Response Considerations: Gases and Evaporators
(applicable to all groups with "G" and "E" of SEBC as behaviour)

STATE	GASEOUS		LIQUIDS	
SEBC CODE	G	GD	E	ED
Density @20°C	-		< dsw	
Vapour Pressure (kPa) @20°C	> 101.3		>10	
Solubility (%)	< 10	> 10	< 1	1-5

Attention: for SEBC subgroup "GD","ED" see also → **Response Considerations: Dissolvers**

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 MAINLY GAS AND EVAPORATORS					
STATE		GASEOUS		LIQUID	
SEBC CODE		G	GD	E	ED
BEHAVIOUR and FATE	**Processes when spilled at sea**	Immediate Evaporation / Atmospheric partitioning	Dissolution	Rapid Evaporation	Dissolution
	Environmental Factors influencing intensity of process	State of the sea / Wind intensity /Air and Water Temperature / Humidity (when on board)/ Solar irradiance / coastline morphology			
	Drift and spread of HNS	Atmospheric dispersion with potential production of dangerous air mixture. Potential violent reactions with smoke / gas / aerosol production even toxic. No persistent.	Dispersion, diffusion, dilution on sea surficial waters		Dispersion, diffusion, dilution on sea surficial waters
	Other relevant HNS properties and hazards	Flash point, explosive range, reactivity, toxicity, corrosivity, gas/ vapours density			
	Impact for marine environment	Gas/evaporators substances tend to abandon readily the water column by partitioning in first in sea surface layer and then in atmosphere: time and space limited impact (generally low) on pelagic ecosystem; risks could be more significant for avifauna and most sensitive pleuston organisms.			
For hazard and risks see also → **Hazard**					

Considerations

- Main risks to safety and/or human health (crew; population in case of source and cloud next to the coast) → **Response Considerations: Toxic Substances→ Response Considerations: Flammable and Explosive Substances**
- Minor risks for marine environment (no persistent substances)
- Response interventions are concentrated on board the ship.

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 forecast

→ **Incident Data Gathering**
→ **Incident Notification**
→ **Incident Resource**

Situation assessment

On the base of the information gathered on the incident and the contingency planning risk, consider to 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 clouds, etc. and then to stop or reduce the source of the HNS spill → **First actions (responders)** → **First actions (casualty)**
- Consider public safety
  → **Safety Zones**
- Equipment/Logistics
  → **PPE**
  → **Hazard: Portable gas detectors for first responders**

MONITORING

Modelling

- Modelling of gas cloud in air 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 explosive or unknown gas); drones
  → **Remote Sensing Technologies**
- Use of markers (not in case of explosive or unknown gas) for safety and operational reasons
  → **Substance Marking**

Monitoring through *in situ* measuring instruments and research technique

Air sampling

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

Water Sampling

- Water sampling by “niskin” bottles and storage of samples for laboratory (for not superficial spill) / bottle sampling for surface water (for substances “DE” and “ED”). For GD substances (in particular with regarding for VOC and semi-VOC)

→ **Sampling Techniques and Protocols**

→ **HNS Detection and Analysis Methods**

RESPONSE OPTION

Action on vessel → Emergency Boarding

- Delimit the risk area on board
- Stop the release of substance from its source → **Sealing and plugging**
- ventilate when possible (e.g. with ventilators) to reduce concentration but be careful if there is a very rich atmosphere (>UEL) present. In this case ventilation will reduce concentration below UEL.

  → **Response Considerations: Flammable**
- For small spills consider to use techniques to prevent/control ignition or evaporation of the chemicals → **Using Foam**
- Recovering operation of the residual load → **Cargo Transfer**
- Towing & boarding → **Emergency Towing → Place of Refuge**

Action on pollutant

- High pressure water spray jet →**Using Water Curtain**
- Re-condensation of spilled gas at liquid state: for small spillage
- Controlled release technique → **Controlled release**
- Wildlife response is focused on toxic effects on avifauna or marine mammals (inhalation hazards) → **Wildlife response**

Containment and Recovery **–** None. Monitor only

Option zero

Evaluate non-intervention strategy in case of: high risks for humans' health; no risks of cloud advection towards the coast. Set up exclusion / interdiction areas, until natural processes have reduced pollutant concentrations → **No intervention**

POST SPILL

Environmental Investigation

- Generally, NO NEED for gaseous and high volatile substances. To be consider in case of damages subsequent gas/evaporators spill (e.g. fire and/or explosion)
- For soluble substances (GD): detection of concentrations in water and evaluation of the effects on sensitive organisms:
- Chemical and ecotoxicological analysis on samples of contaminated water.
- Chemical analysis and studies on biomarkers of sedentary specie
- The same investigations must always be carried out in areas chosen as a reference. No for explosive HNS

→ **Environmental restoration and recovery**

→ **Post Spill Monitoring**

→ **HNS Detection and Analysis Methods**

EXAMPLE OF GASEOUS / EVAPORATORS CHEMICALS OF MARINE ENVIRONMENTAL CONCERNS		
SEBC Group	**Main characteristics and impact for marine environment**	**GHS pictograms**

Vinyl Chloride (G)	Highly flammable, shows long-term toxicity (carcinogen), thermal degradation with the formation of toxic / corrosive fumes. *Incident: Brigitta Montanari, 1984; off Croatian coast. Cargo: bulk (1,300 tons of vinyl chloride monomer)* *Incident: tanker-barge Pampero, 2020; at the locks in Sablons, Rhône France. Cargo: bulk (2200 tons)*	
Ammonia anhydrous (GD) shipped in liquid state	Corrosive, highly toxic to the aquatic organisms due to formation of a highly corrosive solution with water. *Incident: René 16, 1976; Port of Landskrona, Sweden. Cargo: bulk (533 tons of anhydrous ammonia)*	
Benzene (E)	Toxic liquid for human and environment. Not persistent in water column, tends to partition in atmosphere. Depending of the release conditions, it could be toxic for marine organisms, in particular for pleuston due to tendency of benzene to float. Dangerous for marine mammals and avifauna if inhaled. Vapours of benzene are heavier than air. *Incident: Barge, 1997; Mississipi River, USA. Cargo: bulk (pyrolysis gasoline contained 41.0% benzene)*	
Methyl-t-butyl ether (ED)	It has low acute and chronic toxicity to the marine species but acute effects were found to high concentration for the grass shrimp and marine mussel. It determines limitations of the use of the sea. Vapours heavier than air.