



Ultra Low Sulfur Diesel Handling

AWMA Workshop
BP Alaska
September 16, 2005

Review Existing Testing Information

- Transports
- Stations
- Pipelines

Recommendations from MAP and AOPL/API
ULSD Fuels Team

Compliance Assurance

Sulfur Content

Heating Oil – up to 5000 ppm

Jet Fuel – up to 3000 ppm

High Sulfur Diesel (HSD) above 500 ppm

Low Sulfur Diesel (LSD) up to 500 ppm

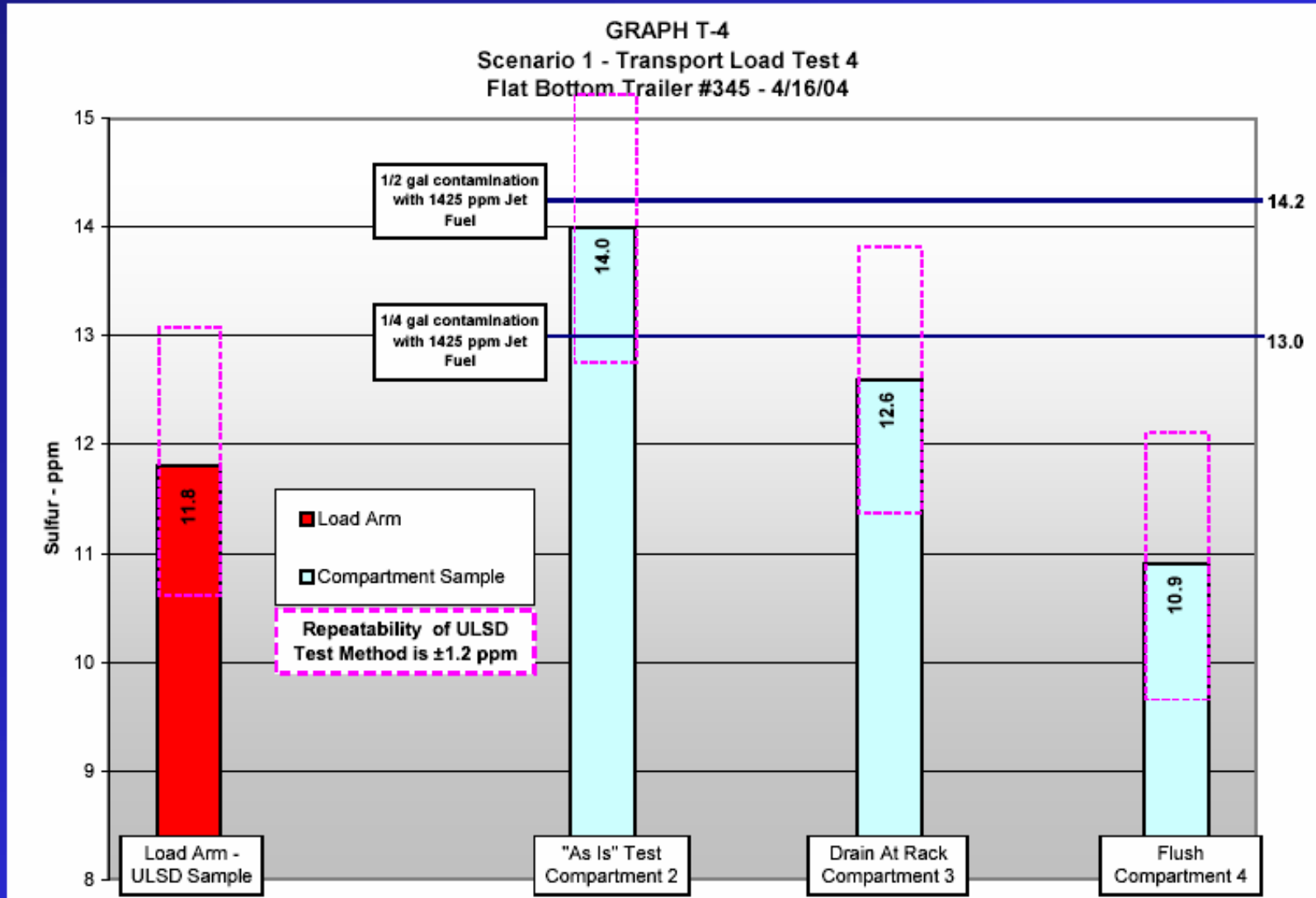
Ultra Low Sulfur Diesel (ULSD) up to 15 ppm

- Evaluate the capability of barge, pipeline, terminal, transport, and retail facilities to deliver ≤ 15 ppm ULSD to the retail customer.
- Determine impact of transport heels
- Establish if the transport type, flat vs. slope bottom, contributes differently to contamination.

