apcd air pollution control district
SANTA BARBARA COUNTY

March 18, 2024

[redacted]
United Launch Alliance, L.L.C
PO Box 5219
Vandenberg SFB, CA 93437

FID: 11785
Permit: A 15795
SSID: 11166

Re: Authority to Construct Application 15795

Dear [redacted]

On March 18, 2024, the Santa Barbara County Air Pollution Control District (District) determined that your application for Authority to Construct (ATC) No. 15795 for three liquefied natural gas flares, a storage tank, and associated equipment used for Vulcan Centaur launches was complete. The District will make a decision to either issue or deny a permit for the application within 180 days from the completeness date or 180 days after lead agency approval of the project, whichever time period is longer.

Please be advised that proceeding with the construction of your project without an ATC permit violates District Rule 201 and may result in penalties.

Please include the Facility Identification (FID) and Permit numbers shown above on all correspondence regarding this permit application. If you have any questions, please contact me at MountainC@sbcapcd.org or (805) 979-8314.

Sincerely,

Charlotte Mountain, Air Quality Engineer III
Engineering Division

cc: United Launch Alliance - Vulcan EELV 11785 Project File
[redacted]
Engr Chron File

\\sbcapcd.org\shares\Groups\ENGR\WP\VAFB\ULA - Vulcan EELV\ATCs\ATC 15795\ATC 15795 - ATC Completeness - 3-18-2024.docx

Aeron Arlin Genet, Air Pollution Control Officer
(805) 979-8050 | 260 N. San Antonio Rd., Ste. A Santa Barbara, CA 93110 | ourair.org | @OurAirSBC

CONFIDENTIAL INFORMATION DELETED

January 28, 2022

Mr. Kevin Brown
Santa Barbara County Air Pollution Control District
260 N. San Antonio Road, Suite A
Santa Barbara, CA 93110

Re: Incomplete Authority to Construct Application 15795; FID 11785

Dear Mr. Brown,

United Launch Alliance, LLC (ULA) is pleased to submit the attached application revision for Authority to Construct 15795 associated with the Vulcan Centaur Space Launch Program at Vandenberg Space Force Base. Also included are responses to the incompleteness items provided by Santa Barbara County Air Pollution Control District on October 28, 2021. Please note that the application contains confidential information, including proprietary operational data. Per conversation with Mr. Geoff Conable from AECOM on January 27th, 2022, separate files containing marked confidential materials and those available for public view will be submitted at a later date.

Items not included in this submittal include Toxics Incompleteness Item 2, *Health Risk Assessment* and Planning Incompleteness Item 1, *California Environmental Quality Act*. These items will be addressed and submitted at a later date.

Please advise if any additional measures are needed on behalf of ULA.

Respectfully,

[redacted] E-Signed 01.28.2022

[redacted]
Safety, Health, and Environmental Affairs Specialist
ULA, Vandenberg Space Force Base

Enclosures:
Narrative Description
Appendix A – Flare Volume Estimate
Appendix B – Application Forms
Appendix C – BACT Analysis
Appendix D – Dispersion Modeling Protocol
Appendix E – Site Plan
Appendix F – Vandenberg SFB Memorandum
Appendix G – Visibility, Soil and Vegetation Analysis
Appendix H – Responses to Incompleteness Items

United Launch Alliance
P.O. Box 5219
Vandenberg AFB, CA 93437

1 SLC-3 Vulcan Centaur V Summary

ULA is developing the Vulcan Centaur vehicle to provide a more versatile and cost competitive space launch vehicle while maximizing the use of existing space launch infrastructure and reducing reliance on foreign made goods. Specifically, the current Atlas V Launch Vehicle with Russian-supplied RD-180 engines and the Delta IV heavy lift capable rocket (located at VSFB Space Launch Complex 6) will be consolidated to one launch site and launch vehicle at VSFB Space Launch Complex 3 (SLC-3). All references to SLC-3E are clarification from previously occupied launch site to the west of SLC-3 named SLC-3W. SLC-3W launch site has been decommissioned by the Space Force and no longer is in use.

ULA announced the Vulcan Centaur Program in 2015 to reduce cost, increase launch capability and consolidate launch site infrastructure to a single launch complex. The Vulcan Centaur launch vehicle partners with companies in the United States (US) to develop rocket engines that eliminate reliance on the current Atlas V Russian-supplied RD-180 engines. The Vulcan Centaur vehicle is designed primarily to meet all current United States Air Force (USAF) Launch Service Agreement (LSA), previously referred to as the Evolved Expendable Launch Vehicle (EELV), requirements and will support National Aeronautics and Space Administration (NASA), Department of Defense (DoD) and commercial payloads. The Vulcan Centaur launch vehicle will enable the phase out its current Atlas V and Delta IV Programs and consolidate to a single VSFB launch site at SLC-3. ULA will phase-out both the Atlas V and Delta IV launch vehicles from operation at VSFB as part of this transition.

The Vulcan Centaur launch vehicle will [redacted] than the Atlas V. The first stage will use new [redacted] engines that consume liquid oxygen (LOX) and liquefied natural gas (LNG). Multiple Solid Rocket Motor (SRM) configuration options [redacted] can be specified depending on payload and performance requirements. The Vulcan first stage will integrate with the Centaur V upper stage, which is similar to [redacted] the current Centaur III second stage flying on Atlas V.

ULA plans to launch the Vulcan Centaur V Vehicle from Space Launch Complex 3 (SLC-3) on VSFB and Space Launch Complex 41 (SLC-41) on Kennedy Space Center (KSC).

Vulcan Centaur Program modifications will occur at SLC-3 [redacted]

The facilities shown below, currently in use by ULA, will continue to be utilized for the Vulcan Centaur V vehicle.

OVERVIEW - VULCAN LAUNCH OPERATIONS FACILITIES

[redacted]

SITE CIVIL MODIFICATIONS

EXISTING **NEW - CONCEPTUAL**

[redacted]

The launch site general arrangement and general LNG pipe routing is shown below.

[redacted]

2 Liquefied Natural Gas Detailed System Description

Modifications to SLC-3 include the addition of a Liquefied Natural Gas (LNG) cryogenic fueling system that enables transfer of LNG from a [redacted] storage vessel to the Vulcan Centaur V (Vulcan) launch vehicle fuel tank. Both LNG and liquefied oxygen (LOX) support combustion in [redacted] rocket engines. Transfer of LNG (and LOX) to the Vulcan launch vehicle is through vacuum jacketed (VJ), stainless steel piping, designed to minimize the loss of LNG due to boil-off (natural gas). All natural gas (NG) boil-off is managed through a closed loop recovery system and burned through best available control technology (BACT) compliant flares. All cryogenic fuel and oxidizer systems utilize BACT to minimize loss of commodity (through boil-off) and ensure safe and environmentally conscious management of NG.

2.1 Simplified Single-line Diagram of the LNG System

[redacted]

2.2 Primary Components of the SLC-3 Vulcan LNG System

- [redacted] Storage Vessel – Cryogenic [redacted] vessel, [redacted] Liquid capacity [redacted] Maximum Allowable Working Pressure (MAWP) of [redacted]
- Launch Vehicle Elevated (open) Flare – BACT, 90-foot tall, air assist NG flare used to burn all NG produced by the launch vehicle fuel tank during loading operations on day of launch or testing days.
- Ground System Elevated (open) Flare – BACT, 90-foot tall, air assist NG flare used to burn ground system LNG boil-off [redacted] produced during day of launch/testing.
- Enclosed Flare – BACT, 75-foot tall, air and utility natural gas assist flare used to burn daily boil-off from [redacted] storage vessel and delivery tanker boil-off operations. Primarily supports daily storage vessel boil off-gas.
- [redacted] Knockdown Vessel
    - Natural Gas and LNG collected during the chill down of VJ piping and engines will accumulate in knockdown vessel, or “knock out drum”. [redacted]

[redacted] The “waste fuel” collected within the knockdown vessel is converted to gas using [redacted] vaporizers, then sent to the ground system elevated flare.

- [redacted] LNG Storage Vessel vaporizers
  - Provides pressurization of LNG storage vessel [redacted]
- [redacted]
  - [redacted]
- [redacted] LNG Off-Load Stations
  - Provide back-in delivery tanker access for filling [redacted] storage vessel. The offload stations are accessible from the existing northeast pad entrance road.
  - The offload stations will be designed to safely and adequately collect boil-off for burning through the enclosed flare, and provide a nitrogen purge to inert the off-load station and purge tanker flex hose prior to tanker disconnect.
- [redacted] vacuum jacketed cross-country line will be constructed to transfer LNG between the storage vessel and the launch vehicle fuel tank.
  - Provides liquid fill and drain from the LNG storage vessel and launch vehicle fuel tank
  - [redacted]
- [redacted] vent line will be constructed to run from the [redacted] launch vehicle LNG tank [redacted]
- [redacted]
  - All gas and liquid NG associated with [redacted] system chill down are [redacted] directed to LNG farm knockdown tank.
  - Any liquid natural gas collected within knockdown tank will be vaporized prior to burning through the elevated ground system flare.

2.3 Daily LNG System Operations

Under typical daily operations, the LNG piping used to transfer commodity from the storage vessel to the launch vehicle and elevated flares will be isolated from the storage vessel and positively purged with inert nitrogen gas.

The LNG storage vessel will be maintained at cryogenic temperature (approximately -260 deg. F) at all times to avoid vessel thermal cycles and potential impacts to vessel structural integrity and need for vessel re-chilling. The storage vessel will operate in the Daily LNG storage mode [redacted]

The warming of LNG while in the storage vessel will produce NG boil-off, collecting at the top (ullage) of the vessel. LNG storage vessel ullage pressure will be managed by sending the boil-off gas to the enclosed flare or [redacted]

Daily LNG system operation includes off-loading of LNG from delivery trucks/tankers [redacted] to the LNG storage vessel. Delivery trucks are connected to the LNG ground system off-load station piping using temporary flex hoses. The delivery tuck tanks are pressurized using the truck's on-board equipment to provide the driving force, and isolation valves on the ground system are opened to transfer LNG to the storage vessel. All NG produced during the transfer of LNG from delivery trucks is managed by the enclosed flare. All potential gaseous natural gas (GNG) releases associated with disconnecting the flex hoses from the empty delivery tankers are minimized by use of an inert gaseous nitrogen purge prior to disconnect, however worst-case trapped GNG estimates are included in the Flare Volume Estimate Worksheet (Appendix A of the permit application).

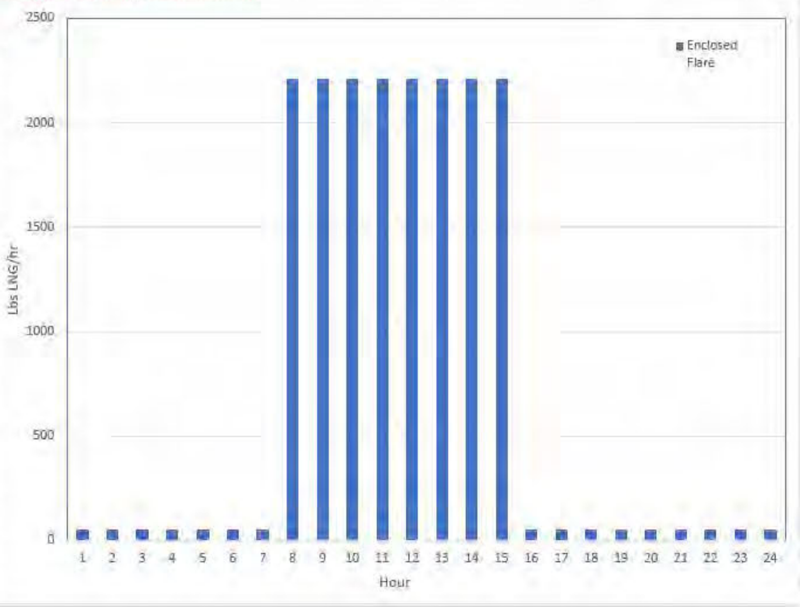
Daily LNG system operation may also include LNG purity sample collection in preparation for launch vehicle loading. [redacted]
All NG produced during the LNG sample collection process is managed by the enclosed flare.

All known daily operations, flow rates, and quantities are described within the Flare Volume Estimate Worksheet (Appendix A of the permit application). A sample enclosed flare usage chart for a tanker offload day [redacted] is shown on the following page.

Vulcan Program - Flaring Timeline (Enclosed)

Not a Day of Launch configuration (Enclosed flare is secured during Launch/WDR/Scrub activities)

Hour	Events	Flaring (lbs LNG/hr)
1	[redacted]	50.436
2	[redacted]	50.436
3	[redacted]	50.436
4	[redacted]	50.436
5	[redacted]	50.436
6	[redacted]	50.436
7	[redacted]	50.436
8	[redacted]	2210.436
9	[redacted]	2210.436
10	[redacted]	2210.436
11	[redacted]	2210.436
12	[redacted]	2210.436
13	[redacted]	2210.436
14	[redacted]	2210.436
15	[redacted]	2210.436
16	[redacted]	50.436
17	[redacted]	50.436
18	[redacted]	50.436
19	[redacted]	50.436
20	[redacted]	50.436
21	[redacted]	50.436
22	[redacted]	50.436
23	[redacted]	50.436
24	[redacted]	50.436

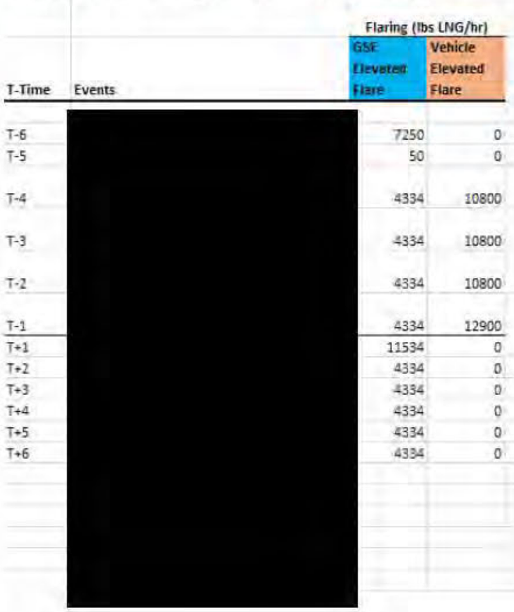


2.4 Day of Launch LNG System Operations

Day of Launch (DOL) operations drive a significant increase in NG boil off-due to the need to cool down ground piping systems and the launch vehicle to cryogenic temperatures. In preparation for the transfer of LNG to the Vulcan launch vehicle, the enclosed flare will be secured, and all gas associated with storage vessel boil-off, LNG system chill-down, and launch vehicle fueling will be directed to ground system elevated flare or launch vehicle elevated flare. The enclosed flare will not run concurrently with elevated flares.

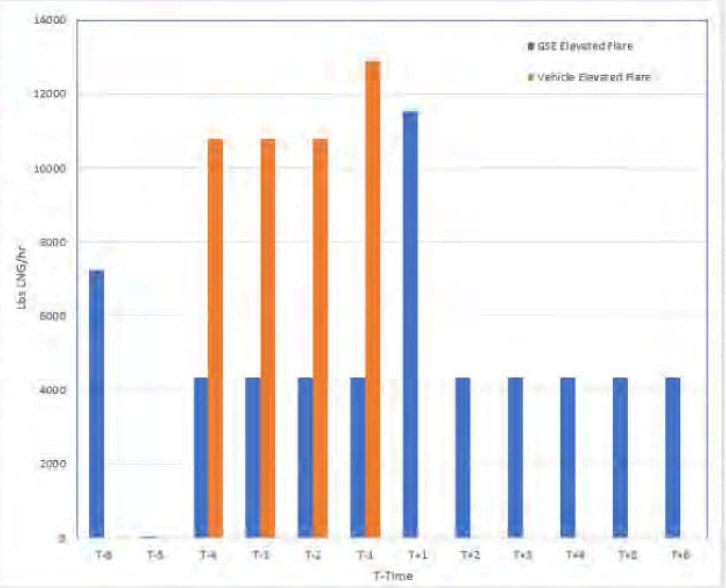
During a nominal launch, both elevated flares will remain lit until all Day of Launch operations are complete. The vehicle flare is piped directly to the vehicle's fuel tank and will stop burning LNG propellant shortly after liftoff, as soon as the vehicle vent ground system is inerted. The facility NG feed pilots will be the only source of emissions from the vehicle elevated flare for the remainder of the day's operation. The GSE elevated flare will continue to burn NG propellant after liftoff until the knock out drum is empty and the remainder of the ground system is inerted, at which point the enclosed flare will be started and both elevated flares shut down, returning the LNG system to the daily system configuration as outlined in paragraph 2.3.

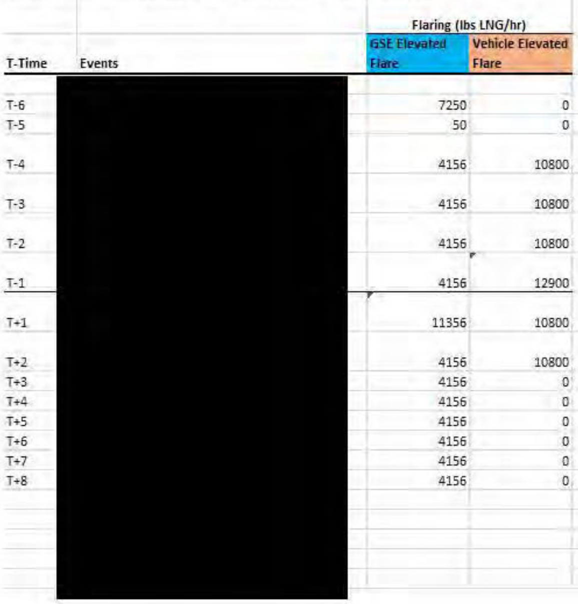
All Day of Launch operations, flow rates, and quantities are detailed in the Flare Volume Estimate Worksheet (Appendix A of the permit application). Sample elevated flare usage charts for a successful Launch day and a Scrub/WDR (tanking test, or "wet dress rehearsal") day are shown on the following page.



Vulcan Rocket Launch - Elevated Flaring Timeline During Launch Day

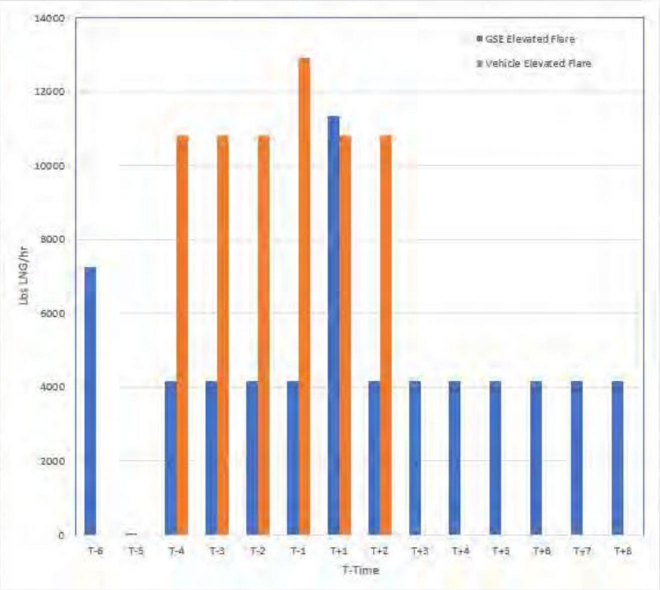
T-Time	Events	Flaring (lbs LNG/hr) GSE Elevated Flare	Vehicle Elevated Flare
T-6	[redacted]	7250	0
T-5	[redacted]	50	0
T-4	[redacted]	4334	10800
T-3	[redacted]	4334	10800
T-2	[redacted]	4334	10800
T-1	[redacted]	4334	12900
T+1	[redacted]	11534	0
T+2	[redacted]	4334	0
T+3	[redacted]	4334	0
T+4	[redacted]	4334	0
T+5	[redacted]	4334	0
T+6	[redacted]	4334	0





Vulcan Rocket Launch - Elevated Flaring Timeline During WDR/Scrub Day

T-Time	Events	Flaring (lbs LNG/hr) GSE Elevated Flare	Vehicle Elevated Flare
T-6	[redacted]	7250	0
T-5	[redacted]	50	0
T-4	[redacted]	4156	10800
T-3	[redacted]	4156	10800
T-2	[redacted]	4156	10800
T-1	[redacted]	4156	12900
T+1	[redacted]	11356	10800
T+2	[redacted]	4156	10800
T+3	[redacted]	4156	0
T+4	[redacted]	4156	0
T+5	[redacted]	4156	0
T+6	[redacted]	4156	0
T+7	[redacted]	4156	0
T+8	[redacted]	4156	0



2.5 Fugitive Emissions during LNG System Operations

External fugitive leakage is not allowed by ULA and should be essentially zero (bubble tight) for all LNG system piping joints and components (valves, tanks, vaporizers, etc.). All Class I hardware is consumer-off-the-shelf (COTS) and meets industry standards for leak tight. All hardware is also tested by ULA both during initial system testing and as part of recurring operations prior to every LNG tanking operation. The following is a summary of the external leak test requirements ULA levies on all hardware used for LNG/GNG service:

- Storage Vessels:
  - The inner tank, tank vacuum jacket, and all tank connections shall be tested for leakage [redacted] No leakage indication shall be allowed [redacted]
- Class I Components:
  - [redacted]
  - External Leak Check Requirement: [redacted] max for 1 minute using GN2 at system MAWP (Maximum Allowable Working Pressure)
- Process Piping (spool level):
  - Each unit shall be [redacted] leak tested [redacted] No leakage allowed.
- Complete System Initial Service Leak Test:
  - Leak tests shall be performed with dry inert gas at maximum operating pressure using nitrogen or helium, unless otherwise specified by engineering drawing/specifications. [redacted]
- Recurring Pre-Cryo Operation Leak Test:
  - Pneumatic Leak Check - Perform pneumatic leak check using inert gaseous nitrogen of all accessible cryogenic transfer line system fittings at Maximum Operating Pressure (MOP). Verify no leakage.

With the exception of the operations with known fugitive emissions as outlined on the Flare Volume Estimate Worksheet (Appendix A of the permit application), no external leaks are expected or allowed on the LNG system.

2.6 Measuring and Recording Throughput of LNG Flares

The storage vessel liquid level is determined [redacted] calibrated to the specific fluid properties (LNG) and storage vessel geometry at SLC-3. [redacted] With the height of the liquid, and the known contour of the tank, change in volume can be accurately calculated and recorded. A graph and formula that shows volume in gallons versus height of liquid in the tank for the vessel's specific geometry will be provided by the manufacturer after fabrication is complete. [redacted]

This volume is recorded continuously at [redacted] by the SLC-3 data acquisition computer system. This data is recorded and stored 24 hours per day, every day of the year, except during power outages at the pad. Total LNG losses from the storage vessel due to daily boil-off and all Day of Launch operations outlined on the Flare Volume Estimate Worksheet (Appendix A of the permit application) can be accurately tracked with this continuous stream of data.

There are two (2) LNG system operations which cannot be directly measured [redacted] and will be accounted for using different methods. During a successful Vulcan launch a known amount of LNG flies away with the vehicle, which is recorded as LNG used from the storage vessel [redacted] but is not ultimately burned through the elevated flares. Each mission has a predetermined volume of LNG that will need to be on the launch vehicle at liftoff, which is precisely controlled by instrumentation on the vehicle fuel tank to ensure mission objectives are met. This "fly-away" quantity is known and can be accounted for whenever total elevated flare emissions are calculated/verified. During a WDR or scrub the majority of LNG that was transferred to the vehicle fuel tank will be drained back to the storage vessel. Any residual LNG that cannot be recaptured will be burned through the flares and register as part of the total system LNG losses as measured and recorded [redacted] on the storage vessel.

The second LNG system operation which cannot be directly measured [redacted]s chilldown boil-off and securing losses during tanker off-loads. Actual liquid level of each delivery truck/tanker is recorded (from truck instrumentation) prior to transfer to the LNG storage vessel, and can be used to calculate total NG sent to the enclosed flare based on the recorded starting and final storage vessel liquid level.

There is also additional facility NG supplied to the enclosed flare as assist gas to ensure the flare is operating at the correct temperature for optimal combustion efficiency at startup. The total estimated assist gas is provided on the Flare Volume Estimate Worksheet based on flare specifications provided by the vendor (Appendix A of the permit application), however annual totals are negligible compared to other LNG system operational emissions.

2.7 Flow Meters

Flow meters for each flare were also considered for this application, however the [redacted] provides better accuracy due to the way in which the LNG system is operated for two primary reasons. The first being that flow meters would need to handle a vast range of NG flowrates that are sent to the flares during different operations, [redacted] up to 60 lbm/sec. In addition, the LNG system has many gaseous helium and nitrogen purges that are introduced to the LNG transfer and vent lines at different stages of cryogenic tanking operations, which mix with the NG going to the flares. While this dilution does not impact the performance of the flares, the compositional changes to the gaseous mixture being burned would be problematic when calibrating or recording data from flow meters, decreasing the accuracy of direct measuring with flow meters.

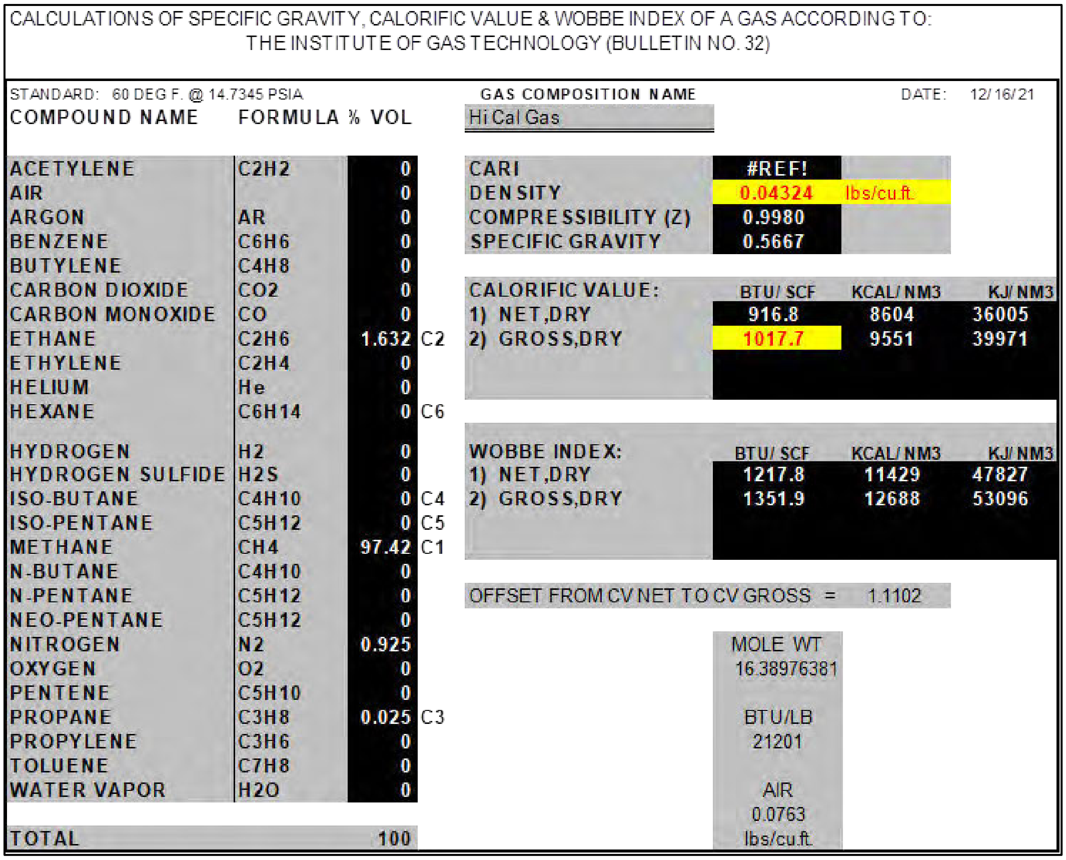
2.8 Individual LNG System Flare Throughput

Since the enclosed flare is never operated at the same time as the elevated flares, verifying total NG burnt specifically by the enclosed flare using the methods discussed in the previous section is simple. In off-nominal situations where the enclosed flare is offline for maintenance, the daily boil-off and/or tanker off-load losses would be redirected to the GSE elevated flare. Since the vehicle elevated flare would not be used at this time, verifying total NG burnt specifically by the GSE elevated flare would also be simple.

During cryogenic tanking or testing days, only the pair of identical elevated flares are used, so once again verifying total NG burnt by the combination of both elevated flares using the methods previously discussed in this section is simple. Since the GSE and vehicle elevated flares are identical, total emissions during cryogenic tanking or testing days can be easily quantified.

2.9 LNG Fuel Properties

The assumed composition of LNG was provided by an LNG vendor and shown in the table below. The density of this composition was calculated using the National Institute of Standards and Technology's (NIST) Reference Fluid Thermodynamic and Transport Properties Database (REFPROP). The resulting assumed LNG density is 3.57 lbm/gal as shown on the table on the following page.



CALCULATIONS OF SPECIFIC GRAVITY, CALORIFIC VALUE & WOBBE INDEX OF A GAS ACCORDING TO:
THE INSTITUTE OF GAS TECHNOLOGY (BULLETIN NO. 32)

STANDARD: 60 DEG F. @ 14.7345 PSIA

GAS COMPOSITION NAME: Hi Cal Gas

DATE: 12/16/21

COMPOUND NAME	FORMULA	% VOL	
ACETYLENE	C2H2	0	
AIR		0	
ARGON	AR	0	
BENZENE	C6H6	0	
BUTYLENE	C4H8	0	
CARBON DIOXIDE	CO2	0	
CARBON MONOXIDE	CO	0	
ETHANE	C2H6	1.632	C2
ETHYLENE	C2H4	0	
HELIUM	He	0	
HEXANE	C6H14	0	C6
HYDROGEN	H2	0	
HYDROGEN SULFIDE	H2S	0	
ISO-BUTANE	C4H10	0	C4
ISO-PENTANE	C5H12	0	C5
METHANE	CH4	97.42	C1
N-BUTANE	C4H10	0	
N-PENTANE	C5H12	0	
NEO-PENTANE	C5H12	0	
NITROGEN	N2	0.925	
OXYGEN	O2	0	
PENTENE	C5H10	0	
PROPANE	C3H8	0.025	C3
PROPYLENE	C3H6	0	
TOLUENE	C7H8	0	
WATER VAPOR	H2O	0	
TOTAL		100	

CARI	#REF!	
DENSITY	0.04324	lbs/cu.ft.
COMPRESSIBILITY (Z)	0.9980	
SPECIFIC GRAVITY	0.5667	

CALORIFIC VALUE:	BTU/SCF	KCAL/NM3	KJ/NM3
1) NET,DRY	916.8	8604	36005
2) GROSS,DRY	1017.7	9551	39971

WOBBE INDEX:	BTU/SCF	KCAL/NM3	KJ/NM3
1) NET,DRY	1217.8	11429	47827
2) GROSS,DRY	1351.9	12688	53096

OFFSET FROM CV NET TO CV GROSS = 1.1102

MOLE WT
16.38976381

BTU/LB
21201

AIR
0.0763
lbs/cu.ft.

Density Calculation using NIST Refprop

	methane	ethane	propane	butane	nitrogen
volume %	97.42	1.632	0.025	0	0.925
density (lbm/cuft)	26.3665	33.94969	36.26289	37.53483	50.32154
density (lbm/gal)	3.524934	4.538729	4.84798	5.018026	6.727479
total density (lbm/gal)	**3.571504**				

Appendix A

Vulcan Centaur Flare Volume Estimate-Provided as an Excel Spreadsheet

Appendix B

Vulcan Centaur Flares

Permit Application Forms

Print Form

air pollution control district
SANTA BARBARA COUNTY

General Permit Application Form -01

Santa Barbara County Air Pollution Control District
260 N. San Antonio Road, Suite A
Santa Barbara, CA 93110-1315

1. APPLICATION TYPE (check all that apply):

☒ Authority to Construct (ATC)
☐ Permit to Operate (PTO)
☐ ATC Modification
☐ PTO Modification
☐ Other (Specify)
☐ Transfer of Owner/Operator (use Form -01T)
☐ Emission Reduction Credits
☐ Increase in Production Rate or Throughput
☐ Decrease in Production Rate or Throughput

Previous ATC/PTO Number (if known)

○ Yes ● No Are Title 5 Minor Modification Forms Attached? (this applies to Title 5 sources only and applies to all application types except ATCs and Emission Reduction Credits). Complete Title 5 Form -1302 A1/A2, B, and M. Complete Title 5 Form -1302 C1/C2, D1/D2, E1/E2, F1/F2, G1/G2 as appropriate. http://www.ourair.org/wp-content/uploads/t5-forms.pdf

Mail or email the completed application to the APCD's Engineering Division at the address listed above or permits@sbcapcd.org.

2. FILING FEE:

A $431 application filing fee must be included with each application. The application filing fee is COLA-adjusted every July 1st. Please ensure you are remitting the correct current fee (the current fee schedule is available on the APCD's webpage at: http://www.ourair.org/district-fees). This filing fee will not be refunded or applied to any subsequent application. Payment may also be made by credit card by submitting the Credit Card Authorization Form found here https://www.ourair.org/wp-content/uploads/apcd-01c.pdf via mail or calling 805-961-8823 to pay via phone.
Do not submit the Credit Card Authorization Form via email.

3. IS YOUR PROJECT'S PROPERTY BOUNDARY LOCATED OR PROPOSED TO BE LOCATED WITHIN 1,000 FEET FROM THE OUTER BOUNDARY OF A SCHOOL? If yes, and the project results in an emissions increase, submit a completed Form -03 (*School Summary Form*) http://www.ourair.org/wp-content/uploads/apcd-03.pdf ○ Yes ● No

If yes, provide the name of school(s)
Address of school(s)
City
Zip Code

4. DOES YOUR APPLICATION CONTAIN CONFIDENTIAL INFORMATION? ● Yes ○ No

If yes, please submit with a redacted duplicate application which shall be a public document. In order to be protected from disclosure to the public, all information claimed as confidential shall be submitted in accordance with APCD Policy & Procedure 6100-020 (*Handling of Confidential Information*): http://www.ourair.org/wp-content/uploads/6100-020.pdf, and meet the criteria of CA Govt Code Sec 6254.7. Failure to follow required procedures for submitting confidential information, or to declare it as confidential at the time of application, shall be deemed a waiver by the applicant of the right to protect such information from public disclosure. *Note: Part 70 permit applications may contain confidential information in accordance with the above procedures, however, the content of the permit documents must be public (no redactions).*

FOR APCD USE ONLY				**DATE STAMP**
FID		Permit No.		
Project Name				
Filing Fee			202.E? YES / NO	

CONFIDENTIAL INFORMATION DELETED

5. COMPANY/CONTACT INFORMATION:

Owner Info ● Yes ○ No Use as Billing Contact?

Company Name: United Launch Alliance, LLC.

Doing Business As:

Contact Name: [redacted] Position/Title: SHEA Specialist

Mailing Address: PO Box 5219

City: Vandenberg SFB State: CA Zip Code: 93437

Telephone: [redacted] Cell: Email: [redacted]

Operator Info ○ Yes ○ No Use as Billing Contact?

Company Name: Same as owner

Doing Business As:

Contact Name: Position/Title:

Mailing Address:

City: State: Zip Code:

Telephone: Cell: Email:

Authorized Agent Info* ○ Yes ● No Use as Billing Contact?

Company Name:

Doing Business As:

Contact Name: Position/Title:

Mailing Address:

City: State: Zip Code:

Telephone: Cell: Email:

*Use this section if the application is not submitted by the owner/operator. Complete APCD Form -01A (http://www.ourair.org/wp-content/uploads/apcd-01a.pdf). Owner/Operator information above is still required.

SEND PERMITTING CORRESPONDENCE TO *(check all that apply)*:

☒ Owner ☐ Operator

☐ Authorized Agent ☐ Other (attach mailing information)

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6. GENERAL NATURE OF BUSINESS OR AGENCY:

United Launch Alliance provides spacecraft launch services to US Government and Commercial customers.

7. EQUIPMENT LOCATION (Address):

Specify the street address of the proposed or actual equipment location. If the location does not have a designated address, please specify the location by cross streets, or lease name, UTM coordinates, or township, range, and section.

Equipment Address: Space Launch Complex 3 (SLC-3)

City: Vandenberg Space Force Base State: CA Zip Code: 93437

Work Site Phone: [redacted]

○ Incorporated (within city limits) ● Unincorporated (outside city limits) ○ Used at Various Locations

Assessors Parcel No(s):

8. PROJECT DESCRIPTION:

(Describe the equipment to be constructed, modified and/or operated or the desired change in the existing permit. Attach a separate page if needed):

Installation of three (3) flares for the safe combustion of natural gas (NG). LNG boil off during loading of the Vulcan launch vehicle and associated events will be directed to two (2) elevated flares. LNG boil off from storage tank and during tanker offloading into storage tank will be directed to one (1) enclosed flare. Please refer to attached documents for project description, supplemental information, emission calculations, BACT selection, and AQIA.

9. DO YOU REQUIRE A LAND USE PERMIT OR OTHER LEAD AGENCY PERMIT FOR THE PROJECT DESCRIBED IN THIS APPLICATION?: ● Yes ○ No

A. If **yes**, please provide the following information

Agency Name	Permit #	Phone #	Permit Date
United States Space Force			

* The lead agency is the public agency that has the principal discretionary authority to approve a project. The lead agency is responsible for determining whether the project will have a significant effect on the environment and determines what environmental review and environmental document will be necessary. The lead agency will normally be a city or county planning agency or similar, rather than the Air Pollution Control District.

B. If **yes**, has the lead agency permit application been deemed complete and is a copy of their completeness letter attached?

● Yes ○ No

Please note that the APCD will not deem your application complete until the lead agency application is deemed complete.

C. If the lead agency permit application has not been deemed complete, please explain.

D. A copy of the final lead agency permit or other discretionary approval by the lead agency may be requested by the APCD as part of our completeness review process.

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10. PROJECT STATUS:

A. Date of Equipment Installation: Jan 9, 2023

B. Have you been issued a Notice of Violation (NOV) for not obtaining a permit for this equipment/modification *and/or* have you installed this equipment without the required APCD permit(s)? If yes, the application filing is double per Rule 210. ○ Yes ● No

C. Is this application being submitted due to the loss of a Rule 202 exemption? ○ Yes ● No

D. Will this project be constructed in multiple phases? If yes, attach a separate description of the nature and extent of each project phase, including the associated timing, equipment and emissions. ○ Yes ● No

E. Is this application also for a change of owner/operator? If yes, please also include a completed APCD Form -01T. ○ Yes ● No

11. APPLICANT/PREPARER STATEMENT:

The person who prepares the application also must sign the permit application. The preparer may be an employee of the owner/ operator or an authorized agent (contractor/consultant) working on behalf of the owner/operator (an *Authorized Agent Form -01A* is required).

I certify pursuant to H&SC Section 42303.5 that all information contained herein and information submitted with this application is true and correct.

[redacted] 9/24/2021

Signature of application preparer — Date

[redacted] — United Launch Alliance, LLC.

Print name of application preparer — Employer name

12. APPLICATION CHECKLIST (*check all that apply*)

☒ Application Filing Fee (Fee = $431. The application filing fee is COLA adjusted every July 1st. Please ensure you are remitting the current fee.) As a convenience to applicants, the APCD will accept credit card payments. If you wish to use this payment option, please complete a *Credit Card Form-01C* https://www.ourair.org/wp-content/uploads/apcd-01c.pdf and submit it via mail or call 805-961-8823 to pay over the phone. **Do not submit the *Credit Card Form-01C* via email.**

☐ Existing permitted sources may request that the filing fee be deducted from their current reimbursable deposits by checking this box. Please deduct the filing fee from my existing reimbursement account.

☐ Form -01T (*Transfer of Owner/Operator*) attached if this application also addresses a change in owner and/or operator status from what is listed on the current permit. http://www.ourair.org/wp-content/uploads/apcd-01t.pdf

☐ Form -03 (*School Summary Form*) attached if the project's property boundary is within 1,000 feet of the outer boundary of a school (k-12) and the project results in an emissions increase. http://www.ourair.org/wp-content/uploads/apcd-03.pdf

☒ Information required by the APCD for processing the application as identified in APCD Rule 204 (*Applications*), the APCD's *General APCD Information Requirements List* (https://www.ourair.org/wp-content/uploads/gen-info.pdf), and any of the APCD's Process/Equipment Summary Forms (http://www.ourair.org/permit-applications) that apply to the project.

☐ Form -01A (*Authorized Agent Form*) attached if this application was prepared by and/or if correspondence is requested to be sent to an Authorized Agent (e.g., contractor or consultant). This form must accompany each application. http://www.ourair.org/wp-content/uploads/apcd-01a.pdf

☒ Confidential Information submitted according to APCD Policy & Procedure 6100-020. (*Failure to follow Policy and Procedure 6100-020 is a waiver of right to claim information as confidential.*)

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13. NOTICE OF CERTIFICATION:

All applicants must complete the following Notice of Certification. This certification must be signed by the Authorized Company Representative representing the owner/operator. Signatures by Authorized Agents will not be accepted.

NOTICE of CERTIFICATION

I, [redacted], am employed by or represent
Type or Print Name of Authorized Company Representative

United Launch Alliance, LLC.
Type or Print Name of Business, Corporation, Company, Individual, or Agency

(hereinafter referred to as the applicant), and certify pursuant to H&SC Section 42303.5 that all information contained herein and information submitted with this application is true and correct and the equipment listed herein complies or can be expected to comply with said rules and regulations when operated in the manner and under the circumstances proposed. If the project fees are required to be funded by the cost reimbursement basis, as the responsible person, I agree that I will pay the Santa Barbara County Air Pollution Control District the actual recorded cost, plus administrative cost, incurred by the APCD in the processing of the application within 30 days of the billing date. If I withdraw my application, I further understand that I shall inform the APCD in writing and I will be charged for all costs incurred through closure of the APCD files on the project.

For applications submitted for Authority to Construct, modifications to existing Authority to Construct, and Authority to Construct/Permit to Operate permits, I hereby certify that all major stationary sources in the state and all stationary sources in the air basin which are owned or operated by the applicant, or by an entity controlling, controlled by, or under common control with the applicant, are in compliance, or are on approved schedule for compliance with all applicable emission limitations and standards under the Clean Air Act (42 USC 7401 *et seq.*) and all applicable emission limitations and standards which are part of the State Implementation Plan approved by the Environmental Protection Agency.

Completed By: [redacted]
Title: SHEA Specialist
Date: 9|24|2021
Phone: [redacted]
Signature of Authorized Company Representative [redacted]

PLEASE NOTE THAT FAILURE TO COMPLETELY PROVIDE ALL REQUIRED INFORMATION OR FEES WILL RESULT IN YOUR APPLICATION BEING RETURNED OR DEEMED INCOMPLETE.

apcd air pollution control district
SANTA BARBARA COUNTY

BACT ANALYSIS SUMMARY FORM

This form must be submitted by all applicants when Best Available Control Technology ("BACT") is required, except for small sources that utilize BACT as listed on the APCD's *Small Source BACT List*, for which case this form is not required. This form supplements APCD Regulation II and applicable APCD application guideline documents. Please fill in all sections of this form completely. Also, fill in a separate form for each emissions unit subject to BACT (multiple units with the same BACT may use only one form). Use additional sheets as necessary.

