



# Scientific Investigation of Marine Claims

## Presentation 1 – Bulk Liquid Sampling

For the  
General Insurance Association of Singapore  
&  
Singapore Maritime Foundation

03<sup>rd</sup> November 2010

## WHY TAKE SAMPLES?



## THE REASON FOR SAMPLING

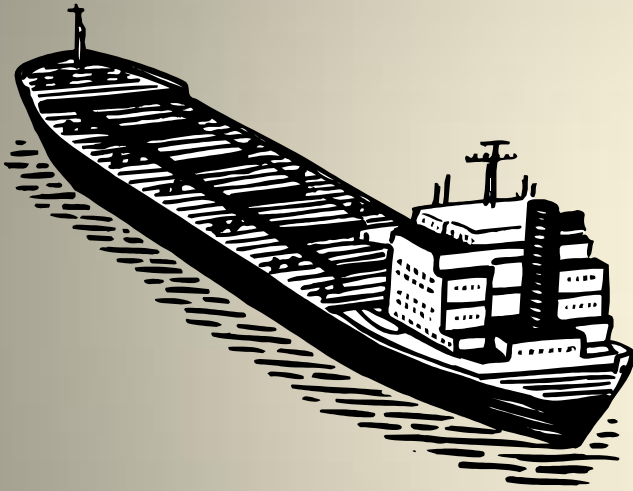
- To assess conformation with specification or other quality requirements
- Quality specifications are produced to ensure that, as far as possible, the product purchased is fit for its intended purpose. But if it isn't .....?
- If the sample is not representative of the whole product bulk, how sure can you be of the quality of that product?

# ISN'T ALL SAMPLING THE SAME?

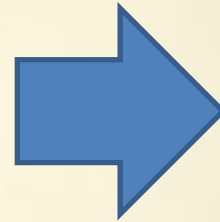


NOT THAT SIMPLE – “RUBBISH IN, RUBBISH OUT”

## HOW REPRESENTATIVE IS THE SAMPLE?



40,000 TONNES,  
50,000,000 LITRES



5 LITRE SHIP'S  
COMPOSITE

THE SAMPLE REPRESENTS ONLY ONE **10-MILLIONETH**  
PART OF THE CARGO

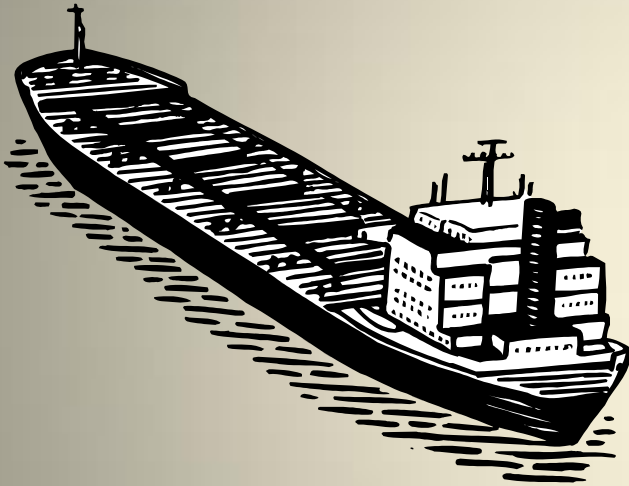
# SAMPLE REPRESENTIVITY

- All samples taken from an homogeneous bulk of liquid should have the same quality
- But what if the bulk is non-homogeneous?
- Non-homogeneous liquids are difficult to sample correctly, and sample representivity is far from a 'given'
- Non-homogeneous liquids include crude oil and fuel oil, two of the most widely-traded petroleum commodities

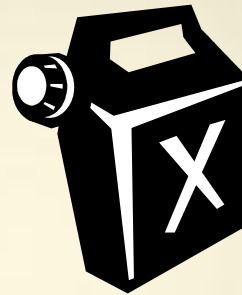
## SAMPLE REPRESENTIVITY

- So, it is important to ensure that the sample is as representative as possible
- This is further emphasised when it comes to sample analysis
- By way of example:

