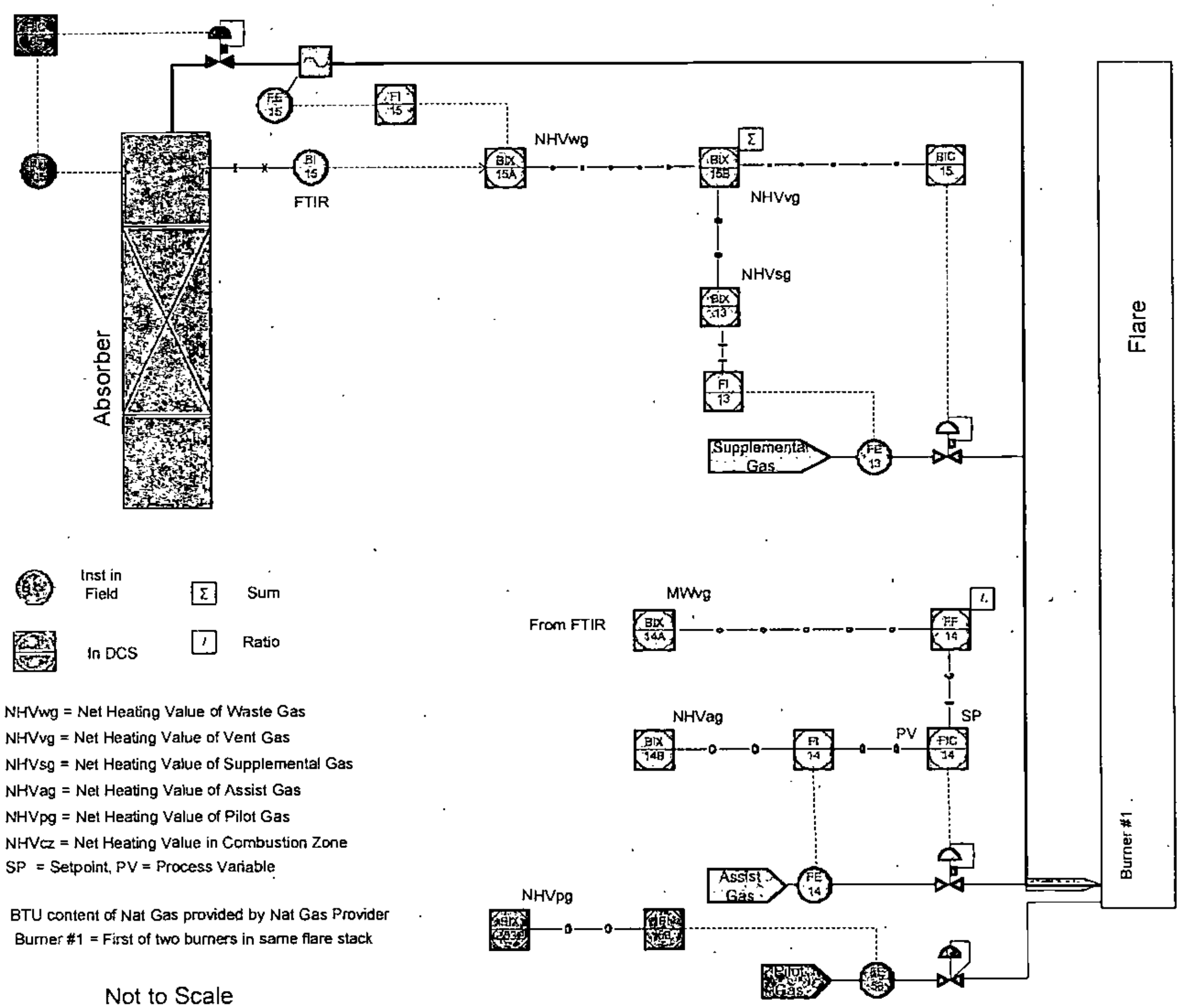
# Appendix B

SABIC Ottawa: Scenario #1 Control Narrative




## Instrumentation

**BI15:** IMACC FTIR

Sample Point: On vessel, upstream of control point

Measurement: The FTIR will identify and quantify each flammable compound that is present in the waste gas stream at a concentration of at least 0.5% by volume. Any compound that is present at a concentration of less than 0.5% by volume will not be quantified because it will not have a significant impact on the Net Heating Value of the waste gas ($NHV_{wg}$). Any volume balance needed to total 100% will be assumed to be nitrogen.