COMPANY NAME: ______________________________ DATE: __________

FACILITY\SOURCE NAME: ______________________________

1. POLLUTANT(S) SUBJECT TO BACT REVIEW: ______________________________

2. EMISSION UNIT(S)/PROCESS(ES) SUBJECT TO BACT REVIEW: ______________________________

   ____

3. BACT SUMMARY:

   Technology: ______________________________

   ____

   Performance Standard: ______________________________

   ____

4. BACT SELECTION PROCESS DISCUSSION: On a separate sheet of paper, describe the justification for the selected control technology as BACT. Include the following in your description: documentation of technical infeasibility which would preclude the use of a more effective control technology; operating conditions at which the maximum daily and hourly emissions will be generated (baseline parameters); maximum daily and hourly emissions at the baseline conditions and the basis of how the emission rates were estimated; calculations, emission data, and/or other information to determine control effectiveness of each potential control technology; and emission limits expressed both in terms of an emissions cap (e.g., pounds per day) and in terms which ensure compliance at any operating capacity (e.g., pounds per million British thermal units, or parts per million by volume).

APPLICATION No

5. BACT EFFECTIVENESS: Discuss how BACT will be effective over all operating ranges.

____

____

____

6. BACT DURING NON-STANDARD OPERATIONS: Discuss whether the proposed BACT is achievable during non-standard operations and if not, what BACT is for those operations.

____

____

7. OPERATING CONSTRAINTS: Identify all process variables for which operating limits need to be set in order to ensure compliance with the selected BACT standards.

____

____

____

8. MONITORING BACT: Describe, in detail, how the selected BACT is to be monitored for its emission reduction effectiveness.

____

____

____

9. ALTERNATE BASIC EQUIPMENT: Discuss whether alternate basic equipment (e.g., electric motors in lieu of IC engines) can be applied to this application.

____

____

10. [ ] Yes [ ] No Will this be a multi-year and/or multi-phase project?

11. [ ] Yes [ ] No Are all referenced documents attached?

12. [ ] Yes [ ] No If PSD BACT is triggered, was a detailed Top-Down BACT Analysis prepared and submitted with the application? Please be aware that the applicant is responsible for providing the APCD with this analysis.

\\\\sbcapcd.org\\shares\\Groups\\ENGR\\LIBRARY\\Permitting\\ApplicationForms\\apcd-02.doc

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apcd air pollution control district
SANTA BARBARA COUNTY

EMISSION REDUCTION CREDITS - AUTHORIZATION OF ERC USE APPLICATION FORM -05U

The owner of an ERC Certificate that is registered in the APCD's Source Register must completely fill in this form and submit it to the APCD each time the ERC Certificate is "used". Please be specific as to the amount and type of ERCs "used" and which specific "emission elements" are the source of the ERCs being used. This form must be filled in for each ERC Certificate subject to use. An application filing fee per Rule 210 (Schedule F.1) is required.

1. SUMMARY INFORMATION

Certificate No: 0513-1123 Expiration Date: ____________

Certificate Owner Name(s): United Launch Alliance

Company and Project Authorized to Use the ERCs: United Launch Alliance, Permitting of NG flares at SLC-3.

Total ERCs Authorized for Use (tons/yr):

NO_x:	1.424	SO_x:	
ROC:	0.200	PM_{10}:	0.222
CO:		PM:	0.222

Company Official Authorized to Release: the ERCs:

[redacted]
Please Print Name

[redacted] e-signed 01.28.2022
Signature

[redacted]
Phone and Fax Numbers

2. USE INFORMATION

☐ Yes ☒ No Will the ERC Certificate be used in whole?

☒ Yes ☐ No If partial use of the ERC Certificate is occurring, will the remaining ERCs belong to the original ERC Certificate owner? If No, then an ERC Certificate Transfer application must first be submitted and then an ERCs may be used by the new owner.

Specify the ERC Certificate Emission Elements (by name and number), the pollutants and the amounts that comprise the authorized "use". (*if no response is provided, the APCD will select for you*): ______________________________

____

____

3. COST INFORMATION

(a) Transaction Type[1]: ☐ Purchase ☐ Use on Company Owned Project

☐ Barter ☐ Subsidiary

(b) ERC Costs:

Pollutant	ERCs Used (tpy)	Total Cost ($)	Unit Cost ($/ton)
NO_x			
ROC			
CO			
SO_x			
PM_{10}			
PM			

(c) ☐ Yes ☐ No Are the total cost values stated above one time payments? If No, please explain in detail the nature of the payments:

____

(d) ☐ Yes ☐ No Are there any other payment provisions or "in-kind" costs associated with this transaction? If Yes, please detail:

____

4. ERC ATTACHED

☐ Yes ☐ No Is the ERC Certificate included with this application? *(The district cannot process this application until the ERC has been submitted.)*

---

[1] If barter was involved and/or no money was exchanged for the ERCs, please calculate an equivalent dollar per ton value for the credit transaction. Barters can include one company placing controls on another company to generate ERCs. The price should reflect the total cost to install the equipment and any additional fees paid as part of the agreement between both companies. The price paid should reflect the value of the ERC at the time of the transaction.

CONFIDENTIAL INFORMATION DELETED

air pollution control district
SANTA BARBARA COUNTY

EMISSION REDUCTION CREDITS - AUTHORIZATION OF ERC USE APPLICATION FORM -05U

The owner of an ERC Certificate that is registered in the APCD's Source Register must completely fill in this form and submit it to the APCD each time the ERC Certificate is "used". Please be specific as to the amount and type of ERCs "used" and which specific "emission elements" are the source of the ERCs being used. This form must be filled in for each ERC Certificate subject to use. An application filing fee per Rule 210 (Schedule F.1) is required.

1. SUMMARY INFORMATION

Certificate No: 0514-1123 Expiration Date: ______

Certificate Owner Name(s): United Launch Alliance

Company and Project Authorized to Use the ERCs: United Launch Alliance, Permitting of NG flares at SLC-3.

Total ERCs Authorized for Use (tons/yr):	NO_x:		SO_x:	
	ROC:	0.210	PM_{10}:	
	CO:		PM:	

Company Official Authorized to Release: the ERCs: [redacted]
Please Print Name

[redacted] e-signed 01.28.2022
Signature

[redacted]
Phone and Fax Numbers

2. USE INFORMATION

☒ Yes ☐ No Will the ERC Certificate be used in whole?

☒ Yes ☐ No If partial use of the ERC Certificate is occurring, will the remaining ERCs belong to the original ERC Certificate owner? If No, then an ERC Certificate Transfer application must first be submitted and then an ERCs may be used by the new owner.

Specify the ERC Certificate Emission Elements (by name and number), the pollutants and the amounts that comprise the authorized "use". (*if no response is provided, the APCD will select for you*): ______________________________

____

____

3. COST INFORMATION

(a) Transaction Type[1]: ☐ Purchase ☐ Use on Company Owned Project

☐ Barter ☐ Subsidiary

(b) ERC Costs:

Pollutant	**ERCs Used (tpy)**	**Total Cost ($)**	**Unit Cost ($/ton)**
NO_x			
ROC			
CO			
SO_x			
PM_{10}			
PM			

(c) ☐ Yes ☐ No Are the total cost values stated above one time payments? If No, please explain in detail the nature of the payments:

____

(d) ☐ Yes ☐ No Are there any other payment provisions or "in-kind" costs associated with this transaction? If Yes, please detail:

____

4. ERC ATTACHED

☐ Yes ☐ No Is the ERC Certificate included with this application? *(The district cannot process this application until the ERC has been submitted.)*

---

[1] If barter was involved and/or no money was exchanged for the ERCs, please calculate an equivalent dollar per ton value for the credit transaction. Barters can include one company placing controls on another company to generate ERCs. The price should reflect the total cost to install the equipment and any additional fees paid as part of the agreement between both companies. The price paid should reflect the value of the ERC at the time of the transaction.

Print Form

apcd air pollution control district
SANTA BARBARA COUNTY

Flare or Thermal Oxidizer Form 200-14
Oil and Gas Equipment

Santa Barbara County Air Pollution Control District
260 N. San Antonio Road, Suite A
Santa Barbara, CA 93110-1315

Submit this supplemental equipment form attached to the **Oil and Gas Production Facility Form-200** to permit **Flares and Thermal Oxidizers** that are part of the project. Submit one application per device. Include manufacturer specifications as an attachment to this form.

Device Name	**GSE Elevated Flare**
Facility Name	**SLC-3**

I. General Information

Operator ID (component ID)	
Manufacturer	**John Zink**
Model	**PLA-78**
Serial Number	**TBD**

II. Flare and Fuel Details

Flare Type	**Open-Pipe**	
Mfg. Heat Input Rating	**5,083**	**MMBtu/hr**
Flare Tip Gas Pressure	**5**	**psig**
Flare Tip Inside Diameter	**4.08**	**ft**

Fuel HHV	**1,017**	**Btu/scf**
Fuel Sulfur Content	**10**	**ppm as H_2S**

III. Pilot Fuel and Purge Gas Details

Pilot Fuel Type	**Natural Gas-Utility**	
If "other", explain		
Pilot Heat Input Rating	**88**	**scf/hr**
Ignition Type	**Auto Ignition**	

Purge Gas Type	**Inert Gas**
If "other", explain	

IV. Auxiliary Systems

Flame Monitor System	**Thermocouple**
If "other", explain	

Smokeless Operation Type	**Other**
If "other", explain	**Air-Assisted Flare**

V. Emission Factors

NOx Limit	**0.068**	**lb/MMBtu**	CO Limit	**0.310**	**lb/MMBtu**
ROC Limit	**0.023**	**lb/MMBtu**	Unplanned Fuel Gas Sulfur		**ppm as H_2S**

For APCD use only. FID # ☐ **App. #** ☐

VI. Estimated Flaring

Daily Planned Flaring	**1,528.6**	MMBtu/day	Annual Planned Flaring	**14,373.1**	MMBtu/year
Daily Unplanned Flaring	**0**	MMBtu/day	Annual Unplanned Flaring	**0**	MMBtu/year
Daily Pilot Throughput	**1,663,000**	Btu/day	Annual Pilot Throughput	**11,088,000**	Btu/year

☒ Yes ☐ No Is manufacturer specifications for this equipment attached to the form?
Application cannot be deemed complete without the attached information.

VII. Device Description	VIII. Location Note
Elevated flare for burning of natural gas resulting from boil off of liquefied natural gas (LNG) during activities associated with loading of LNG into Vulcan rocket.	**Space Launch Complex 3 (SLC-3) at Vandenberg Space Force Base.**

LNG FLARE EMISSION CALCULATIONS

Attachment: GSE Elevated Flare
Permit Number: 15795
Facility: ULA - SLC-3

Fuel Information

Data	*Value*	*Units*	*Reference*
Flare Throughput......................	1,528.608	MMBtu/day	Permit Application
Gas Heat Content......................	1,017.7	Btu/scf	Permit Application
Sulfur Content..........................	10	ppm	Permit Application

Heat Input Data

Value	*Units*	*Reference*
271.465	MMBtu/hour	Based on highest usage hour
1,528.608	MMBtu/day	Permit Application
14,373.077	MMBtu/year	Permit Application

Emission Factors

Pollutant	*lb/MMBtu*	*Reference*
NO_x	0.0680	AP-42, Table 13.5-1
ROC	0.0232	Calculated*
CO	0.3100	AP-42, Table 13.5-2
SO_x	0.0017	Mass Balance Calculation
PM	0.0077	AP-42, Table 1.5-1 (Propane)
PM_{10}	0.0077	AP-42, Table 1.5-1 (Propane)
$PM_{2.5}$	0.0077	AP-42, Table 1.5-1 (Propane)

Flare Potential to Emit

Pollutant	lb/day	TPY	**ERCs Required**
NO_x	103.95	0.49	**0.635**
ROC	35.53	0.17	**0.217**
CO	473.87	2.23	
SO_x	2.54	0.01	
PM	11.69	0.05	**0.071**
PM_{10}	11.69	0.05	**0.071**
$PM_{2.5}$	11.69	0.05	

Processed By: Date:

* 44.097 Propane MW Calculation detailed in SBCAPCD document: ONSHORE OIL AND GAS PRODUCTION FLARE REACTIVE ORGANIC COMPOUND EMISSION FACTOR STUDY.

Print Form

air pollution control district
apcd SANTA BARBARA COUNTY

Flare or Thermal Oxidizer Form 200-14
Oil and Gas Equipment

Santa Barbara County Air Pollution Control District
260 N. San Antonio Road, Suite A
Santa Barbara, CA 93110-1315

Submit this supplemental equipment form attached to the **Oil and Gas Production Facility Form-200** to permit **Flares and Thermal Oxidizers** that are part of the project. Submit one application per device. Include manufacturer specifications as an attachment to this form.

Device Name	**Vehicle Elevated Flare**
Facility Name	**SLC-3**

I. General Information

Operator ID (component ID)	
Manufacturer	**John Zink**
Model	**PLA-78**
Serial Number	**TBD**

II. Flare and Fuel Details

Flare Type	**Open-Pipe**	
Mfg. Heat Input Rating	**5,083**	**MMBtu/hr**
Flare Tip Gas Pressure	**5**	**psig**
Flare Tip Inside Diameter	**4.08**	**ft**

Fuel HHV	**1,017**	**Btu/scf**
Fuel Sulfur Content	**10**	**ppm as H_2S**

III. Pilot Fuel and Purge Gas Details

Pilot Fuel Type	**Natural Gas-Utility**	
If "other", explain		
Pilot Heat Input Rating	**88**	**scf/hr**
Ignition Type	**Auto Ignition**	

Purge Gas Type	**Inert Gas**
If "other", explain	

IV. Auxiliary Systems

Flame Monitor System	**Thermocouple**
If "other", explain	

Smokeless Operation Type	**Other**
If "other", explain	**Air-Assisted Flare**

V. Emission Factors

NOx Limit	**0.068**	**lb/MMBtu**	CO Limit	**0.310**	**lb/MMBtu**
ROC Limit	**0.023**	**lb/MMBtu**	Unplanned Fuel Gas Sulfur		**ppm as H_2S**

For APCD use only. FID # ______ **App. #** ______

VI. Estimated Flaring

Daily Planned Flaring	**1,625.7**	**MMBtu/day**	Annual Planned Flaring	**12,699.8**	**MMBtu/year**
Daily Unplanned Flaring	**0**	**MMBtu/day**	Annual Unplanned Flaring	**0**	**MMBtu/year**
Daily Pilot Throughput	**1,663,000**	**Btu/day**	Annual Pilot Throughput	**4,435,000**	**Btu/year**

☒ Yes ☐ No Is manufacturer specifications for this equipment attached to the form?
Application cannot be deemed complete without the attached information.

VII. Device Description	VIII. Location Note
Elevated flare for burning of natural gas resulting from boil off of liquefied natural gas (LNG) during activities associated with loading of LNG into Vulcan rocket.	**Space Launch Complex 3 (SLC-3) at Vandenberg Space Force Base.**

LNG FLARE EMISSION CALCULATIONS

Attachment: Vehicle Elevated Flare
Permit Number: 15795
Facility: ULA - SLC-3

Fuel Information

Data	*Value*	*Units*	*Reference*
Flare Throughput......................	1,625.692	MMBtu/day	Permit Application
Gas Heat Content.....................	1,017.7	Btu/scf	Permit Application
Sulfur Content.........................	10	ppm	Permit Application

Heat Input Data

Value	*Units*	*Reference*
303.615	MMBtu/hour	Based on highest usage hour
1,625.692	MMBtu/day	Permit Application
12,699.796	MMBtu/year	Permit Application

Emission Factors

Pollutant	*lb/MMBtu*	*Reference*
NO_x	0.0680	AP-42, Table 13.5-1
ROC	0.0232	Calculated*
CO	0.3100	AP-42, Table 13.5-2
SO_x	0.0017	Mass Balance Calculation
PM	0.0077	AP-42, Table 1.5-1 (Propane)
PM_{10}	0.0077	AP-42, Table 1.5-1 (Propane)
$PM_{2.5}$	0.0077	AP-42, Table 1.5-1 (Propane)

Flare Potential to Emit

ERCs Required

Pollutant	lb/day	TPY	ERCs Required
NO_x	110.55	0.43	0.561
ROC	37.78	0.15	0.192
CO	503.96	1.97	
SO_x	2.70	0.01	
PM	12.44	0.05	0.063
PM_{10}	12.44	0.05	0.063
$PM_{2.5}$	12.44	0.05	

Processed By:

Date:

* 44.097 Propane MW Calculation detailed in SBCAPCD document: ONSHORE OIL AND GAS PRODUCTION FLARE REACTIVE ORGANIC COMPOUND EMISSION FACTOR STUDY.

Print Form

air pollution control district
SANTA BARBARA COUNTY

Flare or Thermal Oxidizer Form 200-14
Oil and Gas Equipment

Santa Barbara County Air Pollution Control District
260 N. San Antonio Road, Suite A
Santa Barbara, CA 93110-1315

Submit this supplemental equipment form attached to the **Oil and Gas Production Facility Form-200** to permit **Flares and Thermal Oxidizers** that are part of the project. Submit one application per device. Include manufacturer specifications as an attachment to this form.

Device Name	**Enclosed Flare**
Facility Name	**SLC-3**

I. General Information

Operator ID (component ID)	
Manufacturer	**John Zink**
Model	**ZT-100-0875-1/07/14-LE**
Serial Number	**TBD**

II. Flare and Fuel Details

Flare Type	**Enclosed**	
Mfg. Heat Input Rating	**50.8**	**MMBtu/hr**
Flare Tip Gas Pressure	**5**	**psig**
Flare Tip Inside Diameter	**7.67**	**ft**

Fuel HHV	**1,017**	**Btu/scf**
Fuel Sulfur Content	**10**	**ppm as H_2S**

III. Pilot Fuel and Purge Gas Details

Pilot Fuel Type	**Natural Gas-Utility**	
If "other", explain		
Pilot Heat Input Rating	**120**	**scf/hr**
Ignition Type	**Auto Ignition**	

Purge Gas Type	**Inert Gas**
If "other", explain	

IV. Auxiliary Systems

Flame Monitor System	**Thermocouple**
If "other", explain	

Smokeless Operation Type	**Other**
If "other", explain	**Air-Assisted Flare**

V. Emission Factors

NOx Limit	**0.020**	**lb/MMBtu**	CO Limit	**0.020**	**lb/MMBtu**
ROC Limit	**0.000**	**lb/MMBtu**	Unplanned Fuel Gas Sulfur		**ppm as H_2S**

For APCD use only. FID # ______ **App. #** ______

VI. Estimated Flaring

Daily Planned Flaring	**487.6**	**MMBtu/day**	Annual Planned Flaring	**17,495.2**	**MMBtu/year**
Daily Unplanned Flaring	**0**	**MMBtu/day**	Annual Unplanned Flaring	**0**	**MMBtu/year**
Daily Pilot Throughput	**10,374,000**	**Btu/day**	Annual Pilot Throughput	**1,485,960,000**	**Btu/year**

☒ Yes ☐ No Is manufacturer specifications for this equipment attached to the form?
Application cannot be deemed complete without the attached information.

VII. Device Description	VIII. Location Note
Enclosed flare for burning of natural gas resulting from boil off of liquefied natural gas (LNG) during unloading of LNG into storage tank, during boil off of LNG from storage tank, and during sampling of LNG.	**Space Launch Complex 3 (SLC-3) at Vandenberg Space Force Base.**

LNG FLARE EMISSION CALCULATIONS

Attachment: Enclosed Flare
Permit Number: 15795
Facility: ULA - SLC-3

Fuel Information

Data	*Value*	*Units*	*Reference*
Flare Throughput......................	487.586	MMBtu/day	Permit Application
Gas Heat Content.....................	1,017.7	Btu/scf	Permit Application
Sulfur Content..........................	10	ppm	Permit Application

Heat Input Data

Value	*Units*	*Reference*
50.838	MMBtu/hour	Based on flare size and LNG HHV
487.586	MMBtu/day	Permit Application
17,495.241	MMBtu/year	Permit Application

Emission Factors

Pollutant	*lb/MMBtu*	*Reference*
NO_x	0.0200	JZ Proposal
ROC	0.0001	Calculated*
CO	0.0200	JZ Proposal
SO_x	0.0017	Mass Balance Calculation
PM	0.0077	AP-42, Table 1.5-1 (Propane)
PM_{10}	0.0077	AP-42, Table 1.5-1 (Propane)
$PM_{2.5}$	0.0077	AP-42, Table 1.5-1 (Propane)

Flare Potential to Emit

Pollutant	lb/day	TPY	ERCs Required
NO_x	9.75	0.17	0.227
ROC	0.06	0.00	0.001
CO	9.75	0.17	
SO_x	0.81	0.01	
PM	3.73	0.07	0.087
PM_{10}	3.73	0.07	0.087
$PM_{2.5}$	3.73	0.07	

Processed By: Date:

* 44.097 Propane MW Calculation detailed in SBCAPCD document: ONSHORE OIL AND GAS PRODUCTION FLARE REACTIVE ORGANIC COMPOUND EMISSION FACTOR STUDY.

CONFIDENTIAL INFORMATION DELETED

United Launch Alliance	**STM1032 Rev B** Material Specification	Page 1 of 3
CAGE Code **430Y2**	**PROPELLANT, LIQUID NATURAL GAS**	CN No: CN-015294 Release: 2020-11-18

1.0 SCOPE

1.1 Purpose

This material specification cover sheets Department of Defense performance specification MIL-PRF-32207, "Propellant, Methane", dated 10 October 2006, and its Notice of Validation, dated 20 July 2011, except as modified herein.

It establishes the engineering requirements for the procurement of a liquid natural gas (LNG) propellant commodity, having a total methane molar content between [redacted] at the time of certification, for use in the testing and fueling of launch vehicle propulsion systems.

1.2 Classification

This specification shall be specified on design drawings and specifications by the item identification number STM1032-01.

2.0 APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order or ULA manufacturing instruction forms a part of this specification to the extent specified herein. A subsequent revision of a document may be used unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 U.S. Government Publications:

2.1.1 MIL Specifications:

MIL-PRF-32207	Performance Specification, Propellant, Methane (Includes its Notice of Validation, dated 20 July 2011)

Copies of this document are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Bldg 4D, Philadelphia PA 19111-5094.)

2.2 AIA/NAS Publications:

NAS850	General Packaging Standard

3.0 REQUIREMENTS

With one exception, all other MIL-PRF-32207 requirements for liquid propellant methane (Type II) apply. The requirement exception is 3.1, Chemical and Physical Properties. Instead, the chemical and physical properties of the procured liquid natural gas propellant shall be certified per the limits defined in Table I of this specification, in place of the three, graded, limits found in MIL-PRF-32207, Table I.

3.1 Chemical and physical properties. The chemical and physical properties of the LNG propellant shall conform to those listed in Table I below, when tested in accordance with the listed cross-referenced MIL-PRF-33207 test methods. Other approved sampling test methods may be used if they meet the quality assurance and calibration requirements of MIL-PRF-33207. Content percentages shall be determined on a % Mole (% Mol) basis, instead of a % Volume (% Vol) basis.

TABLE I. Chemical and Physical Properties

Property	LNG Propellant Grade	MIL-PRF-32207 Test Paragraph (2)
[redacted]	[redacted]	[redacted]
Total volatile sulfur, ppm Mol, max	10	4.5.7

Notes, Table I:

(1) No specific limit, but must be reported in % Mol.

(2) Other sampling test methods meeting the quality assurance and calibration requirements of MIL-PRF-33207 may be used.

4.0 VERIFICATION

MIL-PRF-32207, Type II, verification requirements apply. The certification report shall include the content percentages of the volatile hydrocarbons listed in Table I.

Unless otherwise specified in the contract or purchase order, the supplier shall be responsible for the performance of all inspection and test requirements. Unless otherwise specified on the purchase order, the supplier may utilize his own facilities or any commercial laboratory acceptable to the procuring activity. The procuring activity reserves the right to perform any of the inspections and tests set forth in the specification where such inspections or tests are deemed necessary to assure that the material conforms to the specified requirements.

Inspection records of examinations and tests shall be kept complete and available to the procuring activity. These records shall contain all data necessary to determine compliance with the requirements of this specification

5.0 PREPARATION FOR DELIVERY

5.1 Packaging. Packaging shall be per NAS 850, and meet all applicable federal and military requirements for the transportation and storage of liquid natural gas.

6.0 NOTES

6.1 Intended use. The propellant covered by this specification is intended for use as a fuel for rocket engines.

JOHN ZINK HAMWORTHY
COMBUSTION
johnzinkhamworthy.com

11920 East Apache
Tulsa, Oklahoma 74116 USA
☏ (918) 234-5734, Fax: (918) 234-1986

END USER / CLIENT:	United Launch Alliance / AECOM
PROJECT:	Vulcan Centaur Launch Support Vehicle
LOCATION:	Vandenberg Air Force Base, CA
EQUIPMENT:	LNG Elevated Flare Stack LNG Enclosed Ground Flare
PROPOSAL NUMBER:	FS 134657-A1

September 23, 2021

TECHNICAL PROPOSAL LNG FLARE STACK VULCAN

CONFIDENTIAL INFORMATION DELETED

JOHN ZINK
HAMWORTHY
COMBUSTION

johnzinkhamworthy.com

September 23, 2021

[redacted]
United Launch Alliance, Vulcan, VAFB
[redacted]

Customer Reference: **Email Request for Technical Information**

John Zink Proposal No: **FS 134657-A1**

Dear [redacted]

John Zink Co LLC is pleased to provide you with the revised proposal for LNG Flare Stack in response to your inquiry for above reference project.

We appreciate your interest in John Zink and look forward to working with you. If you require any further information or have any questions, please feel free to contact us.

Thank you for allowing us this opportunity to be of service.

Sincerely,

[redacted]
Applications Engineer
[redacted]

I. CONTENTS

DISCOVER THE JOHN ZINK DIFFERENCE

John Zink Hamworthy Combustion's emissions-control and clean-air systems perform vital functions in the world's most demanding industries—from hydrocarbon and chemical processing, to biofuels, automobile manufacturing, food processing, pulp and paper, waste management, and many more. Combining practical problem solving with creative innovation, our people are driven to push the boundaries of John Zink Hamworthy Combustion's legacy achievements to develop a clean generation of products that address the challenges of our clients and an environmentally conscious world.

Headquartered in Tulsa, Oklahoma, John Zink Hamworthy Combustion is home to the best and brightest process engineers, researchers and scientists from all corners of the globe, and the combustion industry's largest research and development test center. Here, we've built a unique brain trust of knowledge, creativity and industrial-scale resources to incubate innovation and propel our industry and mission forward.

John Zink Hamworthy Combustion upholds the principles of its own Quality Management System, which fully meets and encompasses ANSI/ISO 9001:2000 requirements. John Zink Hamworthy Combustion is a part of Koch Industries, a privately held global corporation providing diverse products and solutions for industries and consumers worldwide.

QUALITY MANAGEMENT

- John Zink's Tulsa and Luxembourg operations meet the requirements of the internationally recognized ISO 9001:2000 Quality Management System.

SAFETY & HEALTH MANAGEMENT

- OHSAS 18001 certification of John Zink's Tulsa and Luxembourg facilities underscores our commitment to providing a culture of safety that focuses on identifying and eliminating workplace hazards while maintaining health and safety compliance.

- John Zink's Tulsa facility is a recipient of the Voluntary Protection Program (VPP) Star Certification, which recognizes selective companies that show a commitment to improved safety and health performance beyond the requirements of the OSHA standards, and who have demonstrated safety performance considered best in class.

ENVIRONMENTAL MANAGEMENT

- John Zink's Tulsa and Luxembourg operations meet the requirements of the internationally recognized ISO 14001 Environmental Management System.

- The U.S. Environmental Protection Agency has selected John Zink's Tulsa facility as a member of the agency's National Environmental Performance Track program, which recognizes top environmental performers that voluntarily go beyond compliance.

KNOWLEDGE & EDUCATION MANAGEMENT

- John Zink preserves its legacy expertise and experience through knowledge-sharing practices.

- The IACET-accredited John Zink Institute^{SM} at John Zink Company, LLC offers year-round courses in combustion education to enhance operations knowledge.

- The John Zink Institute^{SM} has earned certification of its Process Burner Fundamentals and Process Burner Operations courses from the American Petroleum Institute. John Zink is the first company to have a burner course certified under API's training provider certification program.

II. SCOPE OF SUPPLY

LNG Flare Stack Vulcan

LNG Elevated Flare Stack for 60 lbs/s

One (1) John Zink model PLA-78 Air Assisted Flare Tip in 310SS/304SS material.

- One (1) 78" diameter Self-Supported Air Plenum with a 28" 304SS Gas Riser to provide an overall height of 90 feet. Air riser is carbon steel, A36 or equal. Gas inlet connection is a 28" #150 RF Flange. *(Note: Flare Stack is designed to be assembled in horizontal position for a single piece lift.)*
- One (1) John Zink model EEF-MS-30 Molecular Seal purge reduction device 304SS Material.
- One (1) Vane Axial Blower, ~250 HP. Mounted on the stack. VFD ready.
- Four (4) *Wind*PROOF™ Pilot / ZEUS High Energy Spark Ignitor assemblies with One (1) K - Type Single Element *Retractable* Thermocouple (310SS Sheath) per pilot.
- One (1) Retractable Thermocouple System for One (1) K - Type Single Element Thermocouple 310SS Sheath per pilot for Total Four (4) Pilots suitable for 90 feet Overall Height Flare Stack.
- One (1) Pilot Manifold of 304 Stainless Steel Material at Flare Tip.
- One (1) Lot Utility Piping from Flare Tip to near grade at Stack base: One (1) 1" diameter sch STD Pilot Gas Line A-312-TP304 Material and One (1) 3" inch diameter Moleculare Seal Drain Line 304SS STD Pipe Material
- One (1) Lot High Temperature Ignition wire from Flare Tip to near grade at Flare Stack base with Rigid Galvanized Conduits.
- One (1) John Zink ZEUS Automatic / Manual Electronic High Energy Spark Ignition System suitable for Four (4) Pilots with Control Panel in a NEMA 4/7. A NEMA 4X stainless steel enclosure with Z-purge for Hazardous Area Classification Class 1 Division 2 Group D is also avaliable.
- If two flare systems are purchased a combined Ignition Cotrol Panel can be provided.
- One (1) NEMA 4X (304SS) Thermocouple Junction Box and One (1) NEMA 4/7 (Cast Aluminum) Zeus Ignition Module Box at Stack base.
- All necessary Vendor Documentation as per John Zink Standard.

III. COMMERCIAL

Pricing- Flare System

Scope- PLA-78 Air Assisted Flare System	Total Price US$
• Elevated 78” Air-Assisted Flare o Smokeless o 250 HP Blower, VFD Capable • 90’ Overall Height • 28” Gas Riser, 304SS • MS-30 Molecular Seal, 304SS • Four (4) WindPROOF™ Fixed Pilots • Retractable Thermocouples • Zeus® Automatic Pilot Ignition Panel o NEMA 4/7	
Total Budget Price, Each	

Scope- PLA-48 Air Assisted Flare System	Total Price US$
• Elevated 48” Air-Assisted Flare o Smokeless o 250 HP Blower, VFD Capable • 90’ Overall Height • 28” Gas Riser, 304SS • MS-30 Molecular Seal, 304SS • Four (4) WindPROOF™ Fixed Pilots • Retractable Thermocouples • Zeus® Automatic Pilot Ignition Panel o NEMA 4/7	
Total Budget Price, Each	

Quote Validity:	30 Days
Standard Warranty:	18 months after shipment or 12 months after start-up.
Freight Terms:	*FCA point of manufacturing* or per contract. JZ suggests Pre-Pay & Add, Cost plus handling fee.

Schedule (Preliminary)

Elevated Flare	Normal Delivery- 28-32 Weeks after acceptance of PO. Drawings in 4-6 weeks.
Documentation	No later than 2 weeks after last delivery.
We have allotted ten (10) business days for drawing approval / comments.	

Subcontracting

John Zink will likely subcontract portions of the project. Some components such as flare pilots are always fabricated in John Zink's facility in Tulsa, OK.
John Zink will disclose all sub-contractors and the customer / end user will have access to the facilities.

Proposed Payment Terms:

- 15% upon receipt of purchase order, due net 30
- 25% invoiced upon first issue of flare GA drawing(s), due net 30
- 35% upon placement of order for major components, due net 30
- 25% invoiced at notification of readiness to ship, pro rata, due net 30

Late Payments: In the event of late payments, the project may be placed on hold as described in the agreed upon Terms and Conditions.

IV. FLARE REGULATIONS / NOTES

- The proposed air-assisted flare does meet the gas exit velocity requirements of 40 CFR 60.18 for the 6 and 3 lbs/s flow rates.
- API-537 recommends 4 pilots with flare tips greater than 42” diameter. John Zink is proposing 4 pilots.
- It is possible to over assist an air-assisted flare and have poor combustion efficiency. If flow measurement and blower controls are necessary, it is important to understand the minimum and normal flare flow rates. John Zink will assist in this evaluation.
- John Zink will provide a VFD capable motor for the blower. The end user should determine if it will be necessary to have flare gas flow measurement and blower speed controls to ensure efficient combustion.
- Flare gas flow measurement and blower controls are not included in John Zink’s current scope.

V. SYSTEM DESCRIPTION

LNG Elevated Flare Stack

JOHN ZINK AZDAIR AIR-ASSISTED FLARE (PLA-78 & 48) LP FLARE

Most hydrocarbon-containing gas streams smoke when burned unless sufficient oxygen is mixed into the combustion zone. Smoke is produced by the cracking and polymerization reactions taking place in the flame core, where there is a high flame temperature and insufficient oxygen for complete combustion. Adequate aeration of the combustion zone reduces or eliminates smoke.

With high-pressure gases sufficient air for complete combustion may be induced into the flame by a combination of jetting action and thermal draft. With low pressure gases, when the jetting action may be negligible and the thermal draft alone is insufficient to entrain enough air for complete combustion, smoke is produced.

The problem of burning low-pressure gas smokeless is usually solved by either aspirating air into the flame using an external (pressure) energy source such as steam or mixing gas directly with air.

Although steam injection is very effective at reducing smoke, such a system is not very suitable for flaring at remote locations where a large steam supply is not available. Air injection often provides the solution. Air can be supplied to the flare by a low-pressure fan.

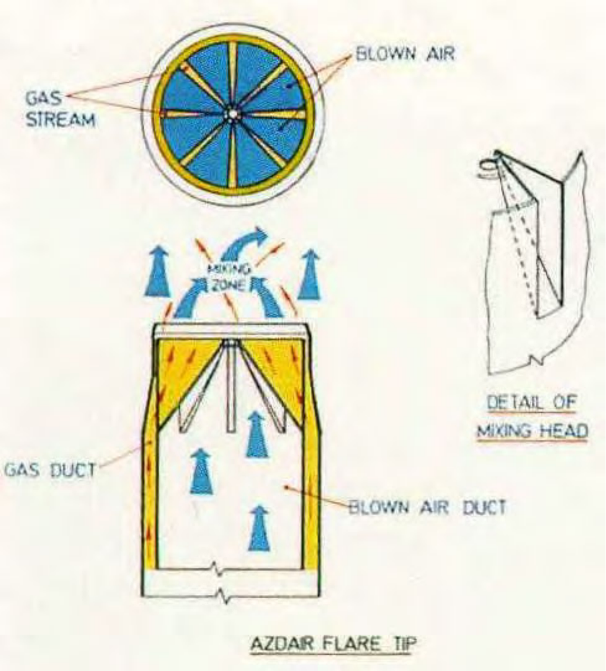
In the Azdair Air-assisted Smokeless Flare, primary air for combustion is supplied via a low-pressure fan, mounted at the base of the stack. The air required for smokeless flaring is supplied as a central core within the gas flame and is designed to provide good mixing of the air and gas which produces a stable, smokeless flame.

The Azdair is designed for duties where low-pressure gases are required to burn smokeless when process steam is unavailable. The Azdair can also give lower radiation levels than a pipe flare for the same gas flow and conditions. Due to the premixed primary air supplied by the air blower, the combustion efficiency increases and the quantity of incandescent carbon, the main source of heat radiation, reduces.

The goal of an efficient air assisted flare design is to maximize the air / gas mixing surface area. Conventional air assisted flares route the gas through the inner annulus of the flare tip mixing head while the air is routed through the outer annulus. This is a poor use of the flare tip cross-sectional area, which creates an outer ring of air around the periphery of the flare tip.

The Azdair flare tip routes the gas through the outer annulus and the air through the inner annulus. This maximizes the air / gas surface mixing area, and also makes efficient use of the ambient air by creating a thin film of gas around the outer periphery of the flare tip diameter. This efficient air / gas mixing head arrangement allows the Azdair flare tip to produce more smokeless capacity per given volume of forced air than the conventional air assisted flare design.

The outer gas annulus of the Azdair flare tip also helps prevent air ingress into the mixing head at low gas flow rates. Conventional air assisted flare tips are much more likely to allow burning inside the tip mixing head at low gas flow rates. This leads to overheating and distortion of the mixing head and subsequent failure of the flare tip.



MOLECUALR SEAL PURGE REDUCTION DEVICE (EEF-MS-30) the molecular weights of the purge gas and the atmospheric air to form a "molecular" seal which prevents air infiltration into the stack. The Molecular Seal, placed directly below the flare tip, consists of a baffled cylinder which forces the incoming air through two vertical-180° bends before entering the flare system. Even when purge gas flow is interrupted, the molecular seal continues to provide protection for a short time interval. In contrast, the protection from an Airrestor or similar velocity dependent device is immediately lost if the purge gas flow is interrupted.

John Zink Company recognizes the increasing operating cost of purge gas. To demonstrate the effectiveness of purge reduction devices in reducing purge gas requirements and in preventing oxygen from entering the flare system, John Zink built three identical, full-size flare stacks. One is equipped with a Molecular Seal, one with an Airrestor, and one is without any purge reduction device. The stacks were tested over an eight-month period and the oxygen content 20 feet below the flare tip was measured.

Type	Purge Gas Velocity, fps	Oxygen, %(1)
Molecular Seal	0.01	0.0
Airrestor	0.04	6-8
Plain Stack	0.35	6-8

(1)20 ft below flare tip

As shown by the above test data, the Molecular Seal provides an oxygen free environment below the flare tip and uses the least amount of purge gas. With the Molecular Seal the purge gas velocity of 0.01 fps is required to insure an acceptable oxygen level under all adverse weather conditions. If a low percentage of oxygen in the flare riser is acceptable, or protection from purge gas loss is not required, an Airrestor may be suitable.

90 FEET TALL SELF SUPPORTED FLARE STACK

The John Zink self-supported flare stack provides a structural support for the flare tips, piping as required. The stack is designed to resist dead load, live load, wind loads, and seismic loads as required by the applicable codes and guidelines. The structural design also incorporates consideration of dynamic effects such as vortex shedding and ovaling vibration.

The riser is manufactured in sections suitable for shipment and assembly, and match marked for field welding. The riser is designed to be welded at grade, in the horizontal position, and lifted as one piece. Each shipping section is provided with lifting lugs and is suitable for field welding.
A detailed description of the stack is included in attached data sheet.

JOHN ZINK *WIND*PROOF HIGH-PERFORMANCE PILOT

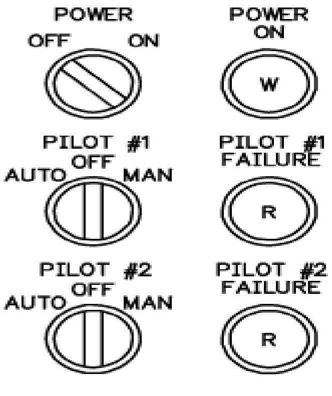
The John Zink *Wind*PROOF Pilot is the best that pilot technology has to offer, with a combination of fuel efficiency and stability in adverse weather conditions. The *Wind*PROOF Pilot stands up to the most severe winds and rain with the long-lasting performance of our other pilot models.

Stable in winds up to a velocity of 160 mph in all positions around the flare tip, the *Wind*PROOF Pilot consist of a tip and tip windshield, ignition and fuel piping, a mixer and strainer assembly, and a mixer windshield. The *Wind*PROOF is stable in the worst conditions while consuming as little as 50 SCFH of fuel gas. Also included are one integral thermowells for thermocouple pilot detection. The *Wind*PROOF can burn a wide variety of fuels without adjustment.
*Wind*PROOF was designed and tested at the only pilot test facility of its kind in the world. At John Zink's International Research and Development Center, we use full scale testing to push our flare products to extraordinary limits. Det Norske Veritas (DNV), the world's most widely respected product verification and Certification Company, witnessed John

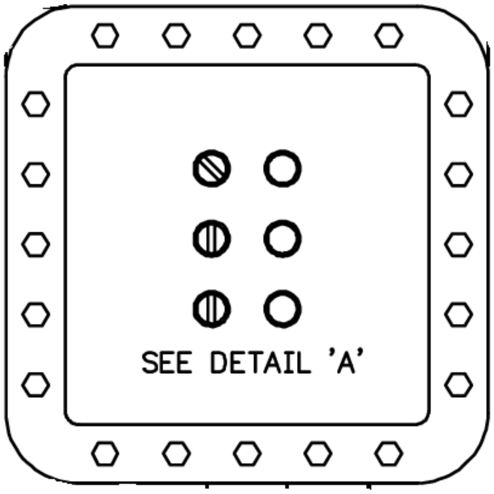
Zink Company’s test of the *Wind*PROOF pilot and verified that the *Wind*PROOF remained lit under test conditions that exceeded 160 mph winds and 30 inches of rainfall per hour.

AUTOMATIC / MANUAL ZEUS ELECTRONIC SPARK IGNITION SYSTEM

The John Zink Automatic ZEUS ignition system provides reliable pilot ignition with minimal installation and utilities costs.



DETAIL 'A'



The pilot is ignited by a unique, patented high energy spark system. The sparking tip is enclosed in a stainless-steel pipe near the pilot discharge, and is cooled constantly by an induced air and gas flow. All ignition transformers are located remote from the pilot, up to 1,500 feet away. Wiring from the control box to the pilot is simple, economical, single pair 16 gage stranded/twisted instrument wire. Ignition is accomplished simply by turning on the fuel gas to the pilot and pushing a single button.

The ZEUS ignition system uses the pre-mixed pilot fuel for flame front generation. The pilot itself combines ignition fuel and combustion air at a venturi mixer located just below the pilot’s base. The fuel gas mixture flows through the pilot’s ZEUS ignition line to the pilot tip. An electrical spark is initiated from the ignition panel and each pilot is ignited in sequence.

A description of the ignition system is included on an attached datasheet.