# SAMPLE FOR DENSITY ANALYSIS



50,000,000 LITRES



5 LITRES  
1/50,000,000



1 MILLILITRE  
1/50,000,000,000

ONLY ONE PART IN 50,000,000,000 IS ANALYSED

## DENSITY ANALYSIS

- If the density of our 50,000,000 litres of cargo was 0.8000 KG/L at loadport (=40,000 tonnes), and if a disport cargo sample had a measured density of 0.7800 KG/L, then that would equate to 39,000 tonnes
- There would thus be an immediate apparent loss of 1,000 tonnes
- If the value of the cargo was USD 500/tonne, that would mean a loss of USD 500,000
- And, paper loss or not, still a claim

# CONTAMINATION

- Typically, contamination is more costly than shortage, as it can often affect the whole cargo
- Contamination can only be determined by sample analysis
- So, if the sample is not representative ....?

# CONTAMINATION

- Suppose our 50,000 tonne cargo was contaminated such that it had to be blended, salvage-sold, or even reprocessed
- The cost of any of these options could easily exceed USD 100/tonne
- Total cost USD 4,000,000 plus

# SHORTAGE

- By comparison, a 200-tonne shortage on our 50,000 tonnes cargo would equate to “only” USD 100,000
- This wouldn't even come close to a 0.5% deductible