Repeatability/Bias:

a. Precision/repeatability: Within ±1% of full scale at 95% confidence with 5-sample (scan) averaging (see "Sampling (scan) Frequency" below).

b. Bias: Within ±3% of full scale based on quantified compounds (see "Measurement" above).

Range (Full Scale): 0 – 3,000 Btu/scf

Sampling (scan) Frequency: 1.2 seconds; results from no less than 5 valid scans will be averaged to generate one data point.

Installation/Operation:

a. The FTIR will measure two waste gas streams independently and simultaneously - one stream for Scenario 1 venting (recovery system) and a second stream for Scenarios 2-6 venting (vent blower header) - and calculate the $NHV_{wg}$ and $MW_{wg}$ of each. The plant's Distributed Control System (DCS) will calculate $NHV_{vg}$, $NHV_{cz}$, and $MW_{vg}$ (using the equations below) of each waste gas stream only when waste gas flow to the flare is present (which will be based on (i) a flow greater than a value that will be determined during initial start-up of the flare system and (ii) the respective source block valve is open).

b. The FTIR continuously monitors each of the two vent gas sources, regardless of flow, upstream of its respective control valve by conducting scans, each 1.2 seconds in duration. Five valid scans are averaged to calculate an average. Assuming the 5 valid scans are consecutive (which will normally be the case), the average is a 6-second average. The FTIR is designed such that, even with no flow to the flare, there is always a flow to the FTIR to obtain a representative sample of waste gas from each source. Thus, assuming each scan is valid, updated values of NHV and MW of the waste gases are obtained every 6 seconds. When a waste gas flow begins, the then-current 6-second average values of NHV and MW are assigned to it. If the flow is continuing after 6 seconds, a new set of averages will be assigned to the next 6 seconds of waste gas flow. Thus, every 6 seconds of continuous waste gas flow will use the NHV and MW values from the previous 6-second average. For a waste gas flow duration of less than 6 seconds, the NHV and MW values from the most recent 6-second average (those existed at the time the flow began) will be used.

c. The sampling system will be temperature-controlled (heated and/or cooled as necessary) to ensure proper year-round operation and to prevent sample gas condensation.

d. If technically feasible, the sampling location will be at least two equivalent duct diameters downstream and at least 0.5 equivalent duct diameters upstream from the nearest point at which a change in the vent gas composition occurs (excluding the addition of supplemental gas) or from any flow disturbance.

e. The background reading of the FTIR will be checked once each day by introducing nitrogen gas directly to the instrument. An acceptable instrument response is one that is within the specifications described in "Repeatability/Bias", item "b", above. This check will be changed from daily to weekly after three months if the daily checks show minimal drift.

Output 1: BTU/scf (see Equations 1 and 2)
Output 2: Molecular Weight (see Equations 6 and 7)

Calibration: Initially, FTIR operation will be validated using calibration standards traceable to the National Institutes of Standards and Technology. Calibration of the FTIR on an on-going basis is not required because the internal reference library provides necessary validation on an on-going basis.

**FE15** Panametrics Flowmeters
**&**
**FE25:** Range: 0-3,950 scfm
Span: 0 – 200 scfm for FE15; 0 – 400 scfm for FE25
Scfm Accuracy: ±5%
Scfm Repeatability: ±2% with > 1 ft/sec velocity
Response Time: 1 sec

MW Accuracy: -4.8 to +2.4%
MW Repeatability: ±2%
Response Time: 4 sec

Calibration: Annually

Natural Gas Flow Measurement: Fox Thermal Mass Flowmeters

**FE13:** Range: 0 – 6,000 scfh
**FE14:** Range: 0 – 6,000 scfh
**FE23:** Range: 0 – 10,000 scfh
**FE24:** Range: 0 – 10,000 scfh
**FE53:** Range: 0 – 150 scfh
**FE73:** Range: 0 – 300 scfh
Accuracy: ±1% Reading, 0.2% full scale
Repeatability: ±0.2%
Response Time: 1 sec

Calibration: Annually

## Control

There are three loops in this control schematic described below.

1. $NHV_{vg}$ Control: Loop #15

   The sample is taken upstream of the absorber control valve for a more consistent control measurement. The concentration of each component is used to calculate the net heating value of the waste gas ($NHV_{wg}$) in BTU/scf per Equation 1.

$$NHV_{wg} = \sum_{i=1}^{n} (C_i H_i)$$

**Equation 1**

$NHV_{wg}$ = Net Heating Value of the Waste Gas
$C_i$ = Concentration of component *i* (% by volume)
$H_i$ = Net heat of combustion of component *i* (BTU/scf)

Previous testing indicates the three organic components of the waste gas stream are 1,3-Butadiene (BD), 2-Butene, and 4-Vinylcyclohexene (4-VCH).