VI. TECHNICAL DETAILS

Process Conditions (60 lbs/s LNG Elevated Flare)

FLARE TIP DATA	
Flare Tip Type	Air Assisted
Flare Tip Model:	PLA-78
Flare Tip Diameter (Inch):	78”
Flare Tip Length (feet):	10 feet
MOLECULAR SEAL DATA	
Seal Type	Molecular
Molecular Seal Model:	EEF-MS-30
Molecular Seal Diameter (Inch):	67”
Molecular Seal Length (ft):	11’-6”
FLARE STACK DATA	
Flare Stack Support Type:	Self - Supported
Air Plenum Diameter (Inch):	78”
Overall Stack Height (feet):	90 feet
Gas Riser Diameter (Inch):	28”
Gas Tip Exit Area (Inch^2)	1,885.75 in^2
Gas Riser Inlet Connection Size (inch):	28”
Gas Riser Inlet Elevation (feet):	10 feet
PROCESS DATA	
Design Case:	Design Case
Flare Gas Composition (mole%):	97% CH_4, 2.8% C_2H_6, 0.1% C_3H_8, 0.1% N_2
Design Flow rate (lbs/hr):	216,000 lbs/hr
Molecular Weight:	16.48
Temperature: (Degree C)	-260 ^{0}F
Net Heating Value (btu/scf):	917 btu/scf
Mach No.	0.039
Exit Velocity (ft/sec):	40.6 ft/sec
Allowable Static Pressure at 18-inch Stack inlet (psig):	5 psig
Site Data for Radiation Calculation:	Wind Speed 20 mile/hour Solar Radiation: excluded
Radiation at grade level excluding solar (btu/hr-ft2)	<1500 btu/hr-ft2

Utility Requirements:

- Pilot Gas: 22 SCFH of propane at 7 psig per pilot
- Ignition Control Panel Power: <3 Amps. / 120 Volt, 60 Hz, 1 phase
- Continuous Purge Gas:
  - PLA-78
    - 6,100 SCFH for Flashback Protection
    - 23,980 SCFH for Tip Life Protection
    - 171 SCFH for MS-30 Molecular Seal
  - PLA-48
    - 2,025 SCFH for Flashback Protection
    - 9,050 SCFH for Tip Life Protection
    - 171 SCFH for MS-30 Molecular Seal

VII. EXCEPTIONS & DEVIATIONS / CLARIFICATION

LNG Elevated Flare Stack

- Air Plenum/Gas Riser is considered a structure and is not a pressure retaining part. It is designed and fabricated in accordance with structural specifications, not piping codes. As requested only Flare Stack Gas Riser shall be designed for 10 psig internal pressure as per B31.3 but hydro test and any other specific requirement related to piping code is excluded. Hydro testing of flare stack is not required or included. Flare Stack is mainly designed per ASME STS-1-2016.
- For Elevated Flare Stack; we have proposed NEMA 4/7 Cast Aluminum Ignition Control Panel suitable for Area Classification Class 1, Div 2, Group D. We are not offering purge control panel hence any requirement related to control box purge is not included / required.
- Interconnecting Thermocouple Wire and Control Wire from the base of the Flare Stack to the Control Panel location is by others. We can include with price adders; if required.
- We have considered 9 inch per 100 feet deflection criteria for Self-Supported Flare as per API 537. Maximum Allowable nozzle loads as per API 537 is considered. No Corrosion allowance allowed for Stainless Steel Flare Stack.
- Each Pilot is provided with One (1) Single Element Type K (310SS Sheathed) Retractable Thermocouple. Ladders and Platforms are not offered.
- No protective coating & painting shall be applied on Stainless Steel Flare Tip, Flare Stack, Utility Piping and Pilots. Stainless Steel surface shall be natural finish. Control Panel and Electricals shall be natural finish and excluded for Surface Preparation and Coating.
- Our proposal doesn’t include any pilot gas piping, pressure gauge or regulators. Recommended Pilot Regulator Setting is 7 psig for the John Zink WindPROOF Pilots for Propane Fuel.
- Offered Control Panel shall be wall mounted which shall be placed at suitable location on site by client.
- Flare Tip & Pilots shall not be designed or fabricated as a pressure vessel / pressure retaining part / piping codes. Flare Tip and Pilots are considered as proprietary items which design and built to John Zink standard.
- Vendor Data supplied will be John Zink standard documents. John Zink shall submit the Drawings / Documents for approval electronically in PDF format only.

- Foundation Design, Start-up, Installation, Erection, Site work, Insulation, DCS & ESD, CCTV system, Area Lighting, Header Piping, Auxiliary Piping not mounted on Stack, Tools for transportation, erection and installation, Foundation Anchor bolts etc. are excluded from our scope. Heat trace, if required by others. Any external lighting by other. Mating Flanges / Bolts / Gaskets at battery limit are not in our scope.

- It is assumed that the total pressure drop of the system from the tanks to the VCU will allow for the natural force of the displaced vapors to push them to the VCU. If the system hydraulics is higher than this a vapor blower will be needed to "pull" the vapors from the tanks to the VCU. It is estimated that the pressure drop of the VCU at max capacity is 30" w.c. pressure.
- If the blower option is selected on the VCU a drip leg or knockout tank may be needed upstream of the blower to protect the blower from any condensation drop out that has collected in the interconnecting piping. It is assumed this would be part of the customers piping but can be provided by John Zink if required.
- VCU Instrumentation in the vapor piping will be 316 stainless steel. John Zink has quoted the main block valve and the detonation arrestor in the main vapor line for cryogenic service. John Zink is currently researching possible blower manufactures that can meet this requirement and will advise as soon as possible.
- It is assumed that the VCU assist air blower and optional vapor blower will utilize a 480 V 3 phase motor.

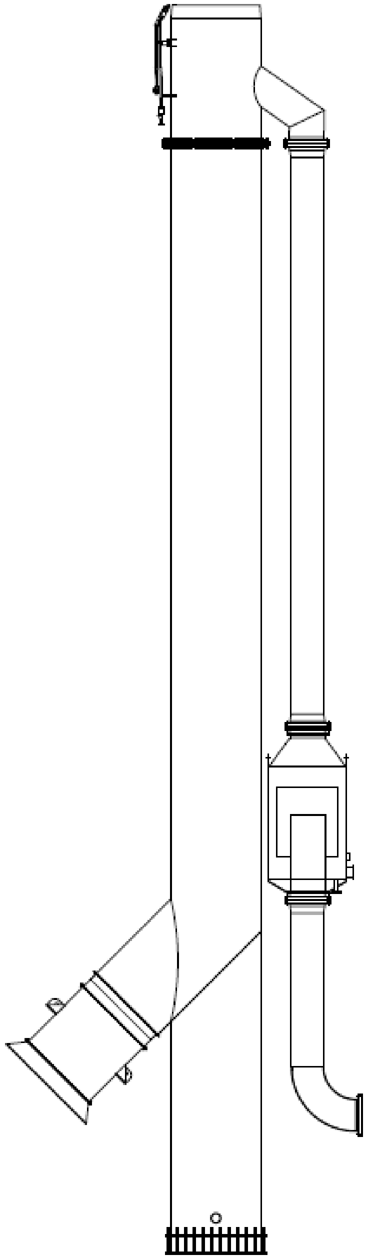
General Notes

- Our proposal is based on John Zink standards for manufacture. Flare tip is designed to John Zink standards.
- Proposed equipment design and scope of supply in compliance with only those specific client specifications provided with the requisition. Nested or referenced specifications that were not provided by purchaser with the requisition are specifically excluded from this proposal.
- All dimensions, material thickness, etc. in this proposal are preliminary and subject to modification, in compliance with specifications, after final engineering.
- The Delivery Schedule is based upon drawing approval by the customer as a hold point therefore, any delay in approving and returning these drawings by the customer will subsequently extend the contractual delivery date. John Zink shall furnish drawings to customer only and shall address only customer's comments not to various authorities.
- Any delay in Approval of drawings/documents, Inspection Visits and scope modification by client shall subsequently extend the contractual delivery date.
- This proposal is based on the use of manual and automated welding processes, including SAW, for the stainless steel flare tip(s) and piping components. The proposal is based on existing weld procedures and qualifications. No additional procedures or testing have been included. Weld procedure and weld map for pilots shall not be provided.

- Any utility piping and conduit of 2" nominal diameter or smaller will be shipped loose in random lengths suitable for field fabrication with loose fittings. Piping in this size range is not pre-fabricated. Conduit will be anchored at top of flare, and U-bolt guides will be furnished along the length of the flare. All differential growth due thermal expansion is to be absorbed in the end users piping at grade.

VIII. PROPOSAL SKETCH

Sketch of flare system: PLA-78, 90’ OAH, MS-30, and Blower.



IX. DATA SHEETS AND OTHER TECHNICAL DATA

- 1. Radiation Plots
- 2. Flare Tip Data Sheets
- 3. Molecular Seal Data Sheet
- 4. *Wind*PROOF Pilot data sheet
- 5. Ignition Control Panel Data Sheet

TECHNICAL QUOTE FOR VAPOR COMBUSTION UNIT

Client: United Launch Alliance

End User: United Launch Alliance

Job Site: Vandenburg, CA

John Zink Ref: 202101-147101, Rev C

Date: July 16, 2021

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Introduction

John Zink Company, LLC is pleased to provide this proposal for a JOHN ZINK® NOx*STAR*™ Vapor Combustion System (VCU), **model ZT-100-0875-1/07/14-LE,** to be located at United Launch Alliance terminal in Vandenberg, CA.

Through the execution of hundreds of vapor control projects, John Zink has developed a thorough understanding that our customers value safety, efficiency, and ease of installation, operation and maintenance in their equipment. The design of the proposed VCU incorporates several features which enhance safety, performance and reliability. John Zink also understands that, in addition to high-quality equipment, our customers value excellence in project execution and service. Purchasing a system from John Zink provides many advantages not limited to the following:

- Experienced design and project management staff dedicated to providing excellent customer service during the execution and installation phases of a project.
- In-house fabrication ability. Because John Zink owns its own 250,000 square foot manufacturing facility, we are able to assemble most systems in our own shop which allows us to better control quality and schedule. We also assemble our control panels in-house and perform a functional test of the control panel and VCU skids prior to shipment.
- Large service organization. Our factory trained technicians provide both preventative maintenance and emergency call-out assistance 24/7.
- Spare parts inventory for quick turn arounds.
- Portable Emission Control Systems (PECS®) for temporary compliance needs.
- Installation assistance.
- John Zink proprietary anti-flashback burners. John Zink is the only VCU supplier to design and manufacture our own anti-flashback burners.
- Elimination of liquid seal. John Zink's anti-flashback burners allow for an additional level of safety so that liquid seal can be removed, reducing equipment maintenance.

Design Basis

This design basis was developed from bid specifications and from reasonable assumptions. This basis is critical to the performance of the unit, and both the site-specific information and the assumptions should be thoroughly reviewed to ensure that they are accurate and acceptable.

Products Loaded:	Liquid Natural Gas (LPG)
Vapor Hydrocarbon Concentration	100 mol% maximum
Max Loading Rate	0.6 lb/sec
Estimated Max Heat Release	46.32 MMBtu/hr
Estimated Min Operating Temp	1700°F
Damper Operating Temp	1800°F
Estimated VCU Pressure Drop	20" w.c. at max design
Detonation Arrestor Classification	Group D Vapors
Inlet Vapor Temp	-220°F

Utilities and other stie-specific consideration

Area Electrical Classification	
VSU skid	Class 1, Div 2, Group D
VCU stack	Outdoor unclassified (non-hazardous)
Motor Type	TEFC
Estimated Electrical Power	
VSU Panel FLA	20 A (120 V / 1 ph / 60Hz)
Combustion Air Blower FLA	155 A (480 V / 3 ph / 60 Hz)
Utility Requirements	
Enrichment/Assist Gas Supply	Natural Gas @ 30 psig minimum
Enrichment/Assist Gas Flow Rate	68 scfm
Estimated Pilot Gas Flow Rate	0.9 scfm
Instrument Air/Nitrogen	80 psig (-40^0F dew point)
VCU Stack Earthquake Design:	IBC 2012 Site Class D
VCU Stack Wind Velocity Design;	ASCE 7-05, 160 mph
Ambient Temperature	32-100 °F

Performance Guarantee

The John Zink® Enclosed Vapor Combustion Unit is designed to combust the hydrocarbon vapors from the incoming air/hydrocarbon vapor mixture in order to comply with guaranteed emission limits as stated below.

99.99% Reduction in Total Hydrocarbon Vapor Emissions
0.02 lb/MMBTU of Nitrogen Oxides (NOx)
0.02 lb/MMBTU of Carbon Dioxide (CO)

Notes to Design Basis

1. Assist gas will be injected at the VCU when the BTU value the vapors are too lean to burn properly and maintain the combustor operating temperature. As the hydrocarbon concentration becomes higher in the vapor stream the assist gas flow rate will automatically be reduced.

2. Pilot gas is required continuously during loading at a rate of approximately 1.0 scfm for natural gas or 0.4 scfm for propane, per pilot.

3. The design basis assumes that there is negligible H_2S and mercaptan. Higher concentrations may require additional precautions to protect against corrosion in the stack and vapor piping.

Process Description

The proposed Vapor Combustion System (MVCS) is designed to control hydrocarbon emissions from vapors displaced during the loading of vessels safely and effectively. The VCS consists of two main process units, one (1) Vapor Safety Unit (VSU) and one (1) NOx*STAR* Vapor Combustion Stack.

Typically, until loading occurs at the loading station, the vapor combustion system is in a standby mode with no pilot flame, the vapor isolation valves are closed, and the air-assist blowers are off. Automatic start-up of the vapor combustion system is initiated by an electrical signal from the loading rack indicating that product loading will occur shortly.

The start-up sequence consists of a short air purge using the air-assist blowers to purge the stack of any combustibles that may be present around the pilots prior to ignition. This brief air purge is followed by automatic electronic ignition of the pilot(s). After pilot ignition, a permit to load signal is passed to the customer. If a stack pre-heat is required assist gas will be injected into the vapor pipe to elevate the internal temperature prior to sending the permit to load signal. Once this signal is received product loading begins at the loading rack and an air-hydrocarbon vapor mixture is sent from the transports being loaded to the vapor combustion unit.

As soon as sufficient flow is available at the VSU skid, it will be detected by the pressure monitoring controls which will automatically open the first stage burner isolation block valve allowing the air-vapor mixture to flow through the detonation arrestor to the burners, where the combustible vapors are ignited by the pilot and burned. The first stage air-assist blower provides partial combustion air and mixing energy to the burner tips to assure smokeless combustion.

As the loading operation at the loading rack is completed, vapor flow to the combustion system decreases resulting in a decrease in system pressure. The pressure monitoring system closes the vapor isolation block valves when the line pressure has drop to 0.5 inch of water column pressure. The pilot(s) and the first stage air-assist blower remains on for a brief time period after loading is complete. If no further loading occurs, the combustion unit will shut down into a standby mode to await automatic re-start as described above.

Equipment Summary

The Vapor Safety Unit (VSU) will be furnished as separate skid mounted assemblies. The equipment is described in detail below. All sizes, dimensions and specifications are preliminary and may be changed in final engineering.

Vapor Safety Unit (VSU) Components

- Quantity: One (1) skid
  - Vapor Staging Valves
    - Quantity: Two (2)
    - Size: 8”
    - Type: High Performance Butterfly
    - Rating: 150#, Wafer
    - Material: SS (Body) / SS (Disk)
    - Seat: Firesafe
    - Actuator Type: Fail Closed, Pneumatic
    - Limit switches: Yes
  - Detonation Arrestor
    - Quantity: One (1)
    - Size: 8”
    - Type: Concentric
    - Material: SS (Body) / SS (Element)
  - Pilot / Assist Gas System
    - Quantity: One (1)
    - Size: 0.75” (Pilot) / 2” (Assist)
    - Material: SS
    - Pilot Shutoff Valve: One (1) Fail Closed Solenoid Valve
    - Assist Shutoff Valve: One (1) Fail Closed Solenoid Valve
    - Control Valve: One (1) Fail In Position, Electric
    - Pressure Regulator: One (1) Common
    - Strainer: One (1) Common
    - Low-Low / High-High Pressure Switch: One (1) Each
  - Instrumentation
    - DA High-High Temp Thermocouple: One (1)
    - Stage Pressure Transmitter: One (1)
  - Skid
    - Material: CS
    - Design: AWS-D1.1
    - Grating: Optional

NOx*STAR* Combustion Stack (VCU) Components

- Quantity: One (1) stack
  - VCU Stack
    - Size: 8’ (OD) x 75’ (OAH)

Lifting Lugs: ....Two (2)
Design Shell MAWT:...500 °F
Corrosion Allowance: ....N/A
Material:...CS
Sample Ports: ....Four (4) 2” NPT

Refractory
Thickness:...Two (2) 1” layers
Temp Rating: ....2400 °F
Pins and Keeper Material:................................Inconel 601
Factory Installed:..Yes
Cure Required: ....No

Anti-flashback Vapor Burners
Quantity: ....Seven (7)
Size: ....14”
Material:...SS (Body) / SS (Element)
USCG Commandant Approved:.........................Yes

Quench Air Damper (ship loose)
Quantity: ....Two (2)
Size: ....3’ x 2’
Material:...CS (Frame) / SS (Blades & Bearings)
Hinged: ....Yes

Pilot (ship loose)
Quantity: ....Two (2)
Self Inspirating: ....Yes
Automatic Ignition: ....Yes

Combustion Air Blower (ship loose)
Quantity: ....One (1)
Motor: ....100 HP (480V / 3ph / 60Hz) VFD driven
Inlet Silencer: ....No
Rain Hood:..No

Combustion Air Blower VFD (ship loose)
Quantity: ....One (1)
Est. Distance from VFD to Blower: ....75 ft maximum

Combustion Air Manifold
Size: ....24” OD x 7’ OAL
Design:..Design but not tested to B31.3
Static mixer Installed:.......................................Yes

Hydrocarbon Analyzer (ship loose)
Quantity: ....One (1)
Type:...Infrared
Sample System: ....Included

Instrumentation
Flame Detection: ....Infrared/ultraviolet flame detectors
High-High Temp Thermocouple:.......................Yes
Control Thermocouple:....................................Yes

Control System

The Vapor Control System will be controlled by a programmable logic controller (PLC). The primary operator interface for the operation of the Vapor Combustion System will be at the operator interface will be provided at the VSU / VBSU control panel. The electrical design and construction are in accordance with NFPA-70 of the NEC.

VSU Panel Enclosure Type:...............................NEMA 4x w/ Z-purge
Hydrocarbon Analyzer Enclosure Type:............NEMA 7
PLC:...Allen Bradley CompactLogix
HMI Panel(s):..Allen Bradley Hi-Bright
Combustion Air Blower VFD.............................NEMA 1
VaporWatch™ ....Included

John Zink Fabrication Standards

Vapor Piping System
Design:..ASME B31.3
Hydrotested: ....No
Radiographed:..No
Material:...SS
Small Bore Pipe (1.5” or smaller): ....Sch 80 with NPT connections
Large Bore Pipe (2” or larger): ....Sch 40 with 150# flanged connections
Gaskets:..1/8” Flexitalic “CGI” or equal
Nuts & Bolts: ....Fluorpolymer Coated CS
U-bolts:...Galvanized CS

Paint
Surface Prep:..SSPC-SP-6
Combustion Stack Primer Coat: ....Inorganic Zinc (2.0-4.0 mils DFT)
Combustion Stack Top Coat: ....Optional
Skid / L&P Primer Coat:...................................Heat Resistant Silicone Acrylic (1.0-2.0 mils DFT)

Components with a manufacturer’s coat will not be painted. Components that could be damaged by blasting such as valves will be hand-tool cleaned (SSPC-SP-2) instead of blasted. No paint is assumed for stainless steel pipe or equipment.

Appendix C

Vulcan Centaur Flares

BACT Analysis

January 2022

BACT RECOMMENDATIONS

To: Santa Barbara County Air Pollution Control District

Subject: United Launch Alliance - Best Available Control Technology Analysis for Elevated and Enclosed Natural Gas Flare Stack System

1. Introduction

This working document describes the process for selecting the Best Available Control Technology (BACT) compliant flares proposed for use at the Space Launch Complex 3 (SLC-3), Vandenberg Space Force Base (VSFB), California. The addition of two elevated and one enclosed flare are required to support operation of the United Launch Alliance, LLC. (ULA) Vulcan Centaur launch vehicle. Using high purity liquefied natural gas (LNG) the Vulcan Centaur launch vehicle will replace the Atlas V Rocket Propellant-1 (similar to kerosene) launch vehicle. This replacement will provide a more versatile and cost competitive space launch vehicle while maximizing the use of existing space launch infrastructure. Data is presented which allows a determination of BACT compliant flares for the proposed action.

The Santa Barbara County Air Pollution Control District (SBCAPCD) manages ambient air pollution in compliance with Federal, State, and local requirements. As shown in Table 1, Santa Barbara County has recently met attainment requirements for the California State Standards of ozone.[1] ULA is sensitive to the desire to maintain this classification.

However, the State standards for particulate matter less than 10 micrometers in aerodynamic diameter (PM_{10}) are exceeded which makes precursor gases an important consideration. Flare emission calculations relative to the Vulcan Centaur launch vehicle indicate the potential for flare emissions to exceed SBCAPCD Rule 802 BACT thresholds for PM_{10} and PM precursors oxides of nitrogen (NOx) and reactive organic compounds (ROC) which are also ozone precursors.

The Vulcan Centaur launch vehicle's booster stage uses liquid oxygen (LO2) and LNG as the oxidizer and fuel, respectively. The boiloff of the LNG is associated with both fuel storage and loading the launch vehicle with fuel prior to launch. Releases to the atmosphere (through flares) are expected due to LNG boiloff. Flares will be used as control devices to burn natural gas.

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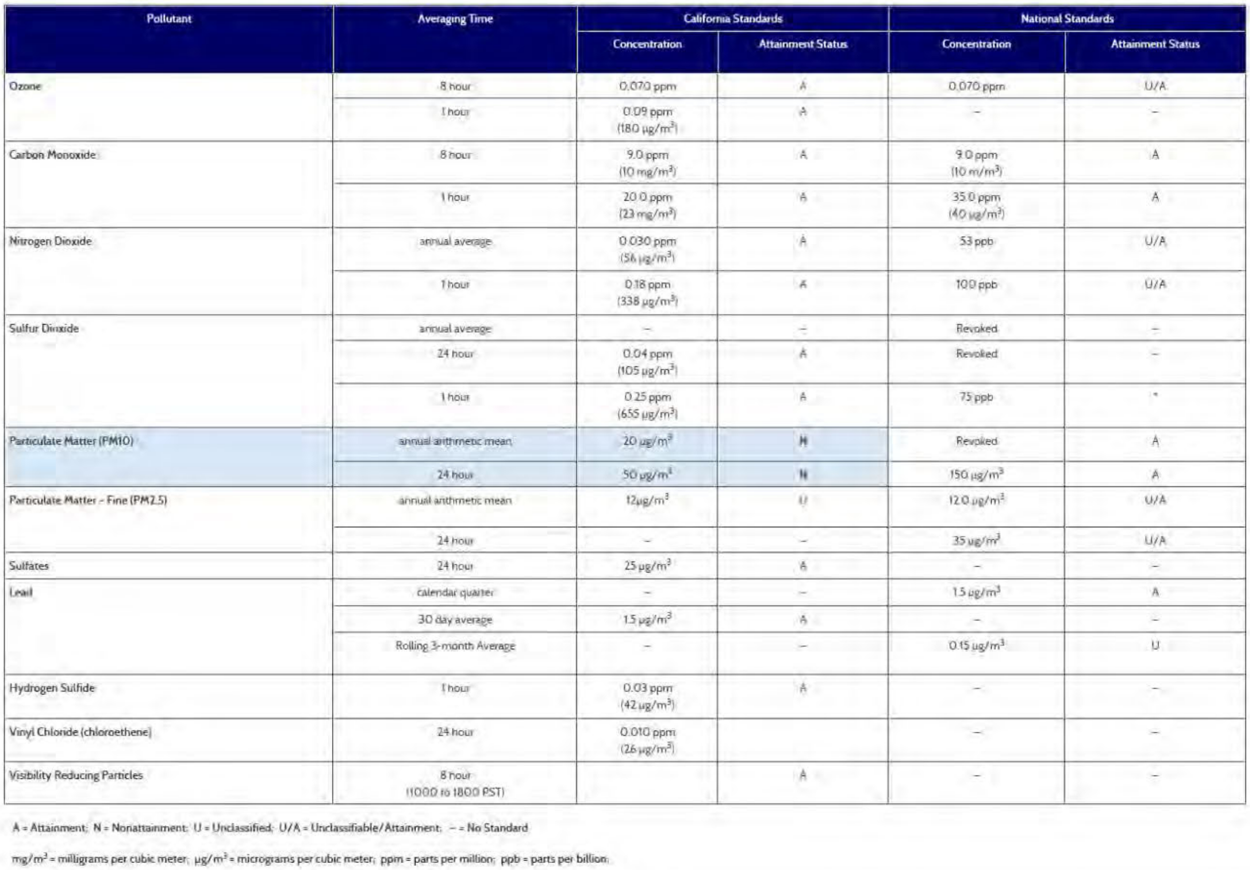
[1] Effective 1 July 2020, Santa Barbara County is designated as attainment for the state ozone standards.

Table 1. California and National Ambient Air Quality Standards



Pollutant	Averaging Time	California Standards		National Standards	
		Concentration	Attainment Status	Concentration	Attainment Status
Ozone	8 hour	0.070 ppm	A	0.070 ppm	U/A
	1 hour	0.09 ppm (180 $\mu g/m^3$)	A	–	–
Carbon Monoxide	8 hour	9.0 ppm (10 mg/m^3)	A	9.0 ppm (10 m/m^3)	A
	1 hour	20.0 ppm (23 mg/m^3)	A	35.0 ppm (40 $\mu g/m^3$)	A
Nitrogen Dioxide	annual average	0.030 ppm (56 $\mu g/m^3$)	A	53 ppb	U/A
	1 hour	0.18 ppm (338 $\mu g/m^3$)	A	100 ppb	U/A
Sulfur Dioxide	annual average	–	–	Revoked	–
	24 hour	0.04 ppm (105 $\mu g/m^3$)	A	Revoked	–
	1 hour	0.25 ppm (655 $\mu g/m^3$)	A	75 ppb	*
Particulate Matter (PM10)	annual arithmetic mean	20 $\mu g/m^3$	N	Revoked	A
	24 hour	50 $\mu g/m^3$	N	150 $\mu g/m^3$	A
Particulate Matter - Fine (PM2.5)	annual arithmetic mean	12$\mu g/m^3$	U	12.0 $\mu g/m^3$	U/A
	24 hour	–	–	35 $\mu g/m^3$	U/A
Sulfates	24 hour	25 $\mu g/m^3$	A	–	–
Lead	calendar quarter	–	–	1.5 $\mu g/m^3$	A
	30 day average	1.5 $\mu g/m^3$	A	–	–
	Rolling 3-month Average	–	–	0.15 $\mu g/m^3$	U
Hydrogen Sulfide	1 hour	0.03 ppm (42 $\mu g/m^3$)	A	–	–
Vinyl Chloride (chloroethene)	24 hour	0.010 ppm (26 $\mu g/m^3$)		–	–
Visibility Reducing Particles	8 hour (1000 to 1800 PST)		A	–	–

A = Attainment; N = Nonattainment; U = Unclassified; U/A = Unclassifiable/Attainment; – = No Standard

mg/m^3 = milligrams per cubic meter; $\mu g/m^3$ = micrograms per cubic meter; ppm = parts per million; ppb = parts per billion.

Use of the Vulcan Centaur launch vehicle, replacing the current Atlas V launch vehicle, will require the existing Rocket Propellant-1 fuel tanks to be replaced with a new [redacted] sphere. [redacted] Storage tank boiloff [redacted] will be controlled by an enclosed flare. Boil off and storage tank gas displacement will also occur during storage tank replenishment activities (tanker deliveries). The enclosed ground flare will also be used to control this boiloff/storage tank gas displaced.

When a Vulcan Centaur is tanked for launch, cryogenic LNG is transferred through facility piping and loaded into the launch vehicle. This event requires chill-down of the ground and airborne systems generating significant natural gas boiloff. Chill-down along with maintaining a tanked launch vehicle, generates boiloff quantities that cannot be managed by an enclosed flare due to operational considerations (e.g. flow rate capability, back pressure requirements, etc.). Elevated (open) flares will be used to manage the natural gas boiloff from the LNG transfer system, vehicle tank filling/topping, and to protect facility and personnel from flare-heat radiation at ground level. Two elevated flares are required to manage the LNG boiloff during Vulcan Centaur tanking activities. Both enclosed flare and elevated flares will use additional utility natural gas to provide for the ignition pilot when flares are operational. The enclosed flare will also use utility natural gas as a makeup gas to support flare startup burn optimization.

Available flare technologies have been identified for emission control considered to meet the intent of BACT while supporting the Vulcan Centaur launch vehicle operation.

2. Emission Calculations

The elevated flares and enclosed ground-level flare, as described, are being used for two different purposes. Each flare type was evaluated separately for the potential to emit. Potential to emit calculations are provided in Attachment 1 while results of the potential emission calculations are shown in Table 2.

Table 2. Predicted Potential Emissions from Elevated Flares (Launch Activity) and Enclosed Ground-Level Flare (Fuel Storage)

Source	**Pollutant**	**Emissions**	
		lb/day	**tons/yr**
Elevated Flares	*NOx*	214.49	0.920
	ROC	73.31	0.315
	CO	977.83	4.196
	SOx	5.24	0.022
	PM	24.13	0.104
	PM_{10}	24.13	0.104
	$PM_{2.5}$	24.13	0.104
Source	**Pollutant**	**Emissions**	
		lb/day	**tons/yr**
Enclosed Ground-Level Flare	*NOx*	9.75	0.175
	ROC	0.06	0.001
	CO	9.75	0.175
	SOx	0.81	0.015
	PM	3.73	0.067
	PM_{10}	3.73	0.067
	$PM_{2.5}$	3.73	0.067

Note – Definitions not previously defined: CO = carbon monoxide, SOx = oxides of sulfur, PM = total PM, $PM_{2.5}$ = particulate matter less than 2.5 micrometers in aerodynamic diameter

Calculated emissions of NOx, ROC, and PM presented in Table 2 above exceeded the BACT threshold of 25 pounds per day for "Any nonattainment pollutant or its precursors (except carbon monoxide)" (SBCAPCD Rule 802, Table 1). Carbon monoxide (CO), as an attainment pollutant, exceeded the BACT threshold of 500 pounds per day (SBCAPCD Rule 802, Table 2).

Of note: the emissions from the elevated and enclosed flares are not additive since the flares are used for two different purposes that do not occur at the same time. Also, BACT threshold exceedances are not a typical day as the number of events per year will be minimal, with estimates of [redacted]aunches during the first year of operations and expanding up to [redacted]aunches per year to include up to 10 vehicle fueling events per year. Additionally, LNG is mostly methane and ethane, which are not ROCs.

3. BACT Determinations

In order to determine possible BACT efficiencies, information of the BACT effectiveness from the use of flares were reviewed. This included references from local air quality control / management districts, the California Air Resources Board (CARB) and the United States Environmental Protection Agency (USEPA). This resulted in information being retrieved from the following agency references:

- SBCAPCD BACT Determinations
- Sacramento Metropolitan Air Quality Management District (AQMD) TBACT/BACT Clearinghouse
- Bay Area AQMD BACT/TBACT Workbook
- San Joaquin Valley Unified APCD BACT Clearinghouse
- South Coast AQMD BACT Guidelines
- San Diego APCD BACT Guidance Document
- ARB BACT-LAER Clearinghouse
- USEPA RACT/BACT/LAER Clearinghouse (RBLC)

Results from this data collection effort are summarized in Table 3.

Table 3. BACT Listings for Flares

Agency	Document Number	Vendor	Type /Model/Use	Fuel Source	Rating (MMBTU/hr)	NOx lb/MMBTU*	CO lb/MMBTU*	VOC lb/MMBTU*
SBCAPCD	1.5.1	N/A	Ultra-low emission burner technology (AIP)/Ground	Oilfield Production		0.0183	0.0074	0.0042
SBCAPCD	1.5.2	N/A	Steam or air assisted/ Coanda effect burner (when steam is unavailable) (AIP)/Elevated	Oilfield Emergency		0.068	0.31	0.1
SCAQMD	448345	John Zink	Enclosed Ultra Low Emission (ZULE)/Ground	Digester Gas	13.1	0.025	0.06	
SCAQMD	513835	Aereon	Enclosed CEB 350/Ground	Digester Gas	12	0.025	0.06	0.038
SCAQMD	491442	John Zink	Ground	Landfill Gas	120	0.025	0.06	99% destruction efficiency
SCAQMD	538706	Aereon	Enclosed, CEB 800/Ground	Oil & Gas Process Gas	27	15 ppm		99.9+% destruction
BAAQMD	82.1	N/A	Enclosed, steam- or air-assisted, w/ staged combustion/Elevated	Refinery				destruction efficiency >98.5%
BAAQMD	82.1	N/A	Steam- or air assisted, w/staged combustion, staged combustion/Elevated	Refinery				destruction efficiency >98%
BAAQMD	80.1	N/A	AIP/ Ground level, enclosed	Digester Gas or Landfill Gas		0.06		
SJVAPCD	Guideline 5.8.12	N/A	AIP - Open flare/Unknown	Dairy Manure Digester				98% control efficiency
SJVAPCD	Guideline 5.8.12	N/A	TF - Ultra-low emissions enclosed/Ground	Dairy Manure Digester				99% control efficiency

Agency	Document Number	Vendor	Type /Model/Use	Fuel Source	Rating (MMBTU/hr)	NOx lb/MMBTU*	CO lb/MMBTU*	VOC lb/MMBTU*
SMAQMD	198	N/A	Unknown, assumed Ground	Landfill Gas	167	0.05	0.15	98% destruction
SDAPCD	None	N/A	None listed					
USEPA**	AP-42	N/A	Elevated	Industrial Flare		0.068	0.31	0.14 (THC)
USEPA	AP-42	N/A	Low Percent Load Enclosed ground-flare	Industrial Flare				0.0038 (THC)
USEPA	AP-42	N/A	Normal to High Percent Load/ Enclosed ground-flare	Industrial Flare				0.0012 (THC)

*Unless otherwise specified

**Additionally, Emission Factor Value for Soot (PM) listed as up to 274 µg/L

Note – Definitions not previously defined: MMBTU/hr = one million British thermal units per hour, lb = pounds, N/A = not applicable, AIP = Achieved in Practice, ZULE = Zink ultra-low emissions, CEB = Certified Ultra-Low Emission Burner, PPM = parts per million, THC = Total Hydrocarbons

In addition to the control efficiencies, multiple vendors were consulted on various flare characteristics to allow determinations of not only effectiveness but practicality of application. It was found that the enclosed flare could use advanced technologies to increase the destruction efficiency of the primary control gas and further reduce emissions for NOx and CO. The same is not true for elevated (open) flares due to structural and operational considerations. Accordingly, advanced technologies listed in Table 3 such as CEB, and ZULE can only be implemented for the ground-level enclosed flares.

Due to the technologies and logistics of location, the expected emission control effectiveness is different when comparing enclosed and elevated flares, with elevated flares often having slightly less control efficiency. This was evident when control efficiencies of the various flares were reviewed. This conclusion is reinforced by a comparison of the USEPA information in Table 3, which has been shaded slightly for recognition. The hydrocarbon emission factors indicate an increased control efficiency for enclosed flares. Other emission factors provided by USEPA for volatile organic compounds (VOC) and CO for elevated flares; total hydrocarbons (THC) for enclosed flares, were not as stringent.

Elevated (open) Flares

VOCs. A review of information from Table 3 indicates that for elevated flares, the expected destruction efficiency of the natural gas releases should be 98%, or as listed by the USEPA, 0.14 lb/MMBTU of VOCs, while SBCAPCD lists 0.1 lb/MMBTU of VOC for a steam assist, each being sequentially more strict. Of note is that due to the small frequency of use (ten or less launch vehicle tanking operations per year), steam assist is not considered practical in this situation. Additionally, as pointed out by the flare manufacturer John Zink and confirmed by other vendors:

> “Elevated Flares by their nature do not lend themselves to direct measurement of the products of combustion using conventional techniques. The industry standards for determination of destruction or combustion efficiency of elevated flares are based on the testing conducted by the USEPA and Chemical Manufacturers from 1983 to 1985 and published in USEPA document" Evaluation of the Efficiency of Industrial Flares (Sept 1985). Based on these studies the USEPA concluded that properly designed and operated flares achieve greater than 98% combustion efficiency. The USEPA promulgated regulations for flares (40 CFR Part 60.18 and 40 CFR Part 63.11(b)) that establish guidelines for exit velocity and minimum heating value for steam assisted, air assisted and non-assisted flares to ensure proper flame stability / destruction efficiency of flares. The emissions factors obtained during this testing are published in USEPA document AP-42. This has become the industry standard (worldwide) for the determination of destruction efficiency of flares. Flares designed within these guidelines have been assumed to provide minimum destruction or removal efficiency (DRE) of 98%.”

Because the fuel being burned in this situation is 99% methane/ethane and the practicality of application, ULA suggests that a 98% destruction efficiency be applied as BACT

NOx. The only formal reference for NOx is the emission factor from USEPA database AP-42.[2] Discussions with vendors confirms that the AP-42 value is commonly used as BACT due to a lack of conclusive results. For landfill gas, lower values are provided than the USEPA emission factor, but this is considered to be a much different use than planned and without details those flares were not considered to be elevated. As such, the BACT for NOx in this application for air-assisted, elevated flares is recommended to be 0.068 lb/MMBTU. This is also the control efficiency for the steam assisted/air assisted flare BACT from SBCAPCD.

CO. Control of landfill gas flares indicate lower emission values are possible, but as previously stated, these particular flares are considered to be used much differently. The USEPA emission factor is recommended for BACT with a value of 0.31 lb/MMBTU and is the same value listed for the steam assist/air assist flare by SBCAPCD.

In summary, it is suggested that the following values be considered BACT for the elevated flares at SLC-3E:

- VOCs – 98% destruction efficiency
- NOx – 0.068 lb/MMBTU
- CO – 0.31 lb/MMBTU

Enclosed Flares

VOC. The estimation for VOC controls is listed for both destruction efficiency and mass per energy usage, ranging from 98.5% to 99.9% and 0.0042 to 0.0012 lb/MMBTU, respectively. If you consider there is approximately 22,800 BTUs in a pound of natural gas, then the SBCAPCD value of 0.0042 lb/MMBTU represents a control value of approximately 99.99%. ULA recommends a practical BACT for VOCs of this non-ROC gaseous control, to be 99.9%.

NOx. NOx values range from 0.0183 lb/MMBTU to 0.06 lb/MMBTU. ULA recommends a value closer to the lower range and from SBCAPCD of 0.02 lb/MMBTU as BACT.

CO. Values for CO range from 0.0074 to 0.06 lb/MMBTU. The value of 0.06 is listed by 3 different control agencies. This was discussed at length with flare vendors. To be BACT, yet practical for this application with drastic changes in flow rate, a value near the lower end of the range is recommended of 0.02 lb/MMBTU.

In summary, it is suggested that the following values be considered BACT for the ground-level enclosed flare at SLC-3E:

- VOCs – 99.9% destruction efficiency
- NOX – 0.02 lb/MMBTU

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[2] USEPA, Compilation of Air Emission Factors, AP-42, Fifth Edition, Volume I, Chapter 13: Miscellaneous Sources, https://www3.epa.gov/ttn/chief/ap42/ch13/index.html, last accessed 25 June 2020.

- CO – 0.02 lb/MMBTU

4. Recommended Flares

Based on the review and recommendations for emission controls that represent BACT for the application at SLC-3E, multiple flares were reviewed, and four possible suppliers determined. These possible suppliers included the companies of Zeeco, Flaregas Corporation, John Zink, Inc., and Cimarron (previously Aereon). Due to a lack of detailed information, Flaregas Corporation was eliminated from further consideration. Table 4, Evaluated Flare Technologies, lists flares that were evaluated for this study.

Safety and applicability must be maintained and were placed as a very high priority. As such, flares were evaluated based not only on control efficiency but also:

- hydraulic loading rates
- wind loading
- earthquake rating
- heat rating
- operable inlet pressure
- temperature considerations
- ability to accept gas at cryogenic temperature
- ability to maintain a flame with feed natural gas concentrations ranging for 0 to 100 percent (applicable to startup due to nitrogen purge)
- able to operate with a variable flow of feed gas

Arbitrary numbers listed in the first column of Table 4 have been assigned to help in this discussion.

Elevated Flare Evaluation and Selection

Flares 4 – 7 were dropped from consideration since they did not meet the suggested BACT efficiencies (see cells highlighted in yellow). This left the remaining three elevated (flares 1 – 3). Based on further discussions with vendors, flares 2 and 3 highlighted in blue, were determined to be the best choices. These flares meet the safety, usage criteria, and the recommended BACT efficiencies.

The John Zink flares were ultimately selected based on a Technical Decision Making (TDM) analysis conducted by ULA. In general, John Zink flares were selected due to the following:

- Similar flare configuration with Launch Complex 41 (LC-41) at Cape Canaveral Space Force Station. Shared spare parts, common communication & control interface, similar operation & maintenance, etc.
- Improved corrosion resistant structures.

- Self-supported structures versus guyed/derrick supported structures reduce footprint accommodations and fit within limited SLC-3 space allowance.

The elevated flares proposed by Cimarron (previously Aereon) appear to offer similar capability as John Zink; however, due to commonality with LC-41 and a more developed ULA design specification for elevated flares, ULA has selected John Zink as the preferred LNG flare provider. John Zink proposals and pertinent correspondence can be found in Attachment 2. Cimarron (previously Aereon) proposals can be found in Attachement 3.

Enclosed Ground-Level Flare Evaluation and Selection

Flares 8, 13 – 16 met many of the requirements, but did not meet the recommended BACT efficiencies and were dropped from consideration (see cells highlighted in yellow). Based on discussions with vendors, flare 11 does not appear to be useable in this situation due to the varying flow rates. Flares 15 and 16 from John Zink were also found to be designed for more constant flows, and were not considered appropriate by the manufacture for our use (safety concerns). Flares 9 and 12 were determined most probable selection for BACT in this application for the ground-level flares.

Several discussions with Cimarron (previously Aereon) has revealed their enclosed flare design is limited on throughput, requires multiple units be staged to achieve desired throughput, and requires a much larger footprint not currently available to SLC-3. The Cimarron estimate requires a 2-unit skid configuration (0.6 lbs./second required).

The John Zink NOxSTAR enclosed flare was selected based on a Technical Decision Making (TDM) analysis conducted by ULA. In general, John Zink flare was selected due to the following:

- High hydrocarbons destruction efficiency.
- Multiple Cimarron flares are needed which would increase the required footprint accommodation within a limited SLC-3 space allowance.
- Using the same vendor for all flares and common between ULA launch sites is important for operational considerations.
- Improved corrosion resistant structures.

