Comparative Blinded Flare Gas Flow Measurement Study

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Wait a minute…I thought this was a Workshop on Smokestack Gas Measurement?

Flare Gas

Smoke Stack

It just so happens the same flow meters that measure smokestacks also measure flare gas.

Smokestack vs. Flare How Are They Different:

- Smokestacks are usually larger.
  - Full-bore meters are not an option.
- Smokestacks have smaller flow ranges:
  - Flare gas can range from 0.1 to 500 feet/sec.
- Smokestacks have more stable flows.
- Flare gas can have transient flow with wide flow swings.
- Flare gas can have large gas composition & density changes.

Smokestack vs. Flare How Are They Similar:

- Very little or no straight run of piping.
- Lots of distorted velocity profiles, skews & swirls.

Comparative Flare Gas Flow Measurement Study

- In 2011, Chevron contracted a blinded study to test various flow meters used in flare gas measurement.
- The goal was to shed some light on different flare gas flow measurement technologies.
- Improve:
  - API-14.10 (Measurement of Flow to Flares)
  - API-22.3 (Testing Protocol for Flare Gas Metering)
- Data presented at the GPA (Gas Producers Association), April, 2013, San Antonio, Texas.

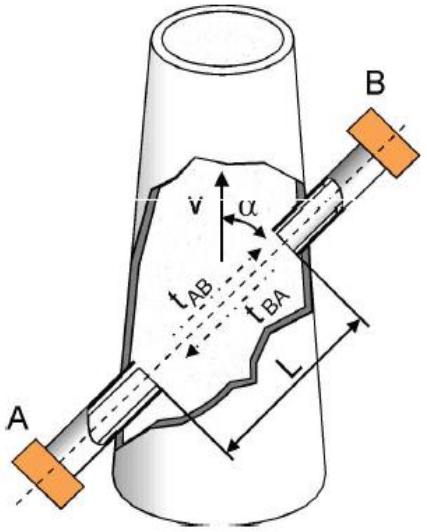
Thank you:
Steve Baldwin, Chevron
Houston, Texas, U.S.A.

Thank you:
Eric Estrada, Targa Resources
Houston, Texas U.S.A.

Comparative Flare Gas Flow Measurement Study

The comparative <u>blinded</u> study ran from 2011 to 2013 and included the following meters:

- **USM (4-path Chordal)**
- **USM (2-path, Diametral)**
- **USM (1-path, Diametral)**
- **USM (1-path, Diametral, Partial Insertion)**
- **Optical Flow Meter**
- **Tracer Gas Dilution Methodology**

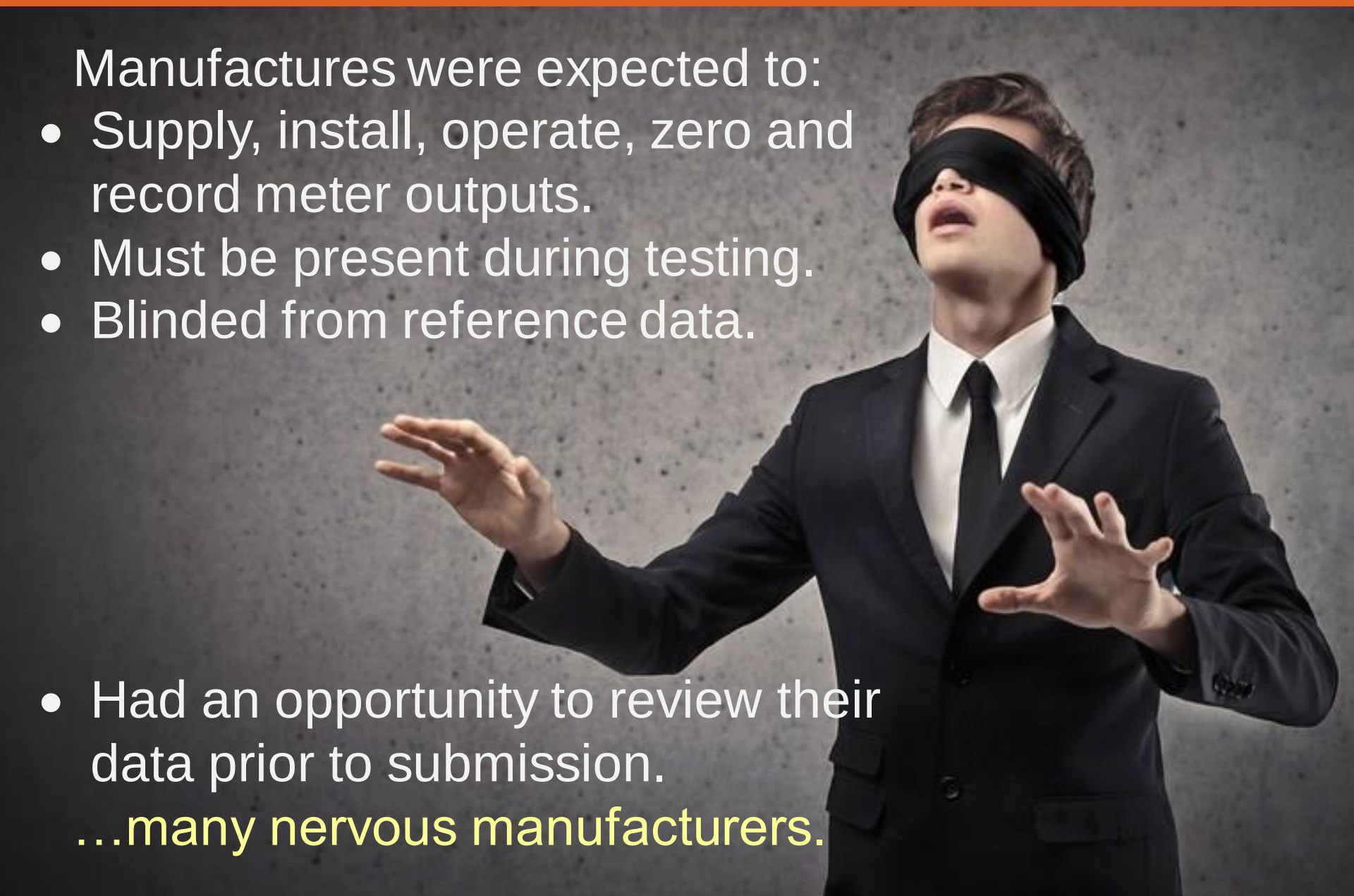


Wanted to test Pitot Tube Technology but time & money didn't allow it.

Rules of the Game:

Fluid:	Air
Temperature:	70°F (Ambient)
Pressure:	12 PSIA (Ambient)
Velocity:	1 to 150 FPS (feet/second)
Pipe size:	10” (6” pipe for 4-path chordal USM)
Pipe orient:	Horizontal
Piping Config:	Ideal straight-run
	Swirling flow after an elbow
	In-Plane & Out-of-Plane

Comparative Flare Gas Flow Measurement Study



Manufactures were expected to:

- Supply, install, operate, zero and record meter outputs.
- Must be present during testing.
- Blinded from reference data.

- Had an opportunity to review their data prior to submission.

