ISO TC 142 – WG9 – Part 5
Offshore & marine

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Developing the part 5

STEP 1

Research
- Defining aerosol (spray)
- Qualification for spray
- Technical Equipment definition

Method
- Test of leakage/migration by volume/mass on deposit water/salt
- Test of efficiency according DEHS (or other aerosol)as the airborne aerosol test (the DEHS to simulate salt aerosol)
- Dust loading and procedure
- Technical Equipment definition

System
- Potential system test
- Multiple test objects

↔ Current focus

Work items originating out of previous ISO meetings and ETN filtration workshop meeting

- A greater scientific approach was required.
- Research sea water composition.
- Define sea water composition.
- Research what is in the air (saline aerosol challenge).
- Define what is in the air (saline aerosol challenge).
- Research what equipment is available to replicate saline aerosol challenge (impaction nozzles, swirl nozzles, rotary atomisers etc).
- Define saline aerosol generation.
- Research how to measure saline aerosol challenge.
- Define how to measure saline aerosol challenge.
- Further debate on test dust ISO vs others.
- RH to be no less than 90% to prevent droplet evaporation.
- Revise draft document.

Research sea water composition

- The concentration of dissolved materials is described by the salinity, which to a good approximation is equal to the mass ratio of dissolved material (i.e., sea salt) in grams per kilogram of seawater.
- The salinity of the vast majority of the world oceans, and the majority of ocean surface water, is between 33 and 37, with 35 being a typical value although in some locations of the salinity of the surface water differs appreciably from 35 (Lewis & Schwartz, 2004, p. 48).
- A typical makeup of 1kg of 35 salinity (Lewis & Schwartz, 2004, p. 49) is:

Makeup	Grams	Moles
NaCl	25.9	0.443
$MgCl_2$	5.0	0.053
Na_2SO_4	4.0	0.028
H_2O	965.1	
Total	1000.0	

- This recipe has many advantages as it can be replicated globally.

Lewis & Schwartz, 2004, p. 49

Depending on the application, many different recipes for artificial seawater can be constructed, the main difference being how minor elements are treated. For biological applications, trace elements and nutrients might need to be included, but for laboratory experiments simulating SSA particles as seawater drops, it is reasonable to assume that only the species with the greatest concentrations are required (except for considerations of effects of surface-active substances). One recipe for 1 kg of seawater of salinity 35, containing the species listed in Table 6 in the concentrations presented there but with Cl^- replacing Br^- and HCO_3^-, and Na^+ replacing Ca^{2+} and K^+ on an equivalent basis, is presented in Table 7; a similar recipe was used by *Tang et al.* [1997]. This recipe, under the assumption of volume additivity, yields $\rho_{ss} = 2.2$ g cm^{-3} for the density of dry sea salt, equal (or very nearly equal) to the value used by several earlier investigators [e.g., *Woodcock*, 1952; *Twomey*, 1954; *Hänel*, 1976]. Various alternative recipes may yield

Table 7. Recipe for Artificial Seawater of Salinity 35

Species	Grams	Moles
NaCl	25.9	0.443
$MgCl_2$	5.0 (10.8[a])	0.053
Na_2SO_4	4.0	0.028
H_2O	965.1 (959.3[a])	
Total	1000.0	

This recipe contains the species listed in Table 5 and results in a solution having the same concentrations, except with Cl^- replacing Br^- and HCO_3^-, and Na^+ replacing Ca^{2+} and K^+, on an equivalent basis.

[a] For $MgCl_2$ in the form $MgCl_2 \cdot 6H_2O$.

Defining aerosol (Spray)

Research what's in the air (saline aerosol challenge)

