Response considerations: DISSOLVER (Solubility > 5%)
(applicable to all group with "D" of SEBC as behaviour)

	GAS	LIQUIDS				SOLIDS	
PHISIC STATE		**floaters**		**sinkers**		**floaters**	**sinkers**
SEBC CODE	**GD**	**D**	**DE**	**DE**	**D**	**D**	**D**
Density @20°C	-	< dsw		> dsw		< dsw	> dsw
Vapour Pressure @20°C (kPa)	> 101.3	<10	>10		<10	-	
Solubility @20°C (%)	> 10	>5				100	

Attention: for SEBC subgroup "GD", "DE", "ED" see also → **Response Considerations: Gases and Evaporators**
for floater and sinker see also respectively → **Response Considerations: Floater** → **Response Considerations: Sinker**

Response strategies need to consider the factors affecting the behaviour and fate of the released substances as well as the short- and long-term processes when spilled at sea:

PROCESSES AND FACTORS AFFECTING BEHAVIOUR AND FATE OF DISSOLVER IN MARINE ACCIDENT								
PHYSIC STATE		**GAS**	**LIQUIDS**				**SOLIDS**	
SEBC CODE			**floaters**		**sinkers**		**floaters**	**sinkers**
		GD	**D**	**DE**	**DE**	**D**	**D**	**D**
BEHAVIOUR and FATE	**Processes when spilled at sea**	Solubilization, dispersion, diffusion dilution, potential violent reactions.						
		Immediately Evaporation		Partially evaporation				
	Environmental Factors influencing intensity of processes	State of the sea, air/water temperature, water-column turbulence / humidity (if on board)						
					Sea-bottom currents, bottom morphology, bathymetry			Sea-bottom currents, bottom morphology, bathymetry
	Drift and spread of HNS	Production of plumes in water column; dispersion, diffusion, dilution						
		Atmospheric dispersion	Floating slick until it is completely dissolved. Involve sea superficial layer.		Dissolving submerged floating plume. Residuals can accumulate on sea bottom.		Floating on sea surface until it is completely dissolved. Involve sea surficial layer	Solids and their dissolving plume sink in water column. Sea bottom is potentially involved.
				Atmospheric dispersion				
		Evaluate risk of violent reactions with smoke / gas / aerosol production even toxic. (e.g. exothermic reaction from strong acids and bases). Evaluate risks of flammability explosivity.						
	Other relevant HNS properties	Toxicity; reactivity; flammability; explosivity; pH						
			viscosity					
			Δd ($d_{sw} - d_{liquid}$): affect speed of sinking and buoyancy					
	Impact for marine environment	Main risks are primarily for pelagic ecosystem. In case of dissolver and sinker substances benthic ecosystem could be also affected. Possible sever interference and limitation to coastal amenities.						
For hazard and risks see also → **Hazard**								

Considerations

- Very narrow time window for response at sea

• In case of dissolving substances, containing and recovering operations are very limited. Usually, the only response is leave natural processes act like dispersion, dilution, and, where possible, determine an acceleration of these processes.

SITUATION ASSESSMENT AND FIRST ACTIONS

Information gathering

- Immediately refer to SDS or chemical databases. In case of unknown substance act as in case of maximum risk → **Safety Data Sheet Content**
- Immediately refer to data related to location of the incident and other relevant information
- Consider sea-weather conditions
  → **Incident Data Gathering**
  → **Incident Notification**
  → **Incident Resource**

Situation assessment

On the base of the information gathered on the incident and the contingency planning risk, proceed to:

- hazard identification
  → **Response Consideration: Toxic Substances**
  → **Response Consideration: Hazard flammable and explosive substances**
  → **Response Consideration: Reactive Substances**
  → **Response Consideration: Corrosive Substances**
- estimation of risk and vulnerability
- evaluation of consequences
  → **Situation Assessment**

First actions

- Take into account the first actions to guarantee safe conditions for the responders identifying and reducing the hazards of explosion, fire, exposure to toxic vapours, etc. and then to stop or reduce the source of the HNS spill. → **First actions (responders)** → **First actions (casualty)**
- Identification of the main hazards
  → **Response Considerations: Toxic Substances**
  → **Response Considerations: Flammable and Explosive Substances**
  → **Response Considerations: Reactive Substances**
  → **Response Considerations: Corrosive Substances**
- Consider public safety
  → **Safety Zones**
- Equipment/Logistics
  → **PPE**
  → **Hazard: Portable gas detectors for first responders**

MONITORING

Modelling

- Modelling dissolved plume in water column. Input to be considered: chemical-physical parameters of the substance, weather condition and forecast, type of spill source → **HNS Spill Modelling**