Table 4. Evaluated Flare Technologies

FLARE SPECIFIC INFORMATION					EMISSION INFORMATION					
AECOM Flare Number	**Source of Information**	**Manufacturer**	**Designaton**	**Type**	**NOx**	**UoM**	**CO**	**UoM**	**VOC Destruction Efficiency**	**UoM**
ELEVATED					**ELEVATED**					
1	Manufacturer Spec	John Zink	IV43163-501	Elevated Flare	0.068	lb/MMBtu	0.31	lb/MMBtu	98+	% Destruction
2	Manufacturer Quote	John Zink	PLA-78	Elevated Flare/Air Assist	0.068	lb/MMBtu	0.31	lb/MMBtu	98+	% Destruction
3	Manufacturer Discussion	Aereon	SFVP - 2448	Elevated Air Assist Flare	0.068	lb/MMBtu	0.31	lb/MMBtu	98+	% Destruction
4	Manufacturer	Zeeco		Steam Assisted	0.0485	lb/MMBtu	0.3503	lb/MMBtu	99+	% Destruction
5	Manufacturer	Zeeco		Steam Assisted	0.0680	lb/MMBtu	0.3465	lb/MMBtu	99+	% Destruction
6	Manufacturer	Zeeco		Air & Nonassisted	0.0641	lb/MMBtu	0.5496	lb/MMBtu	99+	% Destruction
7	Manufacturer	Zeeco		Air & Nonassisted	0.1380	lb/MMBtu	0.2755	lb/MMBtu	99+	% Destruction
GROUND-LEVEL					**GROUND**					
8	SCAQMD	Aereon	CEB 350	Enclosed Ground Flare	0.025	lb/MMBtu	0.06	lb/MMBtu	99+	% Destruction
9	SCAQMD	Aereon	CEB 800	Enclosed Ground Flare	0.018	lb/MMBtu	0.01	lb/MMBtu	99+	% Destruction
10	Manufacturer Discussion	Aereon	CEB 1200	Enclosed Ground Flare	0.018	lb/MMBtu	0.01	lb/MMBtu	99.9	% Destruction
11	Manufacturer Discussion	Aereon	CEB 4500	Enclosed Ground Flare	0.018	lb/MMBtu	0.01	lb/MMBtu	99.9	% Destruction
12	Manufacturer Brochure	John Zink	NOxSTAR	Enclosed Ground Flare	0.02	lb/MMBtu	0.02	lb/MMBtu	99.99	% Destruction
13	Manufacturer Spec	John Zink	IV43163-503	Enclosed Ground Flare	0.14	lb/MMBtu	0.14	lb/MMBtu	99+	% Destruction
14	Manufacturer Order	John Zink	ZT-10xx-0450-1/01/03-X	Enclosed ZTOF Vapor Combustor	0.14	lb/MMBtu	0.14	lb/MMBtu	99+	% Destruction
15	SCAQMD	John Zink	TBD	Zink Ultra Low Emission (ZULE) - Enclosed	0.025	lb/MMBtu	0.06	lb/MMBtu		
16	SCAQMD	John Zink	TBD	ZULE	0.025	lb/MMBtu	0.06	lb/MMBtu	99	% Destruction

Attachment 1

Vulcan Centaur Flares

Potential Emission Calculations

For Emission Calculations please refer to ULA Vulcan Centaur Launch Vehicle LNG Flaring System permit application

Attachment 2

Vulcan Centaur Flares

Information: John Zink, Inc.

Information Responses from John Zink, Inc

What are the control efficiencies of the elevated flare (vapor destruction efficiency, NOx and CO emissions)?

JZHC: Elevated Flares by their nature do not lend themselves to direct measurement of the products of combustion using conventional techniques. The industry standards for determination of destruction or combustion efficiency of elevated flares are based on the testing conducted by the US EPA and Chemical Manufacturers from 1983 to 1985 and published in EPA document" Evaluation of the Efficiency of Industrial Flares (Sept 1985). Based on these studies the US EPA concluded that properly designed and operated flares achieve greater than 98% combustion efficiency. The EPA promulgated regulations for flares (40CFR60.18 and 40 CFR 63.11(b)) that establish guidelines for exit velocity and minimum heating value for steam assisted, air assisted and non-assisted flares to ensure proper flame stability / destruction efficiency of flares. The emissions factors obtained during this testing are published in EPA document AP-42. This has become the industry standard (worldwide) for the determination of destruction efficiency of flares. Flares designed within these guidelines have been assumed to provide minimum DRE of 98%.

Temperature of release for elevated flare?

JZHC: We assume the gas temperature reaching the Flare Tip is the same as the temperature provided by the Customer for a specific gas case. Reality is there will be some heat loss/gain due to atmospheric conditions, but this heat transfer is minimal in the short time the gas is traveling thought the riser.

It appears the elevated flare is to be air assisted. How do we maintain the flares over the range of concentrations (0 to 100%)?

JZHC: A VFD should be used to controls the amount of air required for the flare gas going to the flare. Using the VFD, the air flow can be increased and decreased as the flare gas flow increases or decreases.

Does the 80 foot flare meet the surface radiation requirement of 1500 BTU/hr-ft2?

The height provided will be with the consideration of 1500 BTU/hr-ft2 at grade.

Will the elevated flare handle the flow up to 216,000 lbm/hr?

Yes. The elevated flare is being designed for 2160,000 lbm/hr and 100% smokeless.

Will the ground level flare meet surface radiation specifications of 440 BTU/hr-ft2?

JZHC: The NOxSTAR is a totally enclosed flare. There is no visible radiation at grade. If surface radiation not the same as visible radiation, could you please confirm that the ground flare meet surface radiation specifications of 440 BTU/hr-ft2?

For the ground level flare, how do we maintain the flare over the range of concentrations (0 to 100%)?

JZHC: A VFD should be used to controls the amount of air required for the flare gas going to the flare. Using the VFD, the air flow can be increased and decreased as the flare gas flow increases or decreases.

What are the wind loading specifications?

JZHC: None assumed now as a structural design has not been completed. AECOM to specify
Specified in document sent on 6/5/2020: Wind loading: ASCE 7-10 risk category III

What are the earthquake ratings?

JZHC: None assumed now as a structural design has not been completed. AECOM to specify
Specified in document sent on 6/5/2020: Earthquake rating: D, IBC 2012

JOHN ZINK HAMWORTHY
COMBUSTION
johnzinkhamworthy.com

11920 East Apache
Tulsa, Oklahoma 74116 USA
☎ (918) 234-5734, Fax: (918) 234-1986

END USER / CLIENT:	United Launch Alliance / AECOM
PROJECT:	Vulcan Centaur Launch Support Vehicle
LOCATION:	Vandenberg Air Force Base, CA
EQUIPMENT:	LNG Elevated Flare Stack LNG Enclosed Ground Flare
PROPOSAL NUMBER:	FS 134657-A1

September 23, 2021

TECHNICAL PROPOSAL LNG FLARE STACK VULCAN

CONFIDENTAIL INFORMATION DELETED

JOHN ZINK HAMWORTHY COMBUSTION

johnzinkhamworthy.com

September 23, 2021

[redacted]
United Launch Alliance, Vulcan, VAFB
[redacted]

Customer Reference: **Email Request for Technical Information**

John Zink Proposal No: **FS 134657-A1**

Dear [redacted]

John Zink Co LLC is pleased to provide you with the revised proposal for LNG Flare Stack in response to your inquiry for above reference project.

We appreciate your interest in John Zink and look forward to working with you. If you require any further information or have any questions, please feel free to contact us.

Thank you for allowing us this opportunity to be of service.

Sincerely,

[redacted]
Applications Engineer
[redacted]

I. CONTENTS

DISCOVER THE JOHN ZINK DIFFERENCE

John Zink Hamworthy Combustion's emissions-control and clean-air systems perform vital functions in the world's most demanding industries—from hydrocarbon and chemical processing, to biofuels, automobile manufacturing, food processing, pulp and paper, waste management, and many more. Combining practical problem solving with creative innovation, our people are driven to push the boundaries of John Zink Hamworthy Combustion's legacy achievements to develop a clean generation of products that address the challenges of our clients and an environmentally conscious world.

Headquartered in Tulsa, Oklahoma, John Zink Hamworthy Combustion is home to the best and brightest process engineers, researchers and scientists from all corners of the globe, and the combustion industry's largest research and development test center. Here, we've built a unique brain trust of knowledge, creativity and industrial-scale resources to incubate innovation and propel our industry and mission forward.

John Zink Hamworthy Combustion upholds the principles of its own Quality Management System, which fully meets and encompasses ANSI/ISO 9001:2000 requirements. John Zink Hamworthy Combustion is a part of Koch Industries, a privately held global corporation providing diverse products and solutions for industries and consumers worldwide.

QUALITY MANAGEMENT

- John Zink's Tulsa and Luxembourg operations meet the requirements of the internationally recognized ISO 9001:2000 Quality Management System.

SAFETY & HEALTH MANAGEMENT

- OHSAS 18001 certification of John Zink's Tulsa and Luxembourg facilities underscores our commitment to providing a culture of safety that focuses on identifying and eliminating workplace hazards while maintaining health and safety compliance.

- John Zink's Tulsa facility is a recipient of the Voluntary Protection Program (VPP) Star Certification, which recognizes selective companies that show a commitment to improved safety and health performance beyond the requirements of the OSHA standards, and who have demonstrated safety performance considered best in class.

ENVIRONMENTAL MANAGEMENT

- John Zink's Tulsa and Luxembourg operations meet the requirements of the internationally recognized ISO 14001 Environmental Management System.

- The U.S. Environmental Protection Agency has selected John Zink's Tulsa facility as a member of the agency's National Environmental Performance Track program, which recognizes top environmental performers that voluntarily go beyond compliance.

KNOWLEDGE & EDUCATION MANAGEMENT

- John Zink preserves its legacy expertise and experience through knowledge-sharing practices.

- The IACET-accredited John Zink Institute℠ at John Zink Company, LLC offers year-round courses in combustion education to enhance operations knowledge.

- The John Zink Institute℠ has earned certification of its Process Burner Fundamentals and Process Burner Operations courses from the American Petroleum Institute. John Zink is the first company to have a burner course certified under API's training provider certification program.

II. SCOPE OF SUPPLY

LNG Flare Stack Vulcan

LNG Elevated Flare Stack for 60 lbs/s

One (1) John Zink model PLA-78 Air Assisted Flare Tip in 310SS/304SS material.

- One (1) 78" diameter Self-Supported Air Plenum with a 28" 304SS Gas Riser to provide an overall height of 90 feet. Air riser is carbon steel, A36 or equal. Gas inlet connection is a 28" #150 RF Flange. *(Note: Flare Stack is designed to be assembled in horizontal position for a single piece lift.)*
- One (1) John Zink model EEF-MS-30 Molecular Seal purge reduction device 304SS Material.
- One (1) Vane Axial Blower, ~250 HP. Mounted on the stack. VFD ready.
- Four (4) *Wind*PROOF^{TM} Pilot / ZEUS High Energy Spark Ignitor assemblies with One (1) K - Type Single Element *Retractable* Thermocouple (310SS Sheath) per pilot.
- One (1) Retractable Thermocouple System for One (1) K - Type Single Element Thermocouple 310SS Sheath per pilot for Total Four (4) Pilots suitable for 90 feet Overall Height Flare Stack.
- One (1) Pilot Manifold of 304 Stainless Steel Material at Flare Tip.
- One (1) Lot Utility Piping from Flare Tip to near grade at Stack base: One (1) 1" diameter sch STD Pilot Gas Line A-312-TP304 Material and One (1) 3" inch diameter Moleculare Seal Drain Line 304SS STD Pipe Material
- One (1) Lot High Temperature Ignition wire from Flare Tip to near grade at Flare Stack base with Rigid Galvanized Conduits.
- One (1) John Zink ZEUS Automatic / Manual Electronic High Energy Spark Ignition System suitable for Four (4) Pilots with Control Panel in a NEMA 4/7. A NEMA 4X stainless steel enclosure with Z-purge for Hazardous Area Classification Class 1 Division 2 Group D is also avaliable.
- If two flare systems are purchased a combined Ignition Cotrol Panel can be provided.
- One (1) NEMA 4X (304SS) Thermocouple Junction Box and One (1) NEMA 4/7 (Cast Aluminum) Zeus Ignition Module Box at Stack base.
- All necessary Vendor Documentation as per John Zink Standard.

III. COMMERCIAL

Pricing- Flare System

Scope- PLA-78 Air Assisted Flare System	Total Price US$
• Elevated 78" Air-Assisted Flare o Smokeless o 250 HP Blower, VFD Capable • 90' Overall Height • 28" Gas Riser, 304SS • MS-30 Molecular Seal, 304SS • Four (4) WindPROOF™ Fixed Pilots • Retractable Thermocouples • Zeus® Automatic Pilot Ignition Panel o NEMA 4/7	
Total Budget Price, Each	

Scope- PLA-48 Air Assisted Flare System	Total Price US$
• Elevated 48" Air-Assisted Flare o Smokeless o 250 HP Blower, VFD Capable • 90' Overall Height • 28" Gas Riser, 304SS • MS-30 Molecular Seal, 304SS • Four (4) WindPROOF™ Fixed Pilots • Retractable Thermocouples • Zeus® Automatic Pilot Ignition Panel o NEMA 4/7	
Total Budget Price, Each	

Quote Validity: 30 Days

Standard Warranty: 18 months after shipment or 12 months after start-up.

Freight Terms: *FCA point of manufacturing* or per contract.
JZ suggests Pre-Pay & Add, Cost plus handling fee.

Schedule (Preliminary)

Elevated Flare	Normal Delivery- 28-32 Weeks after acceptance of PO. Drawings in 4-6 weeks.
Documentation	No later than 2 weeks after last delivery.
We have allotted ten (10) business days for drawing approval / comments.	

Subcontracting

John Zink will likely subcontract portions of the project. Some components such as flare pilots are always fabricated in John Zink's facility in Tulsa, OK.
John Zink will disclose all sub-contractors and the customer / end user will have access to the facilities.

Proposed Payment Terms:

- 15% upon receipt of purchase order, due net 30
- 25% invoiced upon first issue of flare GA drawing(s), due net 30
- 35% upon placement of order for major components, due net 30
- 25% invoiced at notification of readiness to ship, pro rata, due net 30

Late Payments: In the event of late payments, the project may be placed on hold as described in the agreed upon Terms and Conditions.

IV. FLARE REGULATIONS / NOTES

- The proposed air-assisted flare does meet the gas exit velocity requirements of 40 CFR 60.18 for the 6 and 3 lbs/s flow rates.
- API-537 recommends 4 pilots with flare tips greater than 42” diameter. John Zink is proposing 4 pilots.
- It is possible to over assist an air-assisted flare and have poor combustion efficiency. If flow measurement and blower controls are necessary, it is important to understand the minimum and normal flare flow rates. John Zink will assist in this evaluation.
- John Zink will provide a VFD capable motor for the blower. The end user should determine if it will be necessary to have flare gas flow measurement and blower speed controls to ensure efficient combustion.
- Flare gas flow measurement and blower controls are not included in John Zink’s current scope.

V. SYSTEM DESCRIPTION

LNG Elevated Flare Stack

JOHN ZINK AZDAIR AIR-ASSISTED FLARE (PLA-78 & 48) LP FLARE

Most hydrocarbon-containing gas streams smoke when burned unless sufficient oxygen is mixed into the combustion zone. Smoke is produced by the cracking and polymerization reactions taking place in the flame core, where there is a high flame temperature and insufficient oxygen for complete combustion. Adequate aeration of the combustion zone reduces or eliminates smoke.

With high-pressure gases sufficient air for complete combustion may be induced into the flame by a combination of jetting action and thermal draft. With low pressure gases, when the jetting action may be negligible and the thermal draft alone is insufficient to entrain enough air for complete combustion, smoke is produced.

The problem of burning low-pressure gas smokeless is usually solved by either aspirating air into the flame using an external (pressure) energy source such as steam or mixing gas directly with air.

Although steam injection is very effective at reducing smoke, such a system is not very suitable for flaring at remote locations where a large steam supply is not available. Air injection often provides the solution. Air can be supplied to the flare by a low-pressure fan.

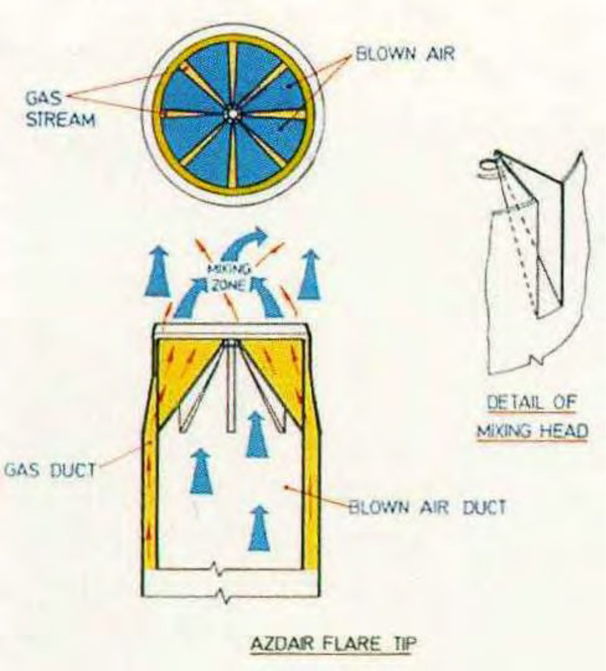
In the Azdair Air-assisted Smokeless Flare, primary air for combustion is supplied via a low-pressure fan, mounted at the base of the stack. The air required for smokeless flaring is supplied as a central core within the gas flame and is designed to provide good mixing of the air and gas which produces a stable, smokeless flame.

The Azdair is designed for duties where low-pressure gases are required to burn smokeless when process steam is unavailable. The Azdair can also give lower radiation levels than a pipe flare for the same gas flow and conditions. Due to the premixed primary air supplied by the air blower, the combustion efficiency increases and the quantity of incandescent carbon, the main source of heat radiation, reduces.

The goal of an efficient air assisted flare design is to maximize the air / gas mixing surface area. Conventional air assisted flares route the gas through the inner annulus of the flare tip mixing head while the air is routed through the outer annulus. This is a poor use of the flare tip cross-sectional area, which creates an outer ring of air around the periphery of the flare tip.

The Azdair flare tip routes the gas through the outer annulus and the air through the inner annulus. This maximizes the air / gas surface mixing area, and also makes efficient use of the ambient air by creating a thin film of gas around the outer periphery of the flare tip diameter. This efficient air / gas mixing head arrangement allows the Azdair flare tip to produce more smokeless capacity per given volume of forced air than the conventional air assisted flare design.

The outer gas annulus of the Azdair flare tip also helps prevent air ingress into the mixing head at low gas flow rates. Conventional air assisted flare tips are much more likely to allow burning inside the tip mixing head at low gas flow rates. This leads to overheating and distortion of the mixing head and subsequent failure of the flare tip.



MOLECUALR SEAL PURGE REDUCTION DEVICE (EEF-MS-30) the molecular weights of the purge gas and the atmospheric air to form a “molecular” seal which prevents air infiltration into the stack. The Molecular Seal, placed directly below the flare tip, consists of a baffled cylinder which forces the incoming air through two vertical-180° bends before entering the flare system. Even when purge gas flow is interrupted, the molecular seal continues to provide protection for a short time interval. In contrast, the protection from an Airrestor or similar velocity dependent device is immediately lost if the purge gas flow is interrupted.

John Zink Company recognizes the increasing operating cost of purge gas. To demonstrate the effectiveness of purge reduction devices in reducing purge gas requirements and in preventing oxygen from entering the flare system, John Zink built three identical, full-size flare stacks. One is equipped with a Molecular Seal, one with an Airrestor, and one is without any purge reduction device. The stacks were tested over an eight-month period and the oxygen content 20 feet below the flare tip was measured.

Type	Purge Gas Velocity, fps	Oxygen, %(1)
Molecular Seal	0.01	0.0
Airrestor	0.04	6-8
Plain Stack	0.35	6-8

(1)20 ft below flare tip

As shown by the above test data, the Molecular Seal provides an oxygen free environment below the flare tip and uses the least amount of purge gas. With the Molecular Seal the purge gas velocity of 0.01 fps is required to insure an acceptable oxygen level under all adverse weather conditions. If a low percentage of oxygen in the flare riser is acceptable, or protection from purge gas loss is not required, an Airrestor may be suitable.

90 FEET TALL SELF SUPPORTED FLARE STACK

The John Zink self-supported flare stack provides a structural support for the flare tips, piping as required. The stack is designed to resist dead load, live load, wind loads, and seismic loads as required by the applicable codes and guidelines. The structural design also incorporates consideration of dynamic effects such as vortex shedding and ovaling vibration.

The riser is manufactured in sections suitable for shipment and assembly, and match marked for field welding. The riser is designed to be welded at grade, in the horizontal position, and lifted as one piece. Each shipping section is provided with lifting lugs and is suitable for field welding.
A detailed description of the stack is included in attached data sheet.

JOHN ZINK *WIND*PROOF HIGH-PERFORMANCE PILOT

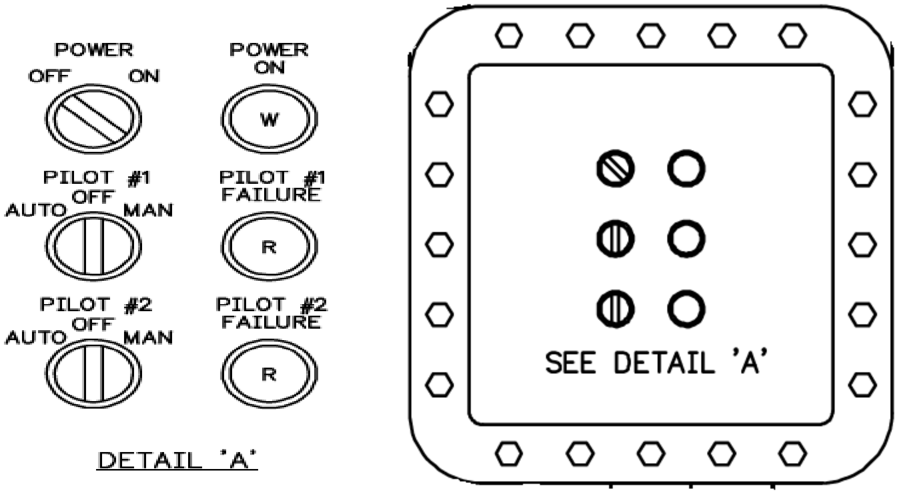
The John Zink *Wind*PROOF Pilot is the best that pilot technology has to offer, with a combination of fuel efficiency and stability in adverse weather conditions. The *Wind*PROOF Pilot stands up to the most severe winds and rain with the long-lasting performance of our other pilot models.

Stable in winds up to a velocity of 160 mph in all positions around the flare tip, the *Wind*PROOF Pilot consist of a tip and tip windshield, ignition and fuel piping, a mixer and strainer assembly, and a mixer windshield. The *Wind*PROOF is stable in the worst conditions while consuming as little as 50 SCFH of fuel gas. Also included are one integral thermowells for thermocouple pilot detection. The *Wind*PROOF can burn a wide variety of fuels without adjustment.
*Wind*PROOF was designed and tested at the only pilot test facility of its kind in the world. At John Zink's International Research and Development Center, we use full scale testing to push our flare products to extraordinary limits. Det Norske Veritas (DNV), the world's most widely respected product verification and Certification Company, witnessed John

Zink Company's test of the *Wind*PROOF pilot and verified that the *Wind*PROOF remained lit under test conditions that exceeded 160 mph winds and 30 inches of rainfall per hour.

AUTOMATIC / MANUAL ZEUS ELECTRONIC SPARK IGNITION SYSTEM

The John Zink Automatic ZEUS ignition system provides reliable pilot ignition with minimal installation and utilities costs.



The pilot is ignited by a unique, patented high energy spark system. The sparking tip is enclosed in a stainless-steel pipe near the pilot discharge, and is cooled constantly by an induced air and gas flow. All ignition transformers are located remote from the pilot, up to 1,500 feet away. Wiring from the control box to the pilot is simple, economical, single pair 16 gage stranded/twisted instrument wire. Ignition is accomplished simply by turning on the fuel gas to the pilot and pushing a single button.

The ZEUS ignition system uses the pre-mixed pilot fuel for flame front generation. The pilot itself combines ignition fuel and combustion air at a venturi mixer located just below the pilot's base. The fuel gas mixture flows through the pilot's ZEUS ignition line to the pilot tip. An electrical spark is initiated from the ignition panel and each pilot is ignited in sequence.

A description of the ignition system is included on an attached datasheet.

VI. TECHNICAL DETAILS

Process Conditions (60 lbs/s LNG Elevated Flare)

FLARE TIP DATA	
Flare Tip Type	Air Assisted
Flare Tip Model:	PLA-78
Flare Tip Diameter (Inch):	78”
Flare Tip Length (feet):	10 feet
MOLECULAR SEAL DATA	
Seal Type	Molecular
Molecular Seal Model:	EEF-MS-30
Molecular Seal Diameter (Inch):	67”
Molecular Seal Length (ft):	11’-6”
FLARE STACK DATA	
Flare Stack Support Type:	Self - Supported
Air Plenum Diameter (Inch):	78”
Overall Stack Height (feet):	90 feet
Gas Riser Diameter (Inch):	28”
Gas Tip Exit Area (Inch^2)	1,885.75 in^2
Gas Riser Inlet Connection Size (inch):	28”
Gas Riser Inlet Elevation (feet):	10 feet
PROCESS DATA	
Design Case:	Design Case
Flare Gas Composition (mole%):	97% CH_4, 2.8% C_2H_6, 0.1% C_3H_8, 0.1% N_2
Design Flow rate (lbs/hr):	216,000 lbs/hr
Molecular Weight:	16.48
Temperature: (Degree C)	-260 ^{0}F
Net Heating Value (btu/scf):	917 btu/scf
Mach No.	0.039
Exit Velocity (ft/sec):	40.6 ft/sec
Allowable Static Pressure at 18-inch Stack inlet (psig):	5 psig
Site Data for Radiation Calculation:	Wind Speed 20 mile/hour Solar Radiation: excluded
Radiation at grade level excluding solar (btu/hr-ft2)	<1500 btu/hr-ft2

Utility Requirements:

- Pilot Gas: 22 SCFH of propane at 7 psig per pilot
- Ignition Control Panel Power: <3 Amps. / 120 Volt, 60 Hz, 1 phase
- Continuous Purge Gas:
  - PLA-78
    - 6,100 SCFH for Flashback Protection
    - 23,980 SCFH for Tip Life Protection
    - 171 SCFH for MS-30 Molecular Seal
  - PLA-48
    - 2,025 SCFH for Flashback Protection
    - 9,050 SCFH for Tip Life Protection
    - 171 SCFH for MS-30 Molecular Seal

VII. EXCEPTIONS & DEVIATIONS / CLARIFICATION

LNG Elevated Flare Stack

- Air Plenum/Gas Riser is considered a structure and is not a pressure retaining part. It is designed and fabricated in accordance with structural specifications, not piping codes. As requested only Flare Stack Gas Riser shall be designed for 10 psig internal pressure as per B31.3 but hydro test and any other specific requirement related to piping code is excluded. Hydro testing of flare stack is not required or included. Flare Stack is mainly designed per ASME STS-1-2016.
- For Elevated Flare Stack; we have proposed NEMA 4/7 Cast Aluminum Ignition Control Panel suitable for Area Classification Class 1, Div 2, Group D. We are not offering purge control panel hence any requirement related to control box purge is not included / required.
- Interconnecting Thermocouple Wire and Control Wire from the base of the Flare Stack to the Control Panel location is by others. We can include with price adders; if required.
- We have considered 9 inch per 100 feet deflection criteria for Self-Supported Flare as per API 537. Maximum Allowable nozzle loads as per API 537 is considered. No Corrosion allowance allowed for Stainless Steel Flare Stack.
- Each Pilot is provided with One (1) Single Element Type K (310SS Sheathed) Retractable Thermocouple. Ladders and Platforms are not offered.
- No protective coating & painting shall be applied on Stainless Steel Flare Tip, Flare Stack, Utility Piping and Pilots. Stainless Steel surface shall be natural finish. Control Panel and Electricals shall be natural finish and excluded for Surface Preparation and Coating.
- Our proposal doesn’t include any pilot gas piping, pressure gauge or regulators. Recommended Pilot Regulator Setting is 7 psig for the John Zink WindPROOF Pilots for Propane Fuel.
- Offered Control Panel shall be wall mounted which shall be placed at suitable location on site by client.
- Flare Tip & Pilots shall not be designed or fabricated as a pressure vessel / pressure retaining part / piping codes. Flare Tip and Pilots are considered as proprietary items which design and built to John Zink standard.
- Vendor Data supplied will be John Zink standard documents. John Zink shall submit the Drawings / Documents for approval electronically in PDF format only.

- Foundation Design, Start-up, Installation, Erection, Site work, Insulation, DCS & ESD, CCTV system, Area Lighting, Header Piping, Auxiliary Piping not mounted on Stack, Tools for transportation, erection and installation, Foundation Anchor bolts etc. are excluded from our scope. Heat trace, if required by others. Any external lighting by other. Mating Flanges / Bolts / Gaskets at battery limit are not in our scope.

- It is assumed that the total pressure drop of the system from the tanks to the VCU will allow for the natural force of the displaced vapors to push them to the VCU. If the system hydraulics is higher than this a vapor blower will be needed to “pull” the vapors from the tanks to the VCU. It is estimated that the pressure drop of the VCU at max capacity is 30” w.c. pressure.
- If the blower option is selected on the VCU a drip leg or knockout tank may be needed upstream of the blower to protect the blower from any condensation drop out that has collected in the interconnecting piping. It is assumed this would be part of the customers piping but can be provided by John Zink if required.
- VCU Instrumentation in the vapor piping will be 316 stainless steel. John Zink has quoted the main block valve and the detonation arrestor in the main vapor line for cryogenic service. John Zink is currently researching possible blower manufactures that can meet this requirement and will advise as soon as possible.
- It is assumed that the VCU assist air blower and optional vapor blower will utilize a 480 V 3 phase motor.

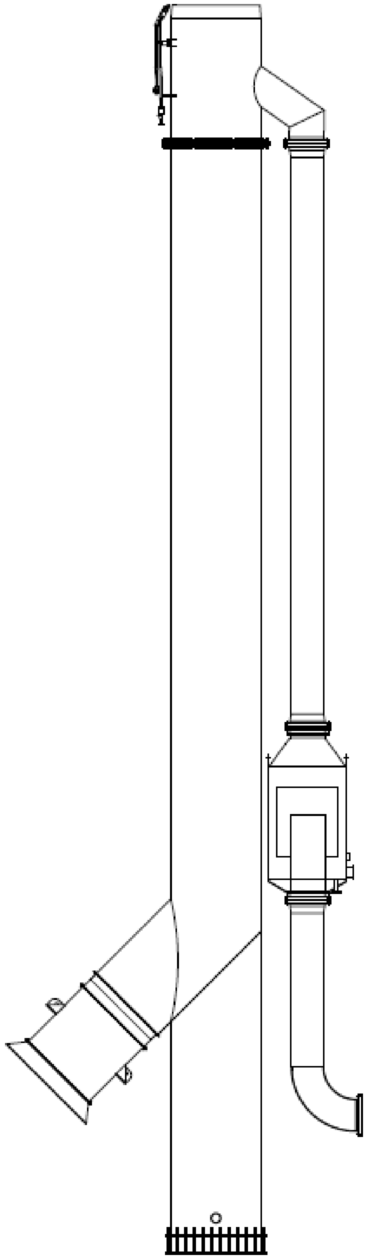
General Notes

- Our proposal is based on John Zink standards for manufacture. Flare tip is designed to John Zink standards.
- Proposed equipment design and scope of supply in compliance with only those specific client specifications provided with the requisition. Nested or referenced specifications that were not provided by purchaser with the requisition are specifically excluded from this proposal.
- All dimensions, material thickness, etc. in this proposal are preliminary and subject to modification, in compliance with specifications, after final engineering.
- The Delivery Schedule is based upon drawing approval by the customer as a hold point therefore, any delay in approving and returning these drawings by the customer will subsequently extend the contractual delivery date. John Zink shall furnish drawings to customer only and shall address only customer’s comments not to various authorities.
- Any delay in Approval of drawings/documents, Inspection Visits and scope modification by client shall subsequently extend the contractual delivery date.
- This proposal is based on the use of manual and automated welding processes, including SAW, for the stainless steel flare tip(s) and piping components. The proposal is based on existing weld procedures and qualifications. No additional procedures or testing have been included. Weld procedure and weld map for pilots shall not be provided.

- Any utility piping and conduit of 2" nominal diameter or smaller will be shipped loose in random lengths suitable for field fabrication with loose fittings. Piping in this size range is not pre-fabricated. Conduit will be anchored at top of flare, and U-bolt guides will be furnished along the length of the flare. All differential growth due thermal expansion is to be absorbed in the end users piping at grade.

VIII. PROPOSAL SKETCH

Sketch of flare system: PLA-78, 90’ OAH, MS-30, and Blower.



IX. DATA SHEETS AND OTHER TECHNICAL DATA

- 1. Radiation Plots
- 2. Flare Tip Data Sheets
- 3. Molecular Seal Data Sheet
- 4. *Wind*PROOF Pilot data sheet
- 5. Ignition Control Panel Data Sheet

TECHNICAL QUOTE FOR VAPOR COMBUSTION UNIT

Client: United Launch Alliance

End User: United Launch Alliance

Job Site: Vandenburg, CA

John Zink Ref: 202101-147101, Rev C

Date: July 16, 2021

UNLESS OTHERWISE AGREED BY THE PARTIES IN WRITING, THIS PROPOSAL AND ANY RESULTING TRANSACTION SHALL BE SUBJECT TO JOHN ZINK COMPANY, LLC'S GENERAL TERMS AND CONDITIONS OF SALE, ATTACHED HERETO.

Table of Contents

Introduction

John Zink Company, LLC is pleased to provide this proposal for a JOHN ZINK® NOx*STAR*™ Vapor Combustion System (VCU), **model ZT-100-0875-1/07/14-LE,** to be located at United Launch Alliance terminal in Vandenberg, CA.

Through the execution of hundreds of vapor control projects, John Zink has developed a thorough understanding that our customers value safety, efficiency, and ease of installation, operation and maintenance in their equipment. The design of the proposed VCU incorporates several features which enhance safety, performance and reliability. John Zink also understands that, in addition to high-quality equipment, our customers value excellence in project execution and service. Purchasing a system from John Zink provides many advantages not limited to the following:

- Experienced design and project management staff dedicated to providing excellent customer service during the execution and installation phases of a project.
- In-house fabrication ability. Because John Zink owns its own 250,000 square foot manufacturing facility, we are able to assemble most systems in our own shop which allows us to better control quality and schedule. We also assemble our control panels in-house and perform a functional test of the control panel and VCU skids prior to shipment.
- Large service organization. Our factory trained technicians provide both preventative maintenance and emergency call-out assistance 24/7.
- Spare parts inventory for quick turn arounds.
- Portable Emission Control Systems (PECS®) for temporary compliance needs.
- Installation assistance.
- John Zink proprietary anti-flashback burners. John Zink is the only VCU supplier to design and manufacture our own anti-flashback burners.
- Elimination of liquid seal. John Zink's anti-flashback burners allow for an additional level of safety so that liquid seal can be removed, reducing equipment maintenance.

Design Basis

This design basis was developed from bid specifications and from reasonable assumptions. This basis is critical to the performance of the unit, and both the site-specific information and the assumptions should be thoroughly reviewed to ensure that they are accurate and acceptable.

Products Loaded:	Liquid Natural Gas (LPG)
Vapor Hydrocarbon Concentration	100 mol% maximum
Max Loading Rate	0.6 lb/sec
Estimated Max Heat Release	46.32 MMBtu/hr
Estimated Min Operating Temp	1700°F
Damper Operating Temp	1800°F
Estimated VCU Pressure Drop	20” w.c. at max design
Detonation Arrestor Classification	Group D Vapors
Inlet Vapor Temp	-220°F

Utilities and other stie-specific consideration

Area Electrical Classification	
VSU skid	Class 1, Div 2, Group D
VCU stack	Outdoor unclassified (non-hazardous)
Motor Type	TEFC
Estimated Electrical Power	
VSU Panel FLA	20 A (120 V / 1 ph / 60Hz)
Combustion Air Blower FLA	155 A (480 V / 3 ph / 60 Hz)
Utility Requirements	
Enrichment/Assist Gas Supply	Natural Gas @ 30 psig minimum
Enrichment/Assist Gas Flow Rate	68 scfm
Estimated Pilot Gas Flow Rate	0.9 scfm
Instrument Air/Nitrogen	80 psig (-40^0F dew point)
VCU Stack Earthquake Design:	IBC 2012 Site Class D
VCU Stack Wind Velocity Design;	ASCE 7-05, 160 mph
Ambient Temperature	32-100 °F

Performance Guarantee

The John Zink® Enclosed Vapor Combustion Unit is designed to combust the hydrocarbon vapors from the incoming air/hydrocarbon vapor mixture in order to comply with guaranteed emission limits as stated below.

99.99% Reduction in Total Hydrocarbon Vapor Emissions
0.02 lb/MMBTU of Nitrogen Oxides (NOx)
0.02 lb/MMBTU of Carbon Dioxide (CO)

Notes to Design Basis

1. Assist gas will be injected at the VCU when the BTU value the vapors are too lean to burn properly and maintain the combustor operating temperature. As the hydrocarbon concentration becomes higher in the vapor stream the assist gas flow rate will automatically be reduced.

2. Pilot gas is required continuously during loading at a rate of approximately 1.0 scfm for natural gas or 0.4 scfm for propane, per pilot.

3. The design basis assumes that there is negligible H_2S and mercaptan. Higher concentrations may require additional precautions to protect against corrosion in the stack and vapor piping.

Process Description

The proposed Vapor Combustion System (MVCS) is designed to control hydrocarbon emissions from vapors displaced during the loading of vessels safely and effectively. The VCS consists of two main process units, one (1) Vapor Safety Unit (VSU) and one (1) NOx*STAR* Vapor Combustion Stack.

Typically, until loading occurs at the loading station, the vapor combustion system is in a standby mode with no pilot flame, the vapor isolation valves are closed, and the air-assist blowers are off. Automatic start-up of the vapor combustion system is initiated by an electrical signal from the loading rack indicating that product loading will occur shortly.

The start-up sequence consists of a short air purge using the air-assist blowers to purge the stack of any combustibles that may be present around the pilots prior to ignition. This brief air purge is followed by automatic electronic ignition of the pilot(s). After pilot ignition, a permit to load signal is passed to the customer. If a stack pre-heat is required assist gas will be injected into the vapor pipe to elevate the internal temperature prior to sending the permit to load signal. Once this signal is received product loading begins at the loading rack and an air-hydrocarbon vapor mixture is sent from the transports being loaded to the vapor combustion unit.

As soon as sufficient flow is available at the VSU skid, it will be detected by the pressure monitoring controls which will automatically open the first stage burner isolation block valve allowing the air-vapor mixture to flow through the detonation arrestor to the burners, where the combustible vapors are ignited by the pilot and burned. The first stage air-assist blower provides partial combustion air and mixing energy to the burner tips to assure smokeless combustion.

As the loading operation at the loading rack is completed, vapor flow to the combustion system decreases resulting in a decrease in system pressure. The pressure monitoring system closes the vapor isolation block valves when the line pressure has drop to 0.5 inch of water column pressure. The pilot(s) and the first stage air-assist blower remains on for a brief time period after loading is complete. If no further loading occurs, the combustion unit will shut down into a standby mode to await automatic re-start as described above.

Equipment Summary

The Vapor Safety Unit (VSU) will be furnished as separate skid mounted assemblies. The equipment is described in detail below. All sizes, dimensions and specifications are preliminary and may be changed in final engineering.

Vapor Safety Unit (VSU) Components

Quantity:......................One (1) skid

Vapor Staging Valves

Quantity: ....Two (2)
Size: ....8”
Type:......................High Performance Butterfly
Rating: ....150#, Wafer
Material:......................SS (Body) / SS (Disk)
Seat: ....Firesafe
Actuator Type:......................Fail Closed, Pneumatic
Limit switches:......................Yes

Detonation Arrestor

Quantity: ....One (1)
Size: ....8”
Type:......................Concentric
Material:......................SS (Body) / SS (Element)

Pilot / Assist Gas System

Quantity: ....One (1)
Size: ....0.75” (Pilot) / 2” (Assist)
Material:......................SS
Pilot Shutoff Valve:......................One (1) Fail Closed Solenoid Valve
Assist Shutoff Valve:......................One (1) Fail Closed Solenoid Valve
Control Valve:......................One (1) Fail In Position, Electric
Pressure Regulator:......................One (1) Common
Strainer:......................One (1) Common
Low-Low / High-High Pressure Switch: ....One (1) Each

Instrumentation

DA High-High Temp Thermocouple: ....One (1)
Stage Pressure Transmitter:......................One (1)

Skid

Material:......................CS
Design:......................AWS-D1.1
Grating: ....Optional

NOx*STAR* Combustion Stack (VCU) Components

Quantity:......................One (1) stack

VCU Stack

Size: ....8’ (OD) x 75’ (OAH)

Lifting Lugs: ....Two (2)
Design Shell MAWT:..500 °F
Corrosion Allowance: ....N/A
Material:..CS
Sample Ports: ....Four (4) 2” NPT

Refractory
Thickness:...Two (2) 1” layers
Temp Rating: ....2400 °F
Pins and Keeper Material:.................................Inconel 601
Factory Installed:..Yes
Cure Required: ....No

Anti-flashback Vapor Burners
Quantity: ....Seven (7)
Size: ....14”
Material:..SS (Body) / SS (Element)
USCG Commandant Approved:.........................Yes

Quench Air Damper (ship loose)
Quantity: ....Two (2)
Size: ....3’ x 2’
Material:..CS (Frame) / SS (Blades & Bearings)
Hinged: ....Yes

Pilot (ship loose)
Quantity: ....Two (2)
Self Inspirating: ....Yes
Automatic Ignition: ....Yes

Combustion Air Blower (ship loose)
Quantity: ....One (1)
Motor: ....100 HP (480V / 3ph / 60Hz) VFD driven
Inlet Silencer: ....No
Rain Hood:..No

Combustion Air Blower VFD (ship loose)
Quantity: ....One (1)
Est. Distance from VFD to Blower: ....75 ft maximum

Combustion Air Manifold
Size: ....24” OD x 7’ OAL
Design:..Design but not tested to B31.3
Static mixer Installed:.......................................Yes

Hydrocarbon Analyzer (ship loose)
Quantity: ....One (1)
Type:...Infrared
Sample System: ....Included

Instrumentation

Flame Detection: .... Infrared/ultraviolet flame detectors
High-High Temp Thermocouple: .... Yes
Control Thermocouple: .... Yes

Control System

The Vapor Control System will be controlled by a programmable logic controller (PLC). The primary operator interface for the operation of the Vapor Combustion System will be at the operator interface will be provided at the VSU / VBSU control panel. The electrical design and construction are in accordance with NFPA-70 of the NEC.

VSU Panel Enclosure Type: .... NEMA 4x w/ Z-purge
Hydrocarbon Analyzer Enclosure Type: .... NEMA 7
PLC: .... Allen Bradley CompactLogix
HMI Panel(s): .... Allen Bradley Hi-Bright
Combustion Air Blower VFD .... NEMA 1
VaporWatch™ .... Included

John Zink Fabrication Standards

Vapor Piping System

Design: .... ASME B31.3
Hydrotested: .... No
Radiographed: .... No
Material: .... SS
Small Bore Pipe (1.5” or smaller): .... Sch 80 with NPT connections
Large Bore Pipe (2” or larger): .... Sch 40 with 150# flanged connections
Gaskets: .... 1/8” Flexitalic “CGI” or equal
Nuts & Bolts: .... Fluorpolymer Coated CS
U-bolts: .... Galvanized CS

Paint

Surface Prep: SSPC-SP-6
Combustion Stack Primer Coat: .... Inorganic Zinc (2.0-4.0 mils DFT)
Combustion Stack Top Coat: .... Optional
Skid / L&P Primer Coat: .... Heat Resistant Silicone Acrylic (1.0-2.0 mils DFT)

Components with a manufacturer’s coat will not be painted. Components that could be damaged by blasting such as valves will be hand-tool cleaned (SSPC-SP-2) instead of blasted. No paint is assumed for stainless steel pipe or equipment.