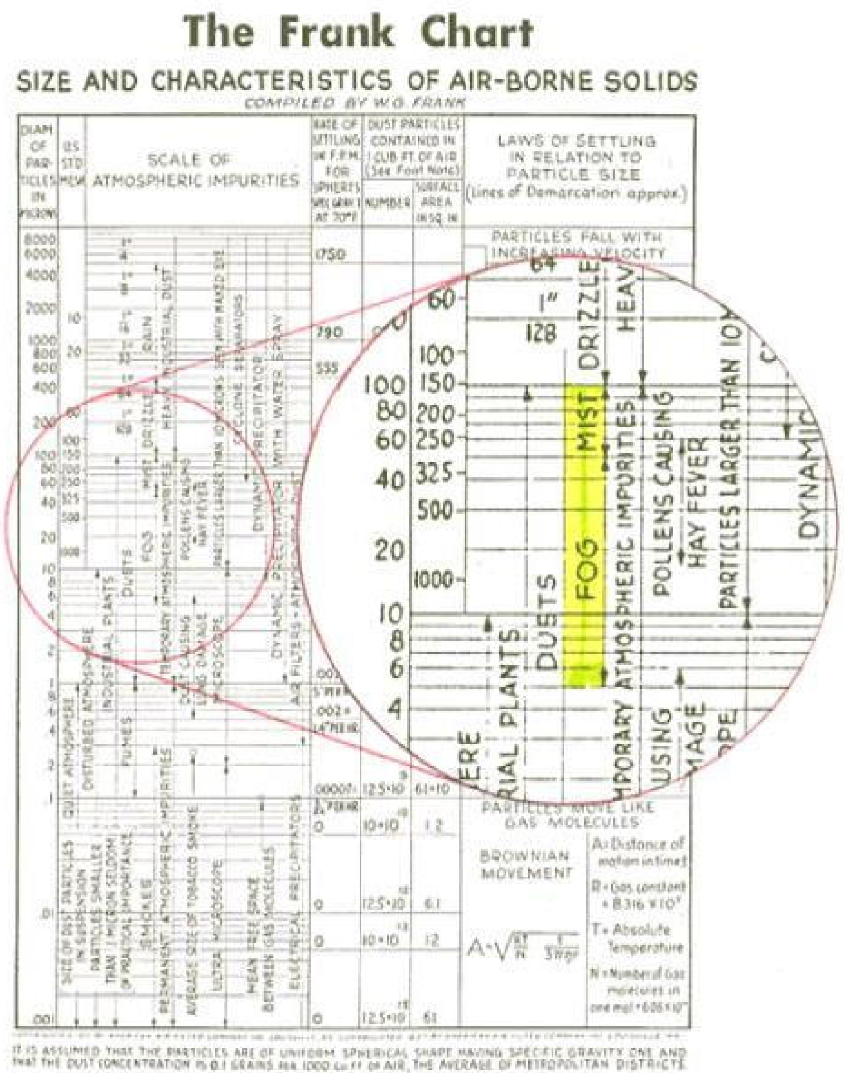
- Extensive research on aerosols, precipitation, clouds, fogs and mists.

	Range LWC	Common LWC	Range droplet size	Common droplet size
Stratus and stratocumulus clouds	0.05 - 3 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	10 - 20 µm
Fogs	0.02 - 5 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	10 - 20 µm
Mists	0.02 - 5 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	0.5 - 10 µm

Aqueous phase liquid water content (LWC) and droplet sizes (Seinfield & Spyros, 2006, p. 286), (Mason, 1975, pp. 40-59, 94-124).

Also underpinned by the now dated Frank chart………

Define what's in the air (saline aerosol challenge)



Equipment and qualification of Spray

What equipment is available to replicate saline aerosol challenge

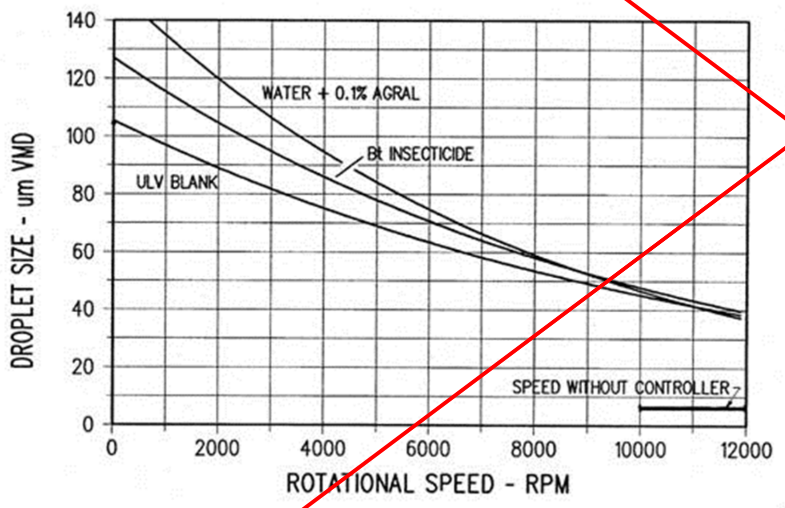
- Impaction atomiser (fogging nozzle)
- Rotary atomiser
- Aerosol generator
- Internal mix atomiser (fogging nozzle)