# WHAT KIND OF SAMPLE?

## MANUAL SAMPLES

- RUNNING
- SKIM
- TOP
- UPPER
- MIDDLE
- LOWER
- BOTTOM
- “DEAD” BOTTOM

## MANUAL SAMPLES

- ALL-LEVEL
- SPOT/ZONE
- LINE
- RE-CIRCULATION/TRANSFER
- MANIFOLD
- SUCTION/DRAIN
- TANK SIDE TAP
- COMPOSITE

# WHAT KIND OF SAMPLE?

## AUTOMATIC SAMPLES

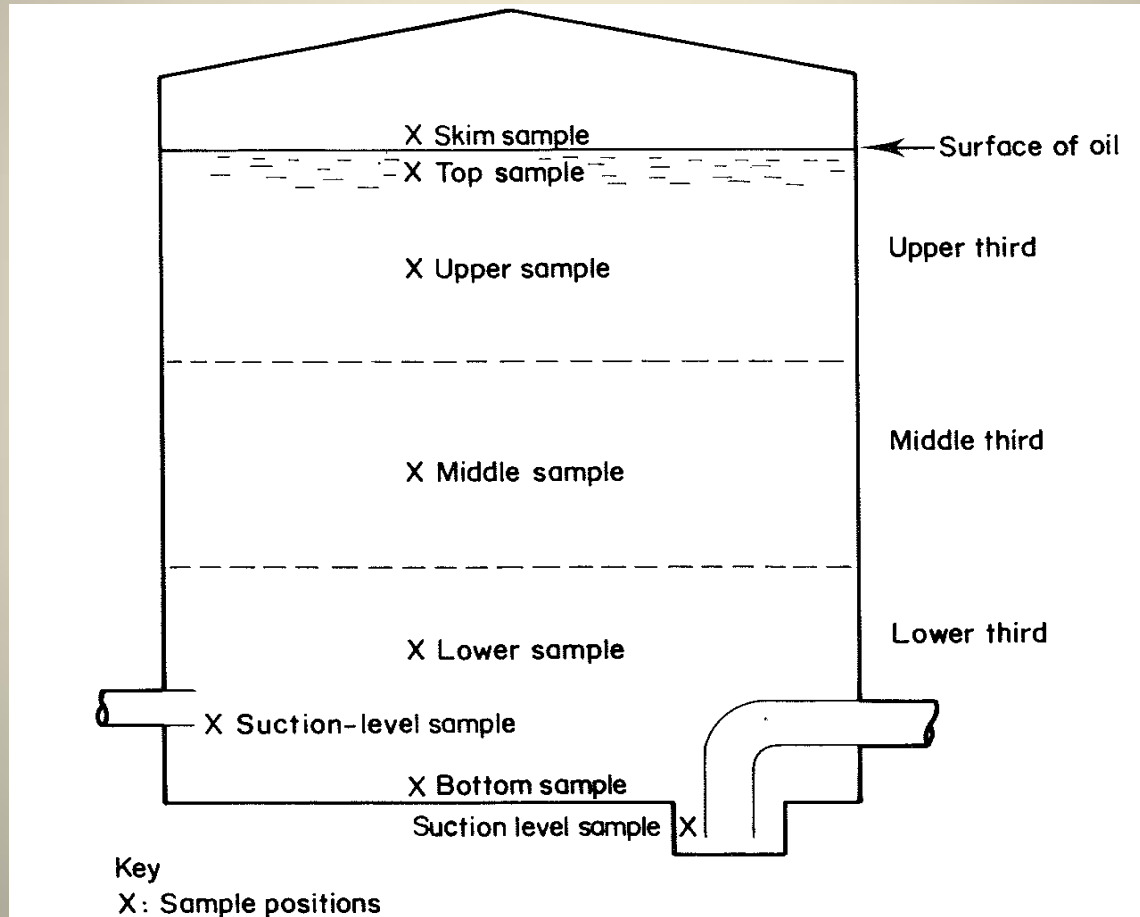
- TIME-PROPORTIONAL
- FLOW-PROPORTIONAL

## SEMI-AUTOMATIC SAMPLES

- DRIP

OF ALL THE AVAILABLE SAMPLING POSSIBILITIES,  
FLOW-PROPORTIONAL AUTOMATIC SAMPLING, IF PROPERLY SET UP,  
PRODUCES THE MOST REPRESENTATIVE SAMPLES

## TANK SAMPLING LOCATIONS



## THE SPOT SAMPLE

- A spot sample is one taken from a specific location, or “spot”, in a tank or a pipeline, at a specific time
- A spot sample is taken from a tank by lowering a stoppered bottle to a designated point in the tank, removing the stopper with a sharp jerk, and allowing the bottle to fill completely before withdrawing it
- After removing the bottle from the tank, product is typically poured from the bottle so it is 80-85% full before it is capped

## THE ZONE SAMPLE

- A zone sample is a sample taken to be that part of the liquid column which is trapped within the whole height of a sampler when it seals at a single spot location within a tank, after having been fully flushed as it was lowered to that position
- The zone sampler has of late become the cargo inspector's "weapon of choice", often his only sampling weapon, in a "one size fits all" approach which is, unfortunately, prevalent within the inspection industry today

## THE COMPOSITE SAMPLE

- Upper, middle, and lower spot samples from the oil phase can be combined in equal proportions in the field to make a tank composite sample which is representative of the bulk
- Other types of composites, such as vessel's whole-cargo composites, should not be prepared in the field because the component percentages cannot be accurately measured under field conditions

# THE RUNNING SAMPLE

- A running sample is obtained by lowering an unstoppered bottle or beaker to the draw off level of the tank, but above the level of any free water, and raising it again to the surface such that the bottle is about three-quarters full when withdrawn from the liquid
- If the sample is not about three-quarters full, it must be discarded and a further sample taken. Flow restrictors can be used if the bottle cannot be moved through the liquid at a speed commensurate with achieving this result

# THE RUNNING SAMPLE

- In reality, a 'true' running sample is all but impossible to achieve, particularly in non-homogeneous petroleum liquids such as fuel oil or crude oil
- The flow of liquid into the sample bottle depends upon the square of the depth of the bottle within the liquid – at a depth of 4 metres, the in-flow of liquid into the sampler is 4 times that at a depth of 2 metres. Thus flow cannot be properly controlled

# THE RUNNING SAMPLE

- IN SHORT, THE RUNNING SAMPLE IS ALL BUT USELESS FOR NON-HOMOGENEOUS LIQUIDS

## LOADING – CRITICAL SAMPLES

- Shore tanks
- Shore lines
- End of dock line
- Ship Manifold
- First foot
- Ship's tanks