While previous testing has shown that 4-VCH is present, it is present at a very low level (1997 testing: <60 ppm) and thus will not be included in the total $NHV_{wg}$ calculation. See Table 1 for information on previous vent gas testing and the effects 4-VCH had on $NHV_{vg}$:

Table 1

| | BD | 2-Butene | 4-VCH | $N_2$ | BTU/scf[5] | BTU/scf from VCH |
|---|---|---|---|---|---|---|
| BTU/scf | 2,690[1] | 2,825[2] | 5,712[3] | 0 | ---- | |
| 1997 Test Avg | 101,485 ppm | 24,433 ppm | 36.9 ppm | Balance | 342.23 | 0.21 |
| 1997 Max VCH[4] | 99,822 ppm | 22,521 ppm | 57.4 ppm | Balance | 332.47 | 0.33 |
| 2008 Test Avg | 167,684 ppm | 35,851 ppm | Not tested | Balance | 552.35 | ---- |

1 BTU content from Perry's Chemical Engineers' Handbook 8th Edition, McGraw-Hill.
2 BTU content of *trans*-2-Butene from Perry's Chemical Engineers' Handbook 8th Edition, McGraw-Hill. The BTU content of *cis*-2-butene is 2,830 BTU/scf, so the more conservative value is being used.
3 BTU content from previous flare testing: Emission Test Report No. 5193D, Myramid Analytical, Inc, 1997.
4 Test point from 1997 Flare test with maximum 4-VCH value.
5 Calculated from Equation 1.

Equation 2 is used to determine the NHV of the waste gas, assuming the only organic components present are BD and 2-Butene. $C_i$ values are received from the FTIR analyzer.

The BTU content for *trans*-2-Butene is shown in the below equations:

$$NHV_{wg} = (C_{BD} \text{ x } 2690) + (C_{Butene} \text{ x } 2825)$$

**Equation 2**

While the $NHV_{vg}$ requirement is 200 BTU/scf, the $NHV_{cz}$ requirement is 300 BTU/scf and supplemental gas will be added to meet the greater of the two as shown in Equation 3. Using Equation 1 to determine the $NHV_{cz}$ (combined $NHV_{wg}$ and $NHV_{sg}$) where $NHV_{sg}$ = 900 BTU/scf, the % volume of supplemental gas ($C_{sg}$) required for $NHV_{cz}$ = 300 BTU/scf is derived below and set forth in Equation 3.

$$NHV_{cz}\ Required\text{: } 300 = (NHV_{wg} x\ C_{wg}) + (NHV_{sg}\ x\ C_{sg})$$

Where $C_{wg} = (1 - C_{sg})$.

$$300 = (NHV_{wg} - NHV_{wg}C_{sg}) + (900 \text{ x } C_{sg})$$

$$(300 - NHV_{wg}) = (900 - NHV_{wg}) \text{ x } C_{sg}$$

$$C_{sg} = \frac{300 - NHV_{wg}}{900 - NHV_{wg}}$$

**Equation 3**

The % volume of supplemental gas required to meet 300 BTU/scf calculated in Equation 3 can also be used as % volume flowrate to calculate the required flow setpoint of supplemental gas as a ratio to the waste gas flow as shown in Equation 4:

$$Q_{sg} = Q_{vg} \text{x } C_{sg}$$

$$Q_{wg} = Q_{vg} \text{ x } C_{wg}$$

$$Q_{vg} = Q_{wg}/(1 - C_{sg})$$

Therefore, the supplemental gas flowrate required to maintain a minimum net heating value in the combustion zone of 300 BTU/scf is:

$$Setpoint\ Q_{sg} = C_{sg}(Q_{wg}/(1 - C_{sg}))$$

**Equation 4**

With the total vent gas flowrate being:

$$Q_{vg} = Q_{wg} + Q_{sg}$$

**Equation 5**

2. Opacity Control: Loop #14

Per flare design, control of the assist gas for smokeless operation uses the relationship of the Assist Gas to Vent Gas Mass Ratio and Net Heating Value of the Vent Gas.

Equation 1 is used to calculate the $NHV_{vg}$ below:

$$NHV_{vg} = \left(C_{wg} \text{ x } NHV_{wg}\right) + \left(C_{sg} \text{ x } 900\right)$$

$NHV_{wg}$ comes from Equation 2, $NHV_{sg}$ = 900 BTU/scf, and $C_{wg}$ and $C_{sg}$ are the same as in Equation 3.