Impaction atomiser (fogging nozzle)

- Not suitable with saline solution, as nozzle can become blocked over time with NaCl build-up

Rotary atomiser

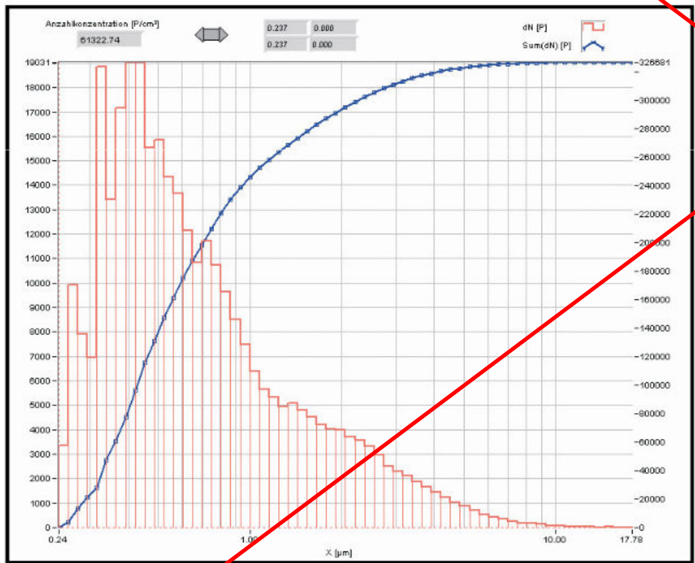
	Range LWC	Common LWC	Range droplet size	Common droplet size
Fogs	0.02 - 5 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	10 - 20 µm
Mists	0.02 - 5 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	0.5 - 10 µm



Droplet range = >38 - >105µm - too large!

Aerosol generator

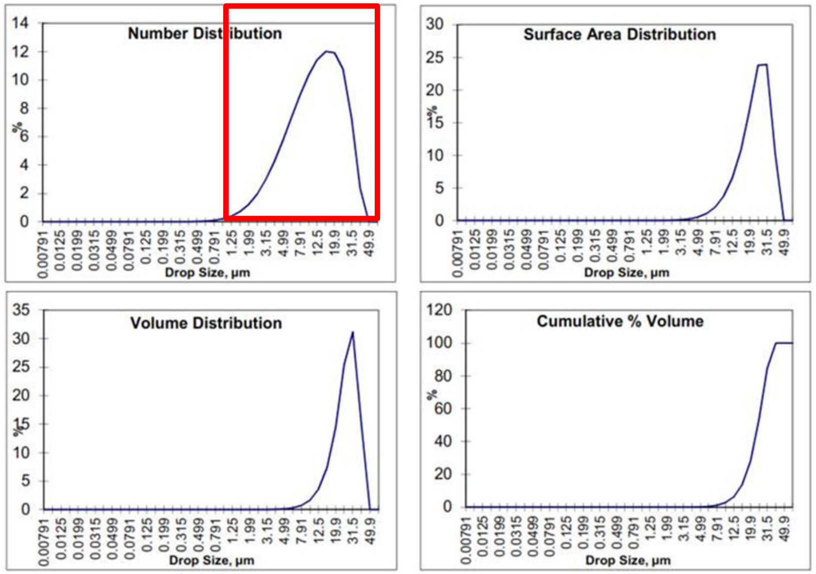
	Range LWC	Common LWC	Range droplet size	Common droplet size
Fogs	0.02 - 5 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	10 - 20 µm
Mists	0.02 - 5 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	0.5 - 10 µm

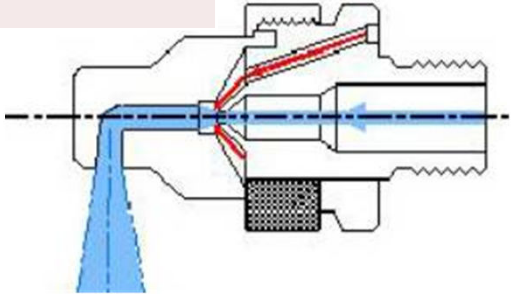


Droplet range = 5nm – 15µm – slightly outside target!
LWC (approx) = 50 - 167g/m3 – too large!