SUFFICIENT SAMPLES MUST BE TAKEN FOR BOTH  
TESTING AND RETENTION

# SHORE TANK SAMPLING

- Upper, Middle and Lower samples should be taken
- These samples should be checked for (at least) density to ascertain if the tank contents are homogeneous (well mixed)
- If homogeneous then a composite can be prepared for further testing
- If non homogeneous it is necessary to take further samples (i.e. samples at metre intervals)



# PRIOR TO LOADING

- Prior to loading, a sample should be taken from the shoreline at a point as close as possible to ship's flange and its quality compared to that of the material to be loaded (shore tank)
- The testing required for this shoreline sample will depend on the product in the line and the cargo specification – for example if the shoreline had previously contained gasoline and a lower flash material was to be loaded, flash point testing would be required to ensure no contamination had taken place



# AT START OF LOADING

- If it is thought the previous cargo carried by the vessel could contaminate the cargo to be loaded, then the ship's lines should be flushed and approximately one 'foot' of product loaded into each cargo tank
- On completion of the flushing, a 'first foot' sample should be taken from each tank and tested for key quality parameters – this testing may have to be completed before further loading can proceed



# UPON COMPLETION

- On completion of loading sufficient samples for both testing and retention should be drawn from each individual cargo tank
- A sealed set of samples should be placed on board the vessel against a receipt, signed by the Master or Chief Officer stating *“TO BE HANDED TO THE RECEIVER AT DISPORT”*



## DISCHARGE PORT SAMPLES

- Samples of the product, if any, already in the shore tanks nominated to receive cargo
- Samples from the individual cargo tanks on board the vessel prior to discharge
- Depending upon the cargo, line samples may be necessary
- Samples from the shore tanks after completion of discharge

## SAMPLING METHODS

- **CLOSED SAMPLING**
  - DESIGNED TO PREVENT ESCAPE OF CARGO VAPOURS, MINIMISE RISK OF FIRE/EXPLOSION AND ADVERSE HEALTH EFFECTS
  - USAGE IS COMMONPLACE AND LIKELY TO INCREASE
  - MANY PORTS AND VESSELS PERMIT **ONLY** CLOSED SAMPLING
  - USES DEDICATED SAMPLING DEVICES DESIGNED TO OPERATE VIA THE CARGO TANK VAPOUR LOCK SYSTEM
  - LIMITS THE TYPE AND VOLUME OF SAMPLE WHICH CAN BE TAKEN
  - MAKES OBTAINING REPRESENTATIVE SAMPLES DIFFICULT

## CLOSED SAMPLER SYSTEM



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# OPEN HATCH SAMPLING

- DEEMED TO BE ENVIRONMENTALLY UNFRIENDLY
- POTENTIALLY HAZARDOUS WITH RESPECT TO FIRE/EXPLOSION
- POTENTIALLY HAZARDOUS TO HEALTH
- ENABLES ALL APPROPRIATE SAMPLE TYPES TO BE RELATIVELY EASILY TAKEN THEREBY GREATLY IMPROVING THE LIKELIHOOD OF OBTAINING REPRESENTATIVE SAMPLES



## SAMPLING DEVICES

### TRADITIONAL SAMPLING CAN

- USED FOR SPOT AND RUNNING SAMPLES (USUALLY WITH RESTRICTOR)
- STAINLESS STEEL PREFERRED FOR MOST PETROLEUM AND CHEMICAL APPLICATIONS
- ONLY SUITABLE FOR OPEN HATCH SAMPLING