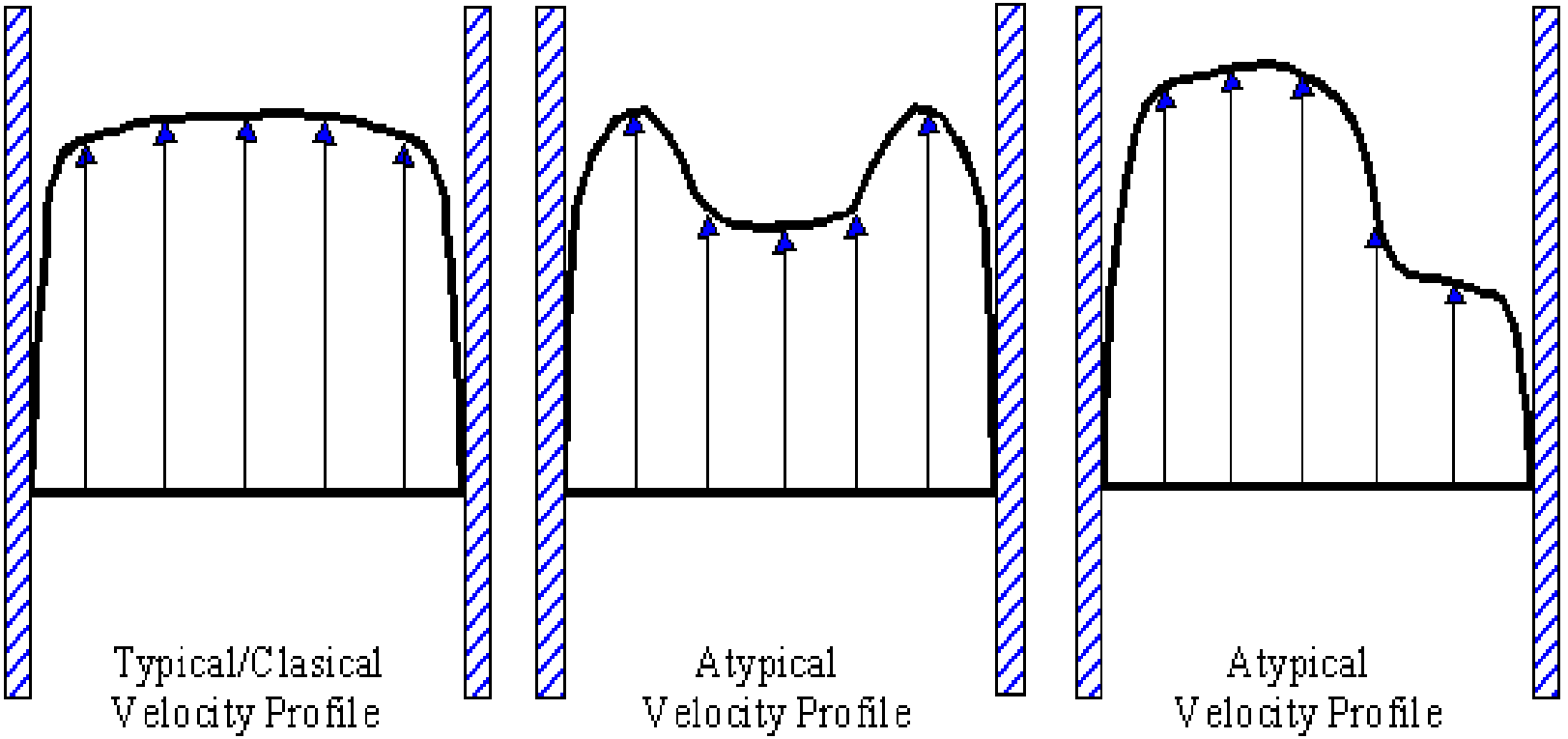
…many nervous manufacturers.

Warning!

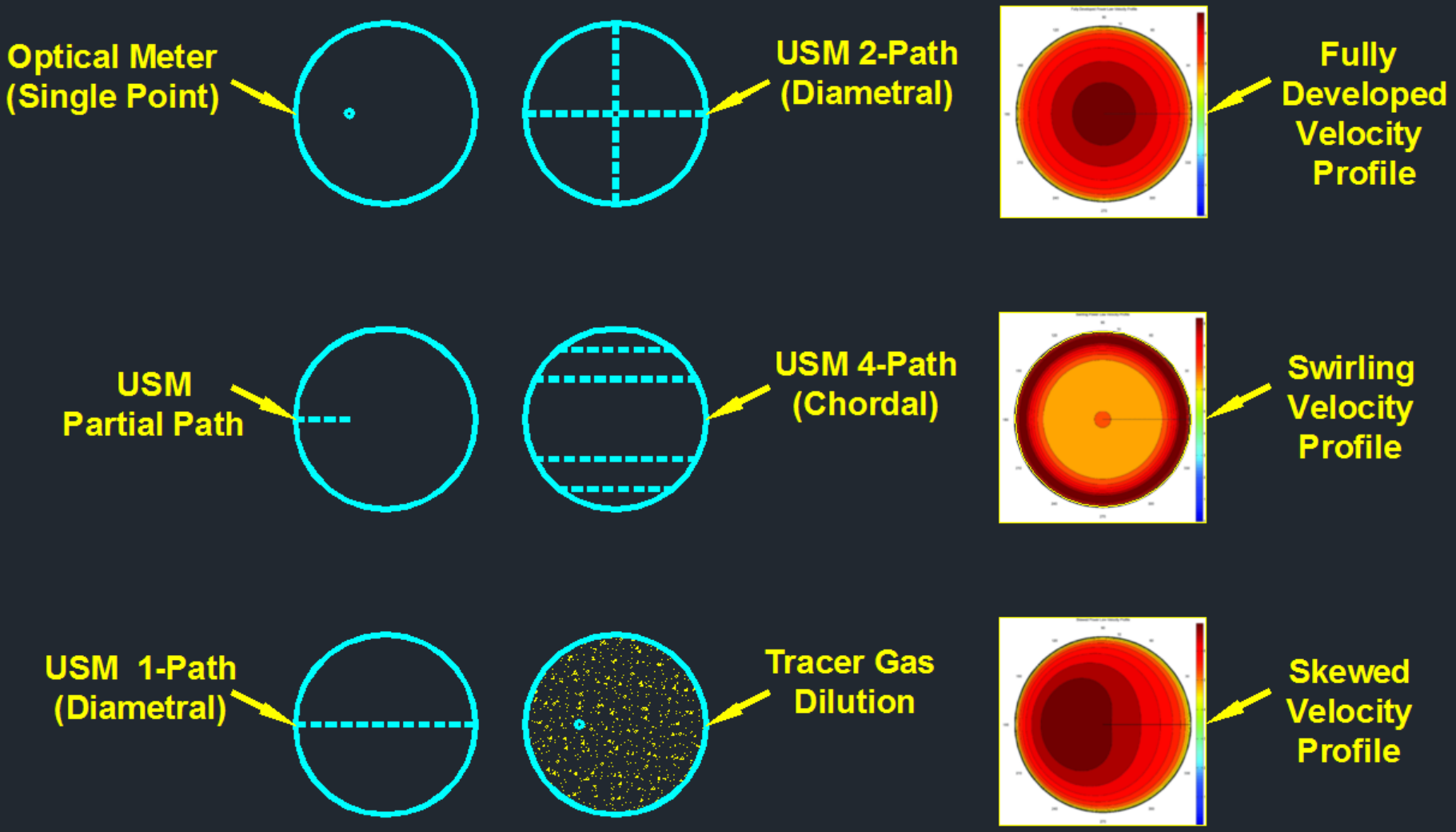
Test results based on:

- Limited testing with a small sample size in 6” and 10” pipes.
- Extreme caution should was exercised when extrapolating these results to other
  - Pipe sizes
  - Different piping configurations
  - Different fluids
  - Different meters types

Consider Flare Gas & Smokestack Velocity Profiles:



Consider How a Meter Senses the Flow:



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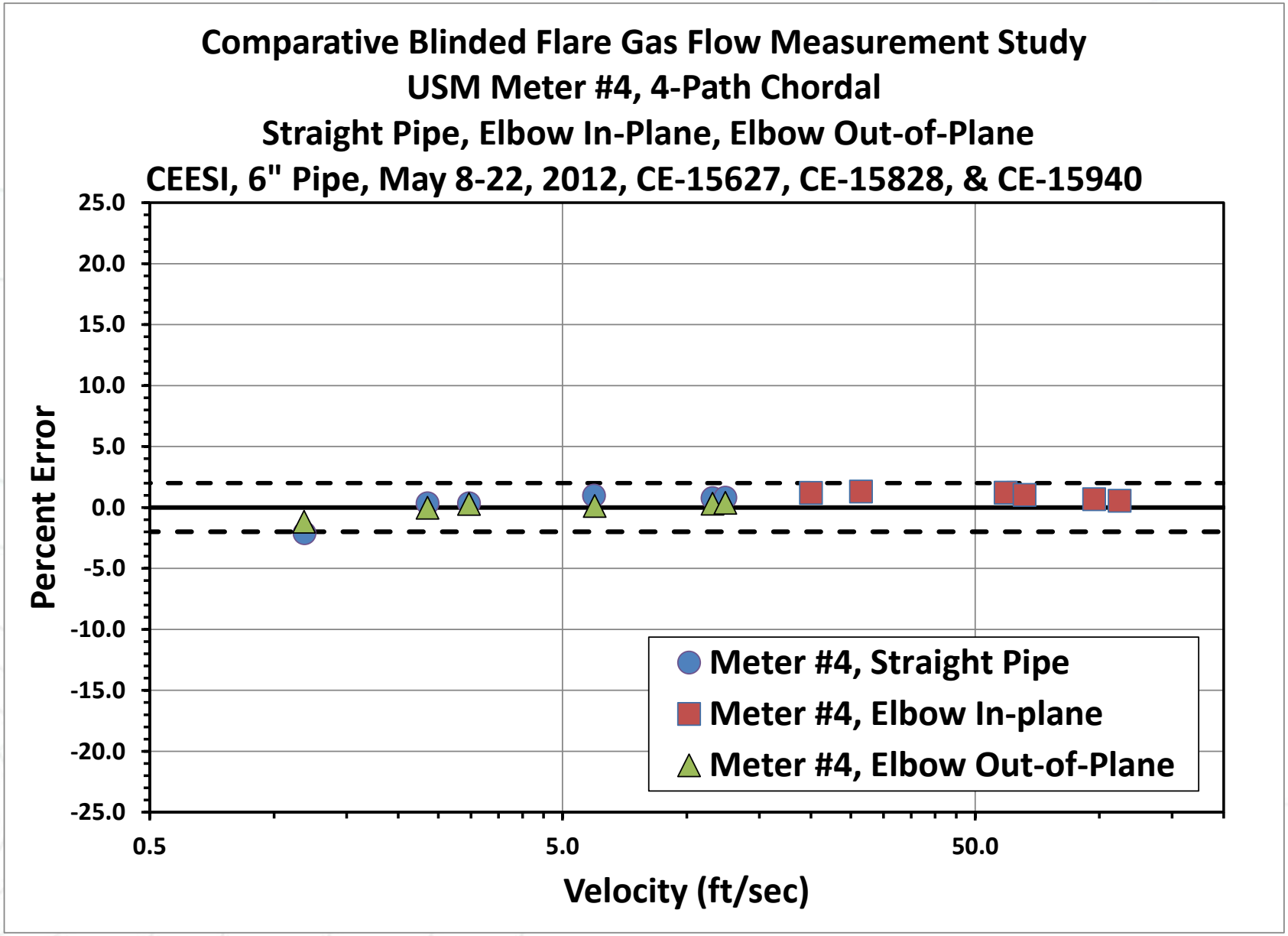

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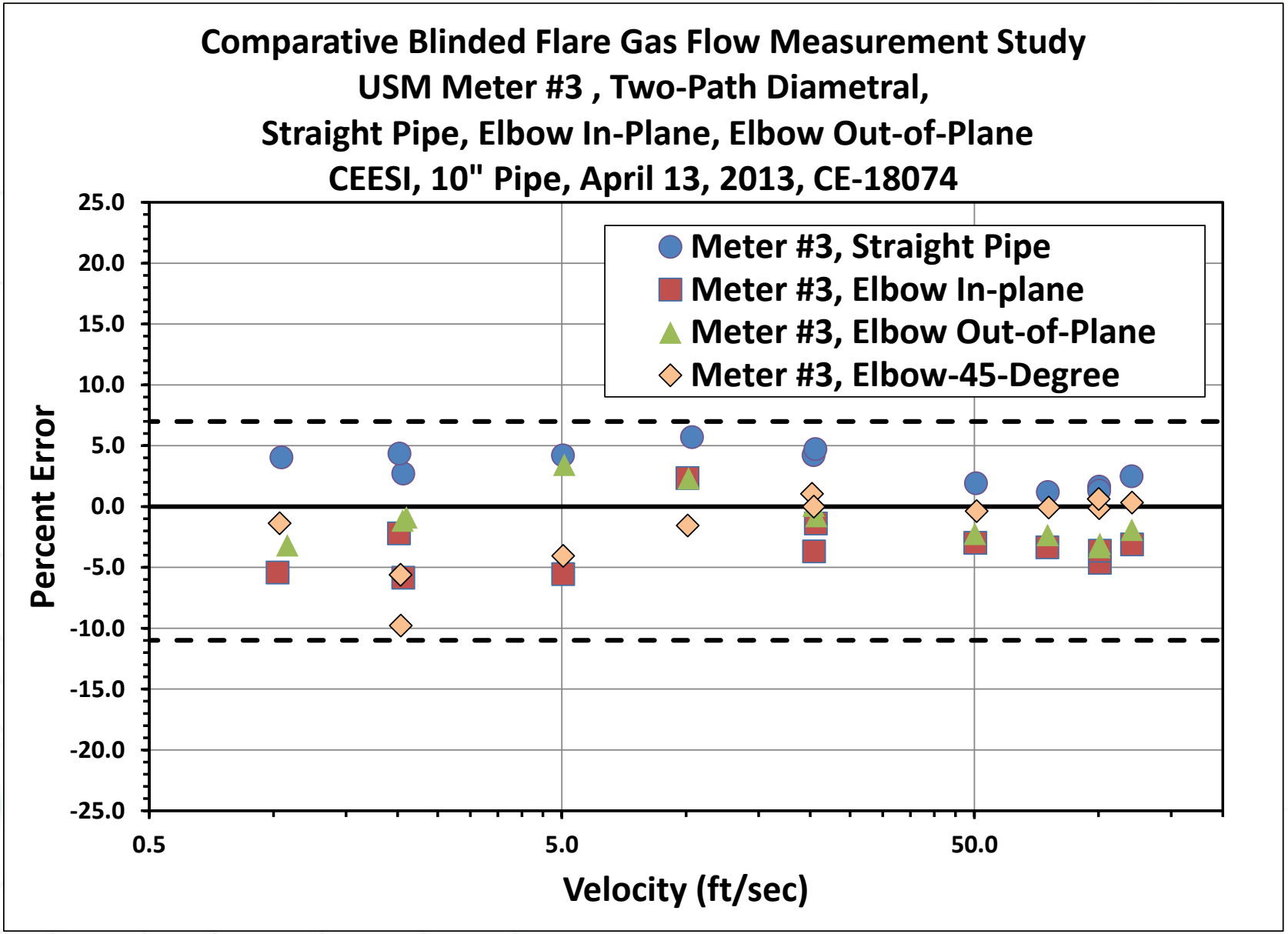

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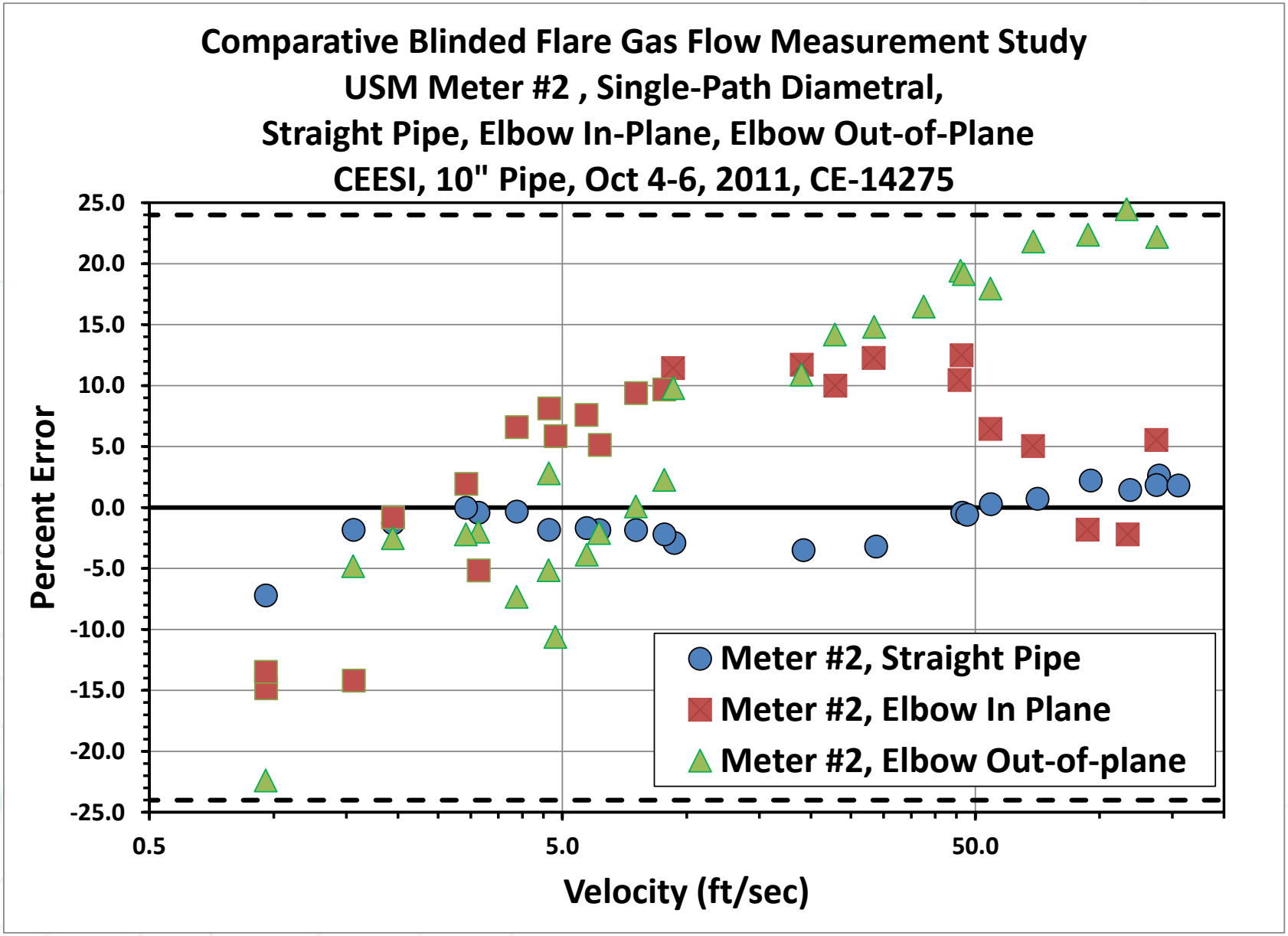