Internal mix atomiser (fogging nozzle) @ 3,400m3/hr

	Range LWC	Common LWC	Range droplet size	Common droplet size
Fogs	0.02 - 5 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	10 - 20 µm
Mists	0.02 - 5 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	0.5 - 10 µm





Droplet range = 0.7 – 50µm.

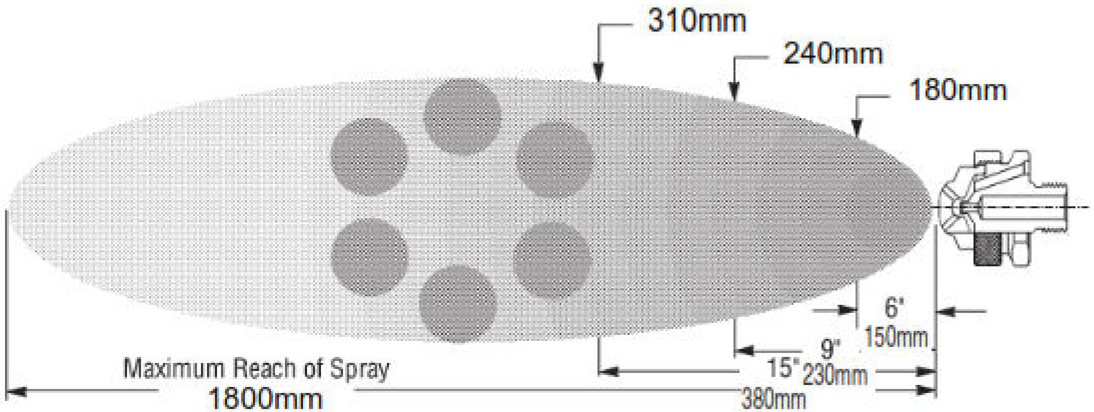
LWC (approx) = 4.7g/m3 (4 nozzles @ 3,400m3/hr).

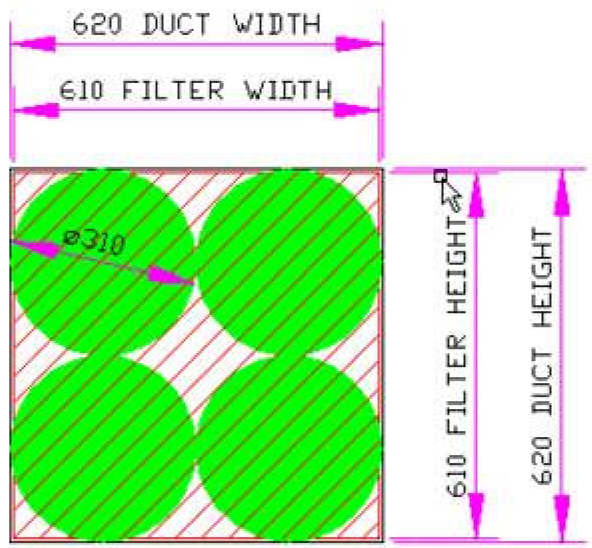
Off the shelf solution, however, tailored solutions possible.