Monitoring through remote measuring instruments and research technique

- Aerial surveillance: planes and helicopters (not in case of dangerous situations); drones
  → **Remote Sensing Technologies**
- Use of markers to make the substance visually detectable in water column with ROV or specific sensor (e.g. fluorimeter): NO applicable in case of explosive or unknown dissolver

→ **Substance Marking** → **Remotely Operated Vehicles** → **Sampling Techniques and Protocols**

Monitoring through *in situ* measuring instruments and research technique

- Acquisition of chemical-physical parameters on water column by multi-parametric probe and analytical determinations using field instruments (e.g. GC-MS, GC-FID, GC-PD, IR, etc.).
- Trace gas sensors/explosimeter and gas detection (in case of explosion or fire risks or flammable/toxic vapours/aerosol formation or unknown substances.
  → **Hazard: Portable gas detectors for first responders**
  → **Sampling Techniques and Protocols**

Water sampling

- Water sampling by "niskin" bottles (for deep or sub-surficial sampling) or by manual sampling (e.g. with a glass-bottle for floating substances) and storage of samples for laboratory. Use multi-parametric probe for plume localization. Very small narrow time window. Specialized personnel could be required
- Sampling solid substance (if not completely dissolved) on surficial and sub-superficial seawaters with specific nets, etc. Very small narrow time window

→ **Sampling Techniques and Protocols**
→ **HNS Detection and Analysis Methods**

Air sampling

- Trace gas sensors: detectors for toxic substances (on board and in environment); explosimeter and gas detection to detect explosion or fire risks;
- Oxygen deficiency: electrochemical oxygen sensor
  → **Hazard: Portable gas detectors for first responders**

RESPONSE OPTIONS

Action on the vessel → Emergency Boarding

- Stop the release of substance from its source → **Sealing and plugging**
- Recovering operation of the residual load → **Cargo Transfer**
- On board: collect spillage, where practicable, using sorbent material for safe disposal. → **Sorbents**
- Towing & boarding → **Emergency Towing** → **Place of Refuge**

Action on pollutant → HNS Response in the Water Column

- Neutralising agent: in case of accidents with substances that induce strong pH variations. Applicable only for small spills, restricted areas and no currents, consider solubilization kinetics
- Suction of contaminated water and suitable purification treatment (e.g. adsorption on activated carbon; flocculating agents). Applicable only for shallow waters and calm waters

- Physical barrier to stop or slow down pollutant development. In presence of vapour or smoke, contain by bubble barriers. Applicable for small spill and calm weather conditions
- Filtering flow to protect intakes
- Recovery of solids suspended in water column → **HNS Response in the water column**
  - Wildlife response is focused on avifauna, marine mammals exposed to toxic or corrosive substances → **Wildlife response**

Controlled release technique

- Controlled release of substance still stored on board (not advisable – evaluate for offshore, only after a rigorous evaluation)

Option Zero

- Evaluate non-intervention strategy (not advisable – evaluate for offshore only)

→ **No intervention**

POST SPILL

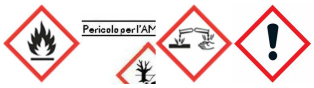
Environmental Investigation

- Chemical and ecotoxicological analysis on contaminated seawater and/or undiluted substance.
- Chemical analysis and biological on marine organisms (e.g. biomarkers) and involved wildlife

→ **Environmental restoration and recovery**

→ **Post Spill Monitoring**

→ **HNS Detection and Analysis Methods**

EXAMPLE OF DISSOLVERS THAT POSE HEALTH AND/OR MARINE ENVIRONMENTAL HAZARDS		
SEBC Group	**Main characteristics**	**GHS pictograms**
Methyl amine solution in water <42% (DE) (L-Liquid)	Irritating and toxic for human. Slightly acutely toxicity for marine organisms. It determines limitations of the use of the sea.	
Sodium metal (D- solid)	Highly reactive metal. May ignite spontaneously in air. Reacts violently with water to give sodium hydroxide and hydrogen, which ignites spontaneously. Highly soluble salt production when in water. Time and space limited impact for marine environment. The high viscosity slows down dilution and dispersion. *Incident: Cason, 1987; off North Spain; Cargo: Package*	
NaOH Caustic Soda (D-Solid)	Corrosive and irritating substance. Main risks for intervention team, on-board personnel; social and economic impact. Generally low acute toxicity for marine organisms but high risks due corrosive and irritating power. High viscosity slows down dilution and dispersion For pH values >8,5-9 or < 3-5 very high danger for aquatic life. *Incident: Puerto Rican, 1984; San Francisco Bay, USA; Cargo: bulk*