Attachment 3

Vulcan Centaur Flares Information:
Cimarron (previously Aereon)

FLARE INDUSTRIES
A CIMARRON COMPANY

CIMARRON
CREATING A CLEANER ENVIRONMENT™

Budgetary Proposal

Air Assist Flare System

with

The Model 270 Energex Retractable Ignition System

Project	Vaporized LNG
Customer Name	AECOM
Customer Location	Los Angeles, CA
End User Name	ULA
End User Location	California

CONFIDENTIAL INFORMATION DELETED

Customer Name:	AECOM
Project Reference:	Vaporized LNG

Flare Industries, a Cimarron Company, is pleased to offer the following proposal for your consideration for the project referenced above. Thank you for considering Flare Industries for this project and we look forward to working with you.

Flare Industries provides technical support for all of our quality products from our team of experienced engineers and product specialists. In addition, we also offer field services in all major US and International basins to support Cimarron-sold and leased equipment, as well as customer-owned equipment. Field service rates as published at time of Purchase Order will apply. Feel free to contact your sales representative or service manager for additional information or for a proposal for our field or technical services.

Flare Industries is an ISO 9001:2008 compliant company. Flare Industries is certified by ASME for providing pressure vessels and boilers.

Please contact me if you have any questions or require additional information.

Regards,

[redacted]
Regional Sales Director [redacted]
[redacted]

Cimarron Energy
[redacted]

[redacted]
Application Engineer

Cimarron Energy
[redacted]

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SECTION PAGE

1.0 Commercial

1.1 Base Item Pricing/Delivery

Item	Description	Qty	Price (Total)	Delivery (weeks ARAD*)
1	Dual SFVP-1836 x 80 Derrick Supported Flare System	1		

1.2 Optional Item Pricing/Delivery

Item	Description	Qty	Price (Total)	Delivery (weeks ARAD*)
1	M270 1YR Spares Kit 120VAC	1		
2	M270 2YR Spares Kit 120VAC	1		
3	Pilot Gas Valve Train	1		
4	FOB Delivery: Point of Manufacture	1		

2.0 Technical

2.1 Process Conditions

Gas Composition	Mole %	Case 1	-	-
Oxygen	O_2			
Nitrogen	N_2	1.00		
Air	$N_2 + O_2$			
Carbon Dioxide	CO_2	0.10		
Water	H_2O			
Hydrogen	H_2	0.10		
Ammonia	NH_3			
Carbon Monoxide	CO			
Methanol	CH_4O			
Hydrogen Sulfide	H_2S	0.0001		
Methane	CH_4	97.00		
Ethane	C_2H_6	1.80		
Propane	C_3H_8			
I Butane	C_4H_{10}			
N Butane	C_4H_{10}			
I Pentane	C_5H_{12}			
N Pentane	C_5H_{12}			
Hexane	C_6H_{14}			
Heptane	C_7H_{16}			
Octane	C_8H_{18}			
N-Nonane	C_9H_{20}			
N-Decane	$C_{10}H_{22}$			
Ethylene	C_2H_4			
Propylene	C_3H_6			
Butene	IC_4H_8			
Butylene	NC_4H_8			
Pentene	C_5H_{10}			
Cyclopentane	C_5H_{10}			
Methylcyclopentane	C_6H_{12}			
Cyclohexane	C_6H_{12}			
Methylcyclohexane	C_6H_6			
Cycloheptane	C_7H_{14}			
Acetylene	C_2H_2			
1,2 Butadiene	C_4H_6			
1,3 Butadiene	C_4H_6			
Benzene	C_6H_6			
Toluene	C_7H_8			
Styrene	C_8H_8			
Ethylbenzene	C_8H_{10}			
Xylene	C_8H_{10}			
Max Mass Flow Rate	lb/hr	216,000		
Max Vol. Flow Rate	MMscfd	-		
Gas Temperature	°F	-200		
Pressure Available	psig	5		
Molecular Weight	-	16.43		
Lower Heating Value	Btu / scf	911		

Maximum Radiation Permitted	
Total Radiation	1500 BTU/HR.FT2
Distance from Flare Base	0 FEET
Solar Radiation	250 BTU/HR.FT2
Site Conditions	
Ambient Temperature	0/100 ° F
Elevation (above msl)	250 FT
Humidity	70 %
Seismic Classification	Zone 0
Exp. / Importance Factor	C / 1.15
Wind Speed for Radiation	20 MPH
Wind Speed for Structure	170 MPH
Electrical Classification	
Outside Sterile Area	Unclassified
Inside Sterile Area	Unclassified
Utilities Required	
Electricity	1 Ph / 60 Hz / 120 V
Electricity (Blower)	3 Ph / 60 Hz / 480 V
Pilot Gas Per Pilot	65 SCFH @ 5 - 15 PSIG/PILOT
Purge Gas	241 SCFH/FLARE
Ignition Gas	N/A
Instrument Air	N/A
Type of Flare	
☒ Elevated	☐ Offshore
☐ Bio-Gas	☐ Multi-Point
☐ Enclosed Flare	☐ Horizontal Flare
☐ Rental	☐ Portable
Support of Structure	
☐ Self-Supported	☒ Derrick Supported
☐ Guyed	☐ Boom Flare
Flame Monitoring System	
☒ Thermocouple	☐ Infra-Red Monitor
☐ Ionization Rod	☐ Ultraviolet Monitor
Ignition System Features	
☒ Automatic	☒ Manual
☒ Electric Spark	☒ Retractable
☐ Flame Front Generator	☐ Self-Inspirating
Method of Smoke Elimination	
☐ Steam Assisted	☒ Air Assisted
☐ Sonic Flaring	☐ None
Destruction Efficiency	
Destruction Efficiency Required > 98%	
Accessories	
☐ Liquid Seal	☐ Knock-Out Drum
☒ PLC	☐ Flame Arrestor
☐ Molecular Seal	☐ Ladders /Platforms
☐ Export Packing	☐ ACWL

Smokeless Flow	%/Scale	100/R-1				

2.2 Technical Specifications

2.2.1 Base Scope of Supply

Item	Qty	Description
1	2	**SFVP-1836 Air-Assisted Flare Tip:**

- 6 Feet X 36 Inch Nominal Diameter
- Multiple Arm Configuration
- High Capacity / High Efficiency Air Flare Tip Design
- Narrow Exit Slots Provide a Large Air / Fuel Boundary
- Concentric Design With 18 Inch Inner Gas Riser & 36 Inch Outer Air Plenum
- Dynamic Purge Seal
- 36 Inch Plate Flange
- Tip Material:
  - Body: 316 Stainless Steel
  - Flange: Carbon Steel (A105 Or Equivalent)

Item	Qty	Description
2	2	**74 Foot (80 ft Total Height) Derrick Supported Flare Riser**

- 36 Inch Diameter Air Riser
  - 74 Ft x 36 Inch Nominal Diameter Riser
  - 36 Inch x 150# Carbon Steel Plate Flange Connection to Tip
  - Considering 1/16 Inch Corrosion Allowance on Air Riser
- 18 Inch, Main Flare Gas Inner Riser:
  - 74 Ft x 18 Inch Nominal Diameter Riser
  - Concentric to Air Riser
  - Shop Weld Connection for Flare Tip Burner
  - 18 Inch x 150# RF Inlet Flange Connection
- Material:
  - Air Riser: API-5LB, A-53B, and A-36 Carbon Steel
  - Waste Gas Inner Riser: 304 Stainless Steel
- Cimarron Standard Offshore Paint System
  - SSPC-SP10 Surface Prep
  - Primer – CARBOLINE CARBOZINC, CZ-11 (2-3 MILS DFT)
  - Intermediate – CARBOLINE CARBOGUARD 890 (4-6 MILS DFT)
  - Top Coat – CARBOLINE CARBOTHANE 134 HG (2-2.5 MILS DFT)

Item	Qty	Description
3	1	**Derrick Support Structure**

- Supports both Quoted Flare Systems
- Fixed Derrick Support Structure
- Material – Carbon Steel
- Cimarron Standard Offshore Paint System
  - SSPC-SP10 Surface Prep
  - Primer – CARBOLINE CARBOZINC, CZ-11 (2-3 MILS DFT)
  - Intermediate – CARBOLINE CARBOGUARD 890 (4-6 MILS DFT)

  - Top Coat – CARBOLINE CARBOTHANE 134 HG (2-2.5 MILS DFT)

4 6 **Model 270 RETRAX Fuel Efficient Pilot:**

- (3) Pilots per Flare Tip
- High Energy Spark Type Pilot
- Ignition Wire & Conduit to Grade
- Type K Thermocouple (Dual Element)
- Thermocouple Wire & Conduit to Grade
- Pilot Material:
  - Pilot Head - 310 Stainless Steel
  - Pilot Body - 316 Stainless Steel

5 1 **ESI Electronic Control System:**

- Main Control Panel (for Both Flares)
  - Mounted Remote from The Flare
  - NEMA 4X Weather-Proof Controls Enclosure
  - Material: 304 Stainless Steel
  - Manual & Automatic Ignition Modes
  - Automatic Re-Ignition Upon Pilot Failure
  - Allen Bradley PLC (connected to VFDs) for Communication with Plant DCS
  - Pilot Status Indication
  - Form-C Dry Contacts for Pilot Failure Alarm
  - Includes Self-Supporting Control Stand
- Exciter Junction Box
  - Mounted at the Base of the Flare
  - Material: 304 Stainless Steel
  - (6) High Energy Ignition Exciter/ Transformer

6 6 **Retractability Package For 80 Ft Flare**

- Allows Pilot To Be Maintained From Grade Level
- Electrical Wiring Harness
- Track Assembly
- Manual Winch & Pulley Assembly
- Winch Cable

7 2 **High Volume / High Pressure Blower:**

- Preliminary: 32,500 CFM @ 8 - 9” W.C.
- 3 PH/60HZ/480VAC
- Final Blower Size Selection To Be Defined In Engineering Stage
- VFD Compatible Motor

8 2 **Variable Frequency Drive & Controls for 75 HP Blower**

- NEMA 4X Enclosure
- Adjusts Blower Speed
- Required Upstream Signal Provided by Others

		• Supplied Loose for Installation in Motor Control Center (MCC)
9	**2**	**Mass Flowmeter with Integrated Transmitter** • Ship Loose Mass Flow Meter • Flow Element: 350 °F, 316L Stainless Steel • Integrated Transmitter • 3/4 Inch MNPT Process Connection, 1-6 Inch Insertion • 85 VAC to 265 VAC • Transmitter Outputs: (2) 4-20 mA Analog: HART, Modbus • Custom Calibration
10	**3**	**Flare Industries Operation Manual**

2.2.2 Optional Items

Item	Qty	Description
1	**1**	**Recommended Lot of Spare Parts for Commissioning** • For the model 270 pilot / ESI Control Panel
2	**1**	**Recommended Lot of Spare Parts for 2-Year Operation** • For the model 270 pilot / ESI Control Panel
3	**1**	**Pilot Gas Valve Train** • Aluminum Body Regulator • Ball Valve and Strainer • Pressure Gauge
4	**1**	**FOB Delivery: Point of Manufacture (TBD)** • Non-Technology Items: Derrick, Riser, Piping

2.3 Shipping Details

☒ Inland Freight Packing
☐ Export Packing *

*Export packing and crating includes wooden box for flare tip and pilots suitable for sea / air freight. Export packing not applicable for non-technology items like flare stacks, structures, service piping and skids.

2.4 Recommended Spares List

No.	Description	Start-Up	2 Years
	ESI Control System		
1	DPDT, 120VAC Relay, 15 Amp	2	4
2	4PDT, 120VAC Relay, 15 Amp	2	4
3	Temperature Controller – 120VAC	0	1
4	Glass Fast Acting Fuse, 1 Amp	3	5
5	Glass Fast Acting Fuse, 3 Amp	3	5
6	Electronic Timer (240VAC)	0	2
7	Ignition Exciter (FII)	0	1
	Pilot Gas Valve Train		
8	Pressure Gauge 2" 0 - 30 psi	1	2
	Model 270 Pilot		
9	Dual Thermocouple, 96"	1	2
10	Pilot Mixer, 1", 245/250 316SS	0	1
11	Pilot Strainer – ½" THD SS, MUL	0	1
12	Compression Fitting for Pilot Spark Rod	0	1
13	Spark Rod Tip 12.5" (1.2 FT)	0	1
14	Spark Rod Base 92.4" (7.7 FT)	0	1
15	High Voltage Ignition Wire Splice Kit	0	2
16	Ceramic Thermocouple Connector (Male)	1	2
17	Ceramic Thermocouple Connector (Female)	1	2

2.5 Attachments to The Offer

No.	Document	Revision
1	20-10385 Radiation Isopleth R2	2

3.0 Documentation

The tables below list the information/documentation that is provided standard (free of charge) or can be provided as an option. Customer to ensure all necessary information and conditions submitted to Flare Industries to complete deliverable.

3.1 Engineering Documentation

Flare industries will provide the following documentation along with the equipment on this project:

No.	Type	Submission	Category
1	Piping & Instrumentation Diagram (P&ID)	Yes	For Customer Approval
2	Mechanical General Arrangement	Yes	For Customer Approval
3	Inspection Test Plan (for review)	No	-
4	Ladder Logic (Cause and Effect) Diagrams	Yes	For Information
5	Control Enclosures Drawings, as Applicable	Yes	For Information
6	Operating & Maintenance Manuals	Yes	For Information
7	Manufacturing Record Books (MRB)	No	-

3.2 Quality/ Non-Destructive Testing

Flare industries will provide the following documentation along with the equipment on this project:

No.	Type	Extent	Applicable
1	Visual Inspection	Complete Package	Yes
2	Dimensional Check	Complete Package	Yes
3	Factory Acceptance Test	Ignition System Only	Yes
4	Dry Film Thickness	Painted Carbon Steel Components Only	Yes
5	Radiography	-	No
6	Dye Penetrant Examination	-	No
7	Ultrasonic Testing	-	No
8	Magnetic Particle Examination	-	No
9	Hydro-Testing Extent	-	No
10	Pneumatic Testing Extent	Valve Trains Only, Where Applicable	Yes
11	Pickling and Passivation	-	No
12	PMI	-	No

3.3 Optional Engineering Documentation:

Standard engineering documentation provided free as noted above in section 2.1. Additional requested documentation not noted as included in pricing above, will be charged at an hourly rate of $125/man hour. The following table serves to provide budgeted hours by documentation type.

Description	Budgeted Hours
Equipment/Instrumentation/Sizing Datasheets: (Data Sheet on Unit, per Company or Cimarron Standard Template. Shows Design Data, Equipment Line Diagram (Not P&ID), Connection Schedule, Etc., not an OEM Brochure or Cut Sheet)	2-4 Hours Per Data Sheet
Instrumentation Oem Brochures & Cut Sheets: (OEM Brochures and Cut Sheets on Instruments placed in the final Job Data Book)	2-4 Hours Per Unit
Lifting Analysis: (Analysis for Shackles, Spreaders Bar, Pins, Guide Wire. Lifting Diagram Showing Unit Lift Plan, Bolting Diagram)	10 -20 Hours Per Unit
Process Sizing/Code Calculation: (Additional Process Calculations such as B31.3 Line Sizing, Pressure Calculations, Pressure Vessel Sizing Calculations, Instrument Sizing, Pump Sizing, Wind & Seismic Calculations, Etc.)	2 -10 Hours Per Unit
Structural Calculation: (Beam Calculation per AISC Steel Construction Manual)	10 -15 Hours Per Unit

4.0 Specifications & Clarifications

4.1 Project Specifications

Flare Industries proposal is based on the documents and specifications as listed below which define our proposal requirements for the material, fabrication, testing and inspection of the equipment, except as specifically stated or otherwise clarified in our proposal.

Only the documents/specifications listed below were considered in the proposal preparation. Cross-referenced documents are not considered.

No.	Description	Document No	Rev No.
1	Email correspondence	Email correspondence	-

4.2 Custom Clarifications

1. No custom clarifications at this time.

4.3 Standard Clarifications

4.3.1 Technical Clarifications

- When a guy wire supported flare is offered, our scope of supply ends at the spelter socket or turnbuckle and pin. Any additional hardware required to anchor the guy wire, such as a ring or plate, is considered part of the deadman design and is excluded.
- This design is exclusive of all external loadings due to upstream piping. Wind, seismic and temperature loadings have been considered. Allowable nozzle loads other than those published by API-537 are not considered.
- Air Craft Warning Lights unless mentioned in scope of work section of proposal.
- Structural design for stacks greater than one hundred feet in height does not include provision or facility for single piece lift or single point lift. Stack riser erection should take place in a vertical, section-by-section fashion.
- Special tools, such as Spreader Bars for lifting, are not included in the scope of supply, unless specifically listed.
- Weights listed on drawings are for reference only and are not 100% accurate, as the weight of the welds required for that specific design are not included in the weights listed on drawings.
- Lifting Diagram(s) are not included in the scope of supply, unless specifically listed.
- Pilot heads and flare tip castings are made of CK-20 material. The standard Origin of Material for these CK-20 castings is from China.
- Any testing or procedures not marked as included in the quality / testing section of proposal, including pickling and passivation of stainless-steel materials, positive material identification (PMI) testing, post weld heat treatment (PWHT), intergranular corrosion (IGC) testing, load testing, and pilot bench testing are excluded.
- Painting or coating for stainless steel, internal surfaces of equipment, or galvanized equipment is excluded.

- For low pressure flares, the maximum design pressure is considered to be 14.5 psig and design pressures above 14.5 psig are excluded.
- Stack sections will be provided in lengths of 38 feet or less with beveled ends for field welding. If flanged connections are provided on an air flare at the request of the client, the inner gas riser sections must be field welded as flanges interrupt the air flow in the outer riser and negatively affect performance.
- The ignition system / control panel / pilots and related valve trains are a Flare Industries' standard package. As such, they are designed and/or manufactured according to our standards and procedures, using our standard components. All valve train components have the following characteristics: ½ to ¾ inch diameter, threaded fittings, carbon steel construction. No other materials, diameters, flange ratings, piping specifications, or additional materials or instrumentation are included, nor do any client supplied specifications apply, unless specifically agreed to in writing by Flare Industries.
- Refractory of any kind in flare tips, unless specifically indicated. Using refractory in flare tips is an antiquated practice that actually reduces working life by creating heat sinks, which can cause premature failure of such tips. Over time, refractory can also become brittle and fall down into molecular seals, knockout drums, and liquid seals and subsequently cause system failures.
- Dispersion calculations, nozzle load calculations, finite element analysis or other stress analysis, apart from structural calculations of the stack.
- Standard deflection criterion for guyed stacks is L/100 and for self-supported stacks and derricks is L/133. No other deflection criteria are applicable.
- This design is exclusive of all external loadings due to upstream piping. Wind, seismic and temperature loadings have been considered. Allowable nozzle loads other than those published by API-537 are not considered.
- Cimarron requests a site plan or layout prior to submission for GA approval to optimize connection and piping orientations.
- PLC program provided with this project is the proprietary property of Cimarron and will remain in the sole ownership of Cimarron.
- Civil and foundation design for any equipment including anchor bolts or nuts, design of anchor bolt length or projection are excluded as this is part of civil engineering foundation design.
- Bolt kits at battery limit flanged connections are excluded.
- Supply to customer of shop details, fabrication drawings or proprietary calculations is excluded.
- Installation of equipment including supply of cranes and/or personnel is excluded. General installation instructions and assembly drawings can be provided, however, detailed erection instructions and drawings are excluded. These instructions are meant to provide guidance and general steps to complete the installation. These procedures are not intended to be a substitute for experienced installation personnel. Field assembly and erection of the flare is outside the scope of work to be provided by Flare Industries and is the sole responsibility of others. It is understood that the field contractor retained for this purpose is familiar with the assembly and erection of tall towers.
- No interconnecting piping, wire, or conduit is included between proposed equipment, unless otherwise indicated in the scope of work section of proposal.
- All calculations, engineering, and sizing provided in our proposal are preliminary and may change during detailed engineering. Optimization of the design during project phase engineering may occur and is not subject to a reduction in price.
- Any structural calculations may be submitted for information only, not being subject to the approval process unless agreed upon prior to PO acceptance.
- Corrosion allowance for carbon steel is 1/16 inch on wetted parts and 0 for air risers and/or air annuluses. No other corrosion allowance is applicable to our design or scope of work.
- NACE compliant carbon steel is not included, unless specifically mentioned under the scope of work section of the proposal.

- If NACE compliant carbon steel is proposed, materials which exceed the requirements of NACE MR-01-75 are not considered.
- Low temperature carbon steel is not included, unless specifically mentioned under the scope of work section of the proposal.
- Hydro-testing or procedures of any piece of equipment other than stamped ASME pressure vessels, unless specifically indicated in the proposal.
- External insulation, insulation clips or heat tracing of any kind is excluded unless noted within the scope of work of this proposal.
- Armored cable or cable tray of any kind. We are supplying our standard wire and conduit within our battery limits is excluded unless noted within the scope of work of this proposal.
- Material certifications as per BSEN 10204, 3.2 (formerly 3.1a and 3.1c) are excluded.
- **Codes:** Pressure vessels with MAWP in excess of 15psig are designed and fabricated in compliance with ASME Boiler Pressure Vessel Code, Sect VIII Division 1. Piping is designed and fabricated in compliance with ASME B31.3 Process Piping code.
- **Welding:** Cimarron uses welding processes that produce high quality welds with the metallurgical properties required for Cimarron Energy Systems fabricated equipment. Cimarron weld procedures and welders are qualified in accordance with A.S.M.E. Section IX. Qualifications to other codes and standards have not been considered. Cimarron standard weld procedures apply to our equipment, unless otherwise stated in our proposal. Any request to alter or modify our current weld procedures based upon clients' internal specifications is currently excluded from our scope of supply. If new procedures are requested by the client, price and delivery impact will apply.

4.3.2 Project Clarifications

Order of Precedence:

- In the event there is a redundancy or inconsistency between any documents attached, referred to, or appended to this proposal, the scope included in this proposal takes overall precedent.

Technical Scope Changes:

- All scope change requests made by Customer will be addressed with a "change order." Based on the nature of change requested, Cimarron reserves the right to charge a minimum assessment fee of 8 hours of engineering/project management to evaluate the impact of the request. An exact estimate will be provided to the customer to approve prior to proceeding.
- A "change order" is defined as a document Cimarron uses to handle changes to the contract. Such document may be used to change any portion of the contract and must be approved by both parties. Unless exclusively noted, all prior agreed upon terms and conditions apply.

Engineering & Design Deliverables:

- All datasheets, process calculations, drawings, and any other engineering deliverables will be provided in Cimarron's standard format (e.g., cover sheets, title blocks, drawing symbols, datasheet formatting, etc.) unless noted otherwise in this proposal. Pricing for using CUSTOMER or End User's formatting for documentation has not been considered. If customer specified drawing or document format is required to be used by Cimarron, additional engineering and administration fees will be assessed. Doing so will also impact to the project schedule. A "change order" will be provided to the customer with those details upon such request.Drawing and Deliverable Review Cycle:
    - Schedule includes a client review period not to exceed 1 week after submission of a document agreed upon to be submitted for approval. If Cimarron does not receive approval for construction within 1 week of initial approval drawing submittal, the production schedule will be subject to change based on shop load and change impact. Cimarron reserves the right to levy reasonable disruption charges to the

  - customer which will include engineering, project management hours as a minimum if no procurement has been initiated.
  - Approval drawings are sent to the customer with the exclusive intent of communicating the scope of supply included in the proposal and provide information such as mechanical and electrical tie points to the customer. Cimarron reserves the right to address comments received that seek to modify the scope of supply and those that are not related to the scope of supply separately with a "change order."
  - All reviews, approvals, and other interface are to be directly with CUSTOMER for the scope of this proposal. If CUSTOMER is acting on the behalf of an end-user, all discussions, support, and assistance with end-user are under CUSTOMER scope. Cimarron can provide technical assistance not included within the scope of this proposal for an additional fee.
  - For reviews returned by CUSTOMER as "Approved as Noted", "Approved with Comments", or "Reviewed", CUSTOMER understands that Cimarron will commence manufacturing and sourcing of approved scope not affected by open comments. Cimarron to provide final approved document to CUSTOMER assuming there is no further clarification required. The approval cycle will be defined as complete once Cimarron has returned the final approved document to the customer for information only.
  - For reviews returned by CUSTOMER with the words "Rejected" or "Pending", Cimarron will address clarifications with the customer and submit a revised document for approval. This will commence an additional approval cycle.
- If Cimarron has included a preliminary project schedule within or attached to this proposal, the schedule assumes parallel pathing fabrication drawings and long lead material procurement to compress where possible by allowing 1 cycle of approvals between CUSTOMER and Cimarron within the time allotted. Delivery subject to change if assumptions made are not complied to by CUSTOMER. The dates shown in the Project Schedule in are preliminary and subject to change depending on date of Cimarron's acceptance of the PO. However, the indicated durations in the Project Schedule still apply. A revised project schedule will be submitted prior to an officially scheduled kick-off meeting.

Free Issued Scope:

- In the event CUSTOMER is to free issue scope that is designed or engineered by Cimarron, the following protocol is in effect:
  - Cimarron supplies CUSTOMER with fab level drawings or specifications where applicable.
  - CUSTOMER receives approval from end user where applicable.
  - CUSTOMER procures or fabricates their scope as applicable above. Cimarron assists CUSTOMER with any questions or issues experienced during fabrication. Cimarron does not interface directly with the fabricator.
  - CUSTOMER will supply final end product to Cimarron within time specified in approved project schedule. CUSTOMER responsible for any cost or delivery impact to end user resulting from any issues not under Cimarron's responsibility under CUSTOMER scope.
  - Cimarron has authority to reject equipment supplied by CUSTOMER if it does not fall within Cimarron specification or Cimarron quality standards. Rework, delivery impact, or any other cost impact experienced if supplied scope not in compliance within Cimarron supplied fabrication drawings under CUSTOMER responsibility.
  - Any deviations to drawings/specifications supplied to CUSTOMER for CUSTOMER supplied scope require Cimarron approval.

Start-Up and Testing Support:

- Unless specifically noted, any HAZOP assistance beyond the agreed upon engineering deliverables provided in the scope is not included in the price of this proposal.

- Any on-site supervision/start-up test and training offered in this proposal is subject to the following clarifications:
    - Customer to supply date for site supervision/Startup to occur. Cimarron to agree on date. After time allotted in the proposal expires, Cimarron will begin charging day rates, regardless of delays or issues experienced outside of Cimarrons control or responsibility. Startup and site supervision is independent of any warranty claims.
- Offloading and installation of the equipment at the site is not within Cimarron's Scope of Work unless specifically noted in this proposal.
- Field or emission testing of the unit is not within Cimarron's Scope of Work unless specifically noted in this proposal.
- Client to schedule Cimarron technician onsite prior to emission test and an engineering test is required to fine tune the equipment.

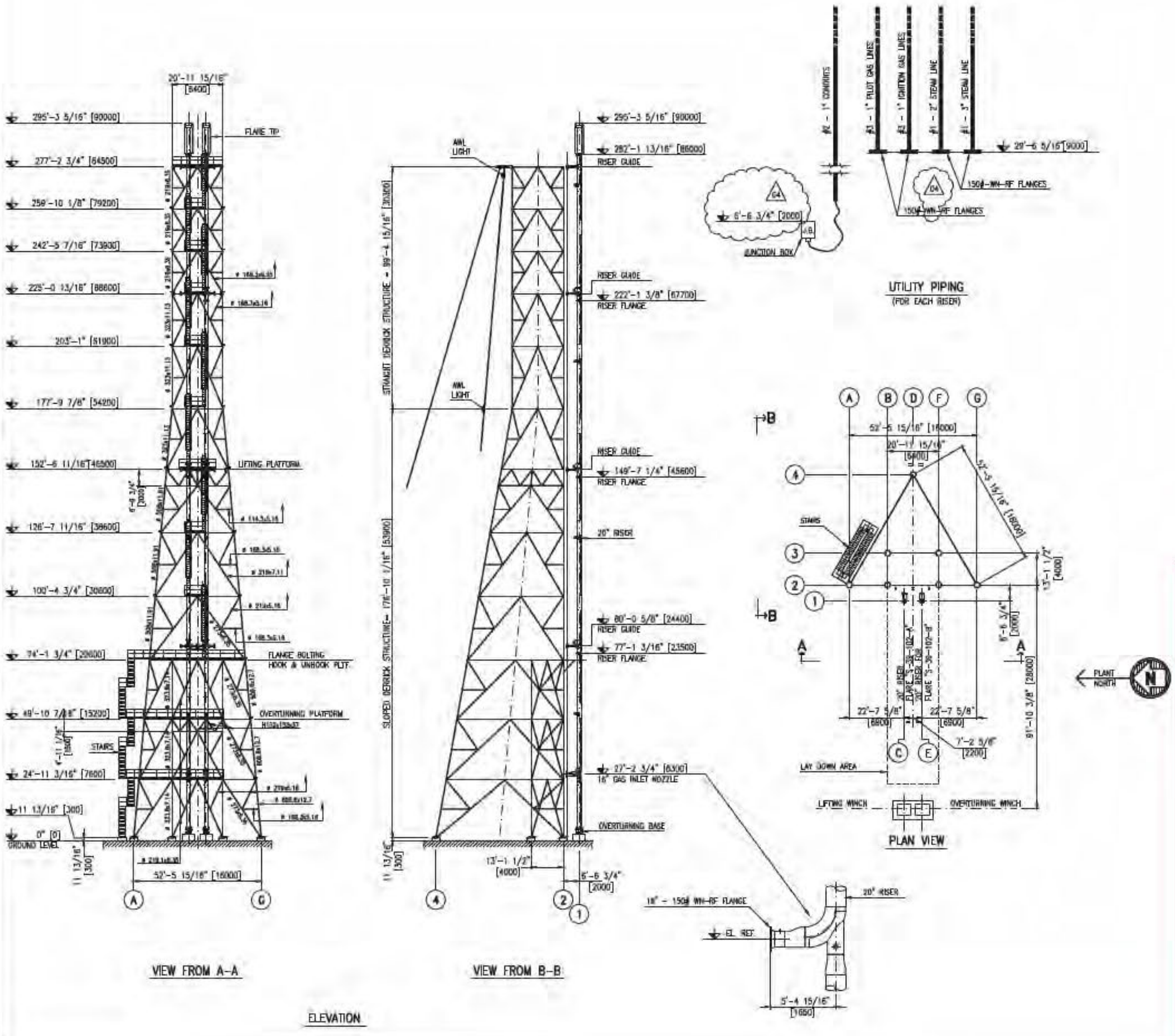
4.3.3 Commercial Clarifications

- Unit pricing includes the unit scope based on the technical specifications listed in section 2, with any clarifications as noted in Section 4. No other scope provided.
- Unit pricing offered herein is valid for a purchase order received for the stated quantity. If fewer than the stated quantity of units is purchased, pricing is subject to change.
- Bid validity is thirty (30) days from the date of this Proposal.
- All pricing in US Dollars.
- In-Stock Equipment and lead time proposed subject to prior sale.
- ARO, After Receipt of Order, is defined as the date Terms and Conditions have been agreed upon by both Cimarron and the customer and the purchase order has been accepted by Cimarron Energy. Drawings are submitted for information only, no approval required from customer for Cimarron to commence fabrication.
- ARAD, After Receipt of Approved Drawings, is defined as the date the customer has approved fabrication level drawings for the products purchased as described in this proposal. The customer is allowed five business days to review drawings after submitted by Cimarron for approval before delivery dates are subject to change.
- The equipment quoted in this proposal is based on
    (i) current shop load and subject to prior sale and management approval;
    (ii) if any drawings require the Customer's approval pursuant to this Proposal, all completion and delivery dates and price will be finalized after such drawings are finalized and approved as set forth herein; and
    (iii) any changes to the scope of this Proposal may affect price and completion dates.
- **Steel Surcharge:** The total contract price of this project is subject to a potential future escalation in steel prices. Cimarron Energy is committed to continuously improving efficiency, managing costs, and when possible protecting our customers from the adverse impacts of rising costs. Unfortunately, given the uncertain nature of the steel market dynamics, we may be adding a steel cost surcharge on our equipment for 2021 deliveries. The surcharge will cover a portion of our cost increases – and will remain separate and transparent from base prices. As the price of steel normalizes, we will adjust or remove any steel surcharge. Our aim is to minimize the impact on your business.
- **Inspections**: Unless noted otherwise, inspections by 3rd party or customer shall be announced within 5 business days prior to arrival on-site. Hold points shall be agreed upon prior to commencement of fabrication. Extra cost and delivery impact due to inspections and/or inspection on scope not agreed upon or referenced within this proposal subject to Change Orders based on time and material costs incurred by Cimarron Energy.
- **Origin of Material Requirements**: Cimarron Energy reserves the right to source at own discretion when no Origin of Material Requirements stated.

- **Customer Free-Issued Items:** All customer free-issued items to be quality checked by Cimarron. Price and lead time subject to change due to any delivery or quality issues of free-issued items.
- **Commercial Exclusions:**
    - (i) Any storage costs that may arise from buyer's late collection of the goods.
    - (ii) Any site services, including meetings, not specifically listed in the scope of work.
    - (iii) Sales tax, VAT or duties.
    - (iv) Third party inspections.
    - (v) Documentation legalization costs.
    - (vi) Drawings for spare parts.
    - (vii) Bank guarantees, performance bonds and warranty bonds.
    - (viii) Whereas regards statements in client specifications or purchase orders concerning specification order of precedence, please be advised that Cimarron proposal, including its integral exclusion list, precedes and precludes all other documents or agreements whether written or verbal.
    - (ix) Freight costs and logistics will be offered to our clients as an optional price or as part of the base price, but not at cost as the phrase "prepay and add" is sometimes interpreted.
    - (x) Cimarron strictly prohibits the use or sale of our equipment in countries sanctioned by the United States Government such as: Iran, Syria, Sudan, North Korea, and Cuba.
    - (xi) All documentation will be supplied in Acrobat pdf format, not Word, Excel, AutoCAD, or any other format.
    - (xii) Please note that documentation and drawing delivery dates are as stated in our proposal, however, if a VDS applies to the project, all delivery dates must be agreed to in writing on a document by document basis.
    - (xiii) Documentation Legalization Costs.
    - (xiv) Our operating and maintenance manuals and quality dossiers will be provided in the English language. Translation of the O&M manuals is available at an additional cost, however, only text generated by FII will be translated. Drawings, cut sheets, data sheets and/or standard documents will be provided in English.
    - (xv) No Cimarron presence at meetings (including, but not limited to, kick-off meetings, HAZOP meetings, drawing review and inspection / certification meetings) is included, unless explicitly mentioned in section 1.3.
    - (xvi) Spare parts when quoted do not include cross sectional drawings, export packing or freight.
    - (xvii) There are no bank guarantees, performance bonds, or warranty bonds included in our scope of supply or price. Cost for these requirements will be added on to our base price quoted as options. All bond and/or bank guarantee formats, if applicable, must be agreed to in writing by Flare Industries.
    - (xviii) Storage of equipment after notification of readiness for shipment.

FLARE
INDUSTRIES
A CIMARRON COMPANY

"The focus of our team is to provide cutting edge combustion and environmental technology, experience, innovation, and superior service; all of which give our growing client base successful solutions and the highest level of quality and satisfaction."



VIEW FROM A-A

VIEW FROM B-B

ELEVATION

UTILITY PIPING
(FOR EACH RISER)

PLAN VIEW

	POS.	DESCRIPTION	MATERIAL
DERRICK STRUCTURE	1	PIPES FOR COLUMNS, HORIZONTAL AND DIAGONALS	ASTM A53 TYPE E OR S Gr. B
	2	FLAT FLANGES, PLATES AND SHAPES	ASTM A36
	3	BOLTING	ASTM A325 METRIC
	4	PLATFORMS AND LADDERS	ASTM A36
	5	GRATING (30x5 BEARING BAR) HOT DIP GALVANIZED	ASTM A36
RISER		RISERS FOR EOCENE FLARE:	
	6	#2 – 20" GAS RISERS	ASTM A106 Gr. B & NACE MR 0103
UTILITY PIPING		UTILITY PIPING FOR EACH RISER:	
		#3 – 1" PILOT GAS LINES	ASTM A106 Gr. B
		#3 – 1" IGNITION GAS LINES	ASTM A106 Gr. B
		#2 – 1" CONDUITS	GALVANIZED CARBON STEEL
		#1 – 2" STEAM LINE	ASTM A106 Gr. B
		#1 – 3" STEAM LINE	ASTM A106 Gr. B

NOTES

04

1. ALL DIMENSIONS ARE IN FPS/ENGLISH UNITS. IN MILLIMETERS SHOWN IN PARENTHESIS.
2. ALL ELEVATIONS ARE REFERRED TO GROUND LEVEL 000.
3. FLANGE BOLT HOLES TO BE STRADDLED ON MAIN AXIS OF THE EQUIPMENT.
4. BOLTING AND GASKETS AT BATTERY LIMIT TO BE SUPPLIED BY OTHERS (SERVICE PIPING AND GAS INLET TO RISER).
5. 20" GAS RISERS AND SERVICE PIPING TO BE DESIGNED, FABRICATED AND TESTED IN ACCORDANCE WITH ASME B31.3 CODE. WELDING SHALL COMPLY WITH ASME IX CODE.
6. WELDING OF STRUCTURAL MEMBERS SHALL COMPLY WITH AWS.
7. ALL WELDS HAVE TO BE COUNTINUOUS AND S=0,7 x MIN. THICKNESS TO BE CONNECTED:
8. TRIAL FIT UP / ASSEMBLY AT WORKSHOP OF THE DERRICK STRUCTURE IS REQUIRED.
9. PAINTING FOR DERRICK STRUCTURE, RISER AND PIPING IN ACCORDANCE WITH SPECIFICATION N°. S-000-13A0-0007V Rev. 02. PLATFORMS, HANDRAILS, STAIRS AND LADDERS TO BE HOT DIP GALVANIZED. NO PAINTING
10. FOR DETAILED INFORMATION SEE CONSTRUCTION DRAWINGS.

CODES:

WIND LOADS	ANSI / ASCE 05
BASIC WIND SPEED	45 m/s
EARTHQUAKE LOADS	ANSI / ASCE 05
STRUCTURAL CHECKS	AISC LRFD

REFERENCE DRAWINGS

FLARE TIP	140658-A-002
RISER ASSEMBLY	140658-SC01-A-001
STEAM LINES	140658-SC01-A-014
UTILITY PIPING	140658-SC01-A-013
CONDUITS	
OVERTURNING BASE	140658-SC01-A-015
SADDLE SUPPORTS	140658-A-F01 (SHEET 8 OF 8)

FOR EARTHING AND LIGHTNING PROTECTION SEE SHEET 3

FOR REFERENCE ONLY

Technical Proposal

AECOM

Vaporized LNG

1/19/2022

AECOM
Reference: CEB

Cimarron Energy is pleased to offer the following technical proposal for your consideration for the above referenced project. Thank you for considering Cimarron Energy for this project and we look forward to working with you.

Cimarron Energy provides technical support for all of our quality products from our team of experienced engineers and product specialists. In addition, we also offer field services in all major US basins to support Cimarron-sold and leased equipment, as well as customer-owned equipment. Field service rates as published at time of Purchase Order will apply. Feel free to contact your sales representative or service manager for additional information or for a proposal for our field or technical services.

Cimarron Energy is an ISO 9001:2008 compliant company. Cimarron is certified by ASME for providing pressure vessels and boilers.

Please contact me if you have any questions or require additional information.

Regards,

[redacted]
Regional Sales Manager - [redacted]

Cimarron Energy
[redacted]
[redacted]

[redacted]
Applications Engineer

Cimarron Energy
[redacted]
[redacted]

1.Technical

1.1. How A CEB Works

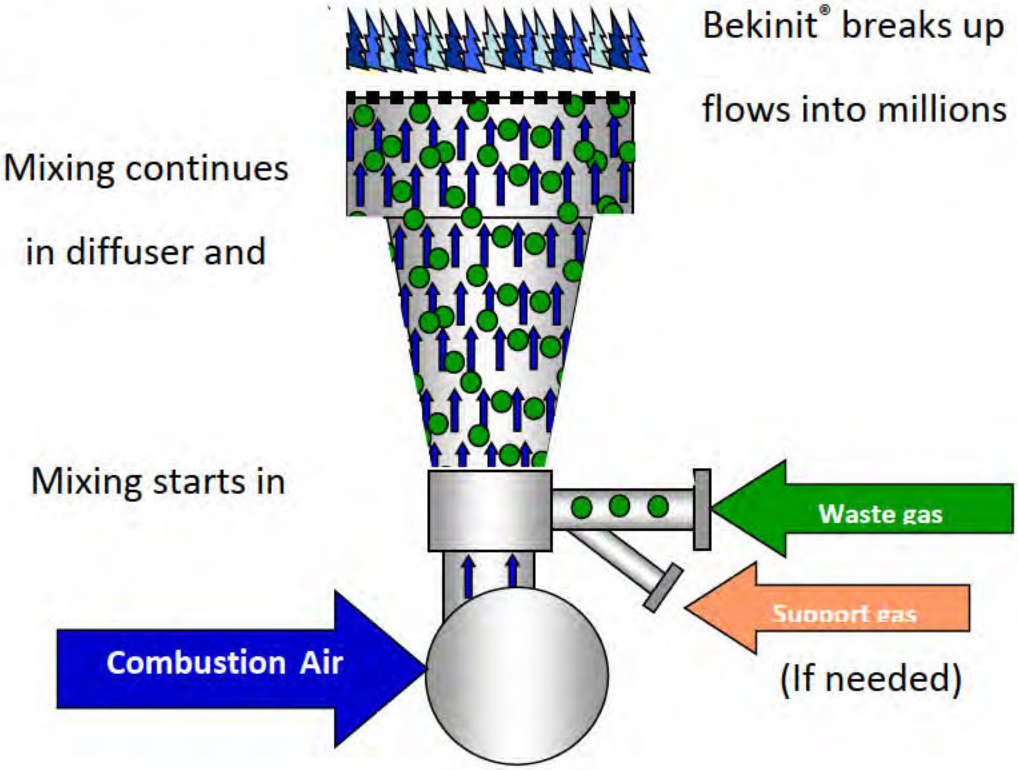
⇒ 100% of the combustion air is provided by a combustion air fan that is driven by a variable frequency drive

⇒ The waste gas from your process enters the CEB® through the waste gas injector where it will flow past static mixers. This is also where the support gas will enter the system, if needed. This causes the waste gas to flow turbulently across the air stream to start the mixing process

⇒ The waste gas and air mixture is allowed to propagate up the diffuser and into the head of the burner. The head of the burner is covered with Bekaert's proprietary Bekinit® burner cloth.

⇒ The Bekinit is made up of fibers of FeCr alloy that are knitted together like a wool sweater. This generates a material with millions of tortured paths for the gases to pass through. This is the final and most critical phase of the mixing process, just prior to combustion

⇒ See the graphic below for more details:



1.2. Technical Summary

Please take your time to carefully review the design conditions stated below and notify Cimarron immediately if any condition does not match your latest requirements. This will help us to reduce turnaround time while providing you a better service, thank you.