Internal mix atomiser (fogging nozzle) 3,400m3/hr

Nozzle array

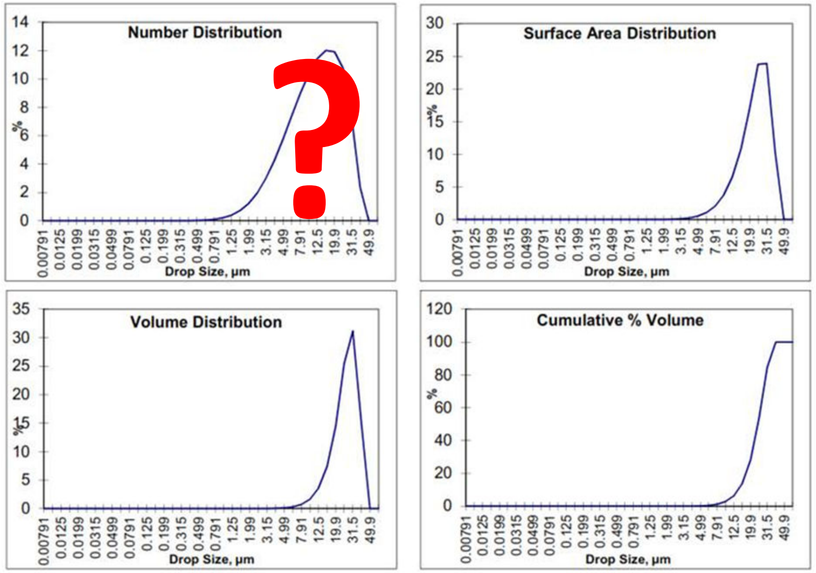
Dispersion pattern

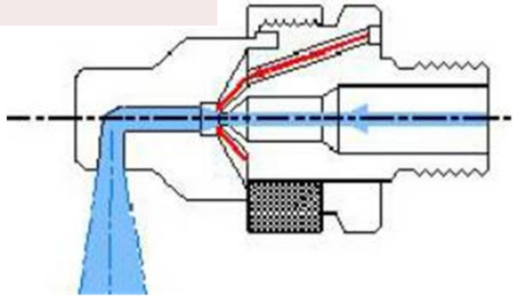




Internal mix atomiser (fogging nozzle) @ 9,100m3/hr

	Range LWC	Common LWC	Range droplet size	Common droplet size
Fogs	0.02 - 5 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	10 - 20 µm
Mists	0.02 - 5 g (water) m^{-3}	0.1 - 0.3 g (water) m^{-3}	0.5 - 50 µm	0.5 - 10 µm

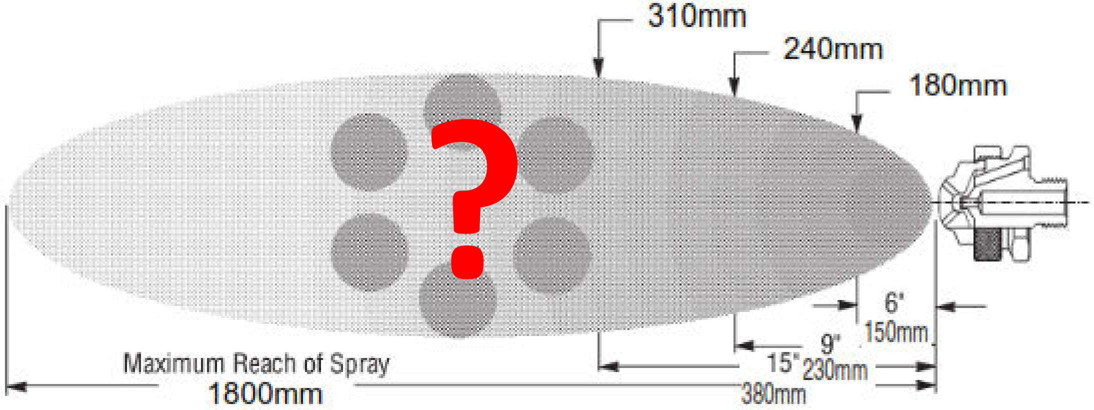




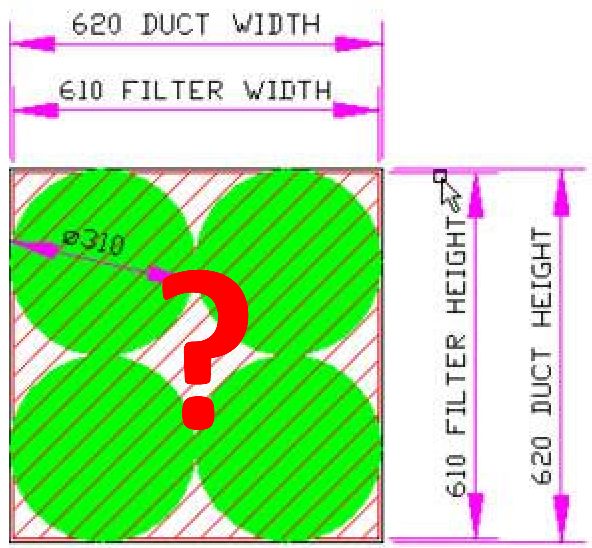
Droplet range = ????µm.
LWC (approx) = ???g/m3.

Internal mix atomiser (fogging nozzle) 9,100m3/hr

Dispersion pattern



Nozzle array



Draft document – revision
(TBD)

Draft document

- Comments from ETN group collected and discussed
- New draft document to be created
- Revision and discussion on next document (next WG9 meeting)
- Co-operation with ETN group to be continued (task group meet in November)