MEMORANDUM

Date: August 1, 2018

To: The Honorable Chairman and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **Item 17B on the August 7, 2018 Board of Supervisors Agenda Regarding World View**

Attached is a detailed response to Supervisor Ally Miller's July 18, 2018 memorandum that placed this Item on the Board of Supervisors Agenda. Please note that most of the questions raised are repetitive from previous inquires placed on the Board's Agenda. The answers remain the same and were answered by me in a February 8, 2018 memorandum.

Assistant County Administrator John Voorhees has been the County's representative in this inquiry and his July 31, 2018 report thoroughly answers all of the questions raised by Supervisor Miller.

It should be noted that the total insurance payout for this matter totals $475,196.08 and is inclusive of all costs associated with investigation, architectural and engineering reports related to repairs and the repairs themselves. This cost, if it is entirely for repairs to the building, represents approximately 3 percent of the initial building cost. This verifies that the damage, while significant, was superficial.

Both Mr. Voorhees and I will answer any additional questions you may have at the August 7, 2018 Board Meeting.

CHH/anc

Attachments

c: John Voorhees, Assistant County Administrator

MEMORANDUM

Date: July 31, 2018

To: C.H. Huckelberry
County Administrator

From: John Voorhees
Assistant County Administrator

Re: **County Staff Responses to Supervisor Miller's World View Issues**

On July 18, 2018 Supervisor Miller directed the Clerk of the Board to place an item on the August 7, 2018 Board of Supervisors meeting agenda to discuss the World View incident on December 19, 2017. In her memo she raises 12 issues that she wishes to address during the meeting. Supervisor Miller has also scheduled a meeting with World View staff on the afternoon of August 7, 2018. In preparation for the Board of Supervisors' meeting, I have prepared the following responses. These responses are based on my own experience, as well as conversations with World View staff and previously issued information. I will paraphrase the issue and provide a response below.

1) Is an outside agency required to lead this investigation to ensure full transparency to the taxpayers?

Response: Per 49 CFR 831.2 the responsible agency for aviation related mishap investigations is the National Transportation Safety Board (NTSB). Title 49 USC 40113 grants the Federal Aviation Administration (FAA) Administrator the authority to conduct investigations concerning aviation safety. Title 51 USC 50917 also grants the FAA authority to investigate commercial space launch mishaps. Generally, the two agencies act autonomously under different policies and objectives. The NTSB's end goal is mishap prevention and has no enforcement authority with its findings. The FAA evaluates compliance and competency in the investigative process and does have an enforcement mechanism. When the two agencies are investigating the same mishap the NTSB generally leads the investigation and invites the FAA to participate as a party to the investigation.

FAA Order 8020.11D prescribes the investigation process and notification rules for aviation related mishaps. When an agency experiences an incident or mishap the agency is responsible to notify the FAA Washington Operations Center Complex who will, in turn, notify the NTSB Response Operations Center. Specifically, FAA Order 8020.11D, Chapter 4, Section 7, sub-section b. states, "the FAA will notify the NTSB of all occurrences of commercial space launch, reentry accidents, and launch site accidents." The same order, Chapter 4, Section 3, sub-section c. states, "in most instances involving non-fatal accidents,

the NTSB will not travel to the accident scene to conduct its investigation, and will rely on the FAA to document the scene."

World View Enterprises (WVE) notified the FAA of the incident on the same day of the occurrence. There was no on-scene investigation performed by either the FAA or the NTSB. Due to public inquiry the Arizona Division of Occupational Safety and Health (ADOSH) sent an investigator to WVE to conduct a workplace inspection. As explained in the County Administrator's February 8, 2018 memo, the report (Inspection Number 1285260.015) had no findings. The report was closed on January 4, 2018.

Outside of the FAA, NTSB, and OSHA there are no other investigative requirements for WVE regarding this incident. In an effort to improve their own business practices and by recommendation of Pima County, WVE commissioned an independent investigation of the incident. The report of the investigation was released on July 10, 2018.

2) Require WVE to provide a listing of all damages including costs to repair any damage on Pima County owned property or on any and all neighboring property.

Response: Pima County Facilities Management conducted an inspection of the WVE facility on December 19, 2017 (the day of the incident). On December 22, 2018 Schneider Structural Engineers conducted a second inspection of the premises. A comprehensive list of damages, including photos, was provided to the Board of Supervisors in a memo from the County Administrator on February 8, 2018. There was no damage to Spaceport Tucson. No claims from neighboring persons or agencies were filed with WVE or Pima County.

As for costs, Pima County bore no financial responsibility for the repairs to the building or surrounding area. Pima County received three checks from the WVE insurance carrier. Those checks were endorsed by the County then forwarded to WVE for deposit and processing in order to accomplish the repairs. The amounts of the checks were $49,791.37, $225,404.71, and $200,000.00.

3) Require WVE to provide reports of any injuries that resulted from the explosion.

Response: WVE included reports of minor injuries (ear ringing) in its incident report made available to the Board of Supervisors on July 10, 2018.

4) Evaluation as to whether Federal and/or State statutes violated in the handling of hazardous materials or in the operations at WVE, including the use of hydrogen, as well as any other explosive or regulated hazardous materials...(list of statutes and regulations followed).

Response: ADOSH conducted an investigation of the WVE incident and employees and had no findings as a result of the agency's interviews. WVE

handles all hazardous materials in accordance with applicable OSHA Safety Data Sheets, Environmental Protection Agency, and Department of Transportation Standards. The quantities of hydrogen stored on the premises of WVE at the time of the incident were well below the regulatory threshold for accountability by OSHA standards. This was explained earlier in a memo from the County Administrator on February 8, 2018.

5) According to this contract (section 7.3.1), Pima County must provide express written consent for hazardous materials being used or stored on this property. Did Pima County issue written consent for any hazardous materials including but not limited to hydrogen?

Response: No. But, this section of the contract actually states that WVE: *"...may not cause or permit any hazardous materials to be brought upon, kept, or used in or about the Premises by WVE, its agents, employees, contractors, or invitees, without the prior written consent of County, other than such hazardous materials that are necessary or useful to WVE's business and will be used, kept, stored and disposed of in a manner that complies with all laws regulating any such materials or substances."*

According to section 7.3.1 of the WVE lease-purchase agreement, WVE operated within its authority. The material was being used in a manner useful to WVE's business and was handled in accordance with all applicable laws regulating its handling.

6) According to this contract, WVE is to maintain compliance with all laws and regulations, as well as coordinate activities with the Tucson Airport Authority (TAA). Was this test coordinated with the TAA? WVE to provide documentation.

Response: WVE has complied with all laws and regulations in accordance with this contract. WVE did coordinate with TAA for this test. WVE filed a Notice to Airmen (NOTAM) with the FAA. This is a standard daily aviation posting used to notify all airmen worldwide of activities (usual or unusual) on an airfield or aviation equipment. It serves as an official method of notification and coordination among all certified aviation organizations. The original issued NOTAM is no longer available as the FAA does not keep all NOTAM history indefinitely. A copy of the posted NOTAM text is below.

TUS 12/079 TUS OBST MOORED BALLOON WI AN AREA DEFINED AS .5NM RADIUS OF TUS239002 2914FT (300FT AGL) FLAGGED AND LGTD 1712191020-1712192100

Below is an unofficial, laymen's translation of the NOTAM text:

NOTAM reference number TUS 12/079. At Tucson International Airport there will be an obstacle (a moored balloon) within an area defined as .5 nautical miles

from the Tucson Airport Navigational Aid's 239 radial at 2 miles. The obstacle will be as tall as 2914 feet mean sea level (MSL) or 300 feet above ground level (AGL). The obstacle is flagged and lighted. This NOTAM is in effect from December 19, 2017 from 10:20 am Universal Time Coordinated (UTC) until December 19, 2017 9:00 pm UTC.

7) Per the Contract terms in the Operating Agreement (section 1.5) WVE had agreed to operate this facility in a safe manner in compliance with all laws and regulations. Will hydrogen be allowed onsite?

Response: WVE has operated the facility in a safe manner and in compliance with all laws and regulations. There is currently no restriction barring the use of hydrogen at the Pima County facility.

8) Listing of all hazardous materials onsite to be provided by WVE.

Response: WVE provided a list of hazardous materials stored onsite (see Attachment 1). Lift gases (helium and hydrogen) are not stored onsite for extended periods of time. They are located onsite just long enough to support flight operations. WVE also provided the OSHA safety data sheet for hydrogen gas (see attachment 2). WVE handles hydrogen in accordance with the OSHA safety data sheet.

9) In light of the explosive materials being used at WVE, it is reasonable at this time to review and increase the required insurance coverage on County owned facilities. One million dollars per each occurrence is woefully inadequate. The current insurance requirements put the taxpayers at extremely high risk for liability. Request that Pima County Risk Management analyze similar operations and present a report of insurance recommendations to the Pima County Board of Supervisors.

Response: The current insurance policy held by WVE was sufficient to cover all costs related to the incident on December 19, 2017.

I had a brief conversation with the Director of Risk Management. After reviewing the WVE insurance policy she believes the provisions of the current policy are appropriate.

An additional review of the adequacy of WVE's insurance coverage is within the purview of the Pima County Board of Supervisors.

10) Are vehicles containing hydrogen and helium considered WVE property under the terms of the insurance agreements? If so, these automobile coverages should be discussed and adjusted, if necessary. Pima County Risk Management should analyze and present a report with recommendations to the Pima County Board of Supervisors.

Response: WVE does not own the vehicles that transport the materials they use to launch or test their balloons.

To clarify, WVE contracts with vendors to supply their lift gases (normally helium). These materials are not stored on the premises for long periods of time. The vehicles that transport the lift gases are owned by the supplier and are only on the premises long enough to support a mission. The lift gases are generally transported to the launch site by tractor-trailer. While connected the vendor holds responsibility for the vehicle and equipment. The vendor then detaches the trailer and leaves it (and the lift gas tanks) on the premises for the mission. During this time WVE takes responsibility for the trailer and its contents. This material is covered under WVE's property and general liability insurance policies.

An additional review of the adequacy of WVE's insurance coverage is within the purview of the Pima County Board of Supervisors.

11) WVE provide a copy of the Property Insurance (Section 10.4) showing the full replacement cost requirement for the facility along with coverage amounts which identify Pima County named as additional insured. With required notifications clause if the Policy is cancelled or lapsed (Pima County must be notified).

