Chapter 7

Risk Assessment

7.1 Hazard Identification

During construction of the breakwater, various hazards could occur, primarily danger for human life and loss of health, damage to machinery and material, whose identification have been carried out for following stages:

- During construction phase
- During Marine operations of offshore Construction machinery and fleet.

7.2 Hazard Identification during Construction Phase

Following hazards may be present, which can pose risk to health or life during off shore construction:

- Personal Injuries
- Falling of personal in sea (Man Over Board)
- Occupational hazards during construction
- Hazard during bad weather (Storm)

7.2.1 Injuries During Construction

During construction phase, general hazards anticipated are related to normal occupational injuries, such as, cuts and bruises, trips and falls, electrocution hazards, construction materials handling hazards, etc. To avoid such hazards standard proper construction safety measures will be taken.

7.2.2 loss of Human Life during Construction

During the construction, there may be danger of falling of person in the sea due to unsafe acts and unsafe conditions. During bad weather, high waves and currents may also pose threat to life of workers; hence, suitable construction safety measures will be taken to minimize such risk at the proposed port.

7.2.3 Occupational Hazards during Construction

During the construction, occupational hazards may emerge due to dust emissions and noise generation due to construction activities. Suitable personal protective equipment (PPE) and control measures will be taken to minimize such occupational hazards.

7.2.4 Hazard during Bad Weather

The bad weather conditions, such, cyclone, high winds, etc, may put life of personnel in danger those are engaged in construction. Appropriate emergency response measures will be taken to respond such emergencies as described in Disaster Management Plan.

7.3 Hazard Identification During barge operations.

During the operation, following hazards may be there, which can pose risk to health or life:

- Collision, striking and ramming
- Vessel/Barge mooring alongside loading jetty
- Injury to Personnel
- Falling of Personnel (Man over board)
- Oil leakage
- Hazard during bad weather.

7.3.1 Collision, Striking and Ramming

During manning operations of loaded barges with tugs, probability of collision and striking with barge loading jetty is principally dependent on:

- Weather conditions,
- Time of barge operations (Day or Night)
- Maneuverability of barges

Even in favourable weather conditions, collision, striking and ramming with jetty at proposed port may occur as a consequence of:

- Steering failure
- Propulsion engine failure
- Failure of controls
- Incorrect or delayed engine response
- Electrical system failure resulting “dead Vessle” during manoeuvring

In the event of collision, oil may be splashed into the sea and result in marine pollution and fire.

7.3.2 Vessel/Barge mooring alongside loading Jetty

Following are the possible cause for contact ship with Jetty at the port during berthing operation:

- Mechanical failure (steering or main engine).
- Vessel blackout,
- Misjudgement by master of ship,
- Failure to appreciate weather,
- Tidal effects,
- Failure to appreciate vessel power to weight ratio (bulk carriers).

7.3.3 Personal Injury at Port

If the incident category of personal injury is considered, it can be assumed the hazard is the rope parting. However, if the whole scenario of mooring is considered within the category of personal injury, parting of the rope will be a cause.

Cause of Hazards

- Using mooring bitts for more than one mooring line.
- Wet or slippery quay surfaces.
- Lack of communication between ship and jetty.
- Trapping hands in mooring ropes.
- Too much load applied, parting of the rope.

7.3.4 Falling Person in Sea (Man Over Board)

During operation of port, person may fall into the sea due to following reasons:

- Slippery quay,
- Disbalancing of person, and
- Flooding at jetty due high currents and waves.

7.3.5 Fire at Port or Ship

During the operation of the port/, fire may breakout due to following reasons:

- Release of fuel oil during bunkering of ship followed by source of ignition
- Fire and explosion at ship
- Electrical short circuit at port
- Arson or vandalism

7.3.6 Oil spill on Jetty/Port/Sea

At port, oil bunkering may be carried out during emergency. At the time of bunkering, oil spill may take place due to following reasons:

- In the event of hose/pump failure, fuel oil may be spilled at the jetty and will create fire hazard due to ignition.
- Spillage of fuel oil on jetty will create slippery floor and falling danger. Fire may take place, if source of ignition is available at the time of release.
- During drifting of ship, oil may be spilled into the sea and it will cause marine pollution and fire hazards.