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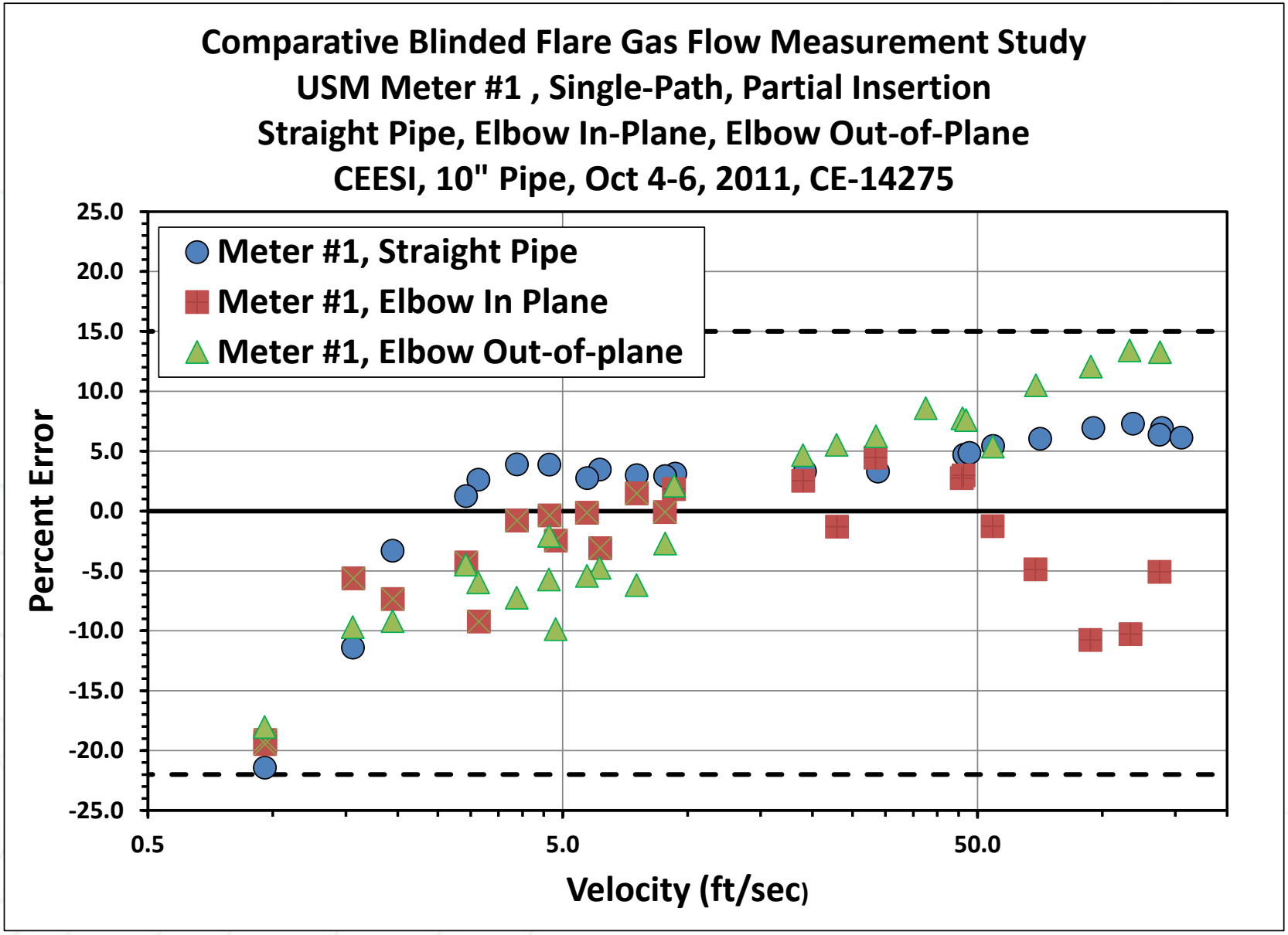

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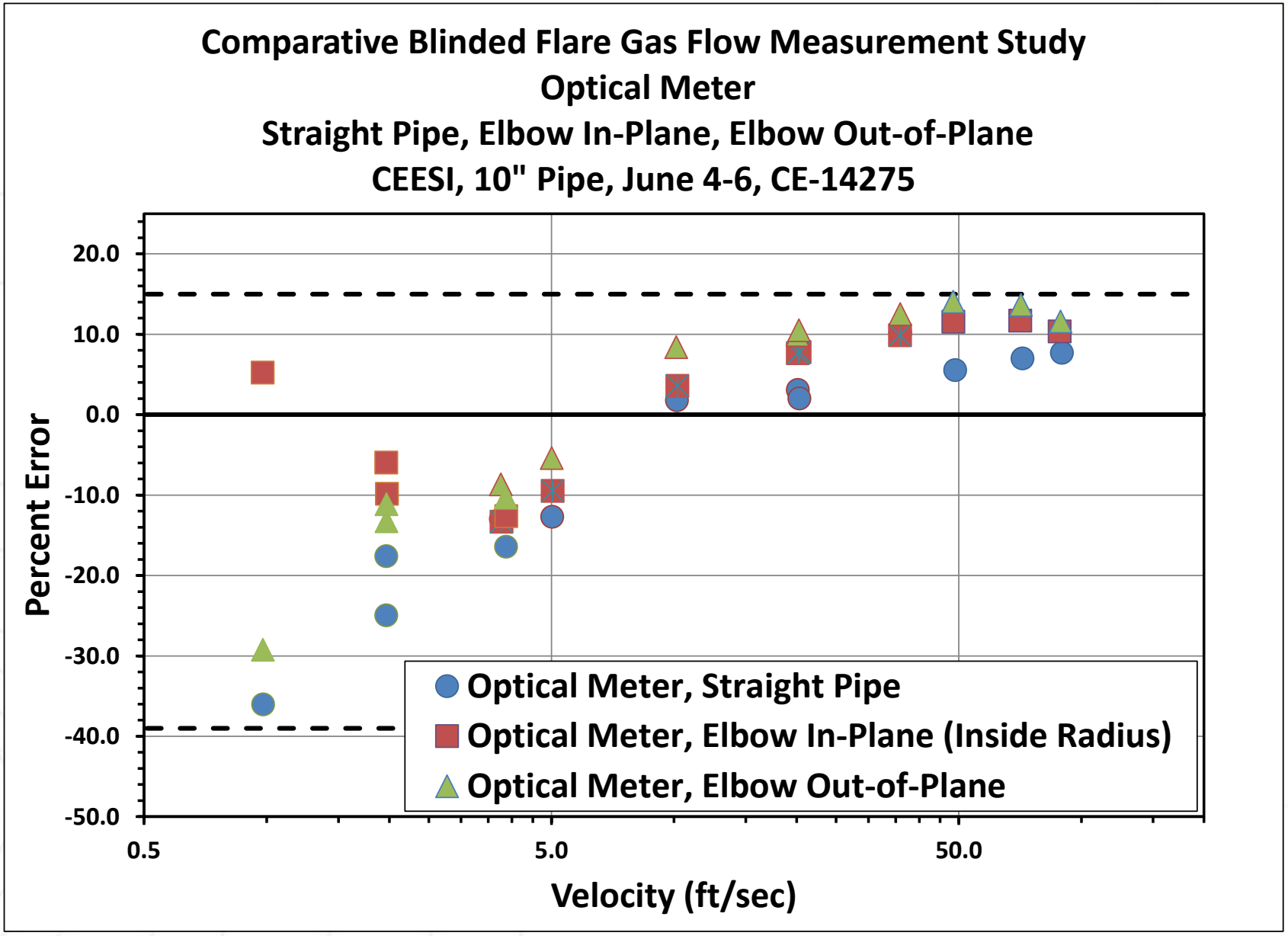