Response: WVE's insurance coverage terms were made available to the Board of Supervisors in a memo from the County Administrator on February 8, 2018.

12) Identify other concerns to be addressed as related to this incident.

Response:
None from this office

JV/lab

Attachments

ATTACHMENT 1

Flammable Locker
Inventory List

Item #	Brand	Description	Size	SDS on file	QOH
1	Rustoleum	Inverted Marking Paint	15oz	Yes	11
2	ACE	Rust Stop	15oz	Yes	7
3	Rustoleum	High Performance Enamel	15oz	Yes	3
4	Rustoleum	Industrial Choice	12oz	Yes	1
5	Performix	Plastidip	11oz	Yes	3
6	Web	Coil Cleaner	14oz	Yes	1
7	Zep	Oven & Grill Cleaner	19oz	Yes	1
8	Rustoleum	Epoxy Shield Anti Slip	12oz	Yes	1
9	Oreilly	Brake Cleaner	14oz	Yes	1
10	Rustoleum	Gloss Enamel	12oz	Yes	9
11	Rustoleum	Clean Metal Primer	12oz	Yes	1
12	Rustoleum	Universal Bonding Primer	12oz	Yes	1
13	ACE	Silicone Sealant	10.1oz	Yes	1
14	3M	Scotchweld Part A	16oz	Yes	1
15	3M	Scotchweld Part B	10.6oz	Yes	1
16	Superior	SLC-400 Cryo Grease	14oz	Yes	2
17	Techspray	Contact Adhesive	12oz	Yes	5
18	Rustoleum	Epoxy Shield Part A	30oz	Yes	1
19	Rustoleum	Epoxy Shield Part B	90oz	Yes	1
20	Techspray	Wondermask	8.7oz	Yes	1
21	Chemtronics	KonForm SR	10oz	Yes	1
22	Minwax	Helmsman Spar Urethane	1gal	Yes	1
23	Techspray	Isopropyl Alcohol	5gal	Yes	1
24	Roundup	Weed & Grass Killer	36.8oz	Yes	1
25	Behr	Exterior Flat	1qt	Yes	1
26	Behr	Interior Semi Gloss	1qt	Yes	1
27	Krylon	Rust Protector Enamel	8oz	Yes	1
28	Fibre Glast	2000 Epoxy Resin	8lb	Yes	2
29	Fibre Glast	2000 Epoxy Resin	2lb	Yes	1
30	Fibre Glast	2120 Epoxy Hardener	2lb	Yes	1
31	Fibre Glast	1153 Epoxy Release	1qt	Yes	1
32	Fibre Glast	2020 Epoxy Hardener	.5lb	Yes	1
33	Fibre Glast	2060 Epoxy Hardener	.5lb	Yes	1
34	RH Products	HH-66 Vinyl Cement	4oz	Yes	1
35	Loctite	SF 7649	4.5oz	Yes	2
36	Rubyfluid	Flux	1pt	Yes	1
37	RTG	Kona 870FT-LV-DP Epoxy	50ml	Yes	4
38	JB Weld	Epoxy	1oz	Yes	1
39	Loctite	LB8065 Anti Seize	.7oz	Yes	1
40	Momentive	RTV159	2.8oz	Yes	1
41	MG Chemicals	Silver Epoxy	14g	Yes	1
42	MG Chemicals	Thermal Adhesive	14.6g	Yes	1
43	Rustoleum	Specialty Flourescent	11oz	Yes	1
44	Loctite	Fast Grab	10oz	Yes	1
45	GC Electronics	GC Potting Epoxy	4oz	Yes	2
46	3M	Scotchgard	10oz	Yes	1
47	3M	90 Spray Adhesive	17.6oz	Yes	2
48	3M	20 Spray Adhesive	13.75oz	Yes	2
49	3M	78 Spray Adhesive	16.9oz	Yes	1
50	Momentive	RTV102	2.8oz	Yes	1
51	3M	Super 77	16.75oz	Yes	1
52	Titebond	Wood Glue	8oz	Yes	1
53	Loctite	U-09FL	1.69oz	Yes	6
54	Eagle Products	Rubbing Alcohol	12oz	Yes	1
55	Set	Set-Pac EZ Epoxy	8.5oz	Yes	1
56	Loctite	7452	1.75oz	Yes	1
57	3M	Super 77	10.7oz	Yes	1

Item #	Brand	Description	Size	SDS on file	QOH
1	3-In-One	Silicone	4 oz	Yes	1
2	Goo Gone	Adhesive Remover	8 oz	Yes	1
3	Loctite	Threadlocker #243	1.22 oz	Yes	1
4	Loctite	Threadlocker #263	50 ml	Yes	1
5	Tri Flow	Clear Synthetic Grease	3 oz	Yes	1
6	Oatey	PVC Purple Primer	8 oz	Yes	3
7	Oatey	Medium Clear PVC Cement	8 oz	Yes	3
8	3M	Foam Fast 74 Spray Adhesive	16.9 oz	Yes	1
9	Goof Off	Pro Strength Remover	12 oz	Yes	1
10	Good Off	Pro Strength Remover	32 oz	Yes	1
11	Expo	White Board Care Cleaner	22 oz	Yes	1
12	Uline	Air In A Can	12 oz	Yes	1
13	WD40	Spray Lubricant	20 oz	Yes	2
14	Non-specific	Isopropyl Alcohol, 50%	12 oz	Yes	1
15	Non-specific	Isopropyl Alcohol, 90%	16 oz	Yes	1
16	SuperLube	Multi-Purpose Synthetic Grease	3 oz	Yes	1

Item #	Brand	Description	Size	SDS on file	QOH
1	Moeller	Zinc Chromite	12 Oz	Yes	4
2	Raid	Max Spider & Scorpion	12 Oz	Yes	1
3	Rustoleum	Ultra Cover Paint	12 Oz	Yes	1
4	Krylon	Fusion Spray Paint	12 Oz	Yes	3
5	Dri Slide	EP Liquid Grease	8 Oz	Yes	1
6	Bostik	Blue Moly	8 Oz	Yes	1
7	Dow Corning	Vacuum Grease	5 Oz	Yes	6
8	3M	Scotch Weld Adhesive	3.3 Oz	Yes	1
9	Valvoline	Dot 3&4 Brake Fluid	32 Oz	Yes	12
10	PTI Chemical	Denurtured Ethyl Alcohol	1 Gal	Yes	4
11	3M	27 Spray Adhesive	14 Oz	Yes	1
12	Handi Foam	Window & Door Sealeant	24 Oz	Yes	1
13	Henkel	Alodine 1201	32 Oz	Yes	1
14	Maxim	Dishwashing Detergent	1 Qt	Yes	1
15	Rustoleum	Self Etching Primer	12 oz	Yes	1
16	Rustoleum	High Performance Enamel	15 Oz	Yes	3
17	TechSpray	Isopropyl Alcohol	1 Gal	Yes	1
18	Krylon	Supermaxx Paint	12 Oz	Yes	8
19	RAE Chemicals	MEK	5 Gal	Yes	1
20	ValTech	Acetone	5 Gal	Yes	1
21	Meguiars	Quik Wax	1 Pt	Yes	1
22	Mobile	Jet Oil 254	1 Qt	Yes	2
23	Mobile	Jet Oil II	1 Qt	Yes	2
24	Sunnyside	2 Minute Remover	1 Gal	Yes	1
25	Crown	Mineral Spirits	32oz	Yes	1
26	Startex	Paint Thinner	32oz	Yes	1
27	Rustoleum	Automotive Enamel	12oz	Yes	1
28	ACE	Premium Primer	12oz	Yes	3

Item #	Brand	Description	Size	SDS on file	QOH
1	LundMark	Paste Wax	16 Oz	Yes	1
2	TechSpray	Contact Adehesive	12 Oz	Yes	1
3	Bernzomatic	MAP/PRO	14 Oz	Yes	2
4	Mobil	Velocite oil #10	16 Oz	Yes	1
5	Mobil	DTE 26 Hydaulic Oil	16 Oz	Yes	1
6	Mobil	Vactra Oil #2	16 Oz	Yes	1
7	Oatey	Dark Thread Cutting Oil	16 Oz	Yes	3
8	Accurate MFG	Surface Plate Cleaner	1 Pt	Yes	1
9	C of O USA	Tapping Fluid	1 Pt	Yes	1
10	Superior	601 Paste Flux	8oz	Yes	1
11	Lubriplate	White Lubricant	1.75 Oz	Yes	1
12	Sunny Side	Mineral Spirits	3.7 Oz	Yes	1
13	Dudas	Isopropyl Alcohol	5 Gal	Yes	1
14	PJ1	Driveshaft Oil 90W	1 L	Yes	1
15	Renewable	Oil ISO68	1 Gal	Yes	1
16	Mobil	DTE 26 Oil	1 Gal	Yes	1
17	Kool Mist	Coolant	1 Gal	Yes	1
18	3M	Foam Fast 74	16.9oz	Yes	3
19	3M	Polysyrene Insulation 78	16.9oz	Yes	3
20	Castrol	Variocut C Moly-Dee	16oz	Yes	1
21	Steco	Tap Magic EP Extra	4oz	Yes	1
22	Dykem	Steel Blue Layout Fluid	4 oz	Yes	1
23	TechSpray	Isopropyl Alcohol	1gal	Yes	1

Item #	Brand	Description	Size	SDS on file	QOH
1	JB Weld	Bonding Agant	1 Pack	Yes	1
2	N/A	Premium Gasoline	5 Gal	Yes	3
3	CPS	AV2 Oil	1 Gal	N/A	1
4	SuperTeck	AntiFreeze	1 Gal	Yes	2
5	Valvoline	85W-140 oil	1 Qt	Yes	5

Item #	Brand	Location	Description	Size	SDS on file	QOH
1	Air Products	Overhang	Compressed Hydrogen	Cylinder	Yes	0
2	N/A	Overhang	Compressed Helium	Cylinder	Yes	0
3	N/A	Overhang	Propane	Cylinder	Yes	4
4	N/A	Hi Bay	Lead Acid Battery	Package	Yes	
5	N/A	Hi Bay	Lithium Ion Battery	Package	Yes	
6	N/A	Thermotron	Compressed Nitrogen	Cylinder	Yes	4