7.3.7 Hazard during Bad Weather (Storm)

- Cyclone, storm, high winds, etc, may put life of personnel and property at port in the danger those are engaged in port operation.

- Flooding at port due to high currents and waves may cause man over board.
- Appropriate emergency response measures will be taken to respond such emergencies as described in Disaster Management Plan.

7.4 Qualitative Risk Assessment

7.4.1 Methodology for Qualitative Risk Assessment for Port

The methodology for qualitative risk assessment is structured process to address issues by achieving clarity on the specific hazards involve in construction and operation of the port. The initial step in this process is to get understanding on activities. Hazards and associated risks are then identified as the basis for a qualitative assessment of internal and external factors impacting the activities. To carry out qualitative risk assessment, following questions are evaluated in systematic order:

- What are the steps in activities?
- What hazards exist (if any) for each step in the activities?
- What is the likelihood of the hazard occurring?
- What are the consequences if the hazard does occur?
- What controls or mitigation measures are required to reduce or eliminate the hazards and their consequences?

Qualitative risk assessment involves all possible sources of hazards, as well as their likelihood and the consequences if the event occurs at jetty operation. Risk levels are decided using professional judgment, experience and technical knowledge about that activity. The qualitative risk assessment process uses a structured and documented approach and uses agreed likelihood and consequence evaluation matrix.

Risk ranking matrix used for qualitative risk assessment is described below in following Figure-7.1. For evaluation of probability/likely hood (L) 1 to 5 point (low to high) are allocated while to describe consequence severity (C) 1 to 5 point (negligible to catastrophic) are allocated. Risk scores are obtained by multiplying likelihood and consequence values. Based on obtained risk score, risk is classified in terms of acceptable, tolerable and not- acceptable.

Risk classification criteria used for qualitative risk assessment are shown in following **Fig. 7.1**.

			Low		Probability		High
			1	2	3	4	5
Impact Severity	Catastrophic						
	Severe						
	Critical						
	Marginal						
	Negligible						

Acceptable **Tolerable** **Not Acceptable**

Fig. 7.1 : Criteria for Risk Assessment

7.4.2 Qualitative Risk Assessment for Construction and Operation of Port

Qualitative risk assessment has been done based on risk criteria described in the methodology. The conditions of hazards in terms of direct and indirect, normal, abnormal and emergency have been given as a part of identification of risk. **Table-7.1** presents over all identification of hazards, risk type, risk assessment and risk management measures for construction and operations phase of port.

Table 7.1 : Identification of Hazards And Risk type/ Risk Assessment/ Risk Management Measures

Risk Identification				Risk Type		Risk Assessment				Risk Control Measures
Activity	Hazard	Condition				Severity		L x C	Risk Classifica-tion	
		D/I	N/AN/E	Likeli hood	Consequ-ence	Level of Likelihood (L)	Level of Consequence (C)			
Construction Phase of the Port										
Construction for the Port	Personnel injuries, cut, slipping	D	N	L	Physical Injuries	4	4	16	Tolerable	• Use of Personal Protective Equipment (PPE) • Follow SOPs • Make available First Aid Box • Make available Ambulance
Construction Activities on Sea Front for Port	Falling Person in Sea (Man Over Board)	D	E	L	Drowning of person/Death	2	2	4	Tolerable	• Life jackets, life buoy with hand rope are kept at jetty at different locations for emergency. • In case of person falling in sea, life buoy shall be thrown towards drowning person, • The port Authority shall be informed for assistance by way of rescue boat or tug.
Construction for Port	Occupational Hazards (Dust Emissions)	I	N	L	Respiratory and pulmonary effect, Irritation to eye and skin	2	4	8	Tolerable	• Use of suitable personnel protective equipment. • Implementation of EMP to prevent dust emissions during Construction.
Bad Weather during Construction (Storm, Cyclone, etc)	Falling of Person in Sea	D	E	L	Drowning of person/Death	2	1	2	Not Acceptable	• Storm signal chart will be displayed. • Alternative locations for shifting the people during cyclone • All tall structures have proper lightening arrester to earth the lighting stroke. •