- Previous contents of transports were jet fuel, 1245 ppm sulfur
- Transports compartmented
 - One loaded “as is”
 - One drained down at rack prior to loading
 - One flushed at rack prior to loading
- 300 gallons loaded in each compartment



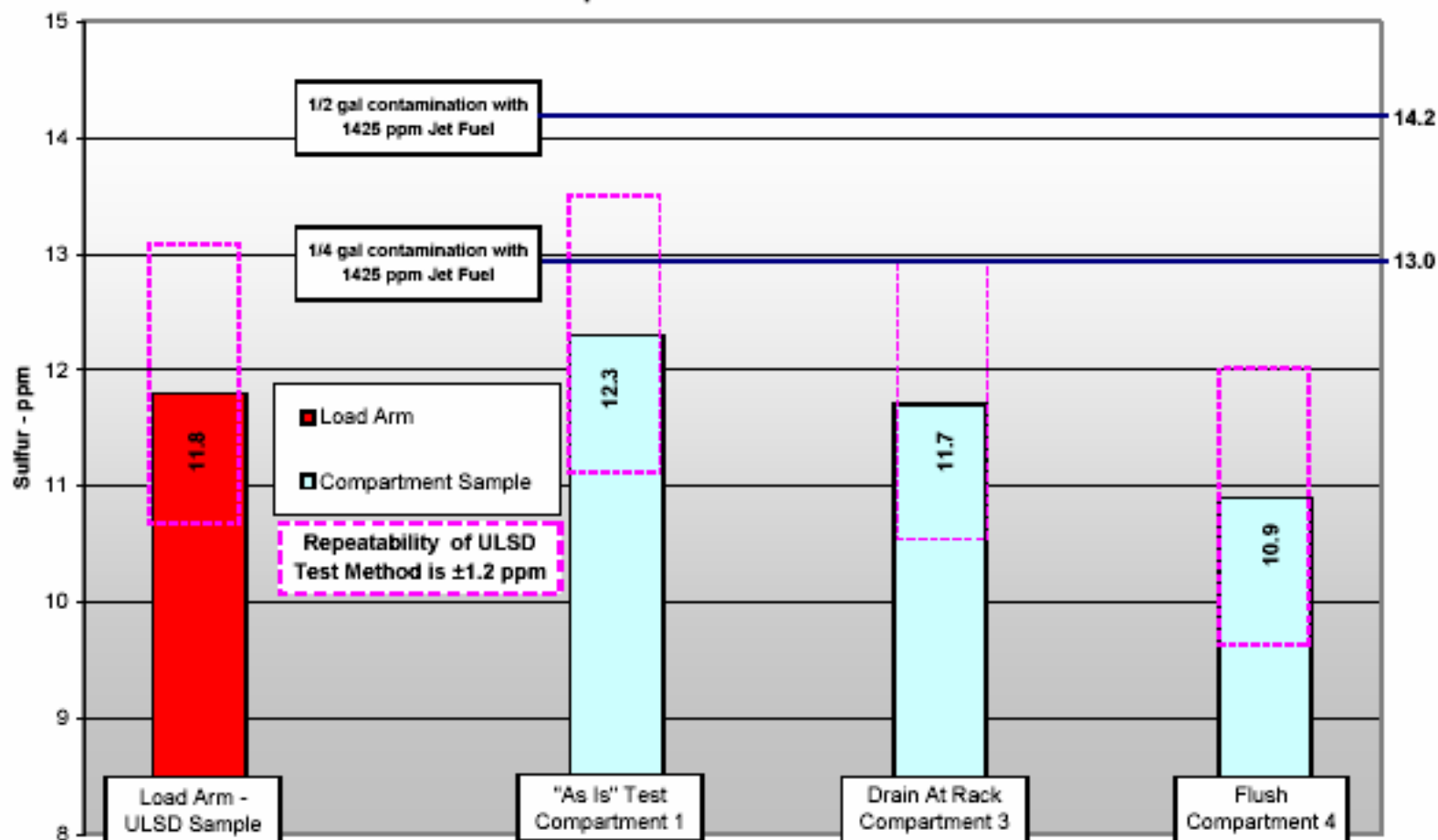
Observations – Flat Bottom Transports





Observations – Slope Bottom Transports

GRAPH T-3
Scenario 1 - Transport Load Test 3
Conical Sloped Bottom Trailer #400 - 4/16/04