Item #	Brand	Description	Size	SDS on file	QOH
1	AutoZone	ATF +4	1 Qt	Yes	10
2	AutoZone	DEX/MERC ATF	1 Gal	Yes	3
3	Mobile	15W-40 Engine Oil	1 Gal	Yes	3
4	SuperTech	10W-30 Engine Oil	1 Gal	Yes	2
5	Quakerstate	10W-40 Engine Oil	1 Gal	Yes	1
6	SuperTech	SAE 30 Chain Oil	1 Qt	Yes	2
7	Crown	Linseed Oil	1 Gal	Yes	1
8	N/A	Deisel Fuel	5 Gal	Yes	1
9	N/A	Unleaded Gasoline	5 Gal	Yes	6
10	N/A	AVH Fuel	1 Gal	Yes	1
11	Prestone	Windshield Washer Fluid	1 Gal	Yes	2
12	Scot Stuff	Floor Finish	1 Gal	Yes	1
13	Dupont	White Lithium Grease	16 Oz	Yes	5
14	Rust Knockout	Rust Stop	1 Qt	Yes	1
15	Oatey	Purple Primer	16 Oz	Yes	1
16	Dunn- Edwards	Velvet Paint	4 Qt	Yes	1
17	WD-40	Silicone Lubricant	11 Oz	Yes	1
18	Pro Mix	2 Cycle Oil	2.6 Oz	Yes	1
19	Oatey	PVC Cement	32 Oz	Yes	1
20	Crown	Paint Thinner	32 Oz	Yes	1
21	STA - Bil	Fuel Stabilizer	32 Oz	Yes	1
22	Spirax	Gear Oil	1 Qt	Yes	1
23	Startex	Xylene Drying Solvent	32 Oz	Yes	1
24	Crown	Heavy Duty Stripper	32 Oz	Yes	1
25	Olympic	Assure Primer	114 Oz	Yes	1
26	Expert Grill	Lighter Fluid	32 Oz	Yes	2
27	Rustoleum	High Performance Enamel	15 Oz	Yes	2
28	Throttle Muscle	Battery Cleaner	10 Oz	Yes	1
29	Throttle Muscle	Battery Terminal Protector	7.5 Oz	Yes	1
30	Sherwin-Williams	7005 Pure White	1 Gal	None	1
31	Spray Bottle	91% Isopropyl Alcohol	24oz	Yes	1

ATTACHMENT 2

Safety Data Sheet

Version 1.16 SDS Number 300000000074
Revision Date 08/01/2016 Print Date 06/02/2018

1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Hydrogen
Chemical formula	:	H2
Synonyms	:	Hydrogen
Product Use Description	:	General Industrial
Manufacturer/Importer/Distributor	:	Air Products and Chemicals, Inc 7201 Hamilton Blvd. Allentown, PA 18195-1501 GST No. 123600835 RT0001 QST No. 102753981 TQ0001
Telephone	:	1-610-481-4911 Corporate 1-800-345-3148 Chemicals Cust Serv 1-800-752-1597 Gases/Electronics Cust Serv
Emergency telephone number (24h)	:	800-523-9374 USA +1 610 481 7711 International

2. HAZARDS IDENTIFICATION

GHS classification

Flammable gases - Category 1
Gases under pressure - Compressed gas.

GHS label elements

Hazard pictograms/symbols

Signal Word: Danger

Hazard Statements:

H220:Extremely flammable gas.
H280:Contains gas under pressure; may explode if heated.
May displace oxygen and cause rapid suffocation.
May form explosive mixtures in air.
Burns with invisible flame.

Precautionary Statements:

Prevention	:	P210:Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking.
Response	:	P377 :Leaking gas fire: Do not extinguish, unless leak can be stopped safely. P381 :Eliminate all ignition sources if safe to do so.
Storage	:	P410+P403:Protect from sunlight. Store in a well-ventilated place.

Hazards not otherwise classified

Burns with an invisible flame.
Can ignite on contact with air.
High pressure gas.
Can cause rapid suffocation.
Extremely flammable.
May form explosive mixtures in air.
Immediate fire and explosion hazard exists when mixed with air at concentrations exceeding the lower flammability limit (LFL).
High concentrations that can cause rapid suffocation are within the flammable range and should not be entered.
Avoid breathing gas.
Self contained breathing apparatus (SCBA) may be required.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Concentration (Volume)
Hydrogen	1333-74-0	100 %

Concentration is nominal. For the exact product composition, please refer to technical specifications.

4. FIRST AID MEASURES

General advice	:	Remove victim to uncontaminated area wearing self contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.
Eye contact	:	In case of direct contact with eyes, seek medical advice.
Skin contact	:	Adverse effects not expected from this product. IF exposed or concerned: Get medical advice/attention.

Ingestion	:	Ingestion is not considered a potential route of exposure.
Inhalation	:	In case of shortness of breath, give oxygen. Move to fresh air. If breathing has stopped or is labored, give assisted respirations. Supplemental oxygen may be indicated. If the heart has stopped, trained personnel should begin cardiopulmonary resuscitation immediately. Seek medical advice.
Most important symptoms/effects - acute and delayed	:	Exposure to oxygen deficient atmosphere may cause the following symptoms: Dizziness. Salivation. Nausea. Vomiting. Loss of mobility/consciousness.

Immediate Medical Attention and Special Treatment

Treatment	:	If exposed or concerned: Get medical attention/advice.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	Use extinguishing media appropriate for surrounding fire.
Extinguishing media which must not be used for safety reasons.	:	Carbon dioxide (CO_2).
Specific hazards	:	Ignitable by static electricity. Burns with an invisible flame. Gas is lighter than air and can accumulate in the upper sections of enclosed spaces. Upon exposure to intense heat or flame, cylinder will vent rapidly and or rupture violently. Keep containers and surroundings cool with water spray. Extinguish fire only if gas flow can be stopped. If possible, shut off the source of gas and allow the fire to burn itself out. Do not extinguish a leaking gas flame unless absolutely necessary. Spontaneous/explosive re-ignition may occur. Extinguish any other fire. Move away from container and cool with water from a protected position. Keep adjacent cylinders cool by spraying with large amounts of water until fire burns itself out. If flames are accidentally extinguished, explosive re-ignition may occur; therefore, appropriate measures should be taken(e.g. total evacuation to protect persons from cylinder fragments and toxic fumes should a rupture occur). Most cylinders are designed to vent contents when exposed to elevated temperatures.
Special protective equipment for fire-fighters	:	Wear self contained breathing apparatus for fire fighting if necessary.
Further information	:	The presence of a hydrogen flame can be detected by approaching cautiously with an outstretched straw broom to make the flame visible.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment, and Emergency Procedures	:	Evacuate personnel to safe areas. Remove all sources of ignition. Never enter a confined space or other area where the flammable gas concentration is greater the 10% of its lower flammable limit. Ventilate the area.
Environmental precautions	:	Do not discharge into any place where its accumulation could be dangerous. Should not be released into the environment. Prevent further leakage or

spillage if safe to do so.

Methods for cleaning up	:	Ventilate the area. Approach suspected leak areas with caution.
Additional advice	:	Increase ventilation to the release area and monitor concentrations. If leak is from cylinder or cylinder valve, call the emergency telephone number. If the leak is in the user's system, close the cylinder valve, safely vent the pressure, and purge with an inert gas before attempting repairs.

7. HANDLING AND STORAGE

Handling

May ignite if valve is opened to air. Protect cylinders from physical damage; do not drag, roll, slide or drop. Do not allow storage area temperature to exceed 50°C (122°F). Only experienced and properly instructed persons should handle compressed gases/cryogenic liquids. Before using the product, determine its identity by reading the label. Know and understand the properties and hazards of the product before use. When doubt exists as to the correct handling procedure for a particular gas, contact the supplier. Do not remove or deface labels provided by the supplier for the identification of the cylinder contents. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. Leave valve protection caps in place until the container has been secured against either a wall or bench or placed in a container stand and is ready for use. Use an adjustable strap wrench to remove over-tight or rusted caps. Before connecting the container, check the complete gas system for suitability, particularly for pressure rating and materials. Before connecting the container for use, ensure that back feed from the system into the container is prevented. Ensure the complete gas system is compatible for pressure rating and materials of construction. Ensure the complete gas system has been checked for leaks before use. Employ suitable pressure regulating devices on all containers when the gas is being emitted to systems with lower pressure rating than that of the container. Never insert an object (e.g. wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve, causing a leak to occur. Open valve slowly. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier. Close container valve after each use and when empty, even if still connected to equipment. Never attempt to repair or modify container valves or safety relief devices. Damaged valves should be reported immediately to the supplier. Close valve after each use and when empty. Replace outlet caps or plugs and container caps as soon as container is disconnected from equipment. Do not subject containers to abnormal mechanical shock. Never attempt to lift a cylinder by its valve protection cap or guard. Do not use containers as rollers or supports or for any other purpose than to contain the gas as supplied. Never strike an arc on a compressed gas cylinder or make a cylinder a part of an electrical circuit. Do not smoke while handling product or cylinders. Never re-compress a gas or a gas mixture without first consulting the supplier. Never attempt to transfer gases from one cylinder/container to another. Always use backflow protective device in piping. Purge air from system before introducing gas. When returning cylinder install valve outlet cap or plug leak tight. Never use direct flame or electrical heating devices to raise the pressure of a container. Containers should not be subjected to temperatures above 50°C (122°F). All piped systems and associated equipment must b e grounded.

Storage

Do not change or force fit connections. Always keep container in upright position. Use a back flow preventative device in the piping. Use only with equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Open/close valve slowly. Close when not in use. Wear Safety Eye Protection. Check Safety Data Sheet before use. Containers should be stored in a purpose build compound which should be well ventilated, preferably in the open air. Observe all regulations and local requirements regarding storage of containers. Stored containers should be periodically checked for general condition and leakage. Protect containers stored in the open against rusting and extremes of weather. Containers should not be stored in

conditions likely to encourage corrosion. Containers should be stored in the vertical position and properly secured to prevent toppling. The container valves should be tightly closed and where appropriate valve outlets should be capped or plugged. Container valve guards or caps should be in place. Keep containers tightly closed in a cool, well-ventilated place. Store containers in location free from fire risk and away from sources of heat and ignition. Full and empty cylinders should be segregated. Do not allow storage temperature to exceed 50°C (122°F). Smoking should be prohibited within storage areas or while handling product or containers. Display "No Smoking or Open Flames" signs in the storage areas. The amounts of flammable or toxic gases in storage should be kept to a minimum. Return empty containers in a timely manner. Flammable storage areas should be separated from oxygen and other oxidizers by a minimum distance of 20 ft. (6.1 m.) or by a barrier of non-combustible material at least 5 ft. (1.5 m.) high, having a fire resistance rating of at least 1/2 hour.