Risk Identification				Risk Type		Risk Assessment				Risk Control Measures
Activity	Hazard	Condition				Severity		L x C	Risk Classifica-tion	
		D/I	N/AN/E	Likeli hood	Consequ-ence	Level of Likelihood (L)	Level of Consequence (C)			
Operation Phase of the Port										
Berthing Operation	Collision, Striking and Ramming of Ship at Jetty at Port	D	E	UL	Jetty or ship damage	2	2	4	Tolerable	• Port will have experienced pilots who guide ships through the channel to berth ships on to the jetty and port facilitate berthing at the jetty for ships in and out movement. • Ship must proceed at a safe speed, which it can to take action to avoid collision and able to stop within the distance for the prevailing conditions (including the visibility, weather, traffic condition, background lights, maneuverability (e.g. stopping distance and turning circles) and draft in relation with the available water). • Ship must use all available means to determine the risk of a collision, including the use of radar (if available) to get early warning of the risk of collision by radar plotting or equivalent systematic observation of detected objects. (e.g. ARPA, AIS).
Handling of Fuel Oil at Port/Jetty or Ship	Fire	D	E	UL	Damage of life and property due to fire	3	3	9	Tolerable	• Regular inspection and maintenance of pump and hose used for bunkering of fuel oil in ship, • Strict supervision during bunkering, • Fire Fighting facilities will be available at the Port.
Movement of Personnel at	Falling Person in Sea (Man	D	E	L	Drowning of person/	2	1	2	Not Acceptable	• Life jackets, life buoy with hand rope will be kept at jetty at different locations for

Risk Identification				Risk Type		Risk Assessment				Risk Control Measures
Activity	Hazard	Condition				Severity		L x C	Risk Classifica-tion	
		D/I	N/AN/E	Likeli hood	Consequ-ence	Level of Likelihood (L)	Level of Consequence (C)			
port during Loading/ Unloading Operation	Over Board)				Death					emergency. • In case of person falling in sea, life buoy shall be thrown towards drowning person, • Port Authority shall be informed for assistance by way of rescue boat or tug.
Oil Spill at port	Fire	D	E	HUL	Damage of life and property due to fire	2	3	6	Tolerable	• Oil bunkering should be carried out at port during emergency only. • Prior intimation should be given to security /Mech. In-charge about oil bunkering for preparation. • Pump and houses used for bunkering should be maintained in good condition and should be inspected before bunkering. • Security mobilizes fire tender along with fire crew at oil bunkering • Mechanical in-charge shall arrange technician and clean up team • In case of oil spill, it shall be controlled at site immediately with oil spill kit. • Oil spill shall be continuously monitored and shall be reported to Emergency Controller of the Port.
Oil Spill at Sea	Marine Pollution	I	AN	UL	Adverse environment impacts, contamination of Sea water	2	3	6	Tolerable	• Pump and houses used for bunkering are maintained in good conditions and should be inspected before bunkering. • Security mobilizes fire tender along with fire crew at oil bunkering • Mechanical in-charge shall arrange

Risk Identification				Risk Type		Risk Assessment				Risk Control Measures
Activity	Hazard	Condition				Severity		L x C	Risk Classifica-tion	
		D/I	N/AN/E	Likeli hood	Consequ-ence	Level of Likelihood (L)	Level of Consequence (C)			
										technician and clean up team • In case of oil spill, it shall be controlled at site immediately with oil spill kit. • Oil spill shall be continuously monitored and shall be reported to emergency jetty's controller • Regular Inspection and maintenance of pump and hose used for bunkering of fuel oil in ship, • Strict supervision during bunkering, • Clean up from water surface through boom, barrier or absorbent.
Bad Weather (Storm, Cyclone, etc)	Falling of Person in Sea	D	E	L	Drowning of person/ Death	2	1	2	Not Acceptable	• Storm signal chart should be displayed. • Alternative locations for shifting the people during cyclone. • All tall structures will have proper lightening arrester to earth the lighting stroke.
Handling of Coal at port	Exposure to dust	D/I	N	L	Irritation in skin and eye	2	4	8	Tolerable	• Use of personnel protective equipment, • Dust control measures, • OCP for safe Materials handling.
Working at Port/Jetty	Minor Accident	D/I	E	UL	Physical injury	2	3	6	Tolerable	• Use of personnel protective equipment, • Follow safe operating procedure.
Conveyor Belt Operation of transferring Coal	Entrapment	D/I	E	HUL	Limb injury / fatal accident	2	4	8	Tolerable	• Work Permit system • Use of Personnel protective equipment
	Dust Inhalation	D/I	N	L	Bronchitis/ silicosis	2	4	8	Tolerable	• Use of personnel protective equipment, • Dust control measures,