The weighted average molecular weight of the waste gas is determined by the FTIR using equation 6:

$$MW_{wg} = \sum_{i=1}^{n} (C_i MW_i)$$

**Equation 6**

$MW_{wg}$ = Molecular weight of waste gas
$C_i$ = Concentration of component i (% by volume)
$MW_i$ = Molecular weight of component i

The percentage volume of each component of the waste gas ($C_{BD}$ and $C_{Butene}$) is determined in the FTIR analyzer, with $N_2$ assumed to comprise the balance, to determine the total molecular weight of the waste gas in Equation 7:

$$MW_{wg} = (C_{BD} \text{ x } MW_{BD}) + (C_{Butene} \text{x } \mathrm{MW}_{Butene}) + ((1 - C_{BD} - C_{Butene}) x\, MW_{N2})$$

**Equation 7**

The molecular weight of the vent gas is then determined based on the relative concentrations and molecular weights of the waste gas and supplemental gas:

$$MW_{vg} = \left(C_{wg} \text{ x } MW_{wg}\right) + \left(C_{sg} \text{ x } \mathrm{MW}_{sg}\right)$$

**Equation 8**

$C_{wg}$ and $C_{sg}$ are % volume of the vent gas components (waste gas and supplemental gas) from Equation 3. $MW_{sg}$ is 16.9 lb/lb-mol.

The Assist Gas to Vent Gas flow ratio on a mass basis is $\dot{m}_{ag}/\dot{m}_{vg}$,

Where

$$\dot{m}_{ag} = \frac{Q_{ag} \cdot MW_{ag} \cdot 60\ min/hr}{385.3}$$

**Equation 9**

and

$$\dot{m}_{vg} = \frac{Q_{vg} \cdot MW_{vg} \cdot 60\ min/hr}{385.3}$$

**Equation 10**

$MW_{ag}$ is 16.9 lb/lb-mol.

Initial ratio setpoint is from the flare design, however the ratio may be changed based on actual operating data.

3. $NHV_{cz}$ Control

Supplemental gas is being added in loop #1 to maintain a net heating value of 300 BTU/scf in the Vent Gas steam in order to meet the minimum heat content requirement in the combustion zone. No other components are being added to the combustion zone that would lower this value. Control of supplemental gas in loop #1 is sufficient to maintain a net heating value in the combustion zone of 300 BTU/scf.

The FTIR Analyzer is the primary instrument for measuring composition, which is used to calculate BTU content and Molecular Weight. In the event of FTIR failure, the Panametrics flowmeter Molecular Weight output shall be used to determine NHV of the waste gas to demonstrate compliance. It will do so based on the assumption that the waste gas consists only of Nitrogen and 1,3-Butadiene (the principal organic component, per Table 1). The average Molecular Weight will be used to determine the concentration of 1,3-Butadiene in the Vent Gas stream, per Equation A. The BD concentration from Equation A will then be substituted into Equations 2 and 7 above when the FTIR is out of service.