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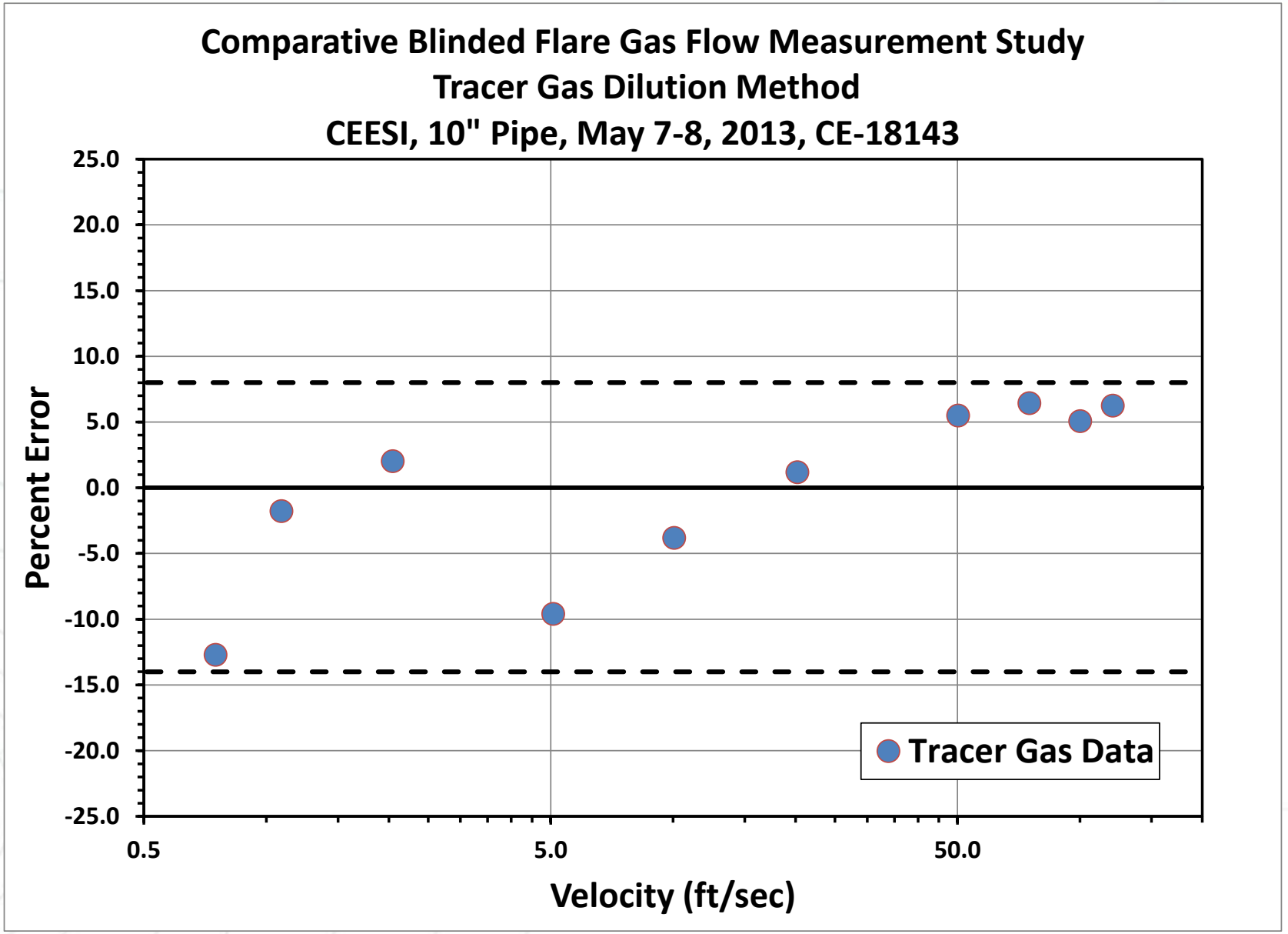
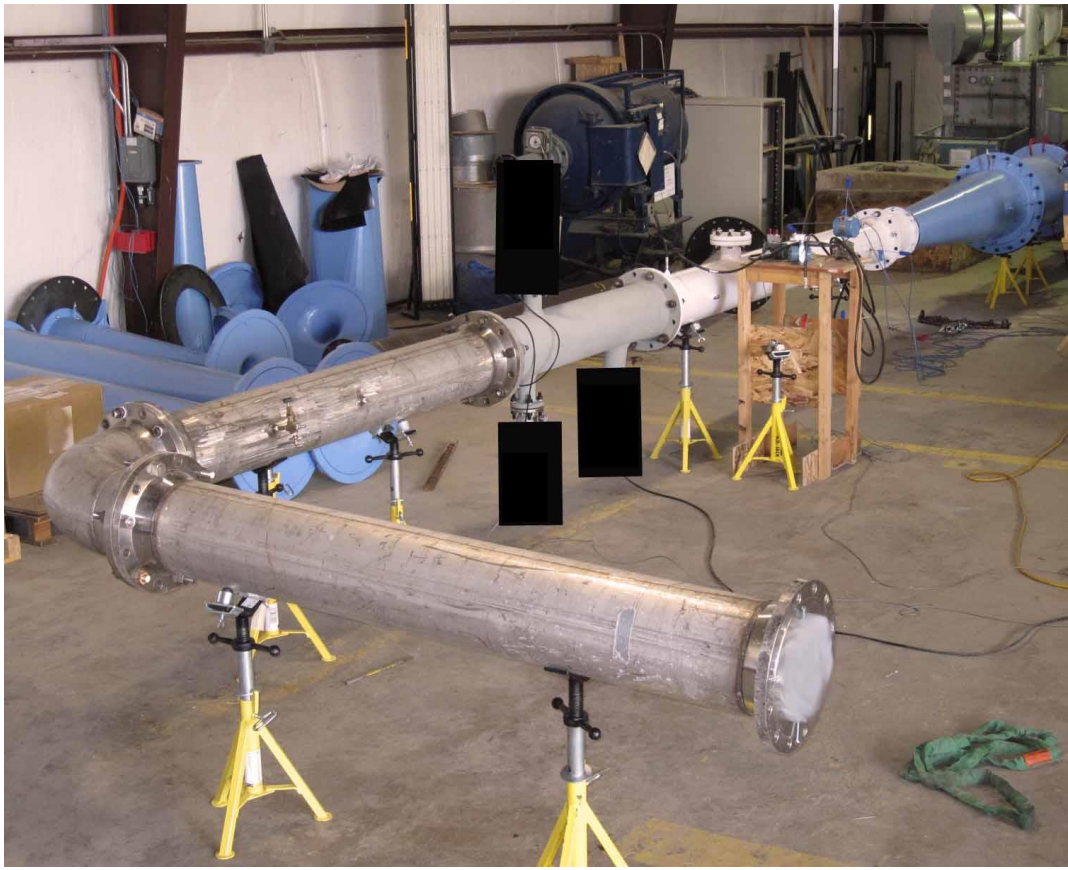


A Few Pictures:



Test Facility & Test Piping

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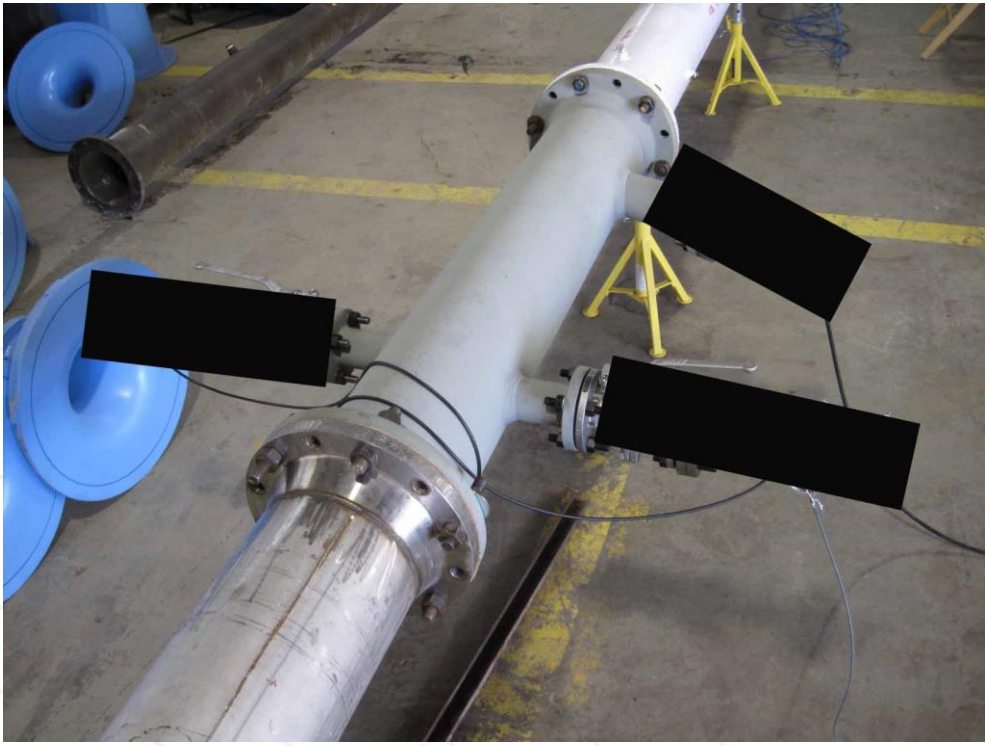

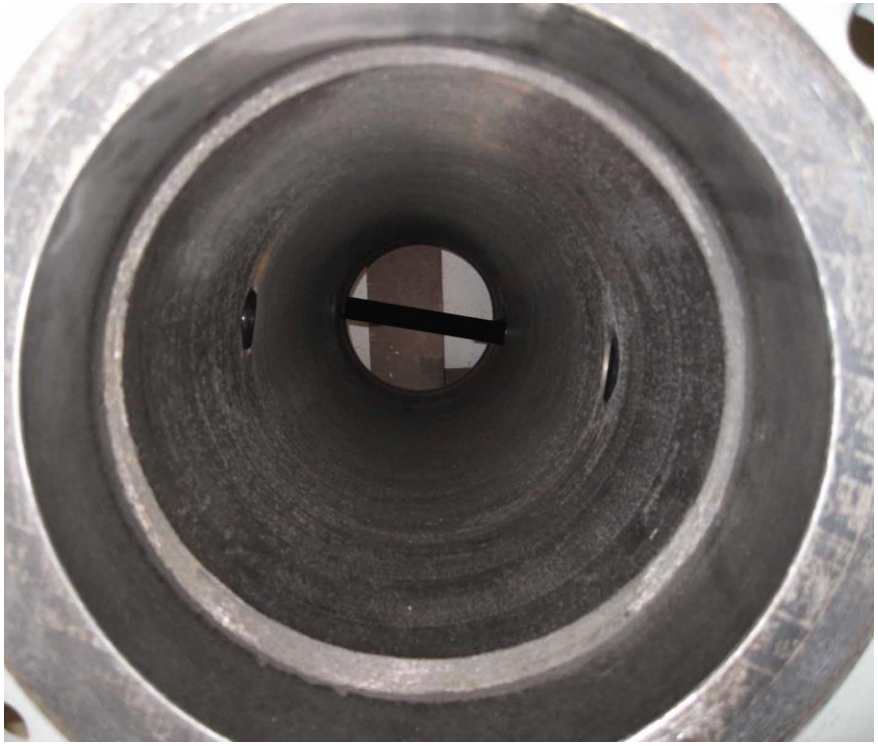

USM (1-Path & Partial Path) Installation

Comparative Flare Gas Flow Measurement Study

USM (2-Path) Installation

Comparative Flare Gas Flow Measurement Study

USM (4-Path Chordal) Installation

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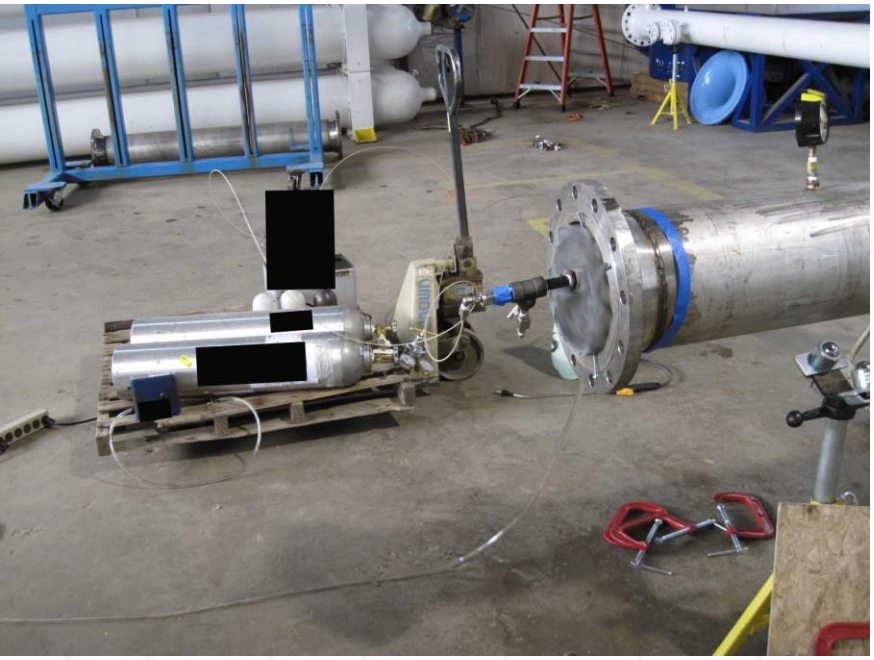
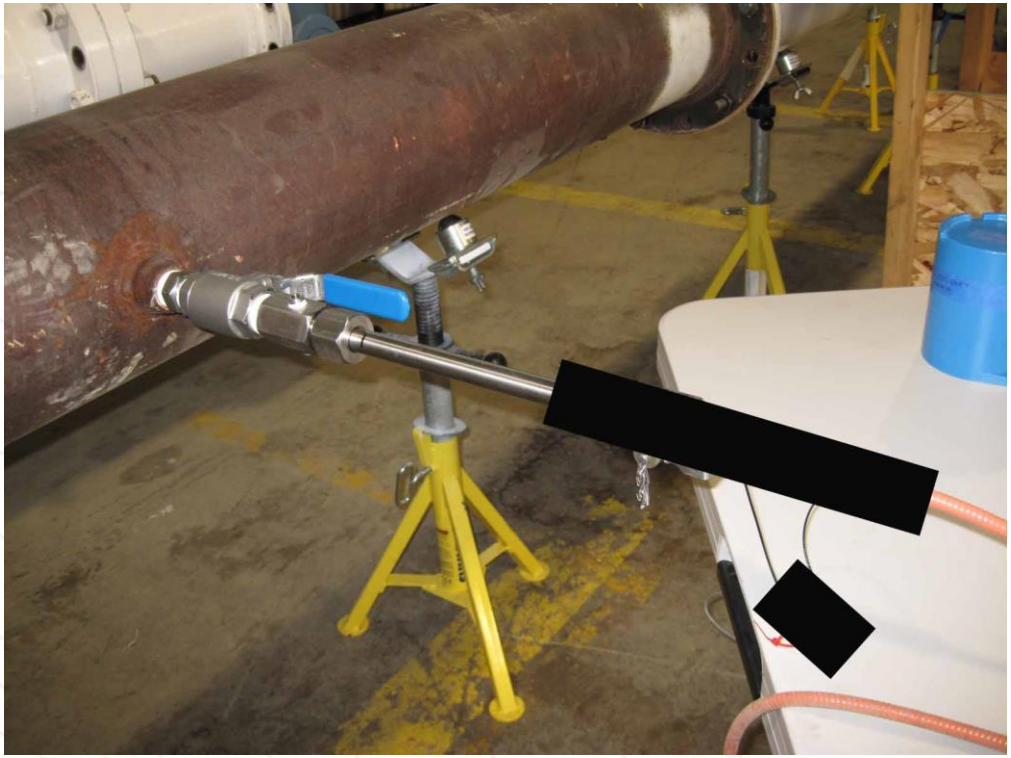