Risk Identification				Risk Type		Risk Assessment				Risk Control Measures
Activity	Hazard	Condition				Severity		L x C	Risk Classifica-tion	
		D/I	N/AN/E	Likeli hood	Consequ-ence	Level of Likelihood (L)	Level of Consequence (C)			
Coal Handling Hazards	Fire	D/I	AN/E	UL	Damage to property, Gaseous Pollution	1	3	3	Tolerable	• Eliminate source of ignitions • Fire Fighting Facilities
	Dust Inhalation	D/I	N	L	Bronchitis/ silicosis	2	4	4	Tolerable	• Use of personnel protective equipment, • Dust control measures,

D= Direct, I= Indirect, N= Normal, AN= Abnormal, E= Emergency; VL= Very Likely, L= Likely, UL= Unlikely, HUL = High unlikely,

7.5 Risk Mitigation Measures

Control Measures to Minimize Personal Injury during Construction

Appropriate induction safety and operational training should be given to personnel engaged in construction activities to avoid personal injuries during construction phase of the port. Unsafe conditions and acts should be minimized/controlled by following inspection and safety audit procedures. Suitable personal protective equipment (PPE), such as, goggles, safety shoes, life jackets, hamlet, etc. should be provided to personnel engaged in construction activities at the port.

Personnel Safety at the Port

During construction of the port, training should be given for safe working at sea front to avoid or minimize the danger of falling of a person in to sea due to unsafe acts and unsafe conditions. Sea survival equipment, such as, life jacket, etc. should be provided to the concerned personnel.

Occupational Hazards during Construction

During the construction of the proposed port, occupational hazards should be minimized by adopting safe operating procedures, best construction practices, by use of suitable personal protective equipment (PPE).

Hazards during Bad Weather

During bad weather conditions, such, cyclone, high winds, etc, standards safety measures should be taken. During bad weather conditions, personnel should not be allowed to remain on the jetty. Appropriate emergency response measures have been described in Disaster Management Plan to respond such emergencies.

7.5.1 Contractor's Safety Responsibilities

- The proposed port shall be committed to the goal of having an injury-free site. To achieve this goal, the safety and health of all personnel shall be receive primary consideration in the planning scheduling and execution of work.
- The Contractor‘s Safety program shall include site-specific and health procedures. The proposed shall include all services required for the complete performance of contractor work and all related job-site work.
- The contractor shall employ at the port construction site a responsible, qualified safety representative whose duties include the protection of persons and property and administration of the Safety Programs.
- The Contractor shall comply with all applicable laws, regulations, conditions of contract and rules or orders of any public authority having jurisdiction relating to the safety of persons or property.

- All Contractor employees, subcontractors and their employees shall be briefed on employee safety and health procedures. In addition, all contractor employees, subcontractor employees shall have in their possession a valid, up-to-date safety card.
- Alcohol, drugs and smoking shall not be allowed onsite under any circumstances, and shall be cause or immediate removal of the employee.
- The contractor shall conduct, a minimum, weekly safety meeting with their personnel. Minutes of these meeting shall be recorded and a copy kept on file for the Port Safety Department to review.
- The Contractor shall perform daily inspections of the project and correct substandard safety conditions and practices.
- The contactor has the primary responsibility for onsite safety for its employees performing work under this program.
- The contractor will be responsible for handling on a daily basis, rubbish generated by its work. The contractor shall keep its work place clean.
- All personnel to be properly trained and instructed in all jobs which require specific training and/or competency to meet all applicable safety regulations and standards.
- Prior to the performance of any work, all contractor employees shall know and understand all rules/requirements that apply to the work they have to perform.
- Employees acting in a supervisory capacity shall require all employees working under their supervision to comply with all applicable safety rules.
- Employees assume responsibility of their own well-being. Personal protective equipment shall be provided and used where required and maintained in proper condition.
- Employees shall keep all work areas clear of debris and trash.
- If for any reason, perimeter cables, barricades or any other safety related items are removed by the contractor during performance of work, it shall be the responsibility of that contractor to replace them promptly when leaving the area. Appropriate precautions shall be taken while the hazard exists.
- **Job Safety Analysis (JSA)**–The contractor shall complete a written JSA, for work to be performed, outlying the equipment to be used, the identified hazards that may exist or be created, and what procedures or safety equipment will be used to eliminate or reduce those hazards. Completed JSA‘s are to be reviewed with the workforce and shall contain their signatures as an acknowledgement.