1.2.1. Gas Composition

PROPERTY	LNG
Methane (mol %)	97%
Nitrogen (ppmv)	10,000 ppmv
Carbon Dioxide (ppmv)	1,000 ppmv
Other Gaseous Impurities (ppmv) (i.e. Ar, H2, He, Ne)	1,000 ppmv
Volatile Hydrocarbons (ppmv)	Balance
Total Volatile Sulfur (ppmv)	1 ppmv
Non-Volatile Residue (NVR) & Particulates (mg/L)	10 mg/L

1.2.2. Design Summary

Design Summary	
Projected Gas Mass Flowrate	0.6 Lb/sec
Projected Gas Vapor Flowrate	806 SCFM
Gas GHV	1068 BTU/SCF
Calculated Thermal Heat Release	51.7 MMBTU/HR
CEB-800 Heat Capacity	27.2 MMBTU/HR
CEB-800 Combustors Required	2

1.2.3. CEB Emission Guarantees

EMISSION GUARANTEES FOR CEB (CERTIFIED ULTRA LOW EMISSION UNIT)		
NOx Emissions	Lb/mmbtu	0.018
CO Emissions	Lb/mmbtu	0.01
DRE (%)	%	>99.9

1.2.4. Utilities Required

Utility	Consumption
Pilot gas:	**120 SCFH of natural gas @ 10 - 15 psig (per pilot)**
Electrical:	**3ϕ / 60 Hz / 480 VAC** **1ϕ / 60 Hz / 120 VAC**

2.Scope of Supply

S.No Qty Description

1\. 2 **CEB® 800 WILL INCLUDE THE FOLLOWING:**

- ONE COMBUSTION AIR BLOWER EQUIPPED WITH A SIEMENS OR AB VARIABLE FREQUENCY DRIVE, WHICH WILL PROVIDE 100% OF THE COMBUSTION AIR REQUIRED FOR THE COMBUSTION PROCESS
  - VFD TO BE SHIPPED LOOSE FOR INSTALLATION IN MCC
- COMBUSTION AIR BLOWER FEATURES INCLUDE:
  - ONE (1) TEFC MOTOR- PREMIUM EFFICIENCY. MOTOR RATED FOR CLASS 1 DIVISION 2
  - ONE (1) EXTERNAL AIR INLET VANE DAMPER WITH A MODULATING ELECTRIC ACTUATOR.
  - ONE (1) DIFFERENTIAL PRESSURE SWITCH ACROSS THE BLOWER.
  - ONE (1) AIR INTAKE FILTER.
- CEB-800 IS COMPLETE WITH FOLLOWING:
  - AIR-GAS MIXING DEVICE AND DESIGNED TO ACCEPT ASSIST GAS IF REQUIRED.
  - PREMIX-CHAMBER WITH BURNER KNIT TO PROCESS THE VAPOR LOAD OF THE ABOVE GAS COMPOSITION.
  - ONE (1) 304 SST INSULATED STACK.
  - ONE (1) TYPE- K THERMOCOUPLE TO MEASURE PRE-MIX CHAMBER TEMPERATURE.
  - ONE (1) TYPE –S THERMOCOUPLE TO MEASURE THE PROCESS TEMPERATURE AND MAIN FLAME DETECTION.
  - ONE (1) DEDICATED HIGH STACK TEMPERATURE TYPE-S THERMOCOUPLE.
  - ONE (1) PILOT EQUIPPED WITH TYPE-K THERMOCOUPLE FOR PILOT CONFIRMATION AND A SPARK ROD.
  - ALL GAS WETTED PARTS TO BE 304 SST.
- ONE (1) COMMON CEB-800 CONTROL PANEL.
- INSULATED EXHAUST STACK WITH TWO 4" EMISSION TESTING PORTS. TESTING PORTS WILL BE 2.5 TIMES THE DIAMETER DOWNSTREAM OF THE BURNER AND 0.5 TIMES THE DIAMETER UPSTREAM OF THE TOP, OFFSET BY 90°. EMISSION TESTING PORTS WILL BE 4" ANSI 150# RFWN FLANGES.
- INCLUDES GALVANIZED ONE (1) CAGED LADDER AND TWO (2) PLATFORMS, WITH LOCATIONS NEAR THE EMISSION TEST PORTS AND ONE NEAR THE PILOT.

2\. 1 **CEB-800 CONTROL PANEL (COMMON PANEL SHARED BETWEEN BOTH UNITS):**

- THE CEB-800 CONTROL SYSTEM WILL INCLUDE A NEMA 4X 304SS CONTROL PANEL (UNCLASSIFIED)
- SIEMENS OR ALLEN BRADLEY COMPACT LOGIX PLC
- COMMUNICATION OVER ETHERNET.
- THE CONTROL PANEL UTILIZES A CONTROL SYSTEM FOR EFFICIENT OPERATION. CONTROL PANEL WILL INCLUDE:
  - SYSTEM POWER ON/OFF CONTROL.
  - SYSTEM REMOTE/MANUAL SELECTOR.
  - ONE (1) PANEL VIEW (HMI)
  - PANEL IS DESIGNED FOR 480V/3PH/60HZ ELECTRICAL POWER INPUT.
  - (NOTE: CUSTOMER WILL NEED TO PROVIDE ADDITIONAL REQUIRED CIRCUIT BREAKERS AND FUSES FOR THE INCOMING POWER).
- FOLLOWING PUSHBUTTONS WILL BE PROVIDED ON THE CONTROL PANEL

  - SYSTEM START
  - SYSTEM STOP
  - PILOT START
  - EMERGENCY STOP
  - ALARM RESET
- CEB SYSTEM STATUS/ALARM CONDITIONS ARE ILLUSTRATED BY INDICATION LIGHTS. CONDITIONS MONITORED INCLUDE:
  - SYSTEM POWER ON
  - SYSTEM OPERATING
  - PILOT ON
  - SYSTEM ALARM
- FOLLOWING OPERATING/DATA AND ALARM CONDITIONS ARE AVAILABLE VIA ETHERNET.
  - SYSTEM PRE-MIX TEMPERATURE
  - SYSTEM OPERATING TEMPERATURE
  - MAIN VALVE OPEN/CLOSE STATUS
  - PILOT OPERATING STATUS
  - BLOWER FREQUENCY
  - BLOWER GENERAL ALARM
  - SYSTEM GENERAL ALARM
- MINIMUM SYSTEM SAFETIES MONITORED BY THE CONTROL SYSTEM INCLUDE:
  - BLOWER LOW PRESSURE (MANUAL RESET)
  - HIGH PRE-MIX TEMPERATURE (REMOTE OR MANUAL RESET)
  - PILOT FLAME FAILURE (REMOTE OR MANUAL RESET)
  - BURNER FLAME FAILURE (MANUAL RESET)
  - HIGH STACK TEMPERATURE (MANUAL RESET)
  - LOW STACK TEMPERATURE (REMOTE OR MANUAL RESET)
  - HIGH GAS INLET PRESSURE (REMOTE OR MANUAL RESET)
  - ADDITIONAL DATA CAN BE PROGRAMMED UPON REQUEST.

3. 2 **SKID MOUNTED GAS TRAIN:**

- PILOT GAS TRAIN TO INCLUDE:
  - ONE (1) ½" NPT MANUAL ISOLATION BALL VALVE
  - ONE (1) ½" NPT Y-STRAINER
  - ONE (1) ½" NPT PRESSURE REGULATOR
  - ONE (1) ½" NPT SOLENOID SHUT-DOWN VALVE
  - ONE (1) PRESSURE GAUGE WITH ISOLATION VALVE
  - ALL PIPING ON PILOT GAS TRAIN TO BE 304 SS
- PROCESS GAS TRAIN TO INCLUDE:
  - ONE (1) 4" 150# MANUAL ISOLATION BALL VALVE (SS BODY/SS TRIM)
  - ONE (1) 4" 150# PNEUMATIC OPERATED ON/OFF VALVE (SSBODY/SS TRIM)
  - ONE (1) 3" 150# PNEUMATIC ACTUATED CONTROL VALVE W/4-20 MA POSITIONER
  - ONE (1) 4" 150# DETONATION ARRESTER (SS BODY/ SS TRIM) EQUIPPED W/ DOWNSTREAM TEMPERATURE TRANSMITTER.
  - ONE (1) PRESSURE GAUGE AND PRESSURE SWITCH WITH ISOLATION VALVE
  - ALL PIPING ON PROCESS GAS TRAIN TO BE 304 SST.

Appendix D

Vulcan Centaur Flares
Dispersion Modeling Protocol

CONFIDENTIAL INFORMATION DELETED

DISPERSION MODELING PROTOCOL

Submitted to

Santa Barbara County Air Pollution Control District
ATTN: [redacted]

Submitted for

United Launch Alliance, LLC
Vandenberg Space Force Base

Submitted by

AECOM
[redacted]

January 28, 2022

Table of Contents

1. Introduction

On behalf of United Launch Alliance's (ULA) Vulcan Centaur Space Launch Program at Vandenberg Space Force Base (VSFB), California, AECOM is submitting this dispersion modeling protocol as part of an Air Quality Impact Assessment (AQIA) to the Santa Barbara County Air Pollution Control District (SBCAPCD). We plan to use details in this protocol during screening and full modeling.

VSFB, under the command of the Space Launch Delta 30, is located within Santa Barbara County on the California south-central coastline at coordinates 34.7420 latitude N and 120.5724 longitude W. The base is approximately 240 km (150 miles) northwest of Los Angeles and equidistant between San Diego and San Francisco. VSFB encompasses an area of more than 99,000 acres with over 67 km (42 miles) of coastline to the Pacific. The bordering city, Lompoc, is approximately 10 km (6.3 miles) to the east, separated by agricultural land use.

Space Launch Complex 3 (SLC-3) currently supports ULA's Atlas V launch vehicles. The launch complex, SLC-3, is approximately 3.8 km (2.4 miles) from the VSFB boundary. Figure 1, Location Map, shows the general area. Figure 2 is provided for greater detail of the launch complex. The western border of SLC-3 is approximately 2.8 km (1.75 miles) from the Pacific Coast and 2.4 km (1.5 miles) from SLC-4.

The Vulcan Centaur Program is proposing modifications that will occur at SLC-3 and include the addition of a liquid natural gas (LNG) system to support Vulcan launch vehicles. The LNG systems will be within the current SLC-3 perimeter and security fences. The projected air pollution sources of interest are two elevated flares and one enclosed flare intended for control of emissions at SLC-3. Emissions are expected for launch operations, during delivery tanker fueling operations, and for daily storage tank boil off.

The modeling will comply with all requirements of New Source Review (Rule 802), Air Quality Impact Analysis, Modeling, Monitoring, and Air Quality Increment Consumption (Rule 805) and the Santa Barbara County Modeling Guidelines for Air Quality Impact Assessments.

Figure 1. General Location Map.

[redacted]

Figure 2. Location Map with Detail.

2. Project Information and Site Description

The planned LNG system will control emissions using: one (1) new enclosed flare and two (2) new elevated flare stacks. The new natural gas flares will be located along the west side of the pad deck backup ramp and new LNG storage tank.

The two (2) elevated utility flare stacks will be used for launch day activity and occasional venting with stack heights of approximately 27 meters (90 feet) and stack diameters of 4.08 feet. For this application, the maximum exit velocity is estimated to be 40.6 ft/s with a waste gas flow volume of 531.5 cubic feet per second (cfs) at an exit temperature of 1700 degrees Fahrenheit. As shown in the emission inventory, attached with this application, hourly flow rates will vary according to the burn rate of liquid natural gas. For each hourly dispersion analysis, the exit velocity and volumetric flow rate will be scaled accordingly for input into the U.S. EPA AERMOD model.

The third flare will be an enclosed flare stack used for burning natural gas from tanker offload operations or the LNG sphere to maintain the desired sphere pressure. It will have a height of almost 23 meters (75 feet) and a stack diameter of 2.324 meters (7.625 feet). The exit temperatures will again be 1700° F. The maximum exit velocity is estimated to be 32.8 ft/sec for a volumetric waste gas flow rate of 1498 cfs. Again, these are maximum exit velocities and volumetric flow rates and will be scaled for each hour based on expected liquid natural gas burn rates and used as input for AERMOD plume rise calculations.

Tables will be included in the dispersion reporting showing all variables used in AERMOD for each hour of analysis.

All flares will be modeled as point sources, choosing the flare option. Additionally, fugitive emissions related to storage and fuel transfer will be based on the emission inventory and modeled as general area sources. No mobile sources will be included.

Launches will be irregular and infrequent, beginning in 2024. Up to [redacted]aunches per year are planned with up to [redacted]additional fueling operations, for wet dress rehearsal/scrub events, for a total of up to 10-each launch fueling operations per year. Emission release rates will be varied during modeling to mirror the releases during events.

A full emission inventory of all equipment and the potential-to-emit (PTE) is contained in the permit application. Emission rates will be based on these values and will include appropriate emission factors in grams per second (g/s) using final agreed to control efficiencies for all times of releases.

3. General Methodology

The general methodology was carefully determined to meet all requirements of the SBCAPCD Dispersion Modeling Guidelines (June, 2020), SBCAPCD Rule 805, the U.S. EPA Guideline on Air Quality Models (GAQM; 40 CFR Part 51 Appendix W), all relevant Air Force guidelines/directives, and discussions with Air Force representatives.

Pollutants requiring dispersion modeling will conform to determinations by SBCAPCD. Currently, the modeled pollutants are thought to include carbon monoxide, nitrogen dioxide, reactive organic compounds, and particulate matter. Sulfur dioxide is not expected to be modeled due to the fuel sulfur content being below 10 ppm. No lead, beryllium, vinyl chloride, or hydrogen sulfide emissions are expected from the flares. Model averaging times will be based on the ambient air quality standards or increments for the pollutant being modeled.

4. Dispersion Modeling

4.1 Process

Modeling, using the U.S. EPA model AERMOD, will be conducted in four stages.

- First, for screening, a sampling gird extending up to 16 kilometers from the fence line will be modeled using a widely spaced grid to determine area trends. Ten (10) percent of either the California or National Ambient Air Quality Standards (AAQS) (modeled results with background) will be used to determine the general impact radius. Predicted concentrations at receptor locations, with background concentrations included, will also be reviewed and compared to the AAQS. The maximum concentrations for the specific averaging periods will be compared based on pollutant parameters as shown in Table 4.1-1 of the SBCAPCD modeling guidelines. The Ambient Ratio Method Version 2 will be used for NOx to NO_2 conversion.
- Second, this grid will be altered and refined as described in Section 4.4 of this document to determine the final radius of impact up to a maximum radius of 50 kilometers (AERMOD limit). The screening analysis will determine if modeling in the San Rafael Wilderness Area is needed and, if necessary, will be included in the more detailed modeling. The new modeling results will be once again be evaluated as described in Section 4.5 of this document.
- Third, based on these results, and if pollutants exceed the significance levels as stated in Section 4.5, further refined grids will be used with closer spacing to ensure maximum concentrations have been identified.
- Last, if exceedances are predicted, additional modeling will be conducted with various control strategies evaluated. If this occurs, we will work closely with SBCAPCD to determine the best way forward.

4.2 Models and Software

The U.S. EPA dispersion model, AERMOD (Version 21112), will be used for this project. It will be executed using the graphical utility interface from Lakes Software, Version 10.2.1. If updates occur during the interim time period, the latest models will be used.

Specific control features will be set according to SBCAPCD specifications which include:

- Use of the rural option
- Use of regulatory default control options
- The UTM Zone 10 with a datum point of 34.639697, -120.588915

Figure 3 shows the three closest meteorology stations to be Lompoc Watt Road (34.781 N, 120.607 W), Lompoc H Street (34.638 N, 120.457 W) and the VSFB South meteorological station (34.596 N and 120.631 W). Figures 4 a-c show the wind rose plots from these three meteorological stations. The effects of local topography, mostly undeveloped, is obvious. The Lompoc H Street station is somewhat different from the other stations due to local terrain to the north and south. The other two stations are also closer to the launch pad. Using the coordinate data, Lompoc Watt Road was determined to be the closest to the launch pad and will be used for the dispersion analysis.

Three preprocessor files could be important to complete the modeling: AERMAP, AERSURFACE, and AERMET. DEM files from the United States Geological Survey (USGS) will be used as input to AERMAP allowing processing of terrain data to determine a hill height scale in conjunction with a layout of receptors and sources to be used in AERMOD control files. AERSURFACE is used to determine surface roughness that effects wind flow. Both AERSURFACE and AERMET files have been developed and are promulgated by SBCAPCD. We will utilize these inputs developed by SBCAPCD as inputs to the AERMOD modeling process.

Variable emission modeling was considered, but it should be noted that emissions are considered be constant each hour of operation. As previously stated, we intend to use the hourly results presented in the emission inventory to derive the hourly rates used during dispersion modeling.

The Tier 2 Ambient Ratio Method Version 2 (ARM2) will be used during conversion of NOx to NO_2.

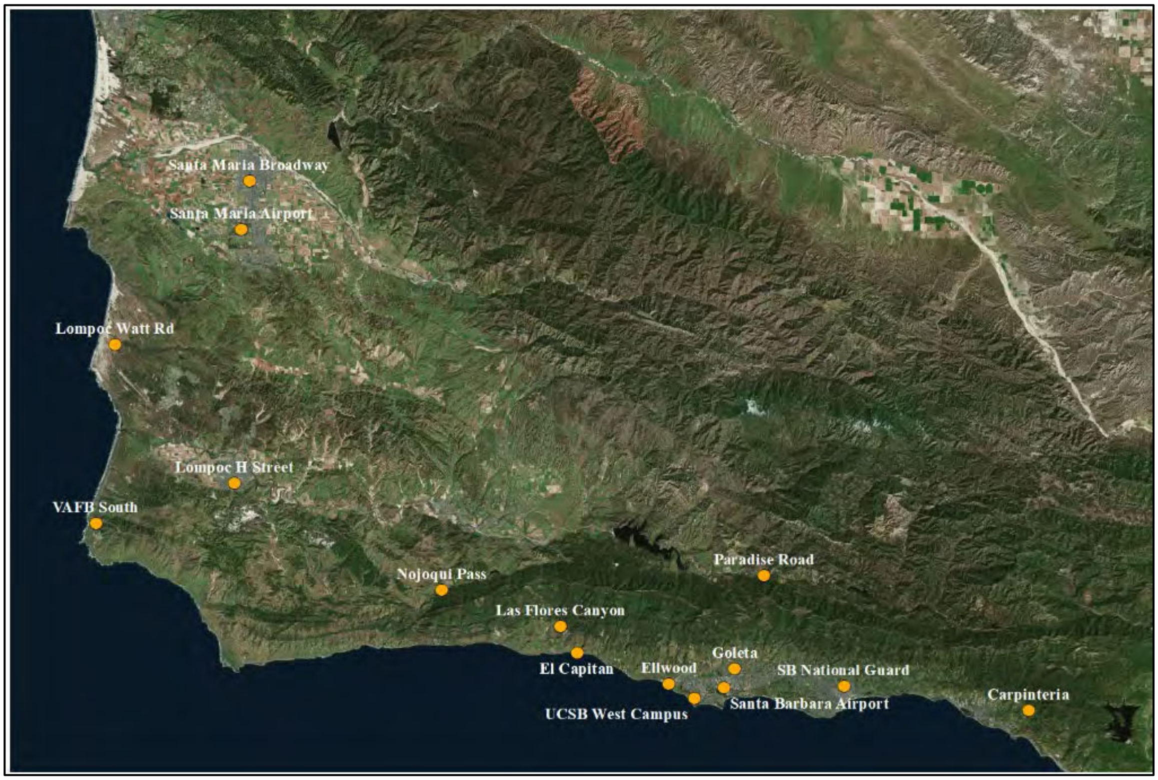


Figure 3. Locations of Nearest Meteorological Stations.

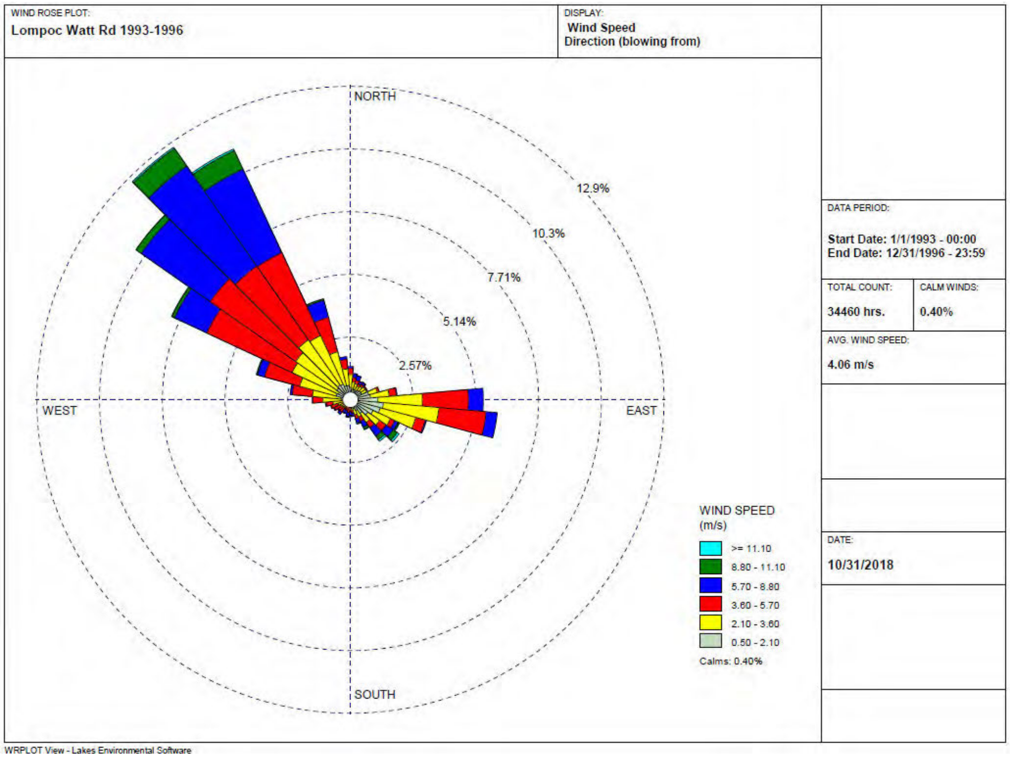
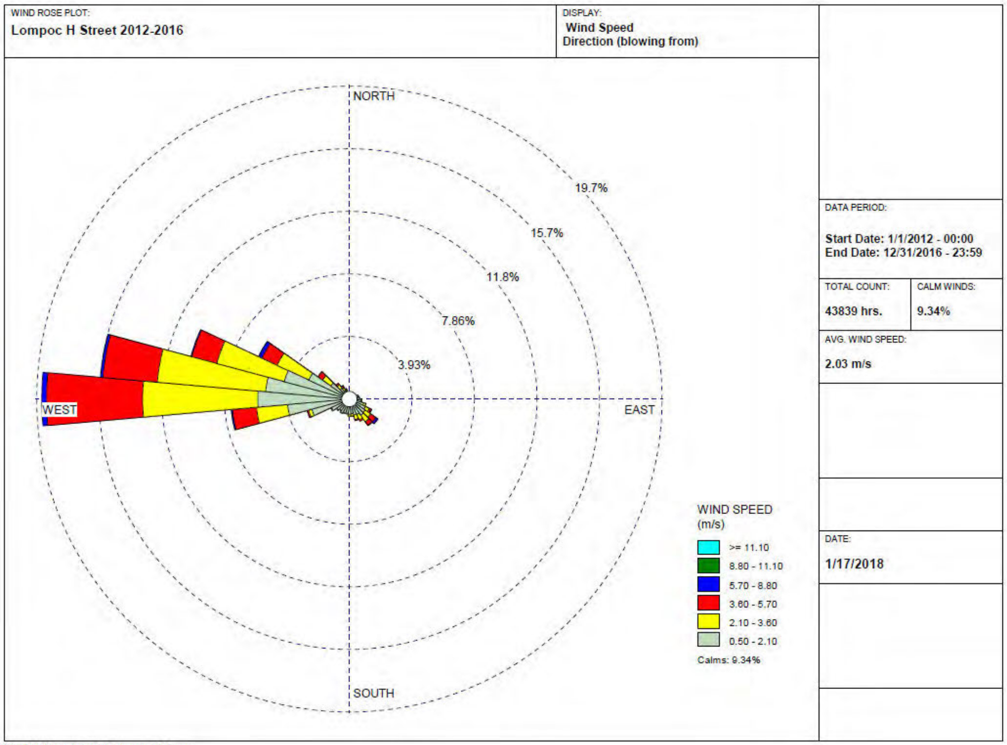
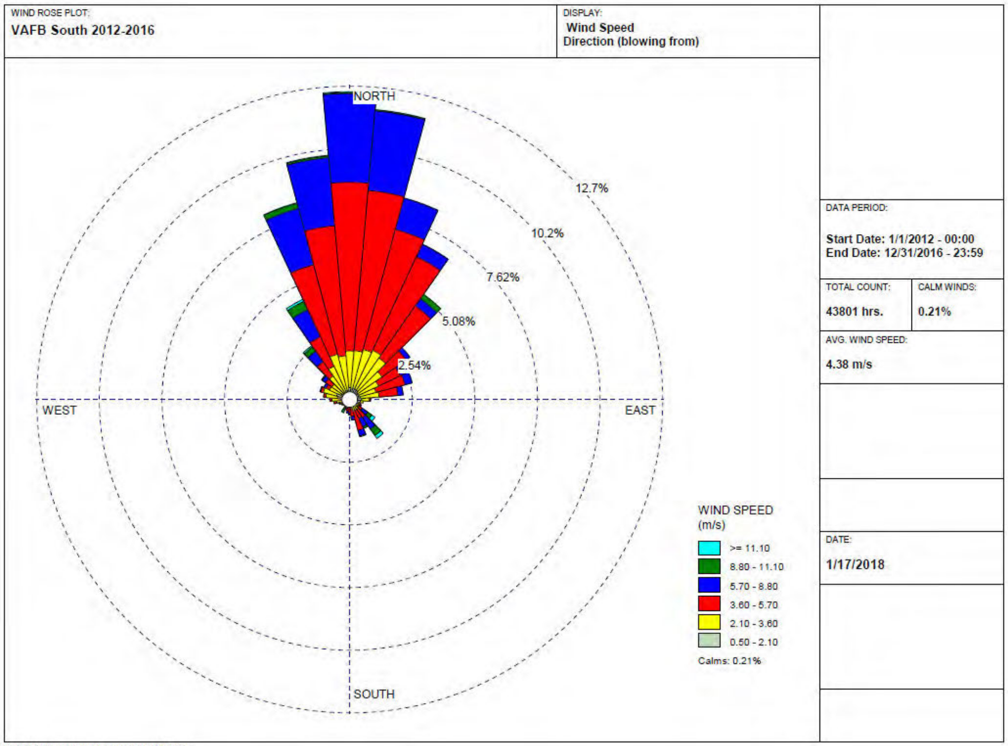


Figure 4a. Wind Roses of the Three Closest Meteorology Stations: Lompoc Watt Rd.



WRPLOT View - Lakes Environmental Software

Figure 4b. Wind Roses of the Three Closest Meteorology Stations: Lompoc H Street.



WRPLOT View - Lakes Environmental Software

Figure 4c. Wind Roses of the Three Closest Meteorology Stations: VAFB South.

4.3 Emission Factors and Total Concentration Results

As stated previously, emission factors and the results of the emission inventory with complete documentation such as calculation spreadsheets were included as part of the submission packages. Based on the emission inventory for each hour of operation, emission factors for the dispersion analysis will be converted to grams per second (g/s). If desired, we will submit tables of all emission rates for preliminary review to the District. Final factors will be included in the final dispersion modeling protocol based on final control efficiencies.

Background concentrations as previously measured by the SVPP location will be used to determine the total local concentrations. The averaging times and background concentrations that are planned to be used are shown in Table 1.

Table 1. Background Concentrations as Measured at SVPP

Pollutant	Averaging Period	Background Concentration (ug/m3)
CO	1 hour	1,264
	8 hour	1,149
NO_2	1 hour (NAAQS)	8.8
	1 hour (CAAQS)	22.6
	Annual	0.6
PM10	24 hour	143.0
	Annual	27.6
PM2.5	24 hour	23.3
	Annual	6.6

4.4 Meteorology

As stated in Section 4.2, we will use AERMET files from SBCAPCD for both surface and profile meteorology data. The Lompoc Watt Road was determined to be the closest to the launch pad as well as provides a pattern that better estimates local impacts (see Figure 4a) and will be used for the AERMET files during dispersion modeling with AERMOD.

4.5 Stack Good Engineering Practice and Building Downwash

When running AERMOD, the good engineering practice (GEP) stack height for the releases will be computed both manually and using the Lakes software. All nearby buildings will be evaluated to show that the buildings are not within the area of impact.

Most nearby structures are single story with one exception. To the southeast of the launch pad the mobile service tower (MST) staging building for the rockets is approximately 118 meters (388 feet) in height. This tall building, and all other substantial buildings will be built into the modeling process. However, the tall building will be of particular interest during modeling and influences on the plumes will be closely evaluated.

4.6 Receptors

The area immediately near the launch pad is vacant and possible sensitive receptors are approximately 5 km (over three miles) away from the location. Although receptors are not required at controlled onsite locations, receptors will be placed in the immediate area wherever human activity occurs for use in the Health Risk Assessment. Receptor networks, based on Cartesian grids, will be heavily used to allow evaluation of maximum concentrations at the property boundary, off-site and at any possible sensitive receptor areas located on the base. Receptors used in the July 1, 2020, VSFB Air Toxics Emission Inventory Plan will be reviewed, and all valid locations included. The flagpole height of all receptors will be set to 0 meters. The initial grid spacing, after a screening evaluation, will be:

- 25-meter spacing at the property boundary
- 25-meter spacing from property boundary out to 200 meters
- 50-meter spacing from 200 meters to 500 meters
- 100-meter spacing from 500 meters to 2000 meters

Receptor grids with greater spacing will extend out to the coast and for several kilometers from the facility sources in other directions. Exact distances will be selected based on the terrain and human activity. The nearest Class I area is the San Rafael Wilderness Area which is over 64 kilometers (40 miles) to the east and with severe terrain along the propagation path. For buoyant or neutrally buoyant emissions, an effective range of 50 km is often thought to be a limit to the modeling process using AERMOD. However, to follow appropriate procedure and with the 10 km border afforded the entire area, use of the SBCAPCD grid for the area could be required based on the initial screening results.

4.7 Background Concentrations

Background concentrations as provided in Table 4.1-2 of the SBCAPCD dispersion guidance and will be used. Figure 5 show local monitoring stations in the area. For any pollutant data not available, we will work with SBCAPCD to determine how other background concentrations will be determined.

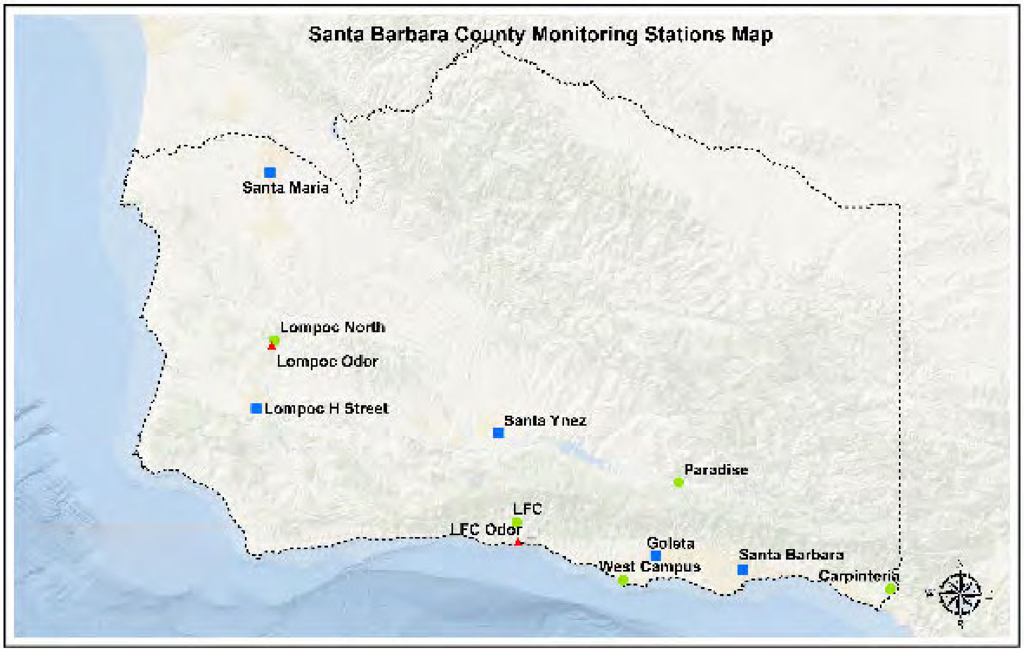


Figure 5. Local Air Quality Monitoring Stations.

4.8 Results and Comparisons

AERMOD outputs of modeled concentrations will be compiled and placed into tables for easy review. Concentrations will be evaluated with and without background concentrations added in depending on analysis type. Comparisons to the AAQS will always include background concentrations while increment analysis will not. Color graphics will also be used to allow a quick review of maps showing the receptor grids and concentration contours.

4.8.1 AAQS Analysis

Total concentrations (modeled plus background), observing averaging times, will be compared to the values in Table 4.1-1 of the SBCAPCD modeling guidelines. The most conservative results will be evaluated first with the highest modeled concentration (i.e., 1st Highest High) for the specified averaging period used since low concentrations are expected. This approach will be made apparent in the reporting. Greater detail will be used to examine concentrations based on pollutant and appropriate averaging/reporting if any AAQS for certain pollutants are approached. This additional analysis will use refined and closer grid patterns for receptors to provide for a greater resolution. Since Santa Barbara County is currently in nonattainment status for PM_{10} for both the annual and 24-hour basis, the evaluation will be based on determining if the project's contribution is less than ten percent of the AAQS.

4.8.2 Increment Analysis

Since this is a new source for the county, increment analysis will also be performed. Modeled pollutants will include particulate matter (total suspended, PM_{10}, $PM_{2.5}$), nitrogen dioxide, carbon monoxide, and reactive organic compounds). Although not expected to occur, if the sulfur content of the fuel is greater than 10 ppm, sulfur dioxide will also be evaluated. Results for modeled concentrations (without background) will be compared to Table 4.2-1 of the SBCAPCD modeling guidelines. Class II increments will be evaluated except in the San Rafael Wilderness Area, where Class I increments will be evaluated if necessary.

5. Reporting

Once the final protocol is agreed to, modeling will be completed. A report will be submitted on modeling results. This reporting will include:

- Facility information
- Source and Emission Inventory Information
- Emission Quantification
- Air Dispersion Information
- Summary of Results

Tables and heavy use of graphics will be used to communicate the information. All input and output files from the dispersion analysis will be submitted as appendices.

Appendix E

Vulcan Centaur Flares

Site Plan

CONFIDENTIAL INFORMATION DELETED

Appendix F

Vulcan Centaur Flares

Vandenberg SFB Memorandum

CONFIDENTIAL INFORMATION DELETED

DEPARTMENT OF THE AIR FORCE
UNITED STAES SPACE FORCE
30TH SPACE WING

MEMORANDUM FOR United Launch Alliance
ATTN: [redacted]

DEC 0 1 2020

FROM: 30 SW/CC
747 Nebraska Ave Suite A200
Vandenberg AFB CA 93437

SUBJECT: ULA Twenty Year Lease Request for SLC-3E - Revised Facility List (Your memo, 8 Sep 20)

1. This letter is in response to the referenced memo regarding launch property requests for your Vulcan Centaur Program. Your revised list contains thirty-three (33) separate facilities yet acknowledges that one of the facilities, Bldg 8337, will not be available for Vulcan operations, which reduces the list to thirty-two (32). A 30th Space Wing notice to vacate Bldg 8337 by 31 Dec 2020 was previously delivered to ULA.

2. Of the remaining thirty-two (32) requested facilities, thirty (30) are approved, to include Bldg 765 for continued limited shared use. Two (2) are not approved as available launch property for use by the ULA Vulcan Centaur Program; Bldg 789 and Bldg 7525. These facilities will be retained for use by the government for government purposes.

3. For the thirty (30) approved facilities, the 30th Civil Engineer Squadron and Program Requirements Office, in coordination with government legal advisors, will coordinate with ULA on a new launch property out grant that will be offered to ULA in support of Vulcan Centaur commercial space operations, in accordance with U.S. Code and DoD regulatory guidance.

4. The existing ULA consolidated (EELV) license out grant (License No. USAF-AFSPC-XUMU-15-2-0409) will be allowed to expire on 24 Sep 2022.

5. My point of contact for the Vulcan program is [redacted] [redacted] and for the new out grant, [redacted] [redacted]

[redacted]
[redacted] USAF
Commander

cc:
30 OG/CC
30 MSG/CC
30 CES/CC/CD/CEI/CEIA
SMC/ECLA
ULA Contract Administrator [redacted]

Appendix G

Vulcan Centaur Flares

Visibility, Soil and Vegetation Analysis

In accordance with the Santa Barbara County Air Pollution Control District's (SBAPCD) Rule 802.H[1], a soil and vegetation analysis and a visibility analysis were conducted for the ULA Vulcan Centaur project because project-related criteria pollutant emissions emit more than the threshold of 240 lb/day for both NO_X and CO (see **Table 1**). The subsections below detail each of the analyses.

Table 1. Total Project Emissions

Pollutant	lb/day	TPY
NO_X	214.49	1.095
ROC	73.31	0.316
CO	977.83	4.371
SO_X	5.24	0.037
PM	24.13	0.17
PM_{10}	24.13	0.17
$PM_{2.5}$	24.13	0.17

Soil and Vegetation Analysis

SBAPCD[2] guidance requires the soil and vegetation analysis follow USEPA's seven-step screening methodology[3]. Step 1 of the screening is the evaluation of maximum ground level concentrations (GLCs). If refined modeling of the emissions has already been completed for another aspect of the project, those values may be used to determine GLCs. If refined modeling has not been conducted, USEPA's Significant Emission Rate (SER) methodology can be used by comparing the project's potential emissions against the SER thresholds provided in USEPA's guidance[2] (Tables 5.6 and 5.7). The SER is defined as the minimum emission rate which would cause the source's impact to just equal the screening concentration. The SER thresholds are based on generic stack parameters which can be adjusted, if necessary, to reflect stack parameters more comparable to the project. If project emissions for all pollutants are less than the SER thresholds, no further action is required and the soil and vegetation analysis is complete.

Following Step 1 of the methodology, project total emissions were compared to the SER thresholds as shown in **Table 2**. The SER thresholds were based on the lowest values available in Table 5.6 of USEPA's guidance[2]. Since the project's emissions result from flaring, the SER values included an adjustment (8.93) from Table 5.8 of the guidance to account for a tall hot stack. **Table 2** shows that project emissions do not exceed any of the adjusted SER thresholds, therefore no further action is required.

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[1] https://www.ourair.org/wp-content/uploads/Rule802.pdf

[2] "Guidelines for Soil and Vegetation Analysis and Visibility Analysis". Santa Barbara County Air Pollution Control District. December 2015. Available at: https://www.ourair.org/wp-content/uploads/SVA-VA-Guidelines.pdf.

[3] "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals". EPA 450/2-81-078. December 12, 1980. Available at: https://www.ourair.org/wp-content/uploads/EPA-Soil-Plant-Screen.pdf.

Table 2. Step 1 Plant and Soil Screening Analysis

Pollutant	Project Emission Rate (tpy)	Lowest Significant Emission Rate(1) (tpy)	Emission Rate Increase Factor(2)	Adjusted SER(3) (tpy)	Emissions Exceed Adjusted SER? (Yes/No)
NO_X	1.10	840.00	8.93	7501.20	No
ROC	0.32	----	8.93	----	(n/a)
CO	4.37	2500.00	8.93	22325.00	No
SO_X	0.04	1.50	8.93	13.40	No
PM_{10}	0.17	----	8.93	----	(n/a)

Notes:

(1) Lowest SER for each pollutant from USEPA Table 5.6

(2) Adjustment factor based on a tall, hot stack from USEPA Table 5.8.

(3) Lowest SER multiplied by Emission Rate Increase Factor.

Visibility Impact Analysis

A Level-1 screening visibility impact analysis using the USEPA's VISCREEN model was conducted following SBAPCD[4] and USEPA[5] guidance to provide a conservative estimate as to whether the plume due to project emissions has the potential to be perceptible under persistent worst-case meteorological conditions. SBAPCD[3] guidelines indicate that a visibility impact must be conducted for the following areas:

1. The nearest Class I Area (San Rafael Wilderness), and
2. Any parks (e.g., city, county, state, or federal) within 20 km of the facility boundary (Class II areas).

The areas included in the analysis are depicted in **Figure 1** and **Figure 2**. Note that in addition to parks, school grounds located within 20 km of the facility were also included in the Class II analysis since they can serve the same function as parks. VISCREEN requires inputs of the maximum project-related short-term emissions of particulate matter (PM) and nitrogen oxides (NO_X) as well as the following distances:

- Minimum distance between the emission source and observer (observer assumed to be located at closest Class I/Class II boundary),
- Minimum distance to Class I/Class II boundary, based on a 22.5° wide sector, and
- Maximum distance to Class I/Class II boundary, based on a 22.5° wide sector.

Table 3 provides the emissions input to the model while **Table 4** provides the distances. Note that while San Rafael Wilderness is 52.3 km from the ULA project site, a minimum distance of 50 km was used in the model consistent with the USEPA-approved range for the model. In accordance with SBAPCD[3] guidelines, the background visual range was set to 25 km for all areas evaluated.

The Class I evaluation criteria for the Level-1 screening analysis are are the plume perceptibility (color difference, ΔE) and green plume contrast (Cp). Since there are no established criteria for Class II areas, model results for the parks/schools are provided for informational purposes only. The results of the visibility impact analysis are presented in **Table 5**, which indicates modeled plume perceptibility and green plume contrast values well below the criteria for San Rafael Wilderness.

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[4] "Guidelines for Soil and Vegetation Analysis and Visibility Analysis", Santa Barbara County Air Pollution Control District. December 2015. Available at: https://www.ourair.org/wp-content/uploads/SVA-VA-Guidelines.pdf.