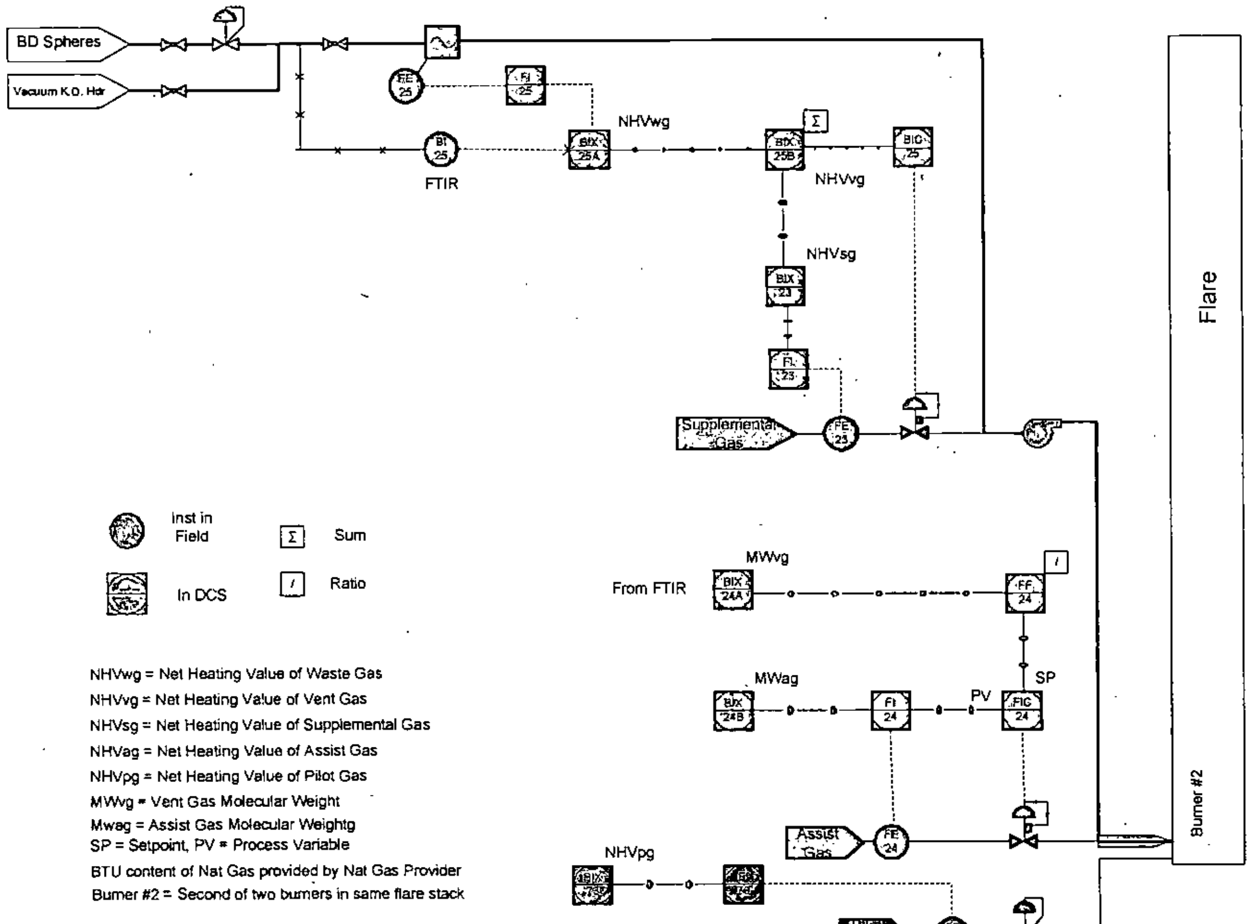
$$C_{BD} = \frac{MW_{wg} - MW_{N2}}{MW_{BD} - MW_{N2}}$$

$$C_{BD} = (MW_{wg} - 28.0)/(54.1 - 28.0)$$

$$C_{BD} = (MW_{wg} - 28.0)/(26.1)$$

**Equation A**

SABIC Ottawa: Scenarios #2-6 Control Narrative




Not to Scale

Control of the second burner (which consists of two burners in parallel) is performed in the same manner as the first, using instrumentation and equations equal to that for Burner #1.

**Abbreviation Key:**

$NHV_{vg}$ = Net Heating Value of Vent Gas (BTU/scf)
$NHV_{wg}$ = Net Heating Value of Waste Gas (BTU/scf)
$NHV_{cz}$ = Net Heating Value in Combustion Zone (BTU/scf)
$NHV_{sg}$ = Net Heating Value of Supplemental Gas (900 BTU/scf), based on average composition data from natural gas supplier

$C_{BD}$ = % Concentration of BD in the Waste Gas
$C_{Butene}$ = % Concentration of 2-Butene in the Waste Gas
$C_{wg}$ = % Concentration of the Waste Gas
$C_{sg}$ = % Concentration of the Supplemental Gas

$Q_{sg}$ = Volumetric Flowrate of Supplemental Gas (scfm)
$Q_{vg}$ = Volumetric Flowrate of Vent Gas (scfm)
$Q_{wg}$ = Volumetric Flowrate of Waste Gas (scfm)
$Q_{ag}$ = Volumetric Flowrate of Assist Gas (scfm)

$MW_{wg}$ = Molecular Weight of the Waste Gas (lb/lb-mol)
$MW_{vg}$ = Molecular Weight of Vent Gas (lb/lb-mol)
$MW_{BD}$ = Molecular Weight of 1,3-Butadiene (54.1 lb/lb-mol)
$MW_{Butene}$ = Molecular Weight of 2-Butene (56.1 lb/lb-mol)
$MW_{N2}$ = Molecular Weight of Nitrogen (28.0 lb/lb-mol)
$MW_{sg}$ = $MW_{ag}$ = Molecular Weight of Supplemental and Assist Gas (16.9 lb/lb-mol), based on average composition data from natural gas supplier

$\dot{m}_{ag}$ = Mass flow rate of Assist Gas (lb/hr)
$\dot{m}_{vg}$ = Mass flow rate of Vent Gas (lb/hr)