Technical measures/Precautions

Containers should be segregated in the storage area according to the various categories (e.g. flammable, toxic, etc.) and in accordance whit local regulations. Keep away from combustible material. All electrical equipment in the storage areas should be compatible with flammable materials stored. Containers containing flammable gases should be stored away from other combustible materials. Where necessary containers containing oxygen and oxidants should be separated from flammable gases by a fire resistant partition.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures

Provide natural or explosion-proof ventilation that is adequate to ensure flammable gas does not reach its lower explosive limit.

Personal protective equipment

Respiratory protection	:	High concentrations that can cause rapid suffocation are within the flammable range and should not be entered.
Hand protection	:	Wear working gloves when handling gas containers.
Eye protection	:	Safety glasses recommended when handling cylinders.
Skin and body protection	:	Safety shoes are recommended when handling cylinders. Wear as appropriate: Flame retardant protective clothing.
Special instructions for protection and hygiene	:	Ensure adequate ventilation, especially in confined areas.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Compressed gas. Colorless gas
Odor	:	None.
Odor	:	Mixture contains one or more component(s) which have the following odor: No

odor warning properties.

Odor threshold	:	No data available.
pH	:	Not applicable.
Melting point/range	:	-435 °F (-259.2 °C)
Boiling point/range	:	-423 °F (-252.9 °C)
Flash point	:	Not applicable.
Evaporation rate	:	Not applicable.
Flammability (solid, gas)	:	Refer to product classification in Section 2
Upper/lower explosion/flammability limit	:	75 %(V) / 4 %(V)
Vapor pressure	:	Not applicable.
Water solubility	:	0.0016 g/l
Relative vapor density	:	0.07 (air = 1)
Relative density	:	0.07 (water = 1)
Partition coefficient (n-octanol/water)	:	Not applicable.
Auto-ignition temperature	:	560 °C
Decomposition temperature	:	No data available.
Viscosity	:	Not applicable.
Molecular Weight	:	2.02 g/mol
Density	:	0.006 lb/ft3 (0.0001 g/cm3) at 70 °F (21 °C) Note: (as vapor)
Specific Volume	:	191.97 ft3/lb (11.9830 m3/kg) at 70 °F (21 °C)

10. STABILITY AND REACTIVITY

Chemical Stability	:	Stable under normal conditions.
Conditions to avoid	:	Heat, flames and sparks. May form explosive mixtures with air and oxidizing agents.

Materials to avoid	:	Oxygen. Oxidizing agents.
Hazardous decomposition products	:	Under normal conditions of storage and use, hazardous decomposition products should not be produced.
Possibility of hazardous Reactions/Reactivity	:	No data available.

11. TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Likely routes of exposure

Effects on Eye	:	In case of direct contact with eyes, seek medical advice.
Effects on Skin	:	Adverse effects not expected from this product.
Inhalation Effects	:	In high concentrations may cause asphyxiation. Symptoms may include loss of mobility/consciousness. Victim may not be aware of asphyxiation. Asphyxiation may bring about unconsciousness without warning and so rapidly that victim may be unable to protect themselves.
Ingestion Effects	:	Ingestion is not considered a potential route of exposure.
Symptoms	:	Exposure to oxygen deficient atmosphere may cause the following symptoms: Dizziness. Salivation. Nausea. Vomiting. Loss of mobility/consciousness.

Acute toxicity

Acute Oral Toxicity	:	No data is available on the product itself.
Inhalation	:	No data is available on the product itself.
Acute Dermal Toxicity	:	No data is available on the product itself.
Skin corrosion/irritation	:	No data available.
Serious eye damage/eye irritation	:	No data available.
Sensitization.	:	No data available.

Chronic toxicity or effects from long term exposures

Carcinogenicity	:	No data available.
Reproductive toxicity	:	No data is available on the product itself.

Germ cell mutagenicity	:	No data is available on the product itself.
Specific target organ systemic toxicity (single exposure)	:	No data available.
Specific target organ systemic toxicity (repeated exposure)	:	No data available.
Aspiration hazard	:	No data available.

Delayed and Immediate Effects and Chronic Effects from Short and Long Term Exposure

Not applicable.

12. ECOLOGICAL INFORMATION

Ecotoxicity effects

Aquatic toxicity	:	No data is available on the product itself.
Toxicity to other organisms	:	No data available.

Persistence and degradability

Biodegradability	:	No data is available on the product itself.
Mobility	:	Because of its high volatility, the product is unlikely to cause ground pollution.
Bioaccumulation	:	Refer to Section 9 "Partition Coefficient (n-octanol/water)".

Further information

This product has no known eco-toxicological effects.

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products	:	Contact supplier if guidance is required. Return unused product in original cylinder to supplier. Do not discharge into areas where there is a risk of forming an explosive mixture with air. Waste gas should be flared through a suitable burner with flash back arrestor.
Contaminated packaging	:	Return cylinder to supplier.

14. TRANSPORT INFORMATION

DOT

UN/ID No. : UN1049
Proper shipping name : Hydrogen, compressed
Class or Division : 2.1
Label(s) : 2.1
Marine Pollutant : No

IATA

UN/ID No. : UN1049
Proper shipping name : Hydrogen, compressed
Class or Division : 2.1
Label(s) : 2.1
Marine Pollutant : No

IMDG

UN/ID No. : UN1049
Proper shipping name : HYDROGEN, COMPRESSED
Class or Division : 2.1
Label(s) : 2.1
Marine Pollutant : No

TDG

UN/ID No. : UN1049
Proper shipping name : HYDROGEN, COMPRESSED
Class or Division : 2.1
Label(s) : 2.1
Marine Pollutant : No

Further Information

Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. The transportation information is not intended to convey all specific regulatory data relating to this material. For complete transportation information, contact customer service.

15. REGULATORY INFORMATION

Toxic Substance Control Act (TSCA) 12(b) Component(s):

None.

Country	Regulatory list	Notification
USA	TSCA	Included on Inventory.
EU	EINECS	Included on Inventory.
Canada	DSL	Included on Inventory.

Australia	AICS	Included on Inventory.
South Korea	ECL	Included on Inventory.
China	SEPA	Included on Inventory.
Philippines	PICCS	Included on Inventory.
Japan	ENCS	Included on Inventory.

EPA SARA Title III Section 312 (40 CFR 370) Hazard Classification
Fire Hazard. Sudden Release of Pressure Hazard.

US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)
This product does not contain any chemicals known to State of California to cause cancer, birth defects or any other harm.

16. OTHER INFORMATION

NFPA Rating

Health : 0
Fire : 4
Instability : 0

HMIS Rating

Health : 0
Flammability : 4
Physical hazard : 3

Prepared by : Air Products and Chemicals, Inc. Global EH&S Product Safety Department

Telephone : 1-610-481-4911 Corporate
1-800-345-3148 Chemicals Cust Serv
1-800-752-1597 Gases/Electronics Cust Serv

Preparation Date : 06/02/2018

For additional information, please visit our Product Stewardship web site at
http://www.airproducts.com/productstewardship/

PIMA COUNTY BOARD OF SUPERVISORS
DISTRICT 1
130 WEST CONGRESS STREET, 11TH FLOOR
TUCSON, AZ 85701-1317
(520)724-2738
district1@pima.gov
www.district1.pima.gov

ALLY MILLER
SUPERVISOR

JUL 18 2018 11:08 CLK BD

MEMORANDUM

To: Julie Castaneda, Clerk of the Board

Date: **July 18, 2018**
From: Ally Miller, District 1 Supervisor
Pima County Board of Supervisors

Re: **Agenda Item for August 7, 2018 Board of Supervisor's Meeting**

Please place the following item on the **August 7, 2018** Board of Supervisors **Agenda:**

Discussion and possible action related to Agenda Item: Discussion and Vote World View Explosion

A. ***Discussion and Vote: To Discuss County Administrator Huckelberry's July 12, 2018 memorandum re "World View Incident Investigation Report" including attachments pertaining to the Hydrogen Balloon explosion which occurred at the Pima County Taxpayer owned Space Port operated by World View on December 19, 2017.***
B. ***Action requested on the attached list of concerns related to this incident include but are not limited to:***

The Pima County Board of Supervisors entered into this agreement with World View in January 19, 2016 per the recommendation of the County Administrator. We must ensure taxpayer interests and residents of this community are protected. It is especially disturbing that the Board of Supervisors has not received any communication from World View regarding this explosion. Had the Arizona Daily Independent not published a video of the explosion, it may have been completely downplayed as a minor incident. It is a miracle that no one was seriously injured or killed by this violent explosion. It could have been

far worse. The residents of this community deserve answers and it is incumbent upon the Board of Supervisors to provide these answers.

I request that Pima County Board of Supervisor's require World View to conduct a full Investigation, at their expense, to determine the cause as well as a report of corrective actions identified to prevent any future incidents.

Following is a list of concerns that has been identified for discussion, action and vote.

1. *Is an outside agency required to lead this investigation to ensure full transparency to the taxpayers?*
2. *Require World View to provide a listing of all damages including costs to repair any damage on Pima County owned property or on any and all neighboring property.*
3. *Require World View to provide reports of any injuries that resulted from this explosion.*
4. *Evaluation as to whether Federal and/or State statutes violated in the handling of hazardous materials or in the operations at World View, including the use of hydrogen, as well as any other explosive or regulated hazardous materials. The following regulations and Statutes should be reviewed by an appropriate agency/subject matter expert to ensure compliance in reference to this incident as outlined per the terms of the Contract:*
    - *40 USC 260 (RCRA)*
    - *42 USC 7401 (Clean Air)*
    - *ARS Title 49 Chapter 3*
    - *ARS Title 49 Chapter 4*
    - *49 CFR 172.01 DOT HAZMAT Table*
    - *40 CFR Part 302 EPA*
5. *According to this Contract (Section 7.3.1), Pima County must provide express written consent for hazardous materials being used or stored on this property. Did Pima County issue written consent for any hazardous materials including but not limited to hydrogen?*
6. *According to this contract, World View is to maintain compliance with all laws and regulations, as well as coordinate activities with the Tucson*

Airport Authority. Was this test coordinated with the Tucson Airport Authority? World View to provide documentation.