[5] "Workbook for Plume Visual Impact Screening and Analysis (Revised)". EPA 454/R-92-023. October 1992. Available at: https://gaftp.epa.gov/Air/aqmg/SCRAM/models/screening/viscreen/WB4PlumeVisualOCR.pdf

Figure 1. Proximity of San Rafael Wilderness to ULA Project Site

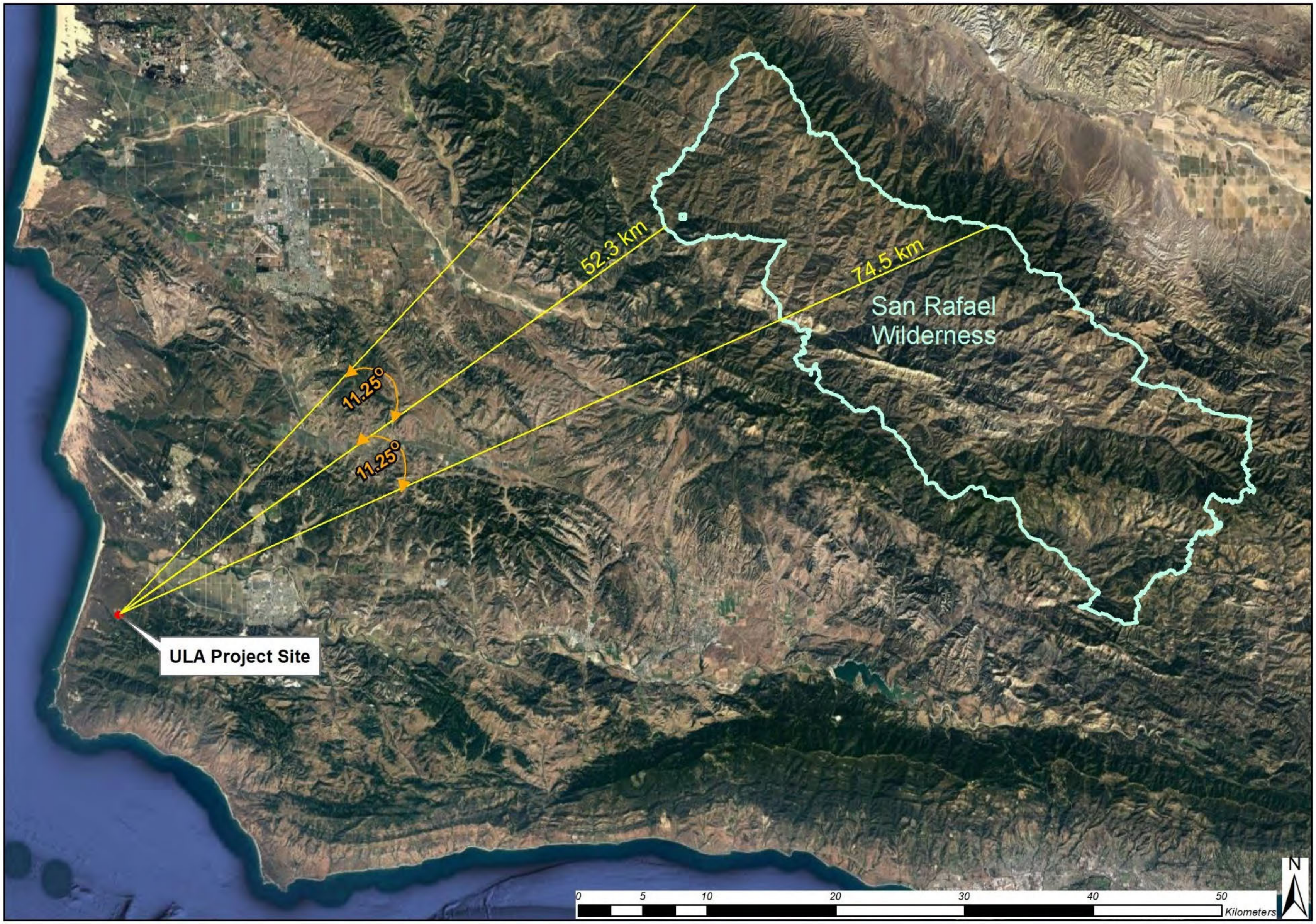
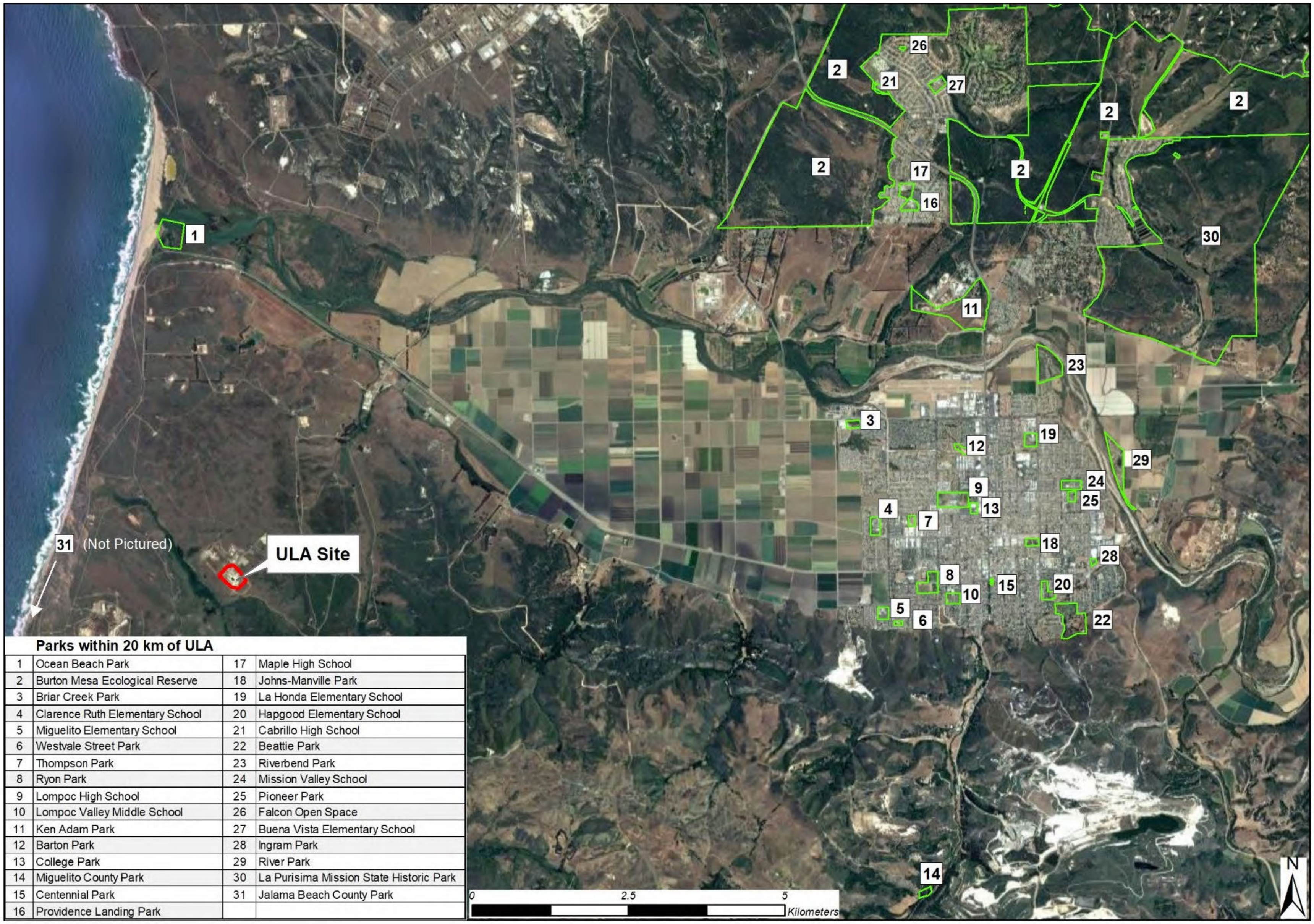


Figure 2. Locations of Parks and Schools Included in Class II Visibility Analysis



Parks within 20 km of ULA

1	Ocean Beach Park	17	Maple High School
2	Burton Mesa Ecological Reserve	18	Johns-Manville Park
3	Briar Creek Park	19	La Honda Elementary School
4	Clarence Ruth Elementary School	20	Hapgood Elementary School
5	Miguelito Elementary School	21	Cabrillo High School
6	Westvale Street Park	22	Beattie Park
7	Thompson Park	23	Riverbend Park
8	Ryon Park	24	Mission Valley School
9	Lompoc High School	25	Pioneer Park
10	Lompoc Valley Middle School	26	Falcon Open Space
11	Ken Adam Park	27	Buena Vista Elementary School
12	Barton Park	28	Ingram Park
13	College Park	29	River Park
14	Miguelito County Park	30	La Purisima Mission State Historic Park
15	Centennial Park	31	Jalama Beach County Park
16	Providence Landing Park		

Table 3. Project-Related Emissions Input to VISCREEN

Pollutant	lb/hr(1)
NO_X	21.449
PM	2.413

Notes:
(1) lb/day emissions converted to lb/hr assuming 10 hours operation per day.

Table 4. Distances Input to VISCREEN

Name	Minimum Distance(1) to Class I/Class II Boundary (km)	Maximum Distance to Class I/Class II Boundary (km)
Class I Areas		
San Rafael Wilderness	50(2)	74.5
Class II Areas		
Ocean Beach Park	5.1	5.6
Burton Mesa Ecological Reserve	9.4	19.5
Briar Creek Park	10.0	10.1
Clarence Ruth Elementary School	10.0	10.2
Miguelito Elementary School	10.1	10.3
Westvale Street Park	10.4	10.5
Thompson Park	10.6	10.7
Ryon Park	10.7	11.1
Lompoc High School	11.1	11.7
Lompoc Valley Middle School	11.2	11.4
Ken Adam Park	11.5	12.7
Barton Park	11.5	11.7
College Park	11.6	11.7
Miguelito County Park	11.8	12.0
Centennial Park	11.9	12.0
Providence Landing Park	12.0	12.3
Maple High School	12.0	12.3
Johns-Manville Park	12.5	12.7
La Honda Elementary School	12.6	12.9
Hapgood Elementary School	12.7	12.9
Cabrillo High School	12.7	12.9
Beattie Park	12.9	13.4
Riverbend Park	13.0	13.5
Mission Valley School	13.1	13.4
Pioneer Park	13.2	13.3
Falcon Open Space	13.4	13.5
Buena Vista Elementary School	13.5	13.7
Ingram Park	13.5	13.6
River Park	13.9	14.3
La Purisima Mission State Historic Park	14.0	18.5
Jalama Beach County Park	16.1	16.6

Notes:
(1) Observer assumed to be located at closest Class I/Class II boundary, therefore this distance is used as both the "Minimum Distance between source and observer" and "Minimum distance to Class I/Class II boundary).
(2) The minimum distance to San Rafael Wilderness is 52.3 km. However, a minimum distance of 50 km was used in the model to be consistent with the 50-km maximum range of the approved use of VISCREEN as a short-range model.

Table 5. VISCREEN Results

Park Name	Observer Distance (km)	Back-ground	Perceptibility (ΔE)			Green Plume Contrast (Cp)		
			Modeled Value		Class I Criteria	Modeled Value		Class I Criteria
			10 deg Viewing Angle	140 deg Viewing Angle		10 deg Viewing Angle	140 deg Viewing Angle	
Class I Area								
San Rafael Wilderness	50.0	Sky	0.077	0.024	2	0.000	0.000	±0.05
		Terrain	0.008	0.002	2	0.000	0.000	±0.05
Class II Areas								
Ocean Beach Park	5.1	Sky	1.403	0.485	-	-0.001	-0.005	-
Burton Mesa Ecological Reserve	9.4	Sky	1.004	0.338	-	-0.001	-0.004	-
Briar Creek Park	10.0	Sky	0.272	0.272	-	-0.003	-0.003	-
Clarence Ruth Elementary School	10.0	Sky	0.793	0.272	-	-0.001	-0.003	-
Miguelito Elementary School	10.1	Sky	0.787	0.270	-	-0.001	-0.003	-
Westvale Street Park	10.4	Sky	0.767	0.263	-	-0.001	-0.003	-
Thompson Park	10.6	Sky	0.755	0.258	-	-0.001	-0.003	-
Ryon Park	10.7	Sky	0.753	0.257	-	-0.001	-0.003	-
Lompoc High School	11.1	Sky	0.734	0.251	-	-0.001	-0.003	-
Lompoc Valley Middle School	11.2	Sky	0.720	0.246	-	-0.001	-0.003	-
Ken Adam Park	11.5	Sky	0.732	0.249	-	-0.001	-0.003	-
Barton Park	11.5	Terrain	0.704	0.241	-	-0.001	-0.003	-
College Park	11.6	Sky	0.699	0.239	-	-0.001	-0.003	-
Miguelito County Park	11.8	Sky	0.688	0.235	-	-0.001	-0.003	-
Centennial Park	11.9	Sky	0.683	0.233	-	-0.001	-0.003	-
Providence Landing Park	12.0	Sky	0.679	0.232	-	-0.001	-0.003	-
Maple High School	12.0	Sky	0.679	0.232	-	-0.001	-0.003	-
Johns-Manville Park	12.5	Sky	0.654	0.223	-	-0.001	-0.003	-
La Honda Elementary School	12.6	Sky	0.649	0.221	-	-0.001	-0.003	-
Hapgood Elementary School	12.7	Sky	0.644	0.220	-	-0.001	-0.003	-
Cabrillo High School	12.7	Sky	0.644	0.220	-	-0.001	-0.003	-
Beattie Park	12.9	Sky	0.637	0.217	-	-0.001	-0.003	-
Riverbend Park	13.0	Sky	0.632	0.215	-	-0.001	-0.003	-
Mission Valley School	13.1	Sky	0.627	0.213	-	-0.001	-0.003	-
Pioneer Park	13.2	Sky	0.622	0.212	-	-0.001	-0.003	-
Falcon Open Space	13.4	Sky	0.614	0.209	-	-0.001	-0.002	-
Buena Vista Elementary School	13.5	Sky	0.609	0.207	-	-0.001	-0.002	-
Ingram Park	13.5	Sky	0.609	0.207	-	-0.001	-0.002	-
River Park	13.9	Sky	0.593	0.202	-	-0.001	-0.002	-
La Purisima Mission State Historic Park	14.0	Sky	0.615	0.207	-	-0.001	-0.003	-
Jalama Beach County Park	16.1	Sky	0.513	0.174	-	-0.001	-0.002	-

Appendix H

Vulcan Centaur Flares

Responses to Incompleteness Items

CONFIDENTIAL INFORMATION DELETED

ATC NO. 15795

RESPONSES TO INCOMPLETENESS ITEM LIST

PERMITTING INCOMPLETENESS ITEMS

General

1. **Federal/VSFB Approval.** Provide an approval letter from VSFB (Base Commander, Space Launch Program, etc.) for the proposed operations and equipment.

   Please refer to Appendix F, Vandenberg SFB Memorandum.

2. **Process Description.** Provide a detailed process description of the project including, but not limited to, truck offloading operations, launch vehicle loading operations, flare operational scenarios, and the various operational scenarios identified in the emission calculations (i.e., daily boiloff, vehicle venting, etc.).

   Please refer to the Narrative Description. This document provides an overview of the project as requested.

3. **Confidential Information.** Review the application and revise redactions as need to ensure that the information is eligible to be redacted per the District's Policies and Procedures as well as California Government Code Section 6254.7.

   Separate files containing marked confidential materials and those available for public view will be submitted at a later date per discussion with Mr. Kevin Brown on January 27th, 2022.

LNG Tank

4. **Manufacturer Specifications.** Submit manufacturer for the LNG tank.

   A tank vendor has not yet been selected. The permit can be updated with manufacturer's tank specifications after the tank is built. Key ULA required features and requirements for the storage vessel can be found in the attached Narrative Description, Paragraphs 2.2, 2.5, and 2.6.

5. **Support Systems.** Submit LNG tank cryogenic system manufacturer specifications and descriptions of the associated equipment.

   Overall LNG system details have not yet been designed, and system components have not yet been selected. However key component descriptions and associated ULA requirements can be found in the attached Narrative Description, Paragraphs 2.1, 2.2, and 2.5.

6. **Flow Meter.** Submit correspondence from flow meter manufacturers stating that a flow meter cannot be used to track LNG tank throughputs. The District prefers that the LNG is directly measured in lieu of calculated volumes. If a flow meter is viable for use on the LNG tank, submit manufacturer specifications for the flow meter.

   Reasoning for using [redacted] instead of a flow meter is presented in the Narrative Description, Paragraph 2.7.

7. [redacted] If a flow meter is not viable for use on the LNG tank, submit manufacturer specifications for the proposed [redacted]

Please refer to the Narrative Description, Paragraph 2.6.

8. **Pressure Calculations.** Provide more details on how the [redacted] will be used to calculate the volume of LNG in the tank including the basis of these calculations and a description of systems and equipment used to make these calculations.

Please refer to the Narrative Description, Paragraph 2.6.

9. **Possible Emissions.** Confirm that the LNG tank has no potential to emit from the LNG tank aside from the vapors routed to the enclosed flare during truck offloading events. Possible emission sources include working and breathing losses during vehicle loading events or venting events.

The tank is a closed system, and all vents are routed to the enclosed flare or elevated flare stack. The external leak requirements ULA levies on the storage vessel and associated hardware are listed in the Narrative Description Paragraph 2.5.

Elevated Flares

10. **Heat Input Capacity.** Address the discrepancy of the elevated flares' listed heat input capacity between Form 200-14 (5,000 MMBtu/hr), emission calculations (354 MMBtu/hr) and manufacturer specifications (unidentified).

The 5,000 MMBtu/hr (5,084 MMBtu/hr based on new calculation) capacity is based on the manufacturer specification of 60 lbs/second and the following calculation 60 lbs/s * 0.023536 MMBtu/lb * 3600 s/hr = 5,084 MMBtu/hr. The capacity grossly misrepresents the flares so Form 200-14 is revised to list the capacity as stated in the next paragraph.

Elevated flares emission calculation spreadsheets were separated, as requested in Item 21 below. Based on launch day highest hourly combustion the GSE flare capacity is calculated to be 271.5 MMBtu/hr and the Vehicle flare capacity is calculated to be 303.6 MMBtu/hr. Form 200-14 is revised to show the calculated capacity.

Please note that flaring at 60 lbs/s is only anticipated to last for [redacted]

11. **Elevated Flare BACT.** Why are enclosed flares not proposed as BACT for the launch vehicle loading operations instead of the elevated flares? If enclosed flares are not a viable option, provide an explanation why enclosed flares were not technically feasible or cost effective. If enclosed flares are a viable option, revise the application accordingly.

The elevated air assisted flare is designed to safely and efficiently burn large volumes of natural gas based on an open flame design. The design basis for an elevated flare follows AP-42 guidelines and targets ground level heat no greater than 1,500 BTU/Hr-Ft^2. The maximum heat output is based on personnel protection in the event of an upset condition. An elevated flare capable of handling up to 60 lbs./sec is 90-feet tall. A similar height enclosed flare is capable of handling just 0.6 lbs./sec flow. It would take up to 100-each enclosed flares to manage the throughput of just 1-each elevated flare. Additionally, each enclosed flare requires a large (up to 250 HP) electric motor, and pilot and makeup gas to optimize fuel and air burn ratios. The cost of one (1) enclosed flare is estimated at [redacted] whereas the elevated (open), air assisted flare is estimated at [redacted] The additional need for electrical power and pilot and makeup gas to support multiple enclosed flares would also exceed current VSFB utility capacity and physical SLC-3 space.

12. **Manufacturer Emission Guarantees.** Submit elevated flare manufacturer emission guarantees for NOx, ROC, and CO in units of lb/MMBtu and/or ppmv. Additionally, include the ROC reference compound (i.e., methane, propane, ethane).

Flare vendor provided the following response to a similar question: Elevated Flares by their nature do not lend themselves to direct measurement of the products of combustion using conventional techniques. The industry standards for determination of destruction or combustion efficiency of elevated flares are based on the testing conducted by the US EPA and Chemical Manufacturers from 1983 to 1985 and published in EPA document" Evaluation of the Efficiency of Industrial Flares (Sept 1985). Based on these studies the US EPA concluded that properly designed and operated flares achieve greater than 98% combustion efficiency. The EPA promulgated regulations for flares (40CFR60.18 and 40 CFR 63.11(b)) that establish guidelines for exit velocity and minimum heating value for steam assisted, air assisted and non-assisted flares to ensure proper flame stability / destruction efficiency of flares. The emissions factors obtained during this testing are published in EPA document AP-42. This has become the industry standard (worldwide) for the determination of destruction efficiency of flares. Flares designed within these guidelines have been assumed to provide minimum DRE of 98%.

13. **Cape Canaveral Flare.** Submit source test results and/or emissions data from the elevated flare(s) installed at Cape Canaveral.

Cape Canaveral flares were not tested. Please see response to Item 12 above for more information.

14. **Electric Motor.** The manufacturer specifications identify two possible electric motors used for the elevated flares (150 bhp or 200 bhp Vane Axial motors). Identify the electric motor(s) that will be installed.

The updated John Zink document confirms a 250HP air assist motor is required for elevated flares. Page 5 of FS 134657-A1 (John Zink LNG Elevated Flare Stack for 60-lb/sec.) This is preliminary data, and the final flare configuration will be provided when the flare design is matured.

15. **Flow Meter.** Submit correspondence from flow meter manufacturers stating that a flow meter cannot be used to track the elevated flare throughputs. The District prefers that the LNG is directly measured in lieu of calculated volumes. If a flow meter is viable for use with the elevated flares, submit manufacturer specifications for the flow meter.

Reasoning for using a [redacted] instead of a flow meter is presented in the Narrative Description, Paragraphs 2.6 and 2.7.

16. [redacted] If a flow meter is not viable for use on the elevated flares, submit manufacturer specifications for the proposed [redacted]

Please refer to the Narrative Description, Paragraph 2.6.

17. **Nitrogen.** Will nitrogen in the fuel lines impact the recorded LNG flows to the elevated flares? If so, provide an explanation how the nitrogen will be calculated and then removed from the recorded fuel flow.

If a [redacted] is utilized to measure flow of LNG from the tank, then nitrogen in the fuel line will not impact the recorded LNG flows.

18. **Identified Operational Scenarios.** Provide a detailed explanation of the 30 pounds per second and 60 pounds per second operational scenarios identified in the John Zink manufacturer specifications including, but not limited to, what equipment or processes send boiled off LNG to the elevated flares, duration of the flaring events, and the daily and annual frequency of these flaring events.

    The 30 lb./sec flow rate flare is not expected to be used at this time. ULA's current design is to use 2-each, 60 lb./sec flares. If the design and testing at LC-41 reveal a lower flow rate flare can be used for launch vehicle elevated flare, ULA will update air permit as required. Please refer to the Narrative Description, Paragraphs 2.3 and 2.4 for operational scenarios.

19. **Unidentified Operational Scenarios.** Provide a detailed explanation of any unidentified elevated flare operations including, but not limited to, what equipment or processes send boiled off LNG to the elevated flares, duration of the flaring events, and the daily and annual frequency of these flaring events. Possible unidentified operational scenarios include flare emergency use, or the elevated flares being used as a backup for the enclosed flare.

    The Narrative Description and Flare volume estimate spreadsheet (Appendix A) provide the requested details on operational scenarios for the elevated flares. Additionally, an uncontrolled event such as an LNG catastrophic roll-over could result in an overpressure event where Pressure Relief Valve (PRV) would open and send NG to the GSE elevated flare [redacted]

20. **Worst Case Process Flow.** Identify the instantaneous worst case LNG flow to the elevated flares and the duration of the associated flaring event. Submit documentation that the elevated flares have the operational capacity to handle the identified instantaneous worst case process flow.

    The instantaneous worst case LNG flow is expected at the GSE elevated flare at 60 lb LNG/second when the storage tank is vented. This event will last no longer than [redacted] The Flare volume estimate spreadsheet provides a description of all known flare operational scenarios, associated flow rate, duration, and quantity. The worst-case operational flow is included in manufacture's capacity of each flare.

21. **Emission Calculations. Address the following for the elevated flare emission calculations:**

    a. **Emission Calculation Spreadsheet.** Revise the elevated flare emission calculations to use the District's emission calculation spreadsheet for flares (link: https://www.ourair.org/wp-content/uploads/ Flare.xlsx). Submit separate emission calculations spreadsheets for the two elevated flares.

       In addition to the Flare volume estimate spreadsheet located in Appendix A, District's emission calculation spreadsheet for each flare is included in Appendix B of this submittal. The District spreadsheets have been slightly modified to accommodate the specific operations of the Vulcan project flares.

    b. **LNG Fuel Properties.** Address why the LNG's heat content (MMBtu/gal) and density (lb/gal) are used in the emission calculations when gaseous natural gas (scf) will be combusted in the elevated flares. Revise the emission calculations to reference the throughputs in units of scf or provide an explanation why the submitted units are more applicable. If the 0.082644 MMBtu/gal and 3.57 lb/gal values will be maintained in the emission calculations, provide documentation for these LNG properties.

       In the revised calculations, LNG's heat content is presented in MMBtu/lb considering that most of the usage is estimated in pounds. The value is calculated from LNG analysis provided by an LNG vendor. The same analysis was used to calculate the density value as shown in table below.

	methane	ethane	propane	butane	nitrogen
volume %	97.42	1.632	0.025	0	0.925
density (lbm/cuft)	26.3665	33.94969	36.26289	37.53483	50.32154
density (lbm/gal)	3.524934	4.538729	4.84798	5.018026	6.727479
total density (lbm/gal)	**3.571504**				

c. **LNG Higher Heating Value.** Revise the emission calculations and application to use the District's default higher heating value of 1,050 Btu/scf for PUC quality natural gas. Alternatively, provide documentation showing that LNG has a different higher heating value than 1,050 Btu/scf. The application states that the higher heating value of LNG is 1,000 Btu/scf (Form 200-14), 917 Btu/scf (flare manufacturer specifications) or 1,050 Btu/scf (emission calculations).

Analysis provided by LNG vendor (Applied LNG) lists heating value of 1017.7 Btu/scf. This value was used to update the emission calculation spreadsheet. Please refer to Narrative Description, Paragraph 2.9 for a copy of analysis.

d. **SO_X Emission Factor.** Revise the SO_X emission factor from 0.0016 lb/MMBtu to 0.0017 MMBtu/hr by adding a 34/32 conversation factor. More information on this needed change can be found here: https://www.ourair.org/wp-content/uploads/ sulfur01.pdf.

The referenced 34/32 factor seems to involve H2S which is not present in LNG. However, SO_x emission factor was revised to 0.0017 lb/MMBtu based on LNG heating value.

e. **PM, PM10, and PM2.5 Emission Factors.** Revise the PM, PM10, and PM2.5 emission factors for the elevated flares to 0.0200 lb/MMBtu. Alternatively, provide documentation showing that different PM, PM10, and PM2.5 emission factors are applicable. In the District's opinion, the submitted emission factors of 0.0077 lb/MMBtu for the combustion of propane in a flare is not representative of the proposed operations since propane is not being combusted.

Propane combustion emission factor (EF) was selected for being a purified substance that resembles LNG. The District's emission calculation spreadsheet for flares references SBCAPCD for PM EF and AP-42, Chapter 1.4, for PM_{10} and $PM_{2\ 5}$. However, AP-42, Chapter 1.4, PM EF for combustion of natural gas is 0.00745 lb/MMBtu (converted from 7.6 lb/10^6 scf). AP-42, Chapter 13.5, does not address PM emissions. The District flare study did not specify a PM EF but the flares in the study burn field gas which is significantly "dirtier" than LNG and would be expected to have higher PM emissions.

f. **Other Edits.** Revise the elevated flare emission calculations as needed based on responses to other incompleteness items.

Flare emission calculation was revised as needed.

Enclosed Flare

22. **Heat Input Capacity.** Address the discrepancy of the enclosed flare's listed heat input capacity between Form 200-14 and emission calculations (50 MMBtu/hr), and the manufacturer specifications (46.320 MMBtu/hr).

    The discrepancy is due to the use of different heating values for LNG. The flare is rated at 0.6 pounds of LNG per second. The attached Form apcd 200-14 lists the enclosed flare capacity at 50.8 MMBtu/hr.

23. **Enclosed Flare BACT.** Address the following for the enclosed flare's BACT determination:

    a. **Oil and Gas Enclosed Flare BACT.** Provide an explanation why the BACT technologies and standards for oil and gas production flares (0.0183 lb/MMBtu for NOx, 0.0074 lb/MMBtu for CO, and 0.0042 lb/MMBtu for ROC) listed in District BACT Guideline 1.5.1 (link: https://www.ourair.org/wp-content/uploads/BACT-Guideline-1.5.1.pdf) are not applicable to the proposed enclosed flare operations. This explanation should include why oil and gas flares were not technically feasible or cost effective.

       Destruction efficiency for hydrocarbons was the main focus when analyzing flares for BACT. Vendors who demonstrated an ability to provide flares suitable for this project were asked to submit specification for their flares with the highest destruction efficiency. The selected flare has an ROC EF of 0.0001 lb/MMBtu compared to oil and gas production flares BACT which has an ROC EF of 0.0042 lb/MMBtu.

    b. **BACT Standards.** Provide an explanation why the Aereon CEB 800, CEB 1200, or CEB 4500 flares were not selected as BACT for this project. All these flare models have emission guarantees (0.018 lb/MMBtu for NOx, 0.010 lb/MMBtu for CO, and 99.9% destruction for ROC) that are equal to or lesser than the proposed values for the John Zink flare (0.020 lb/MMBtu for NOx, 0.010 lb/MMBtu for CO, and 99.9% destruction for ROC). This explanation should include why the Aereon flares were not technically feasible or cost effective.

       Alternatively, provide revised flare emission guarantees from John Zink to meet the BACT standards listed in District BACT Guideline 1.5.1 (depending on the response to the item above) or the Aereon emission guarantees.

       The John Zink NOX Star enclosed flare was selected for several reasons. The primary factors for selecting the John Zink enclosed flare over Aereon include:

       1) Simplified operation with single stack flare that can support flow rate ranges between [redacted] and 0.6 lbs./sec. Aereon solution requires two (2) CEB800's to accommodate the required flowrates for the enclosed flare.
       2) Flare startup requires burning assist gas (natural gas or propane) and air assist to support high destruction efficiency and prevent smoke on startup. Multiple units required by Aereon design drives higher complexity/failure potential, increased use of assist gas to support multiple unit staging (startup & shutdown), and higher cost to support air assist blower power, civil infrastructure (foundations)
       3) The John Zink NOX Star flare has a better documented ROC destruction efficiency than the Aereon CEB flares (99.99% for John Zink vs 99.9% for Aereon).
       4) ULA currently uses exclusively John Zink elevated and enclosed flares for

Vulcan operations at LC-41 on the east coast and sticking with the same vendor for SLC-3 on the west coast simplifies both operation (same software control logic and operations procedures) and maintenance (single supplier/repair team when scheduling periodic or emergency maintenance).

24. **Manufacturer Emission Guarantee.** Submit enclosed flare manufacturer emission guarantees for ROC in units of lb/MMBtu and/or ppmv. Additionally, include the ROC reference compound (i.e., methane, propane, ethane).

Manufacturer emission guarantees for ROC was provided in terms of % reduction in total hydrocarbons. The ROC emission factor in lb/MMBtu was calculated using the stated % and the LNG composition. An ROC reference compound was not provided in the manufacturer's documents.

Performance Guarantee from John Zink proposal:

> "The John Zink® Enclosed Vapor Combustion Unit is designed to combust the hydrocarbon vapors from the incoming air/hydrocarbon vapor mixture in order to comply with guaranteed emission limits as stated below.
> 99.99% Reduction in Total Hydrocarbon Vapor Emissions
> 0.02 lb/MMBTU of Nitrogen Oxides (NOx)
> 0.02 lb/MMBTU of Carbon Dioxide (CO)"

25. **Flow Meter.** Submit the manufacturer specifications for the enclosed flare flow meter.

Reasoning for using [redacted] instead of a flow meter is presented in the Narrative Description, Paragraph 2.7.

26. **Nitrogen.** Provide a detailed explanation how ULA will determine the volume of nitrogen in the enclosed flare fuel lines. ULA noted that the calculated nitrogen volume would be removed from the enclosed flare flow meter's recorded volume.

If a [redacted] is utilized to measure flow of LNG from the tank, then nitrogen in the fuel line will not impact the recorded LNG flows.

27. **Identified Operational Scenario.** Provide a detailed explanation of the 0.60 pounds per second operational scenario identified in the John Zink manufacturer specifications including, but not limited to, what equipment or processes send boiled off LNG to the enclosed flare, duration of the flaring events, and the daily and annual frequency of these flaring events.

Processes that send LNG boiloff to the enclosed flare are detailed in the Flare volume estimate spreadsheet, located in Appendix A. The spreadsheet contains all requested information. Further details are provided in the Narrative Description.

28. **Unidentified Operational Scenarios.** Provide a detailed explanation of any unidentified enclosed flare operations including, but not limited to, what equipment or processes send boiled off LNG to the enclosed flare, duration of the flaring events, and the daily and annual frequency of these flaring events. Possible unidentified operational scenarios include flare emergency use, or the enclosed flare being used as a backup for the elevated flares.

In the event that the Enclosed Flare is off-line for repairs or maintenance, the daily boiloff would be routed to the GSE elevated flare. Off-line duration is expected to be no more than 10-days per year. The enclosed flare is not anticipated to be used as a backup to the elevated flare.

29. **Worst Case Process Flow.** Identify the instantaneous worst case LNG flow to the enclosed flare and the duration of the associated flaring event. Submit documentation that the enclosed flare has the operational capacity to handle the identified instantaneous worst case process flow.

Worst case LNG flow is expected when [redacted] LNG tankers are offloading at the same time. Offloading duration is [redacted] Based on observed field data at LC-41, max flow is expected to be below 0.6 lb/s. John Zink proposal (Appendix C) rates the enclosed flare at 0.6 lb/s.

30. **Emission Calculations.** Address the following for the enclosed flare emission calculations:

a. **Emission Calculation Spreadsheet.** Revise the enclosed flare emission calculations to use the District's emission calculation spreadsheet for flares (link: https://www.ourair.org/wp-content/uploads/ Flare.xlsx).

In addition to the Flare volume estimate spreadsheet located in Appendix A, District's emission calculation spreadsheet for the flare is included in Appendix B of this submittal. The District spreadsheets have been slightly modified to accommodate the specific operations of the Vulcan project flares.

b. **LNG Fuel Properties.** Address why the LNG's heat content (MMBtu/gal) and density (lb/gal) are used in the emission calculations when gaseous natural gas (scf) will be combusted in the enclosed flare. Revise the emission calculations to reference the throughputs in units of scf or provide an explanation why the submitted units are more applicable. If the 0.082644 MMBtu/gal and 3.57 lb/gal values will be maintained in the emission calculations, provide documentation for these LNG properties.

In the revised calculations, LNG's heat content is presented in MMBtu/lb considering that most of the usage is estimated in pounds. The value is calculated from LNG analysis provided by an LNG vendor. The same analysis was used to calculate the density value as shown in table below. Please refer to Narrative Description, Paragraph 2.9.

	methane	ethane	propane	butane	nitrogen
volume %	97.42	1.632	0.025	0	0.925
density (lbm/cuft)	26.3665	33.94969	36.26289	37.53483	50.32154
density (lbm/gal)	3.524934	4.538729	4.84798	5.018026	6.727479
total density (lbm/gal)	**3.571504**				

c. **LNG Higher Heating Value.** Revise the emission calculations and application to use the District's default higher heating value of 1,050 Btu/scf for PUC quality natural gas. Alternatively, provide documentation showing that LNG has a different higher heating value than 1,050 Btu/scf. The application states that the higher heating value of LNG is 1,000 Btu/scf (Form 200-14), 917 Btu/scf (flare manufacturer specifications) or 1,050 Btu/scf (emission calculations).

Analysis provided by LNG vendor (Applied LNG) lists heating value of 1017.7 Btu/scf. This value was used to update the emission calculation spreadsheet. Please refer to Narrative Description, Paragraph 2.9.

d. **SO_X Emission Factor.** Revise the SO_X emission factor from 0.0016 lb/MMBtu to 0.0017 MMBtu/hr by adding a 34/32 conversation factor. More information on this needed change can be found here: https://www.ourair.org/wp-content/uploads/ sulfur01.pdf.

The referenced 34/32 factor seems to involve H2S which is not present in LNG. However, SO_x emission factor was revised to 0.0017 lb/MMBtu based on LNG heating value.

g. **PM, PM10, and PM2.5 Emission Factors.** Revise the PM, PM10, and PM2.5 emission factors for the enclosed flare to 0.0200 lb/MMBtu. Alternatively, provide documentation showing that different PM, PM10, and PM2.5 emission factors are applicable. In the District's opinion, the submitted emission factors of 0.0077 lb/MMBtu for the combustion of propane in a flare is not representative of the proposed operations since propane is not being combusted.

Propane combustion emission factor (EF) was selected for being a purified substance that resembles LNG. The District's emission calculation spreadsheet for flares references SBCAPCD for PM EF and AP-42, Chapter 1.4, for PM_{10} and $PM_{2.5}$. However, AP-42, Chapter 1.4, PM EF for combustion of natural gas is 0.00745 lb/MMBtu (converted from 7.6 lb/10^6 scf). AP-42, Chapter 13.5, does not address PM emissions. The District flare study did not specify a PM EF but the flares in the study burn field gas which is significantly "dirtier" than LNG and would be expected to have higher PM emissions.

e. **Other Edits.** Revise the enclosed flare emission calculations as needed based on responses to other incompleteness items.

Flare emission calculation was revised as needed.

Fugitives

31. **Truck Offloading.** Address the following for the truck offloading operations:

a. **Submitted Emissions.** Submit the truck offloading emission calculations used to determine the 0.856 pounds per year potential to emit listed in the application.

The 0.856 pounds figure was miscalculated. Sources of fugitive emissions are LNG offloading and LNG sampling. LNG tanker will push LNG out of tanker until only gas is exiting tanker and supply line connection to facility is free of liquid. Trapped gas within the [redacted] transfer line is purged with nitrogen to the atmosphere. However, fugitive emissions calculation assumes no purging.

The combined, offloading and sampling, Gaseous Natural Gas (GNG) released is [redacted]t an estimated pressure of [redacted]

Using the ideal gas law n=Pv/RT

[redacted] = 0.07047 lb ROC/year

b. **Frequency.** What is the daily and annual frequency of truck offloading events?

Maximum truck offloading events are anticipated to be [redacted]

c. **Volumes.** What volume of LNG (in units of gallons or scf) is offloaded into the LNG tank on a daily and annual basis?

[redacted]

d. **Offloading Process.** Provide a description of the LNG offloading process.

Please refer to Narrative Description, Paragraph 2.3

e. **Associated Equipment.** Provide a list and brief description of the equipment used to offload LNG from the tanker truck into the LNG tank (i.e., loading racks, electric motors, vapor recovery units, etc.).

Please refer to Narrative Description, Paragraph 2.3

32. **Component Leak Paths.** Components containing LNG are required to be permitted by the District since this equipment has a potential to emit and is not exempt from permit. Submit the following documentation and information to the District:

a. Form 200-20 (link: https://www.ourair.org/wp-content/uploads/apcd-200-20.pdf)

For details on how ULA is not expecting leaks from components, please refer to Paragraph 2.5 "Fugitive Emissions during LNG System Operations" in the attached Narrative Description.

b. MSDS or analysis with the LNG's ROC to total hydrocarbon (THC) ratio

In addition to the Department of Defense performance specification MIL-PRF-32207 (included in the permit application), analysis from an LNG vendor is provided in the Narrative Description. ROC (propane) is 0.025% of volume.

c. Fugitive emission calculations using the District's fugitive emission calculation spreadsheet (link: https://www.ourair.org/wp-content/uploads/Fugitives.xlsx)

District's fugitive emission calculation spreadsheet will not be submitted. Please refer to Item 32.a above.

Alternatively, provide the District with documentation showing that all components containing LNG do not have a potential to emit (ex. all piping is operated under negative pressure).

Other

33. **Emission Reduction Credits (ERCs).** Address the following for the project's offsets and emission reduction credit requirements:

a. **Offset Ratio.** While the provided ERCs are currently owned by ULA, all the provided ERCs did not originate from the United Launch Alliance stationary source (SSID: 11166). Therefore, the applicable offset ratio is 1.3 to 1, not 1.1 to 1. See District Rule 804.D for more details (link: https://www.ourair.org/wp-content/ uploads/Rule804.pdf). Revise the Form-05Us and submitted ERCs accordingly to address the correct offset ratio.

Form-05Us are revised to account for an offset ratio of 1.3 to 1.

b. **Other Revisions.** As needed, update the Form-05Us and submitted ERCs as needed based on other incompleteness responses.

Forms are updated based on revised emission calculations.

34. **Knockout Drum.** Provide manufacturer specifications, brief description, and any other relevant information regarding the knockout drum referenced in the emission calculation operational scenarios.

Please refer to the Narrative Description, Paragraph 2.2.

35. **Removed Equipment or Operations.** Will any equipment or operations currently permitted as part of another ULA facility (FIDs: 00206 and 03970) be removed as part of this project?

[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

36. **Modified Equipment or Operations.** Will any equipment or operations currently permitted as part of another ULA facility (FIDs: 00206 and 03970) be modified as part of this project (ex. change of operational schedule or throughput)?

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

TOXICS INCOMPLETENESS ITEMS

1. **Visibility, Soils and Vegetation Analysis**. A visibility, soils and vegetation analysis is required for this project, per District Rule 802.H. https://www.ourair.org/wp-content/uploads/Rule802.pdf.

   Please refer to Appendix G, Visibility, Soils and Vegetation Analysis.

2. **Health Risk Assessment**. A health risk assessment (HRA) is required for this project. The *Preliminary Dispersion Protocol* dated September 24, 2021 addresses only the Air Quality Impact Assessment (AQIA). A separate modeling protocol is required for the HRA. The District's Modeling Protocol Tables must be submitted for the HRA (https://www.ourair.org/wp-content/uploads/Modeling-Protocol-Tables-for-HRA-Report.xlsx) and may be used in lieu of a written HRA protocol. Please note that the receptors used for VSFB AB 2588 analysis must be used for the HRA. The property boundary receptors were identified in VSFB's July 1, 2020 Air Toxics Emission Inventory Plan (ATEIP) under AB 2588 for Inventory Year 2018. Furthermore, all onsite receptors, pathway receptors, and acute receptors identified in VSFB's 2018 ATEIP submitted July 1, 2020 must be included in the HRA.

   An HRA will be submitted at a later date.

3. **AQIA Protocol**. Address the following comments on the September 24, 2021 *Preliminary Dispersion Protocol* for Vandenberg SFB SLC-3 Flares:

   Responses to AQIA Protocol items are provided below. Additionally, a revised AQIA Protocol is located in Appendix D.

   a. ROC must be included in the increment analysis for the AQIA. Furthermore, if the proposed sulfur content of the fuel increases (currently proposed at 10 ppm) or the proposed project SOx emission rate increases, an ambient air quality standard analysis and an increment analysis for SO2 may be required.

      ROC will be included in increment analysis. If sulfur content of methane fuel exceeds 10 ppm then an increment analysis for SO_2 will be included. However, this is not expected to occur.

   b. Clarify the scope of the project. It appears from the *Preliminary Dispersion Protocol* that only the three flares will be included in the AQIA. However, any increase in emissions from the existing operating conditions is considered part of the project and must be included in the AQIA. As noted above, an ROC increment analysis is required. For that reason, any project ROC emissions, including fugitive emissions, must be included in the increment analysis.

      Based on the results of the fugitive emissions and all sources to be included, the AQIA will include these sources as included in the emission inventory.

   c. The intention of the AQIA is to evaluate concentrations at ambient air locations (i.e., all offsite locations, including the ocean). Furthermore, EPA has clarified that any onsite areas that the facility owner does not control access to are considered ambient air (e.g., public roadways which civilians may access). All onsite locations where VSFB has control of access is not considered ambient air and for that reason, receptors are not required at controlled onsite locations for the AQIA. Please note that receptors for the HRA are treated differently; a receptor must be placed at any location with human activity, as identified in VSFB's 2018 ATEIP submitted July 1, 2020. Please update Section 4.6 of the *Preliminary*

Dispersion Protocol accordingly.