Observations and Recommendations

- Transports need to be completely drained when switching from higher sulfur products to ULSD
- Flat bottom transports can add contamination when loading ULSD
- Sloped bottom transports add little contribution to contamination
- Draining compartments at the loading rack reduced flat bottom contamination
- Flushing compartment with ULSD prior to loading effectively removed any residual sulfur contamination in both transport types
- Transport operators will need to adopt procedures to protect ULSD quality
- Transport operators should consider complete drain down capability prior to loading ULSD

- Identify options on how stations can convert to ULSD from high sulfur diesel
- Determine impact of manifolded underground storage tanks
- Establish if/when product stratification occurs

- Samples pulled from 3 different UST locations (top, middle, bottom)
- One station test optimized
 - Minimized tank inventories
 - Drops made into separate tanks
- Second test not optimized
 - Tank inventory was not minimized
 - Single drops made at site



Station Drop Volume Correlation

$$\% \text{ Drop Volume} = \frac{\text{Volume of Load Delivered}}{\text{Total Inventory After Delivery}}$$

LOUISVILLE	% Drop Volume	Stratify?
Truck Stop A * Indicates the drop tank		
Tank 1 *	70%	No
Tank 2	66%	No
Tank 3	70%	No
Truck Stop B		
Tank 1	86%	No
Tank 2 *	77%	No
Gas Station		
Tank 1*	25%	Yes

MACON	% Drop Volume	Stratify?
Truck Stop C		
Tank 1 *	58%	Slight
Tank 2	49%	Yes
Truck Stop D		
Tank 1	63%	No
Tank 2	62%	No



Station Mixing Calculations

Station Tank 1	Actual Sulfur ppm	Calculated Sulfur ppm	% difference
Truck Stop A	25.1	60.9	- 58%
Truck Stop B – Drop 1	34.6	42.6	- 23%
Truck Stop B – Drop 2	17.2	18.9	- 10%
Truck Stop C	82.4	177.43	- 115%
Truck Stop D	140.3	171.7	- 22%

Observations and Recommendations

- Mixing does occur across manifolded tanks
- Stratification in USTs can occur if the drop volume is less than 60% of the final UST inventory
- Multiple drops into different tanks promote better mixing and quicker conversion
- Stations should be able to successfully provide ≤ 15 ppm with planning multiple drops into each UST
- Minimize inventory levels in USTs prior to receiving ULSD loads to minimize stratification
- Number of loads necessary to convert a station may be estimated using historical sulfur content, tank inventories and site sales

- Residual sulfur in some tanks will contribute to ULSD contamination
 - Tank design
 - Low flow rates
 - Similar product gravities
- Tanks should be dedicated.
- Tanks may need to be drained and flushed with 1 – 2 batches of ULSD.
- Pipelines
 - Between the interface zones, sulfur content does not appear to increase
 - Pumps not restarted during ULSD shipment
 - Minimize dead legs and lock out automatic sumps

Sulfur Content Compliance Assurance

- Adequate periodic testing and samples is required
- Online analyzers and manual samples
 - Immediate results
 - Available lab testing facilities
 - Test method
 - Timely results
- Designate and Track Implications

Review of Suppliers

- Identify points of contamination within each supplier's facility
 - Dead legs
 - Manifold piping
 - Valves
 - Multi-service tankage/tank residuals
- Dedicate systems to ULSD wherever practical
- Update displacement procedures
- Modify batch sequencing
- Enhance training

Batch Testing of ULSD Movements

- Industry studies have shown contamination through the distribution system can be significant.
- Tests show that the potential for sulfur contamination increases with each “hand off”:
 - Tank Farms 1-5 ppm
 - Pipeline movements <1 ppm
 - Barge/water movements <1 ppm
 - Transport trucks 1-2 ppm

How do you know that your product ULSD meets the 15 ppm specification on receipt and delivery?