7. ***Per the Contract Terms in the Operating agreement (Section 1.5) World View had agreed to operate this facility in a safe manner in compliance with all laws and regulations. Will hydrogen be allowed on site?***
8. ***Listing of all hazardous materials on site to be provided by World View.***
9. ***Per the contract terms for the lease-purchase agreement, Pima County has a right to review and reasonably adjust the types and limits of insurance required. All policies are to name Pima County as an additional Insured per the terms of the agreements. In light of the explosive materials being used at World View, it is reasonable at this time to review and increase the required insurance coverage on County owned facilities. $1 million per each occurrence is woefully inadequate. The current insurance requirements put the taxpayers at extremely high risk for liability. Request that Pima County Risk Management analyze similar operations and present a report of insurance recommendations to the Pima County Board of Supervisors.***
10. ***It is important to understand what types of vehicles are being utilized at the Pima County owned facility housing World View. For example; are the vehicles containing hydrogen and helium considered World View property under the terms of the insurance agreements? If so, these automobile coverages should be discussed and adjusted, if necessary. Pima County Risk Management should analyze and present a report with recommendations to the Pima County Board of Supervisors.***
11. ***World View to provide a copy of the Property Insurance (Section 10.4) showing the full replacement cost requirement for the facility along with coverage amounts which identify Pima County named as additional insured. With required notifications clause if the Policy is cancelled or lapsed (Pima County must be notified).***
12. ***Identify other concerns to be addressed as related to this incident.***

Attachment (1): County Administrator Huckelberry memo dated July 12, 2018 including attachments

MEMORANDUM

Date: July 12, 2018

To: The Honorable Chairman and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **World View Incident Investigation Report**

On December 19, 2017, World View Enterprises experienced a balloon rupture incident during testing activities. An investigation panel was assembled to review the data from this incident to determine a cause and delineate any necessary steps to mitigate any further occurrences of this type.

On February 12, 2018, World View Enterprises assembled an Independent Incident Review Team (IIRT) led by Mr. Wayne Hale, Director of Human Spaceflight for Special Aerospace Services, LLP and comprised of experts in the aerospace field. I appointed Assistant County Administrator John Voorhees, a retired United States Air Force pilot with accident investigation experience to oversee the investigation on behalf of Pima County (Attachment 1).

Shortly after the IIRT's assembly, Mr. Voorhees provided some expected guidance to World View Enterprises for the conduct of the investigation (Attachment 2). For the most part, the expectations listed in the email were met by either the report or telephonic and in-person conversations.

The IIRT conducted a five-day review of the incident site and data associated with the incident, to include interviews with the operators. The IIRT concluded its investigation by providing World View Enterprises at least six *"Findings"* (some are conclusions and some are recommendations) in a publicly releasable Independent Incident Review Team Report dated May 15, 2018 in Attachment 3. The IIRT also compiled a more in-depth report for the internal use of World View Enterprises.

On May 21, 2018, World View Enterprises provided a summary report of their investigation (Attachment 3). Pima County staff have reviewed the attached reports and Mr. Voorhees also relayed his own observations that are included in this memo.

According to Mr. Voorhees, the releasable report contains sufficient information to draw the proper conclusions regarding the mishap sequence, causes, and recommendations. The investigating team provided ample information to World View Enterprises to take the

appropriate steps to mitigate the risk of any future occurrence of similar type. The report did not recommend any action to be taken by Pima County to mitigate risk to its facilities.

On July 10, 2018, Pima County Facilities Management performed an inspection of the building repairs. This was the final act needed to close out the County's interest in the investigation. The damage to the facility was characterized as significant but superficial. There was no structural damage to the building. The damage to the facility was completely repaired and the building has been restored to full operational capability.

According to Mr. Voorhees, World View Enterprises followed all standard practices for incident reporting. Tucson Fire Department was already on the scene as a safety observer, performed immediate fire-fighting operations and a building safety inspection following the incident. The National Transportation Safety Board (NTSB) and the Occupational Safety and Health Administration (OSHA) were also notified in accordance with workplace mishap regulations.

Mr. Voorhees noted that the timeline to investigate the incident was protracted. Similar aviation mishaps are generally resolved within 30-60 days from the incident date. In spite of this, there was no evidence of wrongdoing in either the mishap, the reporting process, or the investigation timeline.

One of the recommendations of the IIRT was to appoint a fulltime professional safety director for the company. World View Enterprises has hired a fulltime Director of Safety who will focus on the continuous improvement of the company's safety program. World View Enterprises has demonstrated its commitment to be a good neighbor in the Aerospace Parkway by operating a safe and effective aerospace company.

CHH/lab

Attachments

c: Jayne Poynter, CEO, World View Enterprises, Inc.
Dr. John Moffatt, Director, Economic Development Office

ATTACHMENT 1

MEMORANDUM

Date: February 8, 2018

To: The Honorable Chairman and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **World View Balloon Rupture on December 19, 2017**

Supervisor Miller placed an item on the Board of Supervisor's meeting agenda for February 6, 2018 regarding the above-referenced matter; unfortunately, she did not request information readily available to answer her questions. This memorandum will respond to her January 12, 2018 written memorandum (Attachment 1) as well as any oral discussion that took place at the meeting.

The President and CEO of World View, Jane Poynter and Chief Technology Officer Taber MacCallum, both attended the February 6, 2018 meeting to answer any questions the Board may have regarding World View.

1. Investigation of Balloon Rupture
   World View has commissioned an independent investigation to be conducted by a board of world-class experts in aerospace and aviation incident investigation. The investigation has begun and the County will be a participant to verify the independence of the investigation body. The board is led by Mr. Wayne Hale, a former National Aeronautics and Space Administration (NASA) Space Shuttle program manager and one of the most highly regarded experts in aerospace safety in the world. Additional investigation board members will be not be named at this time, in deference to the integrity of the process and will be available upon publication of the final report. Mr. Hale's brief experience associated with this review is as follows:

   - Mr. Hale retired from NASA on July 31, 2010 as the Deputy Associate Administrator of Strategic Partnerships, Space Operations Mission Directorate. He has previously served as the Space Shuttle Program Manager and the Shuttle Launch Integration Manager. Wayne was a Space Shuttle Flight Director for 40 Space Shuttle flights, and prior to that a Propulsion Officer for 10 early Space Shuttle flights.

   - Mr. Hale has received special honors and awards such as NASA Outstanding Leadership Medals in 1999, 2005, and 2007; NASA

Space Flight Awareness Leadership Award 2002; NASA Exceptional Service Medal 1992; National Space Club Goddard Memorial Astronautics Engineer of the Year 2007; and National Air and Space Smithsonian Achievement Award of the Year 2007.

- Mr. Hale holds a Bachelor of Science in Mechanical Engineering from Rice University and a Master of Science in Mechanical Engineering from Purdue University.

In addition, Pima County's representative and individual who will closely review this investigation is John Voorhees, Assistant County Administrator. Mr. Voorhees is uniquely qualified to represent the County in this matter, as he is a retired senior United States (US) Air Force officer with significant command experience as well as accident investigation experience. He is a US Air Force training flight safety officer with certification equivalent to National Transportation Safety Board and Federal Aviation Administration investigators.

2. Damages to the leased World View Building owned by Pima County
Immediately after the balloon ruptured, Facilities and Risk Management staff inspected the facilities and documented the damage that is primarily superficial. All damage will be fully repaired at no cost to Pima County. In fact, World View and Pima County received the first check for property damage repair from the insurance carrier for $200,000. An architectural firm and an engineering firm have been retained by World View to identify repairs required as a result of the accident. Both firms will monitor the repair work until completed and final approval issued by the insurance company, World View and Pima County. There have been no claims filed by any other party for damage that may have been sustained due to the rupture. Attachment 2 is a Facilities Management Report of the damages. Attachment 2A is a field report from Schneider Structural Engineers. Attachment 2B is a summary report from Swaim Associates LTD, of the damage to the building.

3. Damages to Surrounding Properties
The County has not received any claims of damages from surrounding property owners.

The Raytheon Airport Site facilities sustained minor damage and disruptions in business operations as a result of the incident. Additionally, Raytheon continues to be concerned about the World View "Test Planning" process and the safety reviews/oversight of those test plans for activities on the "Launch Pad". We have committed to work directly with the World View team to communicate and address

Raytheon's concerns and World View leadership has been supportive of that partnership.

4. Injuries
   There were no reported injuries based on the balloon rupture. As is standard World View practice both the Tucson Fire Department and Tucson Police Department were onsite for the testing activity that led up to the balloon rupture. Following standard protocol, World View had also notified the Tucson Airport Authority, Federal Aviation Administration and Raytheon among others, of the test. We understand three employees complained of ringing in their ears, however there have been no other reported injuries at the time of the accident nor any since. Any expenses related to the employees would be covered by World View's workers' compensation insurance. No medical claims or referrals have been made to any medical provider by Pima County as a result of the balloon rupture.

5. State Review
   The Arizona Division of Occupational Safety and Health (ADOSH) conducted an investigation of the incident and issued no citations or violations of safety regulations. The case review by ADOSH closed on January 4, 2018. Risk Management contacted ADOSH to confirm that the listed Inspection Detail (Attachment 3), Inspection Number 1285260.015, is available on the US Department of Labor-OSHA website at https://www.osha.gov/pls/imis/establishment.html.

6. Hazardous Materials Stored on Property or used in the Operations, including hydrogen gas
   The Environmental Protection Agency (EPA) and Arizona Department of Environmental Quality (ADEQ) regulations do not apply to storage, use, or release, of hydrogen gas. Their regulations pertain to air quality and management of hazardous waste. Hydrogen gas is not subject to these regulations and is not considered an air pollutant or a hazardous waste.

   The Clean Air Act regulates the accidental release, prevention/risk management plan rule to hydrogen and is applicable if hydrogen is stored or used at the facility if the total quantity of hydrogen exceeds 10,000 pounds. This would require at least 13 fully loaded standard hydrogen tube trailers to exceed this weight of hydrogen. Photos available show less than this quantity of hydrogen present at the site.

   Department of Transportation hazardous material regulations apply to the transportation of materials to the site and therefore are not applicable under the use or storage section of the County contract, Section 7.3.1, requires written consent for hazardous materials, "other than such hazardous materials that are necessary or

useful to WV's business..." Hence, written consent for the use of hydrogen is not required; as it is used as part their business.

We are not aware of any regulated hazardous materials present at the site that would require written consent from the County.

7. Insurance
The following information is regarding certificates and/or evidence of insurance (Attachment 4), both liability and property, that are in place for World View Enterprises:

   - Commercial General Liability Insurance is listed as $5 million for each occurrence; including no-fault medical expense coverage for $5,000 per person; and personal and injury insurance t $3 million per occurrence.