7.5.2 Risk Mitigation Measures during barge operations

During operation of the port for handling of coal and cargo, various types of hazards and risks are anticipated. To enhance safety and reduce the risk at the proposed port, following risk mitigation measures should be adopted.

Collision, Striking and Ramming of Ship at Jetty

- All the barges/vessels shall be steered by experienced masters for manoeuvring and mooring operations.
- All barges/vessels shall be sailed at a safe speed, which can avoid collision and can stop within the distance for the prevailing conditions (including visibility, weather, draught restrictions etc)

Personal Injury

During the operation phase of Port, personal injuries may be happened due to unsafe act and practices such as slipping, entrapment in moving parts, minor cut during maintenance, etc. To prevent the personal Injuries during operation phase following measures will be taken:

- Use of personnel protective equipment
- Follow safe operating procedures
- Induction and refresher training to work at jetty

Falling of Person in Sea (Man Over Board)

During the operation of the Port, person may fall in the sea/ man over board, following measures will be taken to save the man over board:

- Life jackets, life buoy with hand rope are kept at jetty at different locations for emergency.
- In case of person falling in sea, life buoy shall be thrown towards drowning person, and
- Port Authorities shall be informed for assistance by way of rescue boat or tug.

Fire on Vessel/Tug

To prevent the fire at the Port/Jetty or ship, following measures will be taken:

- Suitable fire extinguishers will be kept on board of tugs which are duly tested and have passes QC tests.
- Tugs shall be provided with experienced personnel who have valid firefighting certification.
- Proper earthing will be provided to prevent electrical sparks to avoid fire accidents.

Hazard during Bad Weather (Storm)

Following measures will be taken during bad weather (such as storm, cyclone, high winds, etc.):

- Storm signal chart will be displayed at jetty at conspicuous locations
- There will be some alternative locations (jetty RBC gallery) for shifting the people as a precautionary measures and victims whose houses will be damaged due to cyclone.
- All tall structures have proper lightening arrester to earth the lighting stroke, and
- Welfare team takes care of enough availability of food, drinking water and medical assistance to tackle an emergency situation arisen due to natural calamities like cyclone.

Occupational Risk

- **Occupational Risk General:** Personnel working in loading of rock shall follow the compliances directed by the authority.
- **Respiratory Protection:** Workers deployed at loading operations shall wear dust masks.
- **Eye Protection:** Workers engaged at loading operations shall be encouraged to wear approved safety goggles to prevent irritation due to dust in eyes.

Personnel Safety

During the loading operations at loading jetty, safety awareness and training should be given to all personnel involved in the barge loading and operations. Training topics to include know how on mooring, berthing and de-berthing of barges alongside the loading jetty

Person Floatation Devices

Personnel working on jetty should be provided with personal flotation devices, such as, life jackets, life vest, cork jacket, life belt, etc. so that they can survive in the event of falling in to sea during normal operation of jetty and during bad weather.

Safety Slogan and Signs

Safety slogan and signs play important role in improving behavior of personnel for safety. Adequate safety slogans and signage should be displayed at strategic locations. Do and don't Do should be displayed prominently in English and local language.

Safety Education and Training

Safety education and training for working at the port is an extremely vital tool and proper identification of training needs and conduct of customized training programs must be carried out. These need to be reviewed from time to time.

7.5.3 Oil Spill Management

At the port and sea, petroleum oil may be spilled during bunkering and collision of ships together and with jetty.