# SAMPLING DEVICES

## BOTTLE CAGES

DIFFERENTLY-SIZED CAGES  
FOR A VARIETY OF BOTTLE  
SIZES AND SHAPES

USED FOR SPOT AND RUNNING  
SAMPLES

ONLY SUITABLE FOR OPEN  
HATCH SAMPLING



## SAMPLING DEVICES

### ZONE SAMPLER

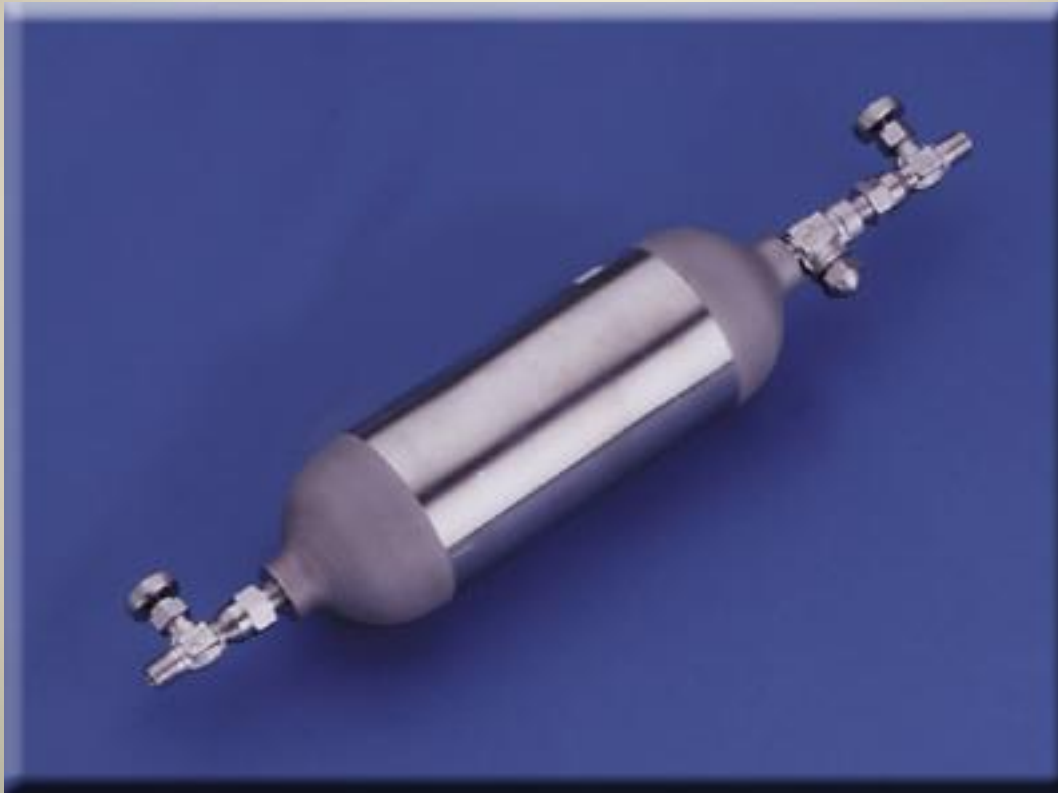
- FLOW-THROUGH SYSTEM WHERE BOTTOM PLATE AUTOMATICALLY SEALS WHEN THE SAMPLER STOPS DESCENDING
- IN EFFECT, TAKES A SAMPLE CORRESPONDING TO A LAYER OF LIQUID EQUATING TO THE HEIGHT OF THE SAMPLER
- CANNOT BE USED FOR SPOT AND RUNNING SAMPLES