   - Workers Compensation Insurance as required by Arizona statue for coverage by employer for any employee's work related injury and Employers' Liability Insurance with policy limits of $1 million for each accident and for each employee.

   - Property Insurance coverage for replacement cost of the building with the insurance value of $12.2 million and the SpacePort insured at $2.2 million. Pima County is also a loss payee. Policy also includes insurance coverage for World View's business personal property with limits of $3 million.

   In addition, the replacement cost of the building is insured at $12.2 million; SpacePort insured at $2.2 million; and Business Personal Property insured at $3 million with Pima County as a Loss Payee on the policy.

8. Vehicles
There were no County vehicles used at the World View facilities. World View vehicles are all gasoline or diesel, with internal combustion engines.

9. Related Economic Development benefits of World View
The location of World View kicked off a number of space related businesses seeking to relocate or expand in Pima County. Vector Space was a direct attraction initiated by World View senior management's meetings with Vector that included positive comments on the County's support and the development of the Aerospace Research Campus. World View's customer list includes the "Who's Who" of the space business with many coming to Spaceport Tucson to collaborate on and participate in mission development and launches.

World View's industry presence and reputation has generated numerous visits to Tucson for technical and operational discussions. The Federal Aviation Administration's Office of Commercial Space Transportation held a discussion related to the management of the airspace at World View with a wide range of attendees.

The annual meeting of the Commercial Spaceflight Federation (CSF) was held at World View in 2017 exposing World View, Spaceport Tucson and the Aerospace Research Campus to the world's leaders in space exploration. Executive members of the CSF include commercial spaceflight developers, operators and spaceports. Associate members include suppliers supporting commercial spaceflight, with recent members including suppliers of mission support services and suppliers of training, medical and life-support products and services.

One of the CSF Associate Members is BRPH, an engineering and consulting firm based in Florida with contracts across a wide range of space-oriented facilities. BRPH has referred a number of space-focused companies and investors to the Aerospace Research Campus including two national developers that proposed to build the Vector headquarters and manufacturing facility as well as other prospects.

Since announcing World View, Pima County and Sun Corridor, Inc. have proposed the Aerospace Research Campus to seven space related companies. More importantly, we are currently in discussions with a microsatellite and rocket manufacturing company looking to expand in the West. The concentration of space related companies like Raytheon, World View, and Vector, as well as the leadership of The University of Arizona in space exploration, and our excellent workforce, make the Aerospace Research Campus an attractive location for other companies. World View's international reputation has been a major source of attraction and awareness for the Aerospace Research Campus.

Summary

I have visited the World View headquarters at least twice since the accident and can confirm that the reports of superficial damage are accurate and that repairs are either underway or have been completed and financed with insurance proceeds. Upon completion of the independent investigation, the accident review board will submit details of its findings and recommendations to World View to ensure no such incident can or will occur in the future. This report will be made available to Pima County for our information and comment. World View staff and personnel have always demonstrated a significant commitment to safety and professionalism, in particularly how they have handled this incident. We very much appreciate having an innovative aerospace company such as World View call Tucson home.

World View is a high economic development source. They have grown rapidly from 44 employees in March of 2017 to 72 employees earning an average wage of $73,738 in December of 2017 with 20 unfilled positions ready for qualified employees. Finding software, mechanical and electrical engineers continues to be a challenge for World View.

CHH/lab

Attachment

c: Jane Poynter, President and CEO, World View Enterprises, Inc.
Taber MacCallum, Chief Technology Officer, World View Enterprises, Inc.
Dr. John Moffatt, Director, Economic Development
Tom Burke, Deputy County Administrator for Administration
Lisa Josker, Director, Facilities Management
Lauren Eib, Risk Manager, Finance and Risk Management

ATTACHMENT 2

John Voorhees

From: John Voorhees
Sent: Thursday, February 15, 2018 12:27 PM
To: Maricela Solis
Cc: John Moffatt
Subject: Investigation of 19 December 2017 incident
Attachments: bd-WV Balloon Rupture.pdf

Maricela,

Hope all is well in World View. I apologize for missing the Feb 6 Board of Supervisors' meeting (had a family issue). Sounds like things went very well and all of the Supervisors' questions were answered adequately. Per the memo attached Mr. Huckelberry has tasked me to 'ride shotgun' on your internal investigation on behalf of Pima County. I have absolutely no desire to influence the outcome of the investigation (or even get involved in the investigatory process). However, I believe there are certain touchpoints where Pima County as the landlord should have awareness. With that, here are some County expectations:

1. I will liaison with the senior investigator on any investigatory matter related to the County's interest. In other words, if there are findings in the investigation that might impact the County's business (something was wrong with the building, infrastructure, launch pad,...) I'd like the investigator to out-brief the County before the final report is released. As long as we're kept in the loop about any developments I will maintain a passive role and await an out-brief.

2. I would expect the County to receive a written publicly releasable (ie sanitized) incident investigation report. The report should cover:

    a. investigator qualifications
    b. investigation methodology (what did they examine and why)
    c. mishap crew details (no names, but years of experience, qualifications/certifications hours on shift at the time of the mishap)
        i. supporting crew details (how many fire fighters, notifications to other agencies)
    d. mishap vehicle details (no proprietary information-just a description of the mishap balloon and servicing equipment [time in service, inspection currency-as applicable])
    e. mishap supporting equipment details (servicing history, certifications,...)
    f. mishap timeline/sequence
        i. planning
        ii. briefings (to include any safety briefing topics discussed prior to the mishap)
        iii. mission operations (what time was the balloon inflated, any non-proprietary information about how the testing went)
        iv. deflation timeline
        v. incident time
        vi. post incident safety measures (notifications, cleanup, securing of evidence,...)
        vii. immediate debrief and aftermath
    g. injuries
    h. damage to facilities
    i. mishap observations – without divulging "safety privileged information" explain the basic cause and effect of the mishap
    j. Findings – (usually "privileged" information and not included in a basic mishap report). I would expect the investigator to provide this to you for mishap prevention

k. Contributing factors – (again usually privileged) not directly related to the cause and effect of the mishap sequence, but may have impacted the characteristics of the mishap or contributed to the mishap sequence development.
l. Other areas of note – sometimes an investigation into one area reveals deficiencies in other areas.
m. Conclusions and recommendations – (usually falls into the 'safety privileged' arena). Again the County would expect a sanitized version of the investigator's recommendations.

3. If there are procedures and processes already in place to mitigate any new risk to life or property, the County would like to see those measures.

4. If there are privileged items that are not publicly releasable but pertinent to our lease relationship the County would expect to be briefed on these findings/items of interest. Having held a formal certification as a mishap investigator I fully understand the need to safeguard and maintain the confidentiality of safety privileged information. I can be a liaison for this information.

5. Unless it has a direct relationship to our tenant agreement I have no expectation of World View to reveal proprietary information. Our interest is not to know everything World View does. But, like you, we wish to protect our investment.

6. Though the report will probably not reach the depth of the reports traditionally accomplished by the FAA, NTSB, or military; there are templates and examples available that may provide a decent backdrop from which to write a report. Let me know if I can help provide anything.

Our goal is to mitigate any and all identified risks to Pima County. To that end I wish to work with you and the involved staff. Thanks for your accommodation.

V/R,
John "Dutch" Voorhees
Assistant County Administrator
Pima County, Arizona

ATTACHMENT 3

WORLD VIEW

May 21, 2018

Chuck Huckleberry
Pima County Administrator
130 W. Congress St.
Tucson, AZ 85701

Dear Administrator Huckleberry:

World View Enterprises has concluded the formal review of the incident that took place on December 19, 2017, at the Tucson Spaceport facility, and has implemented a number of organizational and procedural changes based on the findings and recommendations of an Independent Incident Review Team.

On December 21, 2017 World View management-initiated plans for a thorough and independent review of the technical and organizational causes by a panel of independent aerospace experts led by N. Wayne Hale. Beginning on February 12, 2018, the Independent Incident Review Team (IIRT) conducted a five-day intensive review consisting of on-site data collection, hardware review, and personnel interviews. In addition to finding the proximate technical and organizational causes of the mishap, the IIRT was mandated to review company safety practices and culture to provide recommendations for improvements in those areas.

In response to the incident review and the report of the team detailing key findings and recommendations, World View has enacted several organizational and operational changes necessary for safe and reliable utilization of its evolving operation and capability. Principally among those changes was the hiring of a full-time, globally recognized Director of Safety, Dr. Tony Kern. Dr. Kern has already begun his employment with World View and is responsible for the continuous improvement and implementation of all safety programs and processes, instilling World View with the highest culturally safety standards, and ensuring the organization's overall commitment to safety excellence during all activities and operations. Dr. Kern is one of the world's leading authorities on human performance in time constrained, error intolerant environments. He has authored seven books on human performance, has previously served as the Chairman of the U.S. Air Force Human Factors Steering Group, the National Aviation Director for the U.S. Forest Service, and as the CEO of Convergent Performance, a think-tank dedicated to reducing human error and improving performance in, among other fields, aviation safety and operations.

WORLD VIEW

In addition to hiring Dr. Kern, World View has already implemented numerous changes to its safety culture and operations. World View is working diligently to improve its risk assessment models for all future mission operations, utilizing industry standard tools and peer review methodology. World View has engaged with an independent consultant to improve its already disciplined and rigorous safety standards and training procedures for employee handling of lift gas. World View is expanding corporate safety training, procedures, and the strict enforcement of all standards surrounding the use of Personal Protective Equipment (PPE) for all appropriate personnel. World View has already implemented accountability processes, work time rules, and human resources policies for all mission operations. In addition, and in line with the overall maturing of our organization following our most recent financing round, we have implemented the IIRT's recommendation to establish a Mission Operations organization separate from R&D, which is now formally led by retired NASA Astronaut Col. Ron Garan, who has decades of experience in aviation and spaceflight operations excellence. He is Senior Vice President of Mission Operations and reports to the CEO of World View.

With guidance and oversight from the IIRT, World View management has worked diligently and objectively to fully dissect and understand the cause and various effects of December's operations mishap and how we might prevent such an event from occurring again in the future. Our team is committed to and already well on its way to implementing the recommendations of the IIRT in pursuit of operational and safety excellence.

