SAND2013-6050P

18 July 13

Causal Analysis of 983 SF6 Storage Tanks

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Agenda

- DOE Occurrence Limit
- The Event
- How the system is designed
- Safety Issues
- Possible factors causing burst disc to burst

Occurrence Reporting

"All abnormal releases not resulting as a byproduct of Z-Machine operations that equal or exceed 115 pounds will be reported as required by the Order."

Refer to Correspondence Control Number: 12_230_SNL_05-29-2012
DOE Order 232.2 Occurrence Reporting

Occurrence

Date: 6/27/2013

Time: ~ 17:10

- Weather Conditions: ~ 102°F @ time of event
  - Winds out of East at sustained 10 mph and gusting higher
  - High temp of the day was 105°F
- Tank # 1 Burst Disc Ruptured
  - Had zero pressure
  - Released ~ 1940 lbs of SF6

SF6 Storage Tanks

Located West of 983

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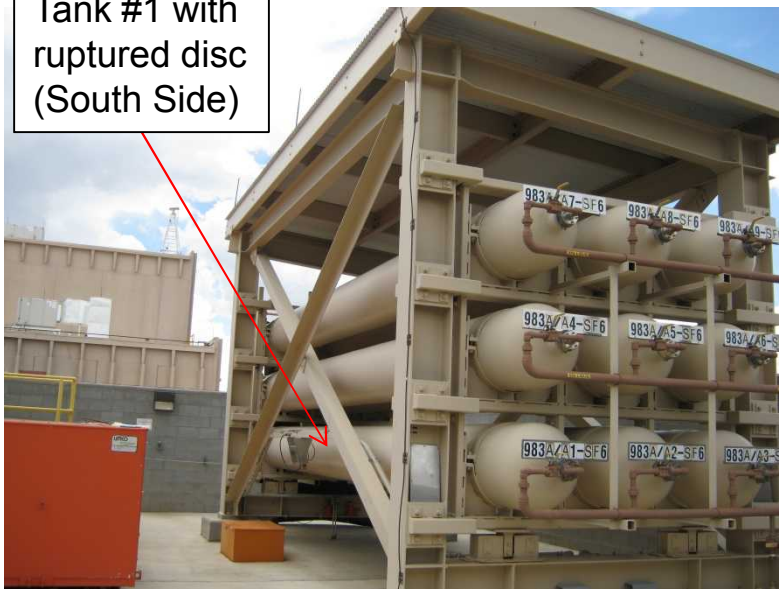
SF6 Storage Tank System

Pressure Relief Discharge Piping

Tank #1 with ruptured disc (West Side)

Tank #1 with ruptured disc (South Side)



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Design Specifications

- Each storage tank
  - Designed to hold 5,355 lbs liquid @ 380 psia
  - Procedure limits to 4100 lbs
    - Release results in less than the ERPG-3 concentration at 100 m [AIHA,1989].
  - Typically fill between 2000-2500 lbs

Pressure Calculations:

Overpressure tested with a safety factor of 1.3
1.3MAWP = 1.3 (520 psig) = 676 psig

MAOP = .85MAWP
= .85(520 psig)
= 442 psig

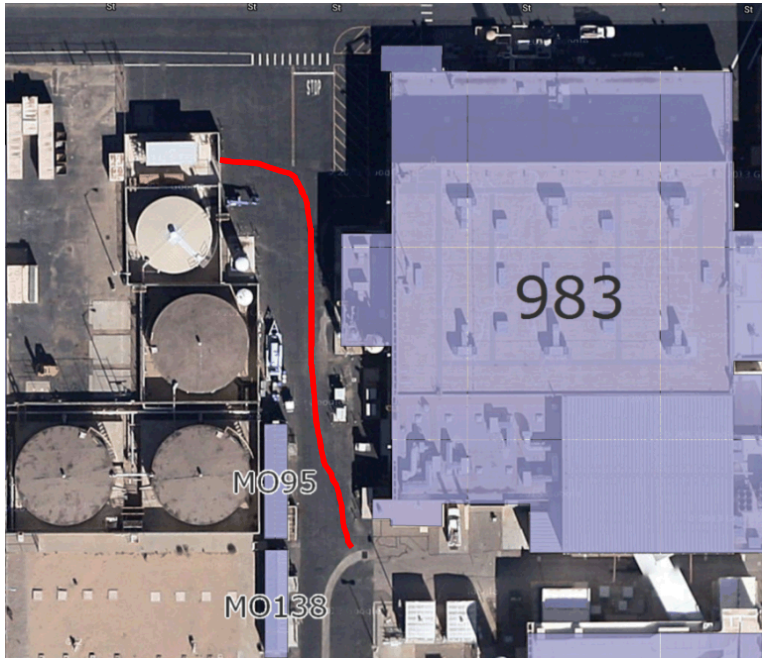
SF6 Critical Temp. < Burst Disc > MAOP

Tank	
MAWP	520 psig
MAOP	442 psig
Volume	75.85 ft^3
Specific Volume	0.0375 ft^3/lb
Burst Disc	
Pressure - Temp	521 psig @ 72 °F
	500 psig @ 110 °F
SF6	
Critical Temp	114°F
Critical Pressure	545 psi