# BOTTOM, DEAD BOTTOM SAMPLERS



# GAS SAMPLING “BOMB”



# BUNKER DRIP SAMPLER



# SAMPLE CONTAINERS



STANDARD TIN-PLATE CANS



EPOXY-LINED CANS FOR JET FUEL

# SAMPLE CONTAINERS



STANDARD GLASS BOTTLES



PLASTIC CONTAINERS

## WHICH CONTAINER TO USE?



TABLE 1 Summary of Container Recommendations<sup>A</sup>

Type of Analysis:	MSEP <sup>B</sup>	Electrical Conductivity <sup>B</sup>	Lubricity	Thermal Stability <sup>C</sup>	Trace Metals	Copper Corrosion <sup>D</sup>
<b>Hard borosilicate glass</b>						
Immediate use	P <sup>E</sup>	P	S <sup>D</sup>	S	NR <sup>E</sup>	S
Storage	P	P	S	NE <sup>F</sup>	NR	S
Reuse	S	P	S	S	NH	S
<b>Soft soda lime glass (washed)</b>						
Immediate use	S	S	NE	NE	NH	NE
Storage	NH	NR	NR	NR	NR	NE
Reuse	S	S	NR	NH	NH	NH
<b>Aluminum containers</b>						
Immediate use	NR	NR	NR	NR	NR	NR
Storage	NH	NR	NR	NR	NR	NR
Reuse	NR	NR	NR	NR	NR	NR
<b>Epoxy-lined steel</b>						
Immediate use	P	P	S	P	NR	S
Storage	P	P	S	P	NR	S
Reuse	P	P	S	P	NR	S
<b>Polytetrafluoroethylene</b>						
Immediate use	S	NR	NR	NE	P	S
Storage	NE	NR	NR	NL	P	S
Reuse	NE	NR	NR	NE	P	S
<b>Tin-plate soldered steel (Superclean only)</b>						
Immediate use	S	S	S	S	NR	NH
Storage	NR	NR	NH	NR	NR	NR
Reuse	NR	NR	NH	NH	NR	NR
<b>High-density linear polyethylene</b>						
Immediate use	S	NR	NR	NR	P	S
Storage	NH	NH	NR	NR	P	S
Reuse	NH	NR	NR	NR	P	S

<sup>A</sup> The containers listed in this summary should not be used without consulting the appropriate paragraphs of this practice for detailed advice.

<sup>B</sup> All transparent or translucent containers must be shielded from light by wrapping with opaque material such as aluminum foil, or enclosure in a dark box or cabinet. Amber bottles reduce photochemical effects.

<sup>C</sup> P = preferred.

<sup>D</sup> S = suitable.

<sup>E</sup> NH = not recommended.

<sup>F</sup> NE = not evaluated but may be suitable.

## CONTAINERS FOR SPECIFIC TESTS

- JFTOT – epoxy lined can
- MSEP - epoxy lined can
- Trace metals – plastic container
- Vapour Pressure test – one litre Winchester bottle preferably inverted and stored in ice – must be the first test to be performed on this sample
- Copper corrosion - dark glass bottles
- Flash point – gas tight containers

## UNIQUELY SEALING



# SAMPLE LABELLING

- Date and time taken
- Taken by whom
- Type of sample (U/M/L, etc.)
- Sample source
- Product grade
- Batch number – where applicable
- Purpose of sample (testing, retention)
- To whom to be delivered
- Inspector/sampler mark



## SAMPLE DOCUMENTATION

- RECORD FOR ALL SAMPLES TAKEN, SHOWING:
  - Seal no
  - Distribution
  - Size
  - Provenance
- If the sample is passed to third party, a receipt must be obtained
- In this way, the provenance of the sample can be traced back to its origin

## ACTUAL EXAMPLES



WHO NEEDS LABELS?



EVAPORATIVE LOSS

# SOME MORE EXAMPLES



CONTAINERS? LABELS?



THE SAMPLE STORE

## FOR ANY INCIDENT

- Ensure that all samples are securely retained and detailed list(s) obtained pending possible further investigation
- Obtain copies of all relevant cargo sampling reports
- Obtain copies of all relevant analysis reports, certificates of quality
- Where possible, control the course of the investigation, particularly with regard to analytical investigations

## SUMMARY

- Representative sampling requires product knowledge, skill, care and the right equipment
- It can be dirty, time-consuming and frustrating
- But it is probably the most important aspect of cargo custody transfer

## SUMMARY

- The downside is that representative sampling often takes time and time is money
- Too often, it is given short shrift by inspectors and too often the required sampling skills are sadly lacking
- And, if the sampling is poor and the samples unrepresentative, resolution suffers

## SUMMARY

- At the end of the day, probably the most important question is “who pays?”
- As insurers, you might well know the answer to that one



# THANK YOU FOR LISTENING

**Dr Cliff Bennett**

**Minton, Treharne & Davies (Singapore) Ltd.**

**Email:** [CBennett@minton.com.sg](mailto:CBennett@minton.com.sg)

**Tel:** + 65 6341 5060

**Fax:** + 65 6293 5708