In addition to addressing the specific recommendations of the IIRT, World View swiftly responded to all surrounding neighbors who reported property damage as a result of the operation. Our team ensured that all claims were handled quickly and appropriately. The damage to the county-owned building has been completely repaired and returned to its original state. World View is proud to be a member of the Tucson community and we are committed to the safe operation of Spaceport Tucson.

The following report documents the results and recommendations of the IIRT Report. World View is confident that these findings will only help progress this unique technology and the organization, safely and effectively.

Sincerely,

Jane Poynter

Co-Founder and CEO, World View Enterprises

1805 E. Aerospace Parkway, Tucson AZ 85756
www.WorldView.space

Independent Incident Review Team Report

May 15, 2018

I. Introduction

On December 19, 2017 World View Enterprises incurred an unexpected explosion during testing activities of a large hydrogen filled balloon at their Tucson, AZ flight facility. On December 21, 2017 World View management-initiated plans for an incident review by a panel of independent aerospace experts to provide a thorough review of the technical and organizational causes of the mishap. The Independent Incident Review Team (IIRT) held its initial meeting at World View Enterprises headquarters in Tucson, AZ on Monday February 12, 2018. Five consecutive days of on-site data collection, hardware review, and personnel interviews were accomplished. In addition to finding the proximate technical and organizational causes of the mishap, the IIRT was mandated to review company safety practices and culture to provide recommendations for improvements in those areas. This report documents the results of that IIRT investigation.

II. Executive Summary

The IIRT recognizes World View as an enterprising and innovative company focused on the development and exploitation of high altitude (stratosphere) balloon technologies for diverse applications including earth observation, near-space science, and communication. The company has been aggressively pursuing advances in performance, manufacturability, power, subsystems, and operations to provide safe and cost-effective operations for their clients. World View leadership expressed their sincere desire to utilize the unexpected explosion as a catalyst for developing organizational and operational changes necessary for safe and reliable utilization of this evolving capability. As such, they requested identification of any issues, concerns, or observations "holding no punches."

Development of high performance cost effective balloon systems led World View to examine the use of hydrogen gas as the lift medium. World View correctly recognized that use of highly flammable hydrogen gas is a hazard and safety risk. World View instituted numerous changes to the balloon operations including the addition of Personal Protective Equipment (PPE) for exposed personnel, hydrogen safety training, and the analysis of potential ignition scenarios. Special efforts were implemented by World View to minimize hazards and potential of all ignition sources. Some of these were the banning of cell phones or other electronic devices in the test area and the electrical grounding of the balloon load tapes to reduce the likelihood of electrostatic discharge.

The IIRT recognizes the meticulous and methodical approach the World View operations and planning team utilized in developing detailed procedures for the initial filling and lift including the conduct of subscale tests to further refine these procedures. The primary objective of the tests was to demonstrate large balloon fill operations with hydrogen gas. During pre-test hazard

assessment, the safety review process incorrectly assessed both the probability and possible consequences of an explosive event during deflation.

The primary objective of the test series was met successfully in the final test. Immediately following successful fill of the balloon, the planned termination of the test required deflating the balloon. This was to be accomplished through a destructive gore or tearing process. The IIRT confirmed that the upper balloon outer skin and upper fill tube demonstrated significant motion (flapping) which most likely resulted in static electricity generating a spark and igniting the hydrogen/air mixture.

The IIRT concludes that ground facilities (which were disconnected at the time), vehicles in the area, or other causes were not contributors to the explosion.

The explosion that followed resulted in a pressure wave that impacted the World View facility and caused some property damage and several personnel experienced ear ringing. The operations ground crew all felt some radiant heat from the explosion but did not experience any overpressure or blast effects and were unharmed. Following the incident and appropriate safing operations, the World View team began an orderly shutdown for the previously scheduled seasonal break.

The IIRT conducted five consecutive days of on-site data collection, hardware review, and personnel interviews. In addition to finding the proximate technical and organizational causes of the explosion, the IIRT's review of company safety practices, operations and organizational culture revealed opportunities to improve, mature, and formalize procedures and process such that hazardous operations can be conducted with appropriate rigor, protocol, and contingency planning. The result was six key findings and several recommendations.

Finding #1: The board finds that escaping hydrogen gas from the planned balloon deflation interacted with the fragmented plastic balloon shell and/or balloon accessories (inflation tube) in such a manner as to build up an electrostatic potential which discharged and caused the hydrogen gas which had mixed into atmospheric air to ignite.

Finding #2: The board finds that the pre-test safety review process incorrectly assessed both the probability and possible consequences of an explosive event during deflation.

Finding #3: The use of hydrogen gas in large balloons can be done safely and has been demonstrated worldwide. If World View determines to continue the use of hydrogen gas in large balloons, the board recommends rigorous additional safety measures be implemented.

Finding #4: Current safety practices at World View should be improved commensurate with other relevant hazardous operations. Changes to culture, practices, procedures, protocols, documentation, accountability and communication will be required.

Finding #5: The World View organization has been evolving and growing rapidly and is expected to continue rapid growth for some time. World View transitioning from an R&D/prototyping type organization to a production and operations organization. To ensure both

company success and safety, changes must be made including internal communications. These changes must be appropriate to the organization to maintain creativity and flexibility

Finding #6: Ops tempo with the staffing level available in the last quarter of 2017 resulted in excessive workloads on some personnel. Human factors concern, crew rest rules, and realistic planning and scheduling processes are being matured at World View and must be made rigorous for future operations.

Key IIRT recommendations include: hiring a formal safety manager for World View operations, improving hazard assessment and risk management processes, procuring additional hydrogen gas operations and analysis support, refining operations crew scheduling rules, recommending design enhancements for the balloon system, and items regarding the transitioning of the organization culture so that the company can include both innovative development and highly reliable production operations.

The Board is extremely encouraged by the receptive posture and openness to feedback of World View as demonstrated by their immediate adoption of these recommendations. The IIRT believes that with comprehensive implementation of the recommendations, World View can be both a safe and extremely effective organization in this unique field of practice.

III. Background

Incident Description and Timeline

The test took place on December 19, 2017. The systematic detailed timeline was by all accounts followed as designed.

All the operations and inflation steps defined in the test plan were successfully completed just before 1 PM local time. The inflation and fill of the balloon demonstrated that the design could successfully hold the lift gas which was the primary test objective. Included in the test plan was disconnection of all ground hydrogen gas loading equipment to put the balloon into a 'launch ready' configuration. The IIRT notes that the inflation tubes were sealed, the hydrogen gas diffusers, hydrogen gas lines to the tube trailers, and all other associated loading equipment was removed from the area near the balloon to what was considered a safe distance.

The only steps remaining were to gore the balloon which would vent the hydrogen gas and post-test clean up.

Shortly before 12:48 PM local time the call was made for the planned deflation and to gore the balloon. The balloon's destruct line functioned as expected and the balloon envelope was successfully split open and started to vent gas.

When gored, most large balloons will peel open with the balloon film rapidly rolling back resulting in a rapid discharge of the lift gas. This destruct system worked as planned in that it opened the balloon, but the balloon fabric did not peel back in the typical manner. Video recordings of the event show the balloon fabric folding back in over the gore tear and

constricting the gas flow out of the balloon. Video recordings show clearly that the gas did not vent from the balloon in the very short amount of time that was expected.

At 12:48 PM the escaping hydrogen ignited, exploded, and set fire to the balloon fabric.

The only credible source for ignition is static electricity discharge which caused the hydrogen gas mixed into air to ignite.

The actual timing of all the test event were recorded by the Test Director but these notes were destroyed in the explosion.

The Tucson fire department was at the test site as a pre-planned safety precaution. Fire fighters delayed action until all the falling burning plastic had reached the ground and it was clear that there was no additional hydrogen gas trapped in the balloon fabric. At that point, the fire department addressed the residual fire, which was contained to the launch pad.

Many of the test operations team who were at ground level reported feeling a radiative heat pulse but no large pressure wave or loud report.

The sound, shock wave interacted with the building causing alarms and fire suppression water activation. In short order, the World View personnel evacuated the building.

Reentry into the building was not allowed until the fire department had checked the building. There was water leakage in balloon production area of the building. A brief structural integrity inspection was performed by Tucson Fire Department, and then the workforce was allowed back into the areas to start the cleanup process.

Three World View employees experienced hearing issues and all received appropriate medical attention. These medical issues were reviewed per OSHA workplace mishap regulations and reported as required in compliance with those regulations. Additionally, counseling services were provided to any World View employee experiencing emotional trauma from the event.

The IIRT notes that no ground facilities were involved in the initiation of the fire and explosion. The IIRT notes that no vehicles in the area (e.g., hydrogen tube trailers, forklift) were involved in the initiation of the fires and explosion. The IIRT did not find any exceptions to reporting requirements for hazardous materials at the facility. The IIRT did not find that schedule pressure, worker fatigue, or other related issues contributed incident.
Following the incident and appropriate cleanup and safing operations, the World View team began a previously scheduled shut down. The IIRT noted that the World View team did not execute some post-mishap procedures which the IIRT expected: only some witness statements were taken, the data sources were collected but not impounded, and the equipment used in the incident were not preserved in a coherent manner. The balloon fabric was placed in a recycle receptacle and the leased vehicles were returned to their owners. Initiation of a review team was not immediately made. The IIRT does not believe that there was any consequence of significance associated with any of these observations.

Property damage to the Pima County owned building is being evaluated with initial estimates on the order of $200,000.00. There was also some minor breakage in surrounding non-World View buildings. In the NASA parlance with which the IIRT is familiar, this event would have been categorized as a Mishap Class C. (reference **NPR 8621.1C** https://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=8621&s=1C)

Investigation Board Process

The independent investigation board was assembled by World View to provide both a technical assessment of the explosive event on Dec 19, 2017 and to assess the overall operating environment including test hardware, software, planning, procedures, decision processes and safety management. World View leadership expressed their sincere desire to utilize this unexpected event as a catalyst for developing organizational and operational changes necessary for safe and reliable utilization of this evolving capability. As such, they requested identification of any issues, concerns, or observations, "holding no punches" and to provide specific recommendations for improvements.

The board consisted of three senior engineering managers with a breadth of experience in conducting hazardous test and flight operations and associated incident and failure investigations. The board also has considerable experience with the management and organizational culture required to perform high reliability operations in hazardous fields.

The five-day onsite review initiated on February 12, 2018. The planned review process included formal technical presentations, hardware inspection, integrated engineering and operations team debriefings, and private interviews of all individuals directly involved in test and any employee indirectly affected who requested an interview.