Tracer Gas Dilution Installation



Optical Meter Installation

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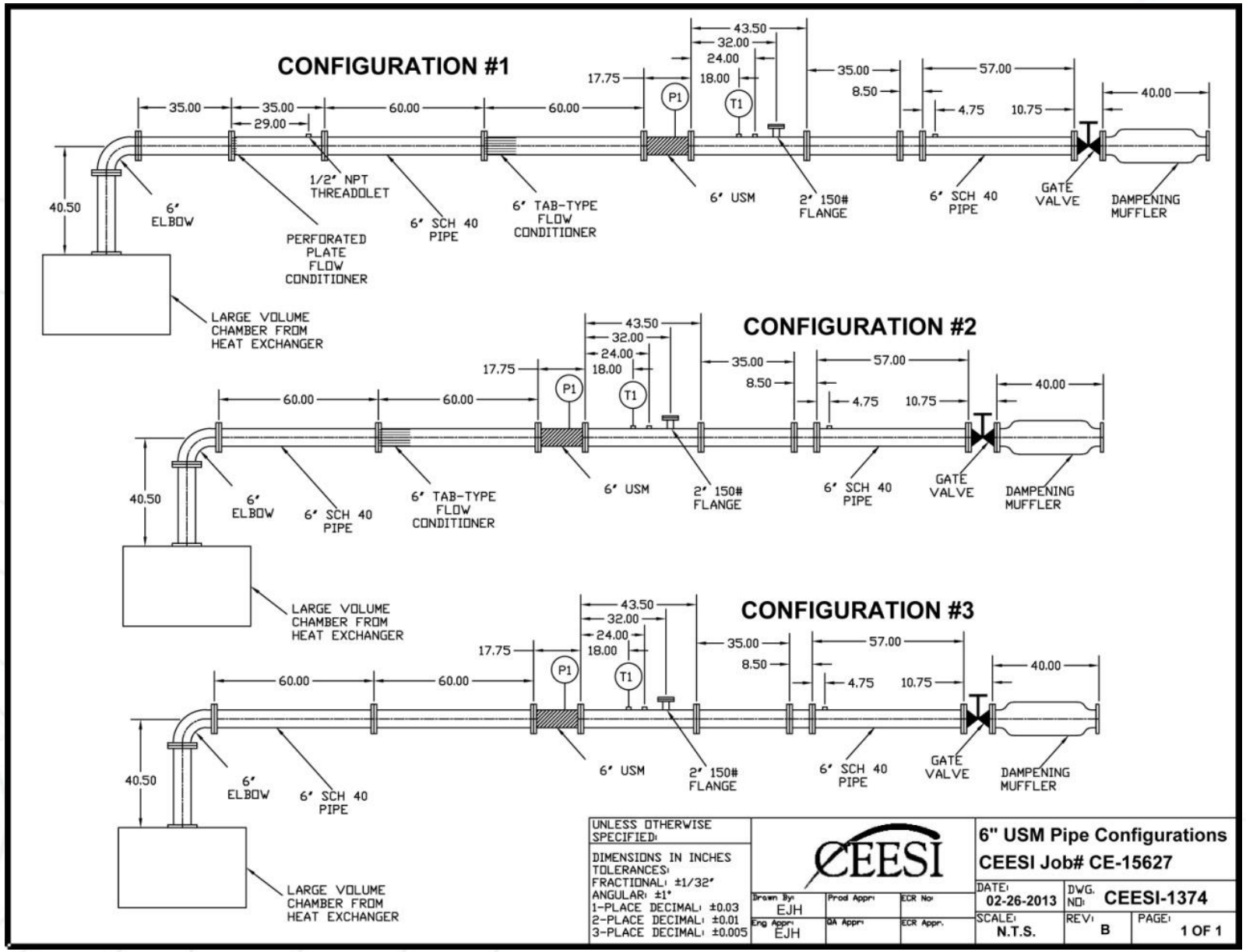

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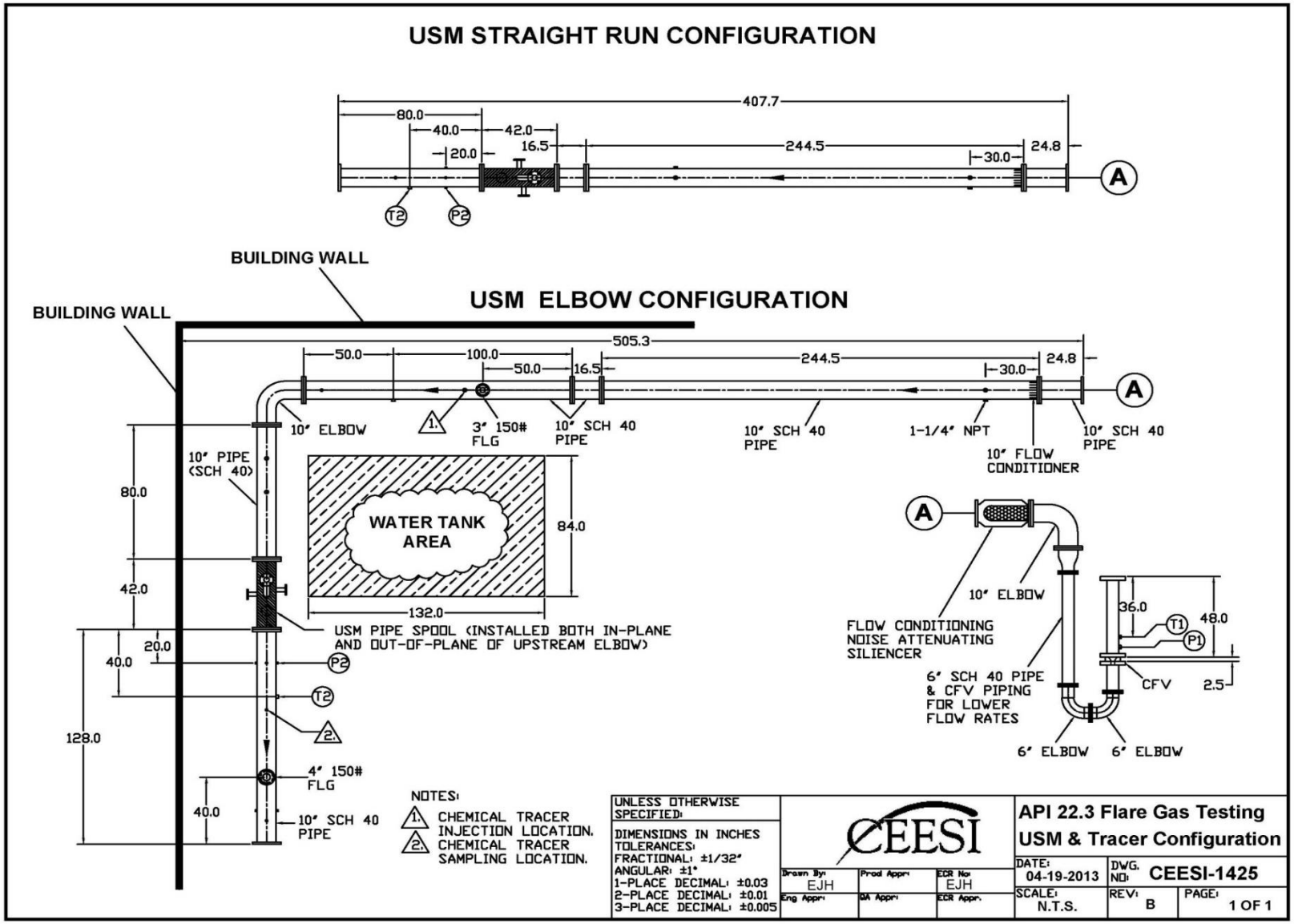