Safety

- Burst disc
  - Designed for relief
  - Prevents catastrophic failure
  - Releases amount of one tank instead of entire storage system
- Not in a confined space
  - No asphyxiation hazard
- SF6 release would have dispersed throughout the area and flowed into storm drain west of 983
  - SF6 is 5x heavier than air

Drain Path



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Temperature Measurements

One week after the occurrence (July 5), temporary tarps where placed over the south and west sides of the storage tanks. All three tanks on the south side are empty.

Temperature readings at various locations on the SF6 storage cylinders were taken with an infrared temperature sensor

- Ambient Temperature ~ 88 °F
- SE metal frame 99 °F
- Bottom South cylinder still exposed to the sun 90 °F
- Bottom South cylinder in the shade from the tarps 82 °F
- SW outside of the tarp 91 °F

AP1

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Slide 10

AP1 was 88 the high temp for the day the readings were taken (or had it been hotter and cooled)?

were temperatures taken at cylinders before the tarp was in place?

Avery, Penny, 7/22/2013

Possible Contributing Factors

- Ambient Temperature
  - Temperatures in the high 90s (°F) in month of June
    - Max 105°F day of occurrence
- Sun hitting on the south tanks could have caused the tanks to have a higher temperature, increasing pressure of SF6 inside the tank
- Sun hitting on the west side piping could have caused the burst discs themselves to have higher temperature, reducing the burst pressure rating
- Burst disc could fatigue over time, reducing burst pressure rating

Burst Disc Performance

FORWARD ACTING SCORED

The FAS is Oseco's problem-solving rupture disc

FAS

- Sizes 1" through 18"
- Standard materials of construction: 316 Series Stainless Steel, Nickel, Inconel® 600, Monel®, and Hastelloy® C
- Excellent for gas or liquid service applications
- Lowest K_R in the industry means less flow restriction
- K_{RG} 0.223 K_{RL} 0.19
- Non-fragmenting design
- "Fail-safe" A damaged or incorrectly installed FAS will always burst at less than the rated pressure
- Elevated temperatures up to 900° F
- Burst tolerance ±5% > 40 psig & ±2 psig ≤ 40 psig
- Non-torque-sensitive

The Oseco FAS (Forward Acting Scored) Rupture Disc is designed and manufactured for high-performance and demanding rupture disc applications.

The FAS is scored after the forming of its high crown. This process yields a high-performance disc to withstand the most difficult applications. The FAS offers a smooth non-scored surface toward the process media. This limits product accumulation on the disc and reduces the risk of polymerization and crystallization of media on the disc surface.

The FAS rupture disc has a 90% operating ratio for applications requiring a high operating to set pressure ratio. Due to the high operating ratio and non-fragmenting design, the FAS rupture disc is an excellent choice for isolation of safety relief valves. Installing the leak-tight FAS rupture disc between the process media and the safety relief valve protects the valve and prevents emissions to the atmosphere.

- Operates at 90% of stamped burst pressure
- PFA-grade Fluoropolymer liners available for atmospheric and/or process sides
- ASME Approved

COMMON APPLICATIONS
Safety relief valve isolation - High Pressure

OPERATING RATIO
90%

BURST TOLERANCE
±5% over 40 psig, ±2 psig at or below 40 psig

MANUFACTURING RANGE
0%

oseco pressure intelligence

A HALMA COMPANY

www.oseco.com

Burst Disc Performance Reduction %

TEMPERATURE °F	TEMPERATURE °C	316 316/TEF*
72	22	100.0
80	27	99.3
90	32	98.4
100	38	97.6
110	43	96.7
120	49	95.9
130	54	95.0
140	60	94.2

Burst Disc	
Pressure - Temp	521 psig @ 72 °F 500 psig @ 110 °F
Ambient Temp	105 °F
SF6 Pressure	522.14 psi (Spec. Vol 0.0375)
Burst Pressure	510 psi (98%)

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Conclusion

- Contributing factors
  - Temperature
  - Direct sunlight
  - Burst disc fatigue
- This was an unplanned release but the system performed as designed per pressure safety guidelines

Questions

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Drains to Low Point