After introductions on February 12, briefings began with a company overview followed by detailed presentations of the test objectives, operations planning, setup, major event timelines, risk and hazardous analysis, and results. Inspection of ground and flight hardware manufacturing, integration, operation and test facility followed. Some of the hardware directly involved in the incident was no longer available for the investigation team to examine. However, similar type equipment was made available for the investigation team to review.

Twenty-six individual interviews of approximately half hour duration each were conducted. These interviews of key World View employees provided detailed understanding and perspective of every aspect of company operations including design, development, production, integration, operations and flight. Insight into company culture and norms especially regarding safety processes were elicited during these interviews.

The anonymous safety reporting system previously put in place by World View also provided additional information on employee concerns and company safety culture.

Much of the data relevant to the immediate explosive event was in the form of photography and videos from various vantage points including a drone video from above and to the east of the balloon during the deflation/explosion.

At the end of the week, initial findings, observations and recommendations were consolidated and presented to the senior leadership team with expectation for final report within several weeks. The board has made themselves available for follow up or clarifying discussion over the next several months.

Investigation Team Biographies

N. Wayne Hale, Jr.
Academic Background
Master of Science in Mechanical Engineering, Purdue University, 1978.
Bachelor of Science in Mechanical Engineering, Rice University, 1976.
Employment History:
2010 to present: Director of Human Spaceflight, Special Aerospace Services, LLP, of Boulder, Colorado. Provides services in technical consulting, management coaching, technical analysis, safety processes, technical seminars, and advising on organizational culture change. Has served as leader or member of several incident review boards. Clientele includes aerospace, energy sector, and other high reliability organizations concerned with safety, management, culture change, and operations in high risk environments.
2008 to 2010: NASA Deputy Associate Administrator for Strategic Partnerships. Established and coordinated new collaborative activities with national space programs of various foreign countries, other government agencies, commercial space flight entities, and academic institutions. Provided critical support to the 2009 President's Blue-Ribbon commission on the future of space exploration, the "Augustine" Commission. Developed the management plans and philosophy for NASA to encourage the development of a commercial human space launch industry to low earth orbit which became the Commercial Crew Program Office. Provided support to national leadership in the development of national space policy.
2003 to 2008: NASA Space Shuttle Program: Program Manager, Deputy PM, and Launch Integration Manager. Executive responsibility for the $5.1 billion, 20,000 employee program. Overall responsibility for returning the Space Shuttle to regular flight following the Columbia accident including safety, technical content, budget development and adherence, schedule establishment and adherence. Extensive media interaction, inter-organizational conflict resolution, interface with legislative and independent oversight organizations. Chief accomplishments while Deputy PM included response to the Columbia Accident Investigation Board (CAIB) and implementation of management restructuring and culture change, served as Mission Management Team chairman with final technical responsibilities for STS-114 flight execution. As Launch Integration Manager coordinated disaster response to Columbia accident at the Kennedy Space Center; interfaced with the CAIB during its investigation and reporting.
March 1988 to January 2003: NASA Flight Director. Operational responsibility for 40 space shuttle flights including 28 launches, 26 landings. Lead Flight Director responsible for overall shuttle mission success on three flights including the first logistics flight to the ISS. Extensive international interfaces required for many flights. Served on the Shuttle-Range Safety Panel; International Space Station Independent Advisory Panel; Space Flight Safety Panel; Mars

Surveyor Program Architecture Peer Review; Recoverable Entry Flight Safety Review Board (X-38). Served on several mishap/incident review boards associated with Space Shuttle Flight Operations incidents.

June 1978 to March 1988: NASA Space Shuttle Systems Flight Controller and supervisor of Shuttle Propulsion and Communications Flight Controllers.

Significant Professional Activities post Government service:

Member At Large for the NASA Advisory Council providing advice to the NASA Administrator and senior US leadership on space policy.
Member of the FAA Commercial Space Transportation Commercial Space Transportation Advisory Committee providing advice to the FAA Deputy Administrator
National Academy of Sciences Committee on Applications of Real Time Monitoring to Offshore Oil and Gas Operations 2014-2016
President, JSC chapter of the NASA Alumni League
Board of Advisors for the Coalition for Deep Space Exploration (CDSE)
Standards Chairman for the Commercial Spaceflight Federation (CSF). 2011-2013

Professional Awards and Honors:

AIAA Associate Fellow, 2015
NASA Exceptional Service Medal, 1992
Three times awarded the NASA Outstanding Leadership Medal, 1999, 2005, 2007
National Space Club, Astronautics Engineer of the Year, 2007
Smithsonian National Air and Space Museum, Current Achievement of the Year, 2007

Christopher E. Singer

Christopher (Chris) Singer recently retired as NASA Deputy Chief engineer and is currently an independent space launch systems consultant and executive coach. He is a proven, dynamic leader with over 34 years of experience in developing innovative solutions for human space flight, design, thru flight and has lead numerous failure and accident investigation teams.

Perspective

For over 34 years, I had the honor and privilege to serve NASA, providing strategic vision, discipline technical leadership, motivational energy creating an innovative environment to advance high performance space systems from propulsion to Life Support.

Career Highlights

NASA Deputy Chief Engineer, March 2016-June 2017, - Lead Engineering integration across 10 field Centers. Created effective relationships and strategies for new partnerships within NASA, other agencies, commercial industry and academia. Infused behavior changes needed to effectively embrace innovation, risk and failure tolerance. Provided expert analysis for catastrophic events including Commercial Crew Development ground and flight systems failures.

Director/Deputy MSFC Engineering, 2004-2016 - Strategic leadership and technical direction to organization of over 2500 engineers responsible for the design, testing, and operation of space transportation, spacecraft systems, and payloads including Space Shuttle Propulsion and Space Launch System (SLS) development. *Columbia* Tragedy/Recover, Led the External Tank Bipod failure scenario recreation and debris mitigation efforts. Shuttle Mission Management representative for final 21 Flights. Provided senior review for numerous ground and flight systems failures including: Commercial Crew Propulsion Systems (Boeing and Space X), Commercial Resupply Launch Vehicle (Orb-3, Engine), Taurus Fairing, Peregrine Solid Rocket Nozzle and many others.

Deputy Director/Chief Engineer MSFC Space Transportation, 2000-2004 - Led 600 person, full-lifecycle organization (Research, Engineering, Test thru Flight Demonstration), responsible for numerous advanced technology space flight projects including Fastrac Engine, X-33, X-34, X-37. Defined Mission Success protocol, Flight Readiness, Contingency/Failure Investigations, systems engineering methods to embrace risk posture for advanced technology development.

Space Shuttle Propulsion Leadership, MSFC & NASA HQ, 1992-2000- Defined and implemented numerous safety and performance upgrades for space shuttle main engine including advanced health monitoring and high pressure turbopumps, enabling 2 times increase in reliability. Led 11 catastrophic ground test engine failure investigations and 3 Space Shuttle on-pad aborts providing systems analysis, fault tree development, hazards and root cause analysis. Rapidly developed mandatory corrective actions including hardware changes, inspection requirements, test, process controls or additional operational health management diagnostic algorithms. Led Safety Review Team for advanced Hydrogen Cold flow facility activation.

Honors & Awards - AIAA Associate Fellow, numerous awards including Distinguished Service, Outstanding Leadership medals and Presidential Rank Award — the highest honors for career federal employees and the coveted Astronaut Corp Silver Snoopy Award.

A native of Nashville, Tennessee, Mr. Singer earned a bachelor's degree in mechanical engineering in 1983 from Christian Brothers University in Memphis, Tennessee.

Henry M. Cathey, Jr.

Henry M. Cathey, Jr. is the Interim Deputy Director of the New Mexico State University's (NMSU), Physical Science Laboratory (PSL) and serves as the manager of the FAA approved NMSU UAS Flight Test Site. His responsibilities also include support for scientific ballooning, Unmanned Aircraft Systems, other suborbital efforts, and PSL Business Development. He has worked for PSL for over 25 years with his core concentrations focused on research and new technology implementation. Mr. Cathey has leadership experience in managing a staff of engineers, R&D efforts, test programs, projects, and flight campaign efforts.

For over 25 years he has supported the NASA Scientific Balloon Program with a focus on the NASA Super Pressure Balloon development effort. He has design, analysis, performance

analysis, balloon production/fabrication, and flight operations experience with numerous balloon test flights. He currently supports other national and international ballooning efforts.

He manages one of the seven FAA approved UAS Flight Test Sites supporting different UAS missions. These include testing of new flight vehicles, qualification of flight systems, new sensor development, and operational planning. UAS R&D efforts focus on applying this new technology to various scientific research activities. He serves as the lead for PSL's efforts related to the FAA Center of Excellence (COE) for UAS research. As part of the ASSURE (Alliance for System Safety of UAS through Research Excellence) team, PSL is helping safely integrate UAS's into the national airspace. Specific efforts focus on small UAS Detect and Avoid Requirements Necessary for Limited Beyond Visual Line of Sight Operations and detection of UAS near airports. He is also leading an FAA Minority STEM education outreach effort that focuses on UAS's as the central learning platform. Events have targeted middle school students across New Mexico through UAS Roadshows and summer camps.

He previously worked on the NASA's first Discovery mission the Near Earth Asteroid Rendezvous (NEAR) spacecraft, the Rossi X-Ray Timing Explorer (XTE), the Tropical Rainfall Mission (TRMM), the first Hubble Space Servicing Mission, and other spaceflight missions. He has experience in design, packaging, and thermal analysis of spacecraft electronics, spectrophotometers, colorimeters, radio receivers, test equipment, and other electronic assemblies. He has designed, planned, managed, and implemented numerous balloon and balloon subsystem tests.

He received his Bachelor of Engineering Degree in Mechanical Engineering from Vanderbilt University in Nashville, TN in 1983, and his Master's Degree from the George Washington University in Washington, DC in 1993. In July of 2015 he was awarded a NASA Exceptional Public Service Medal for his contributions to NASA's mission. In January 2016, he was presented with a NMSU 2016 Research Discovery Award. Mr. Cathey is an Associate Fellow member of the American Institute of Aeronautics and Astronautics (AIAA) and past Chair the AIAA Balloon Systems Technical Committee. He has organized technical conferences, has authored over 45 technical papers, and has served as a technical article reviewer for international refereed journal publications. He has managed and directed nearly 20 co-op students. He actively participates in educational outreach activities speaking to thousands of students over the past 25 years.