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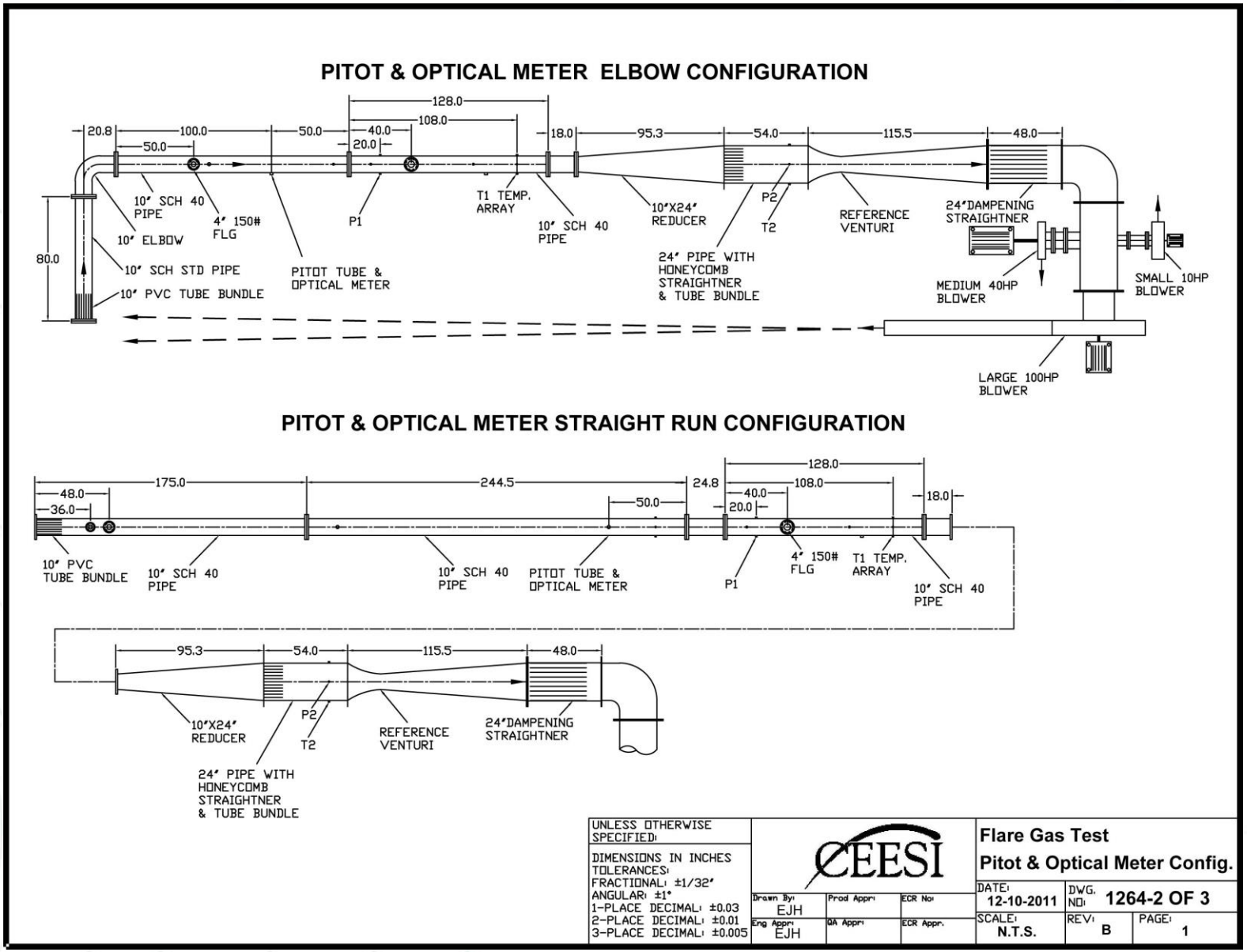


Results:

USM(4-path Chordal)
- Straight: ±1%
- Elbow: ±2%

USM (2-path, Diametral)
- Straight: ±5%
- Elbow: ±10%

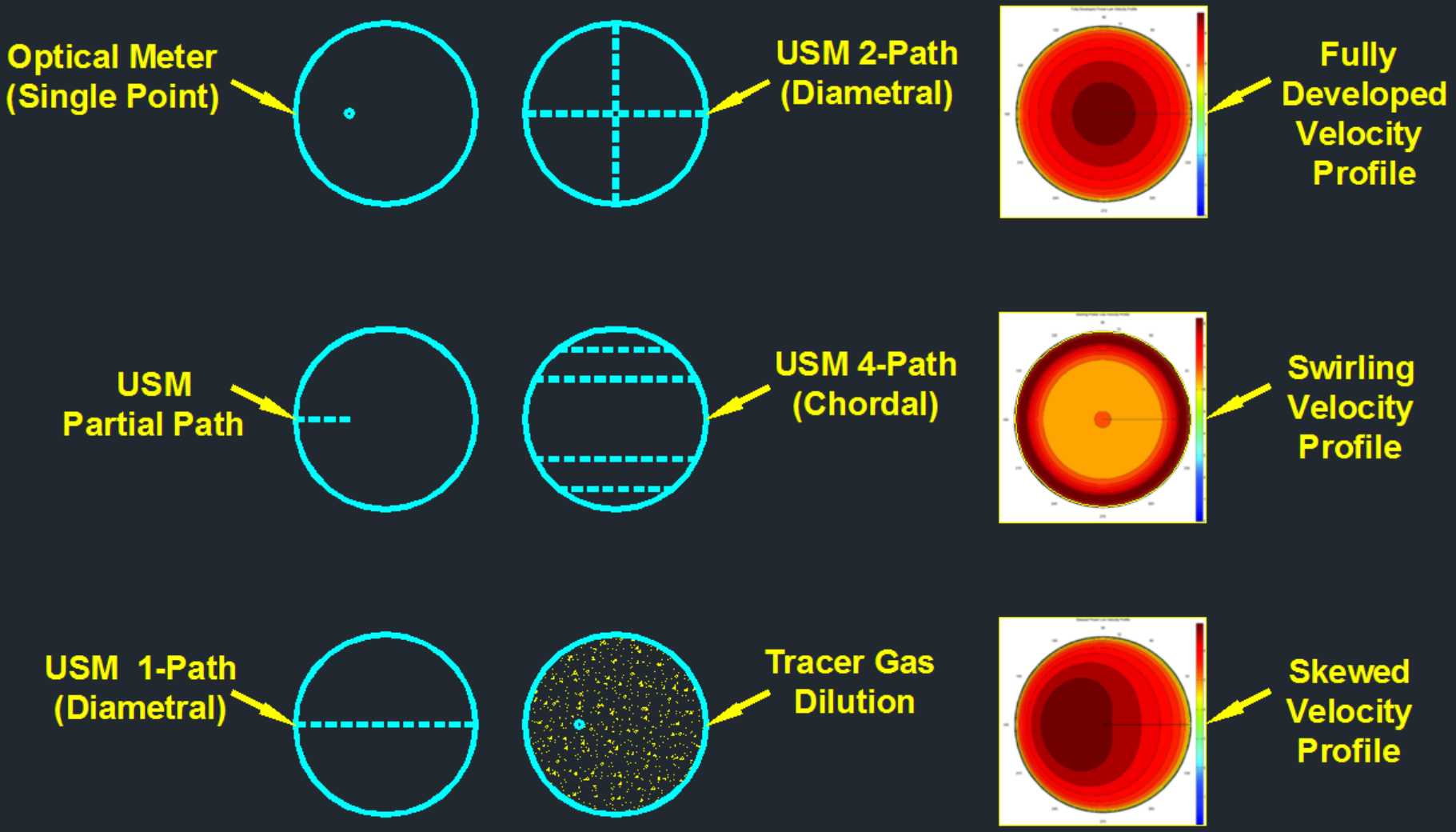
USM (1-path, Diametral)
- Straight: ±3 to 7%
- Elbow: ±25%

USM (1-path, Partial Insert.)
- Straight: ±3-7% (3-150 FPS)
- Straight: ±7-22% (1-3 FPS)
- Elbow: ±20%

Optical Flow Meter
- Straight: ±35%
- Elbow: ±35%

Tracer Gas Dilution
- All Installations: ±6-10%

Consider How a Meter Senses the Flow:



Conclusions:

- Chordal 4-Path best.
- Diametral USM's struggle.
- 2-Path USM's better than 1-Path in elbow.
- Optical Meter not a viable meter.
- Tracer Gas Dilution a viable solution when there is no straight pipe.

The more non-diametral paths the better!

Comments & Questions?

Thank you!