Section 4.6 of the Preliminary Dispersion Protocol (protocol) will be updated to exclude mention of any modeled locations onsite or areas of access control. Needed analysis for the HRA will be determined based on findings for that analysis.

d. VSFB's entire property boundary may be used for the AQIA analysis. The property boundary receptors were identified in VSFB's July 1, 2020 ATEIP for Inventory Year 2018.

In addition to other receptor locations, the entire property boundary as identified in VSFB's July 1, 2020 ATEIP for inventory year 2018 will be included.

e. Due to the location of the project and the nearest Class I area, the District does not anticipate that a Class I Impact Analysis will be required. However, if the AQIA results indicate higher than expected concentrations at the edge of the modeling domain, a Class I Impact Analysis may be required.

Based on the concurrence of the District, no modeling of Class I areas is planned at this time. However, if higher than expected concentrations are determined, a Class I Impact Analysis will be reviewed with the District.

f. Section 4.4 of the AQIA protocol states that the Lompoc Watt Road met station will be used while Section 4.2 states that both South Vandenberg and the Lompoc Watt Road met station will be used in AERMOD in different runs. The Lompoc Watt Road met set will be used for the 2018 HRA for AB 2588 and is also appropriate this AQIA and HRA. Please update Section 4.2 of the *Preliminary Dispersion Protocol* to state that only the Lompoc Watt Road met set will be used.

Only the Lompoc Watt Road met set will be used and other nearby met sets will be ignored.

g. Specify that the rural option will be used.

The rural option will be used.

h. Specify that the regulatory default control options will be used.

The regulatory default control options will be used.

i. Specify the UTM zone and datum.

The UTM Zone 10 will be used, and the datum will be the 34.639697, -120.588915.

j. The current versions of AERMOD and Lakes' AERMOD View were correctly identified in the *Preliminary Dispersion Protocol*. However, please clarify that if any updates to the modeling software occur before the time that the AQIA is submitted, the most current version of the software will be used.

While the most current versions of AERMOD and Lakes' AERMOD were identified in the protocol, if any updates occur before modeling begins, the new versions will be used.

k. Provide the effective release parameters for the open flares, along with any intermediate parameters entered in Lakes or calculations used to determine the values. Documentation of the parameters must be provided.

The effective release parameters will be included with any intermediate parameters and documented in the protocol.

l. While the open flares may be modeled based on effective release parameters, the release parameters for the enclosed flare must be based on its physical characteristics. Provide the stack parameters based on the physical characteristics of the enclosed flare and documentation for these parameters.

Stack parameters for the enclosed flare and physical characteristics will be included in the protocol.

m. Background concentrations in Section 4.3 of the *Preliminary Dispersion Protocol* were the values provided by the District via email on September 22, 2021. However, Section 4.7 of the *Preliminary Dispersion Protocol* states that the background concentrations must still be determined. Please update Section 4.7 to reflect the values provided by the District.

Section 4.7 of the protocol will be revised to include values provided by District.

n. For any nearby buildings excluded from the analysis, include the calculations using the Good Engineering Practice that shows the buildings are not within the area of impact.

GEP calculations will be included to evaluated buildings to identify any buildings within the area of impact.

o. If you would like the District to review the emission rates prior to conducting the AQIA, please submit detailed emission calculation spreadsheets containing all calculation assumptions for each pollutant and averaging period with the revised *Preliminary Dispersion Protocol*. Alternatively, the emission calculation spreadsheets may be submitted with the AQIA report. For the emission calculations, first calculate the emissions on an annual, 24-hour, 8-hour, 3-hour or 1-hour basis, and then convert to grams per second (g/s). The *maximum* possible emissions during each averaging period should be used to model the impacts. For example, an emergency flare is installed at an oilfield, resulting in SO2 emission higher than normal during certain short-term operations. The worst-case short-term flaring scenario is when produced sour gas is routed to the emergency flare for a maximum of 5 minutes in a day. For modeling purposes, the 24-hour, the 3-hour and the 1 hour-SO2 mass emissions from the flare are all equal (e.g., 1 lb) because the flaring event occurs within 5 minutes. However, the emission rate (g/s) varies for each averaging period.

The emission calculations will be submitted for prior review.

RESPONSES to ATC NO. 15795 INCOMPLETENESS ITEMS

1. **Fuel Storage Tank:** Submit fugitive ROC emission calculations for the fuel storage tank.
   All releases from the pressurized fuel storage tank are directed to the enclosed flare. These releases are designated as "daily boiloff" in the emissions calculation spreadsheet. No other fugitive emissions are anticipated from the LNG storage tank. Refer to Section 2.5 of the Narrative Description for ULA's leak testing requirements for the LNG system piping and components, which also apply to the storage tank.
   CIM: We may need more information regarding the components before approving this. If approved, we would likely require leak testing on a regular basis, with any detection resulting in an emissions violation.
   ULA: The ULA provided Narrative Description states that "all hardware is tested by ULA both during initial system testing and **as part of recurring operations prior to every LNG tanking operation**", which we believe would satisfy the requirement to leak test on a regular basis. Furthermore, Section 2.5 of the Narrative Description includes all ULA leak testing requirements for the LNG system, including the "Recurring Pre-Cryo Operation Leak Test" requirements, which state that we leak test using inert GN2 at system Maximum Operation Pressure. So even if a leak developed over time in the LNG piping/valving system due to seal degradation, it would be identified before natural gas was introduced. The storage tank itself is a welded pressure vessel so aside from some sort of physical damage that cracks the tank itself which would be apparent by [redacted] or visible spill (both very unlikely and very off-nominal situations), all other pipe connections and valves fall into the recurring pre-cryo leak test procedures.
   ULA does not tolerate leaks, especially in a fuel system, so it's always in our best interest to maintain and operate a leak-tight system for personnel and equipment safety, and mission success when launching rockets.

2. **Elevated Flare Emissions:** The following comments refer to the elevated flare emission factors submitted in Appendix A.
   a. The ROC emission calculations appear to be based on a molecular weight of 44.097 and HHV of 1000 Btu/scf. Revise the calculations to use the molecular weight of 16.39 and HHV of 1017.7 Btu/scf shown in Appendix H1.
   ROC emission calculations for the two elevated flares were revised to reflect the values suggested by the District.
   CIM: No further comments.
   b. Revise the SOx emission factor calculation to include the (34/32) adjustment factor described in the following document: https://www.ourair.org/wp-content/uploads/sulfur01.pdf.
   The referenced 34/32 adjustment factor accounts for H_2S in some gaseous fuels (e.g., PUC natural gas). H_2S is not present in LNG.
   CIM: No further comments.
   c. The calculated maximum hourly heat input for the GSE elevated flare is based on a flow rate of 11,534 lb/hr, and the calculated maximum hourly heat input for the vehicle elevated flare is based on a flow rate of 12,900 lb/hr. Clarify why the maximum flow rate of 216,000 lb/hr was not used for these calculations.
   Flares were sized for tank pressure reduction events each lasting no longer than 2 minutes once during two (2) separate hours as detailed in "storage tank vent" in emissions calculation spreadsheet. Maximum hourly flow rate for each flare was calculated based on analyzing the various fuel related activities and selecting the highest hourly flow rate for each flare.
   CIM: Provide more details and calculations showing how the values were determined.
   ULA: The calculations are based on a combination of Launch Vehicle [redacted] requirement inputs

[redacted] and estimates based on [redacted] memos and general performance of our LNG ground system at LC-41 in Florida.

- **GSE Elevated Flare flowrate calc for 11,534 lb/hr:**

  - Input #1 - Storage Tank Boiloff:

    Normal Evaporation Rate = [redacted]
    Max liquid capacity of LNG tank [redacted] gal
    Density of LNG = 3.57 lbm/gal
    Unit Conversion = 24 hrs/day

    $$\text{[redacted] [redacted] [redacted] [redacted]} \frac{3.57}{24} = 101\ lbm/hr$$

    ➔ 101 lbm/hr boiloff from storage tank based on [redacted] NER tank procurement requirement

    [redacted]

    ➔ A "full" tank of LNG [redacted] gallons of liquid) means there is ~[redacted] gallons of gas space in the storage tank (10% ullage on a [redacted] gallon tank). [redacted] that monitors storage tank liquid level, as well as a liquid level gauge accessible to ULA technicians and engineers that are present for tanker offloads, would both read the tank as 100% full once there was [redacted] gallons of LNG in the tank. An additional [redacted] tanker trailers would need to be ordered and off-loaded into the storage tank in order to overfill the tank itself. Offload operations are procedurally controlled to ensure storage tanks are not over-filled.

  - Input #2 – Knock Out Drum Boiloff:

    Bleed Flowrate to KOD = [redacted]
    Density of LNG = 3.57 lbm/gal
    Unit conversion = 3600 sec/hr
    Flow duration = [redacted]
    Margin for off nominal needs to drain portions of the system = 1,000 gal

    $$\frac{\text{[redacted]} * 3600 * \text{[redacted]}}{3.57} = 11{,}092\ gal$$

$$11{,}092 + 1{,}000 = 12{,}092\ gal$$

[redacted]

KOD liquid flare off duration = 10hrs *(based on typical east coast operations)*

$$\frac{12{,}092 * 3.57}{10} = 4{,}317\ lbm/hr$$

➔ 4,317 lbm/hr boiloff from KOD

- Input #3 – Venting Storage Tank:

  Max Flare Flowrate Capability = 60 lbm/sec *(LNG Ground system hardware and software controls designed to not exceed flare capability)*

  Venting duration = 120 sec (*based on typical east coast operations to vent storage tank from* [redacted] *)*

$$60 * 120 = \ 7{,}200\ lbm$$

➔ 7,200 lbm in 2 minutes from storage tank vent-down. No vent for remaining 58 minutes.

∴ 101 + 4,317 + 7,200 = **11,618 lbm/hr** (went up from 11,534 after accounting for full storage tank for daily boiloff)

- **Vehicle Elevated Flare flowrate calc for 12,900 lb/hr:**

  - Input #1 – Vehicle Tank Boiloff:

    Max boiloff = [redacted]

    Unit conversion = [redacted]

[redacted]

➔ [redacted] for vehicle tank boiloff

- Input #2 – Venting Vehicle Tank:
  Max peak flowrate (instantaneous) = [redacted]
  Unit conversion = [redacted]

  [redacted]

  ➔ [redacted]

∴ [redacted] **= 12,900 lbm/hr (CONSERVATIVE)**

3. **Daily Boiloff:** The daily boiloff calculations should be based on the maximum LNG storage tank capacity. [redacted]

4. **Knockout Drum Boiloff:** The knockout drum boiloff emission calculations assume a flow rate of 42,840 lb/day for launch days, and 49,266 lb/day for wet dress rehearsals. Provide a formula and explanation of how these values were determined.
   42,840 lb/day equates to 12,000 gallons of LNG/day, the volume estimated to be collected in the knockout drum during launch activities. 49,266 lb/day equates to 13,800 gallons of LNG/day, the volume estimated to be collected in the knockout drum during wet dress rehearsal (WDR) day. These volumes are calculated using the known vehicle LNG drain flowrates [redacted] plus 1,000 gallons of margin per day. These required vehicle drain flowrates have been verified during testing at other ULA launch site facilities.
   CIM: Provide data from testing at other launch site facilities to support these values.
   [redacted] See response to question 2c above for calculation.

5. **LNG Sampling Calculations:** Clarify the formula and inputs used for the LNG sampling calculations, including how the 500 gallon estimate was determined.
   Fugitive emissions calculations are detailed in the Fugitives tab in the emissions calculation spreadsheet. The 500 gallons was estimated by ULA as the volume of LNG that each sampling event would use to chill down the sample device and surrounding fill line based on observation of similar sampling systems at other ULA launch

site facilities.
CIM: Provide data from testing at other launch site facilities to support this value. Also, does the multiplication by 12 in the calculation mean there will be a maximum of 12 events per year?
[redacted] The tank is pressurized to 1[redacted] is approximately 50 GPM. This does not include flow loss through the [redacted] sampler. Samples take approximately 10 minutes based on experience from launches to date in Florida.

➔ 50 GPM * 10 minutes = 500 gallons per sample

Yes, the multiplication by 12 covers [redacted] samples per launch campaign and [redacted] launches per year as outlined in the Narrative Description.

The same storage tank [redacted] that is used to monitor and record all LNG losses that get flared off is used to record total LNG usage during commodity sampling as well.

6. **Flare Pilot Gas:** The submitted manufacturer's specifications indicate that either natural gas or propane can be used for the pilots. The flare pilot gas emission calculations in Appendix A use an HHV of 1050 Btu/scf, implying natural gas will be used. Confirm that only natural gas will be combusted in the flare pilots.
   ULA confirms that only natural gas will be combusted in the flare pilots.
   CIM: No further comments.

7. **Fugitive LNG Emissions:** The following comments refer to the fugitive ROC emission calculations from LNG offloading and sampling submitted in Appendix A.
   a. Section 2.9 of the Narrative Description provides a density of 0.04324 lb/cu.ft. Clarify why this value was not used to calculate the fugitive emissions rather than the ideal gas law.
      At the time these calculations were drafted ULA had not received LNG specs from the vender. Fugitive emissions calculation was updated to reflect LNG density value of 0.04324 lb/cu.ft.
      CIM: No further comments.
   b. Provide a formula showing how the volume of natural gas vented per LNG sampling event (i.e., 0.0082 ft^3) was calculated.
      LNG sampling requires [redacted] flex hoses to connect the ground system to the sample collection device. The following formula was added to the Fugitives tab to show how the stated volume was calculated: [redacted]
      CIM: Thank you for the clarification. [redacted]

8. [redacted]
   CIM: No further comments.

9. **LNG Tank[redacted] Calculations:** When available, submit the requested formula and graph used to determine the LNG tank volume, as well as a description of how the formula inputs will be determined.
   ULA will submit the requested information when available.
   CIM: No comments at this time.

10. **Fly-Away Volume Calculations:** When available, submit the requested explanation detailing how

the fly-away LNG volume will be determined.

The Vulcan launch vehicle has instrumentation to precisely measure the amount of propellant onboard at the time of lift-off to ensure the vehicle performance targets are met and engines are controlled and shut down properly. The "fly-away" volumes at time of lift-off for every mission are recorded and can be used to calculate total elevated flare emissions when required. ULA will submit the requested information when available but please note that due to both proprietary designs and export controls (ITAR), the information will be redacted.

CIM: Clarify if this confidential information cannot be submitted to the District at all, or if it will be submitted in accordance with our *Handling of Confidential Information* policy? (https://www.ourair.org/wp-content/uploads/6100-020-1.pdf)

[redacted] ULA can provide specifics on the vehicle instrumentation that measures the "fly-away" volume, but it will be fully redacted for a public release like all other ITAR and proprietary info.

11. **Emission Reduction Credits (ERCs):** Please note that once the emission calculations are finalized, updated Form-05Us and ERCs will be required to be submitted to the District.

    ULA will submit updated ERC forms once the emission calculations are finalized.

    CIM: No comments at this time.

MODELING INCOMPLETENESS ITEMS

NOTE: The following comments are in response to the incompleteness items from the District's previous letter. No responses are required at this time. Please note that the District will provide comments on the modeling submittals at a later date.

12. **Visibility, Soils and Vegetation Analysis:** A visibility, soils and vegetation analysis was included with the January 28, 2022 submittal and is currently under review.

13. **Health Risk Assessment:** A health risk assessment (HRA) was submitted on November 23, 2022 and is currently under review.

    Comments received and the HRA has been revised. The revised HRA is included with this submittal.

14. **AQIA Protocol:** No further action required.

PLANNING INCOMPLETENESS ITEMS

NOTE: The District is aware that these items are currently being addressed separately. The incompleteness items listed below are the same as the incompleteness items from the District's October 20, 2021 and February 25, 2022 letters. Please note that the District cannot deem our application complete until the CEQA lead agency deems their application complete.

15. **California Environmental Quality Act:** The District is a lead agency under the California Environmental Quality Act (CEQA) for the project, and the District's permit action will require CEQA review prior to issuance. District staff have reviewed the Draft Supplemental Environmental Assessment (SEA) for the referenced project and have provided comments to VSFB on October 28, 2021, see attached. The District has determined that the Draft SEA does not comply with CEQA. Please provide the following information that will help the District assess impacts under CEQA:

    a. **Project Baseline:** In order to establish a CEQA "baseline" for the project, please provide a summary of the project's existing operational air quality emissions profile for the Atlas Program. This summary should include all emission sources, including stationary and mobile source emissions (passenger vehicles, trucks and *Rocketship* vessel, as appropriate), in order to assess the difference in air quality impacts between the existing project and the proposed project. For CEQA purposes, the actual emissions related to project operations over the last three to five years may be necessary to establish a reasonable baseline operational emissions scenario.

b. **Air Quality Impacts:** Provide a summary table that compares the project's air quality impacts (i.e., increase above baseline emissions), including criteria pollutants, toxic air contaminants, and greenhouse gas emissions, to the District's adopted CEQA air quality thresholds.[1] Please include detailed calculations, assumptions, spreadsheets, and model outputs used to assess the air quality impacts.

c. **Construction and Short-term Activities:** Include estimates of air pollutant emissions related to construction activities and any other short-term activities such as the proposed storage tank initial chill-down operation resulting in LNG boiloff.

d. **Impact Analysis:** The CEQA Guidelines provide the following impact areas that should be included in the analysis (CEQA Guidelines Appendix G)[2]: Aesthetics, Biological Resources, Geology/Soils, Hydrology/Water Quality, Noise, Recreation, Utility/Service Systems, Agriculture and Forestry Resources, Cultural Resources, Greenhouse Gas Emissions, Land Use/Planning, Population/Housing, Transportation, Wildfire, Air Quality, Energy, Hazards and Hazardous Materials, Mineral Resources, Public Services, and Tribal Cultural Resources. If the above impact areas have already been analyzed for the proposed project, please provide such analyses and demonstrate how they comply with CEQA. If the analyses were done for a previous iteration of the project, provide a justification for why the analyses are still appropriate for the proposed project. In order to assess impacts, the District must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

e. **Native American Consultation:** Indicate whether California Native American tribes traditionally and culturally affiliated with the project area have been consulted pursuant to Public Resources Code Section 21080.3.1.

f. **Health Risk Analysis:** The proposed project will require that a refined Health Risk Assessment (HRA) be performed.

g. **Air Quality Impact Assessment:** Due to the project's potential to cause or contribute to a violation of an air quality standard, an Air Quality Impact Assessment (AQIA) is required.

h. **Additional Information:** These items are based on the project as described in the permit application. Additional information may be required after review of the applicant's responses to this letter or if changes are made to the project description.

The Draft SEA was revised to include a supplemental CEQA analysis. The Draft-Final SEA with responses to comments was submitted to the District for review by Vandenberg SFB on November 30, 2022. The Final SEA with the signed Finding of No Significant Impact, dated December 2022, is attached with this submittal.

As stated under number 13, a revised HRA is included with this submittal.

An AQIA report was submitted on November 10, 2022. The Increment modeling passed for all pollutants and averaging periods with the exception that 1-hour nitrogen dioxide (NO_2) was above the minimum increment threshold of 100 micrograms per cubic meter ($\mu g/m^3$). Since that time, ULA updated the mobile equipment inventory and location of each piece of equipment. As such, an addendum to the AQIA is included in this submittal, providing an updated analysis for the 1-hour NO_2 modeling.

CONFIDENTIAL INFORMATION DELETED

Response to Comments

ATC NO. 15795 INCOMPLETENESS ITEM LIST

1. **Emission Calculations:** Please submit an updated permit emission calculation spreadsheet that addresses all the comments in this attachment.

   Response: Updated permit emission calculation spreadsheet is attached. The updates address the District's comments.

2. **LNG Tank Capacity:** As noted in comment no. 3 of the District's November 30, 2022, letter, the maximum LNG storage tank capacity should be used for the daily boiloff calculations. If the full [redacted] gallon capacity is not used in the revised calculations because the tank cannot feasibly be filled to this level, provide a specifications sheet that shows the maximum volume that can be stored.

   Response: The tank will be built to ULA specifications. Per discussions with the District on 3 October 2023, ULA is resubmitting a snippet of procurement specifications that specifies the tank capacity at [redacted] gallons. Additionally, the second snippet is from the manufacturer's drawing specifying the capacity at [redacted] gallons.

[redacted]

[redacted]

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[redacted]

3. **LNG Tank** [redacted] **Calculations:** Per comment no. 9 of the District's November 30, 2022, letter, submit the requested formula and graph used to determine the LNG tank volume, as well as a description of how the formula inputs will be determined.

Response: Requested formula and graph are below. Paragraph 2.6 of the Narrative Description document provides full detail of how the tank's [redacted] will measure gallons of LNG in the storage tank. The [redacted] This will be the input to our pad data acquisition system. Software will convert this [redacted] input to gallons using the equation shown on the graph below. Gallons of LNG will be the output from our pad data system that is recorded.

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[redacted]

4. **Fly-Away LNG Volume:** If ULA would like to exclude the fly-away LNG volume from the total amount of LNG reported as combusted in the flare(s) to determine compliance with the permitted emission limits, please confirm that ULA will accept the requirement to report the actual fly-away LNG volume for each launch to the District.

   Response: ULA accepts the requirement to report the actual fly-away LNG volume for each launch. The information to be reported will be considered mission specific and will be redacted in accordance with International Traffic in Arms Regulations.

5. **Truck Offloading Emissions:** The most recently submitted permit emission calculation spreadsheet included a line item for emissions from truck offloading LNG losses routed to the enclosed flare, with no line item accounting for a contingency situation routing these losses to one of the elevated flares if the enclosed flare is offline. However, Section 2.8 of the Narrative Description states: "In off-nominal situations where the enclosed flare is offline for maintenance, the daily boil-off and/or tanker off-load losses would be redirected to the GSE elevated flare." Please choose one of the following options:

   a. Confirm that ULA will accept a permit condition that does not allow tank loading to occur while the enclosed flare is offline; or

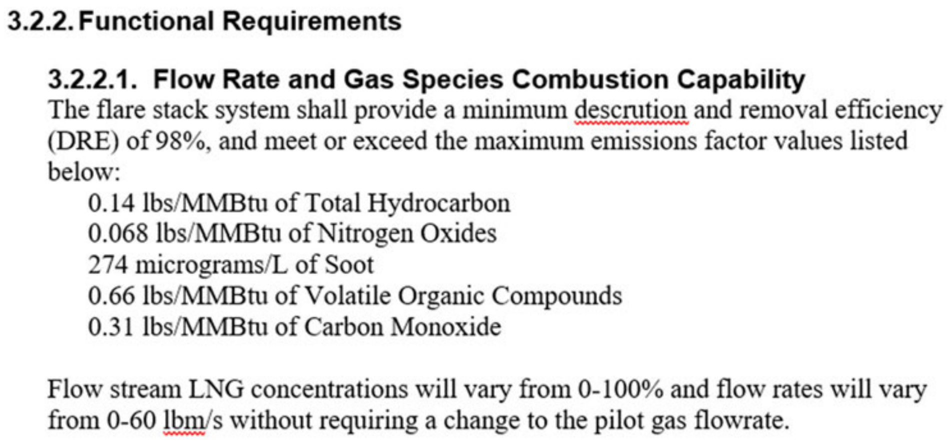
[redacted]

b. Include emission calculations for the truck offloading scenario with the enclosed flare offline. If this option is selected, the maximum amount of LNG delivered while the enclosed flare is offline will be enforced in the District permit.

Response: ULA is choosing option b. Emission calculations were modified so a maximum of 10 LNG offloads could be done while the enclosed flare is offline.

6. **Flare Turndown Ratio:** The District could not find the turndown ratio in the submitted manufacturer's specifications sheet for the elevated flares. Provide the turndown ratio and confirm the elevated flares would be able to safely handle the LNG tank boiloff. Alternatively, confirm that ULA will accept a permit condition that the enclosed flare must be operational at all times to handle the boiloff; in this case, a variance would be required to route the boiloff to either of the elevated flares.

Response: ULA confirms that the elevated flares would be able to safely handle the LNG tank boiloff. Flares will be built to ULA specifications. The following is a snippet from ULA LNG flare procurement specification 1V47156, indicating ULA's requirement to have the elevated flares safely combust 0 – 60 lb LNG/second.



3.2.2. Functional Requirements

3.2.2.1. Flow Rate and Gas Species Combustion Capability

The flare stack system shall provide a minimum descrution and removal efficiency (DRE) of 98%, and meet or exceed the maximum emissions factor values listed below:

0.14 lbs/MMBtu of Total Hydrocarbon
0.068 lbs/MMBtu of Nitrogen Oxides
274 micrograms/L of Soot
0.66 lbs/MMBtu of Volatile Organic Compounds
0.31 lbs/MMBtu of Carbon Monoxide

Flow stream LNG concentrations will vary from 0-100% and flow rates will vary from 0-60 lbm/s without requiring a change to the pilot gas flowrate.

7. **LNG Sampling Emissions:** The most recently submitted permit emission calculation spreadsheet assumes all emissions from LNG sampling events are routed to the enclosed flare. Confirm that ULA will accept a permit condition that does not allow sampling to occur while the enclosed flare is offline.

Response: ULA would like the flexibility of sampling while the enclosed flare is offline. Emission calculations were modified so a maximum of 6 sampling events could be conducted while the enclosed flare is offline.

8. **Flow Meter for Enclosed Flare:** The District understands that flow meters are not feasible for the elevated flares. Please clarify why a flow meter cannot be installed to measure the flow of natural gas to the enclosed flare.

Response: Flow meters do not differentiate LNG, [redacted] or any other gas that may get sent to the enclosed flare. Total mass of LNG delivered, based on weight, is reportable and can be used to calculate gas flow from the tank to the enclosed flare. Offloading will not take place during the same day as WDR or launch.

9. **Emission Reduction Credits (ERCs):** Please note that once the emission calculations are finalized, updated Form-05Us and ERCs will be required to be submitted to the District. This comment is informational only and does not require a response at this time.

   Response: ULA will update the ERC forms and submit the required ERCs once the emission calculations are approved and finalized by the District.

10. **AQIA and HRA Modeling:** The District cannot complete the review of the AQIA and HRA modeling because the emission calculations are not yet finalized. Before revising any modeling, check in with the District to see if there are any comments on the modeling. This comment is informational only and does not require a response at this time.

    Response: Per discussions with the District on 3 October 2023, no revisions have been made.

11. **CEQA**: The District reviewed ULA's August 9, 2023, response to Incompleteness Item 15 in District's letter dated November 30,2022. In response to ULA's response, the District has the following comment.

    The District has reviewed the Final SEA and "Supplemental CEQA Analysis" starting on page 194 of Final SEA. The Final SEA does not comply with the requirements of CEQA; therefore, the District cannot rely on the Final SEA to fulfill its obligations under CEQA.

    A Draft of the SEA was provided for District review on November 30, 2022, with a limited review period of seven working days. However, given that the project application was incomplete at the time of Draft SEA circulation, it was not possible for the District to assess the accuracy of the air quality impact determinations included in the Draft SEA. As the project application continues to be incomplete, the conclusions made in the Final SEA regarding the air quality and climate change impacts of the project are premature and cannot be vetted by the District until such time the application is found to be complete. Please note that notwithstanding the analysis of air quality impacts in the Final SEA, the Final SEA is very likely deficient in addressing other requirements prescribed by CEQA, including mitigation obligations. Since the NEPA document has been completed before the District can begin formal CEQA evaluation of the project, a separate CEQA document will be prepared by the District to fulfill the District's obligations.

    Once the District has a complete application, including confirmation of the project description, emission estimates that will be permitted by the District, and results of the required air modeling (i.e. HRA and AQIA), the District will be able to begin CEQA review for the project. The District may be able to rely on some of the conclusions and information in the Final SEA, however, the District must reach its own conclusions when determining whether a proposed project may have a significant impact on the environment, and the appropriate level of environmental review required to assess impacts. The decision on whether the District will prepare a Negative Declaration, Mitigated Negative Declaration, or Environmental Impact Report will be determined based on the District's assessment of the potential for significant environmental impacts. This assessment will occur once the application has been deemed complete.

    When considering the potential impacts of the project, the District will consider whether the proposed project presents potentially significant impacts to all environmental resource areas identified by the CEQA Guidelines Appendix G[1], including but not limited to air quality and climate change. Within 14 days of determining that the project application is complete, the District will also initiate Tribal Consultation pursuant to Assembly Bill 52 (Public Resources Code: 21073, 21074, 21080.3.1, 21080.3.2, 21082.3, 21083.09, 21084.2, and 5097.94) if such consultation has not already occurred.

    As previously requested, to facilitate our review of the project's potential impacts under CEQA,

[redacted]

please provide direct responses to the following items:

a. **Project Baseline Emissions**: Provide the peak daily and average annual existing (baseline) criteria pollutant and greenhouse gas emissions associated with the ULA Stationary Source for 2022, 2021, and 2020. Existing emissions (or project "baseline" emissions) should be based on actual equipment usage, fuel usage, and material throughput information rather than the maximum permitted levels. For the purposes of CEQA analysis, in addition to emissions from permitted sources, also include emissions from any non-permitted sources associated with the District's actions. For example, mobile equipment or motor vehicle use in support of permitted activities, such as fuel deliveries, employee trips, etc. Emissions from operational activities associated with the Atlas and Delta IV Launch Programs unrelated to the District's permitting actions do not need to be provided at this time (e.g. emissions due to the combustion of rocket propellants on a launch vehicle intended for launch into orbit and emissions from activities related to general base/pad maintenance need not be included).

b. **Proposed Project Operational Emissions**: Provide the daily and annual potential to emit for the ULA Stationary Source upon completion of the proposed project. This includes the reasonable worst-case potential criteria pollutant and greenhouse gas emissions from the operation of any new equipment/activities (e.g. fuel loading and transfer), and any existing equipment/activities that will be utilized in conjunction with the proposed project (e.g. solvents, prime and/or emergency engines, marine vessels, etc.). If the proposed project involves multiple phases and/or operational scenarios, quantify and describe each phase and/or scenario. For the purposes of CEQA analysis, in addition to emissions from permitted sources, also include the reasonable worst-case emissions from any non-permitted sources associated with the District's actions. For example, mobile equipment or motor vehicle use in support of permitted activities, such as fuel deliveries, employee trips, etc. Emissions from operational activities associated with the Vulcan Centaur Launch Program unrelated to the District's permitting actions do not need to be provided at this time (e.g. emissions due to the combustion of rocket propellants on a launch vehicle intended for launch into orbit and emissions from activities related to general base/pad maintenance need not be included).

c. **Construction and Short-term Activities**: Provide estimates of air pollutant emissions related to construction activities necessary to facilitate the District's actions (such as modification necessary for flare stack system, storage tanks, fuel loading, and other ancillary equipment installation). Emissions from construction activities unrelated to the District's permitting actions do not need to be provided at this time. In addition, provide estimates for any other short-term activities such as the proposed storage tank initial chill-down operation resulting in LNG boiloff.

d. **Air Quality Impacts**: Provide a summary table that compares the project's air quality impacts to the District's adopted CEQA air quality thresholds.[2] For the purpose of CEQA impact analysis, the incremental impact of the project should be evaluated and compared to the County of Santa Barbara's CEQA thresholds of significance. The impact of the project is represented by the difference between the existing (or baseline) emissions and the proposed project emissions. Please include detailed calculations, assumptions, spreadsheets, and model outputs used to assess the air quality impacts.

e. **Native American Consultation**: Indicate whether California Native American tribes traditionally and culturally affiliated with the project area have been consulted pursuant

[redacted]

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to Public Resources Code Section 21080.3.1.

[redacted]

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[1] CEQA Guidelines Appendix G (14 Cal. Admin. Code Section 15000 et seq): Aesthetics, Biological Resources, Geology/Soils, Hydrology/Water Quality, Noise, Recreation, Utility/Service Systems, Agriculture and Forestry Resources, Cultural Resources, Greenhouse Gas Emissions, Land Use/Planning, Population/Housing, Transportation, Wildfire, Air Quality, Energy, Hazards and Hazardous Materials, Mineral Resources, Public Services, and Tribal Cultural Resources.

[2] Environmental Review Guidelines for the Santa Barbara County Air Pollution Control District, Revised April 30, 2015

[redacted]

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United Launch Alliance - Vulcan Centaur V

LNG Flare Emission Calculations

[redacted]

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GSE Elevated Flare

LNG Data	Value	Units	Reference
LNG Density	3 57	lb/gal	ULA
Sulfur Content	10	ppm	ULA
LNG HHV	0 023536	MMBtu/lb	Applied LNG

Heat Input Data

Value	Units
273 4	MMBTu/h (1)
1553.7	MMBtu/day
15421.5	MMBtu/y

Emission Factors (elevated flares)

Pollutant	b/MMBtu	Reference
NOx	0 0680	AP-42, Table 13 5-1
ROC	0 0085	Calculated*
CO	0 3100	AP-42, Table 13 5-2
SOx	0 0017	Mass Balance Calculation
PM	0 0077	AP-42, Table 1.5-1 (Propane)
PM10	0 0077	AP-42, Table 1.5-1 (Propane)
PM2 5	0 0077	AP-42, Table 1.5-1 (Propane)

Flare Potential to Emit

Pollutant	lb/day	TPY
NOx	105.65	0.524
ROC	13.19	0.065
CO	481.65	2.390
SOx	2 58	0.013
PM	11 89	0.059
PM10	11 89	0.059
PM2 5	11 89	0.059

Vehicle Elevated Flare

LNG Data	Value	Units	Reference
LNG Density	3 57	lb/gal	ULA
Sulfur Content	10	ppm	ULA
LNG HHV	0.023536	MMBtu/lb	Applied LNG

Heat Input Data

Value	Units
303.6	MMBTu/h (1)
1576 2	MMBtu/day
12699.8	MMBtu/y

Emission Factors (elevated flares)

Pollutant	lb/MMBtu	Reference
NOx	0 0680	AP-42, Table 13 5-1
ROC	0 0085	Calculated*
CO	0.3100	AP-42, Table 13 5-2
SOx	0.0017	Mass Balance Calculation
PM	0 0077	AP-42, Table 1 5-1 (Propane)
PM10	0 0077	AP-42, Table 1 5-1 (Propane)
PM2.5	0 0077	AP-42, Table 1 5-1 (Propane)

Flare Potential to Emit

Pollutant	lb/day	TPY
NOx	107.18	0 432
ROC	13.38	0 054
CO	488.63	1 968
SOx	2.62	0 011
PM	12 06	0 049
PM10	12 06	0 049
PM2.5	12 06	0 049

Enclosed Flare

LNG Data	Value	Units	Reference
LNG Density	3.57	lb/gal	ULA
Sulfur Content	10	ppm	ULA
LNG HHV	0.023536	MMBtu/lb	Applied LNG

Heat Input Data

Value	Units
50 838	MMBTu/h (2)
516.4	MMBtu/day
26958 5	MMBtu/y

Emission Factors (enclosed flare)

Pollutant	lb/MMBtu	Reference
NOx	0.0183	JZ Proposal
ROC	0 0042	JZ Proposal
CO	0 0074	JZ Proposal
SOx	0 0017	Mass Balance Calculation
PM	0.0077	AP-42, Table 1 5-1 Propane)
PM10	0.0077	AP-42, Table 1 5-1 (Propane)
PM2.5	0 0077	AP-42, Table 1 5-1 Propane)

Flare Potential to Emit

Pollutant	lb/day	TPY
NOx	9.45	0.247
ROC	2 17	0.057
CO	3 82	0.100
SOx	0 86	0.022
PM	3.95	0.103
PM10	3.95	0.103
PM2.5	3.95	0.103

Total Flare Potential to Emit

Pollutant	lb/day**	TPY***	ERC Required TPY
NOx	**212.84**	**1 203**	**1.564**
ROC	**26.57**	**0 176**	**0.229**
CO	**970.28**	**4 459**	
SOx	**5.20**	**0 046**	
PM	**23.94**	**0 211**	**0.274**
PM10	**23.94**	**0 211**	**0.274**
PM2.5	**23.94**	**0 211**	

All three flares may operate on the same day

* 16 39 Methane MW. Calculation detailed in SBCAPCD document ONSHORE OIL AND GAS PRODUCTION FLARE REACTIVE ORGANIC COMPOUND EMISSION FACTOR STUDY.

** Daily PTE represents highest emitting day.

*** Annual PTE combines emissions from all flares.

(1) Hourly capacity is claculated by converting the burn rate during the highest hour MMBtu/h

(2) Houly capacity is based on the size of the flare (0.6 lb/s) converted to MMBtu/h .

(3) ROC figure includes fugitive emissions. Detailed fugitive emissions are in Fugitives tab

[redacted]

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ULA Vulcan Centaur Space Launch Program

Fugitive Emissions (ATC 15795)

Event	Daily Maximum Frequency (events/day)	Annual Maximum Frequency (events/year)	GNG Volume Vented/Event$^{(1)}$	Pounds GNG released/Event$^{(2)}$	ROC %$^{(3)}$	Emissions (lb ROC/Event)	Emissions (lb ROC/Day)	Emissions (lb ROC/Year)	Emissions (tons ROC/Year)
LNG Offloading	[redacted]	106	0.87266	0.03773	1%	0.00038	0.00302	0.04000	0.00002
LNG Sampling	[redacted]	12	0.0082	0.00035	1%	0.00000	0.00001	0.00004	0.00000

0.04004

Table Notes:

1 Offloading: Volume is based on [redacted] offloading hose. Hose size provided by vendor.
1 Sampling: Volume is based o[redacted] Information provided by ULA
2 Calculated using density provided by an LNG vendor
3 ROC conservatively estimated at 1%. Significantly lower in vendor analysis.

February 29, 2024

Charlotte I. Mountain
Santa Barbara County Air Pollution Control District
260 N. San Antonio Road, Suite A
Santa Barbara, CA 93110

RE: Response to ATC 15795 Incompleteness, February 15, 2024

Dear Ms. Mountain –

United Launch Alliance, LLC. (ULA) is pleased to submit the attached Emission Reduction Credits – Authorization of ERC Use Application Form-05U, associated with the Vulcan Centaur Space Launch Program at Vandenberg Space Force Base. The following ERCs ULA wishes to use are the process of being renewed and have not yet been issued:

- ERC 0652, previously ERC 513, and
- ERC 0653, previously ERC 514

Please advise if any additional information is needed on behalf of ULA.

Respectfully,

[redacted]

Quality Technical Inspection Support Leader,
Environmental Affairs Specialist
ULA, Vandenberg Space Force Base

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air pollution control district
SANTA BARBARA COUNTY

EMISSION REDUCTION CREDITS - AUTHORIZATION OF ERC USE
APPLICATION FORM -05U

The owner of an ERC Certificate that is registered in the APCD's Source Register must completely fill in this form and submit it to the APCD each time the ERC Certificate is "used". Please be specific as to the amount and type of ERCs "used" and which specific "emission elements" are the source of the ERCs being used. This form must be filled in for each ERC Certificate subject to use. An application filing fee per Rule 210 (Schedule F.1) is required.

1. SUMMARY INFORMATION

Certificate No: ______________________ Expiration Date: ______________________

Certificate Owner Name(s): ____

____

Company and Project Authorized to Use the ERCs: ______________________________

____

Total ERCs Authorized for Use (tons/yr):	NO_x:	________	SO_x:	________
	ROC:	________	PM_{10}:	________
	CO:	________	PM:	________

Company Official Authorized to Release: the ERCs: [redacted]

2. USE INFORMATION

☐ Yes ☐ No Will the ERC Certificate be used in whole?

☐ Yes ☐ No If partial use of the ERC Certificate is occurring, will the remaining ERCs belong to the original ERC Certificate owner? If No, then an ERC Certificate Transfer application must first be submitted and then an ERCs may be used by the new owner.

Specify the ERC Certificate Emission Elements (by name and number), the pollutants and the amounts that comprise the authorized "use". (*if no response is provided, the APCD will select for you*): ____

____

____

3. COST INFORMATION

(a) Transaction Type[1]: ☐ Purchase ☐ Use on Company Owned Project

☐ Barter ☐ Subsidiary

(b) ERC Costs:

Pollutant	ERCs Used (tpy)	Total Cost ($)	Unit Cost ($/ton)
NO_x			
ROC			
CO			
SO_x			
PM_{10}			
PM			

(c) ☐ Yes ☐ No Are the total cost values stated above one time payments? If No, please explain in detail the nature of the payments:

____

(d) ☐ Yes ☐ No Are there any other payment provisions or "in-kind" costs associated with this transaction? If Yes, please detail:

____

4. ERC ATTACHED

☐ Yes ☒ No Is the ERC Certificate included with this application? *(The district cannot process this application until the ERC has been submitted.)*

Please see cover letter for explanation.

---

[1] If barter was involved and/or no money was exchanged for the ERCs, please calculate an equivalent dollar per ton value for the credit transaction. Barters can include one company placing controls on another company to generate ERCs. The price should reflect the total cost to install the equipment and any additional fees paid as part of the agreement between both companies. The price paid should reflect the value of the ERC at the time of the transaction.

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air pollution control district
SANTA BARBARA COUNTY

EMISSION REDUCTION CREDITS - AUTHORIZATION OF ERC USE
APPLICATION FORM -05U

The owner of an ERC Certificate that is registered in the APCD's Source Register must completely fill in this form and submit it to the APCD each time the ERC Certificate is "used". Please be specific as to the amount and type of ERCs "used" and which specific "emission elements" are the source of the ERCs being used. This form must be filled in for each ERC Certificate subject to use. An application filing fee per Rule 210 (Schedule F.1) is required.

1. SUMMARY INFORMATION

Certificate No: ____________________ Expiration Date: ____________________

Certificate Owner Name(s): ____

____

Company and Project Authorized to Use the ERCs: ____________________

____

Total ERCs Authorized for Use (tons/yr):	NO_x:	__________	SO_x:	__________
	ROC:	__________	PM_{10}:	__________
	CO:	__________	PM:	__________

Company Official Authorized to Release: the ERCs: [redacted]

2. USE INFORMATION

☐ Yes ☐ No Will the ERC Certificate be used in whole?

☐ Yes ☐ No If partial use of the ERC Certificate is occurring, will the remaining ERCs belong to the original ERC Certificate owner? If No, then an ERC Certificate Transfer application must first be submitted and then an ERCs may be used by the new owner.

Specify the ERC Certificate Emission Elements (by name and number), the pollutants and the amounts that comprise the authorized "use". (*if no response is provided, the APCD will select for you*): ______________________________

____

____

3. COST INFORMATION

(a) Transaction Type[1]: ☐ Purchase ☐ Use on Company Owned Project

☐ Barter ☐ Subsidiary

(b) ERC Costs:

Pollutant	**ERCs Used (tpy)**	**Total Cost ($)**	**Unit Cost ($/ton)**
NO_x			
ROC			
CO			
SO_x			
PM_{10}			
PM			

(c) ☐ Yes ☐ No Are the total cost values stated above one time payments? If No, please explain in detail the nature of the payments:

____

(d) ☐ Yes ☐ No Are there any other payment provisions or "in-kind" costs associated with this transaction? If Yes, please detail:

____

4. ERC ATTACHED

☐ Yes ☒ No Is the ERC Certificate included with this application? *(The district cannot process this application until the ERC has been submitted.)*

Please see cover letter for explanation.

---

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[redacted]

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