To prevent the oil spill at jetty and sea during bunkering following mitigation measures are taken:

- Oil bunkering will be carried out at jetty during emergency only
- Prior intimation will be given to security / Mech. In-charge about oil bunkering for preparation.
- Pump and houses used for bunkering are maintained in good condition and should be inspected before bunkering.
- Security mobilizes fire tender along with fire crew at oil bunker
- Mechanical in-charge shall arrange technician and clean up team
- In case of oil spill, it shall be controlled at site immediately with oil spill kit.
- Oil spill shall be continuously monitored and shall be reported to emergency jetty's controller.

Oil Spill management will be an integral component at Disaster management Plan for Chhara Port. Sound oil spill management practices will:

- minimize potential to cause harm to human health or the environment;
- conserve resources, including minimization of costs through the reduction
- of response and clean up costs; and

- ensure continued regulatory and public confidence in the Company.
- Oil Spill management will involve two key elements:
- spill prevention – as a first priority; and
- emergency and oil spill response

Oil spill prevention will be maximized by:

- sound design and engineering practice;
- sound construction, operating and maintenance procedures; and
- a high level of environmental awareness and training.

A high level of oil spill response preparedness is also important. Oil spill response priorities are to:

- protect human life and property;
- shut off the source of the oil spillage;
- prevent oil contact on shorelines or sensitive marine and coastal resources;
- recover any free oil, where practicable;
- rehabilitate any affected shoreline and or marine life;
- monitor impacts and recovery;
- review oil spill management procedures;
- implement corrective action programs as necessary;

7.5.3.1 Required Information for Spill Response

- Location of spill
- Source of spill
- Time of spill
- Estimated volume of spill
- Nature and potential danger of spilled material
- Anticipated movement of spilled material
- Action already taken
- Weather conditions at spill site

Upon discovering a spill, Straits employees will make every effort to stop the source of the spill and contain the spilled materials. If any danger to the health and/or safety to employees exist from the spill, only those methods which would allow for minimum contact with the spill site area will be undertaken. Clean-up and removal of the spill will also be undertaken, as soon as possible.

7.5.3.2 Fate and Behavior of Spilled Oil

Oil or fuel can harm the marine environment by smothering marine life or acting as a toxin to both marine and coastal flora and fauna. It can also bio-accumulate in organisms and thus affect organisms higher in the food chain. Sea animals and birds can be harmed when their feathers or fur are coated with oil. Chemical contaminants within the oil can also impair reproduction for sea animals and birds.

7.5.3.3 Oil Movement

When oil is spilled onto the surface of the sea it spreads very rapidly, and after a few hours the slick will usually also begin to break up and form narrow bands or "windrows" parallel to the wind direction. Within a very short time, therefore, the oil will often be scattered within an area of many square miles with large variations in oil thickness being evident. This is one of the fundamental factors that limits the effectiveness of all at-sea response techniques.

Whilst computer models can be used to calculate the probable movement and spreading of spilled oil, experience shows that it is unwise to place total reliance on such predictions. Inadequate knowledge of surface currents in the area of the spill, local wind variations and the unpredictable behaviour of some oils (e.g. submergence of heavy oils in rough seas or low salinity waters due to neutral buoyancy) are among the factors that can cause spilled oil to move in surprising directions. This is why aerial surveillance by experienced observers, possibly supplemented by remote sensing equipment if available, is an essential element of an effective response. Surveillance flights should be undertaken at the outset of an incident and then on a regular basis thereafter to confirm the location and extent of the pollution and to verify and update predictions on the oil's probable movement and the threat it poses to sensitive resources. It is important to co-ordinate flights and flight plans to avoid duplication, and to prevent unnecessary disturbance of colonies of seabirds and marine mammals, which might otherwise be frightened into diving into nearby floating oil.

7.5.3.4 Weathering

At the same time as the oil spreads, moves and fragments it also undergoes a number of physical and chemical changes, collectively termed weathering. Most of these weathering processes, such as evaporation, dispersion, dissolution and sedimentation, lead to the disappearance of oil from the sea surface. On the other hand, the formation of water-in-oil emulsion ("mousse") and the accompanying increase in viscosity as the oil absorbs up to four times its own volume of water, promote the oil's persistence. Ultimately, the marine environment assimilates spilt oil through the long-term process of biodegradation.

The speed and relative importance of the processes depends on factors such as the quantity and type of oil, the prevailing weather and sea conditions, and whether or not the oil remains at sea or is washed ashore.

7.5.3.5 Combat Techniques

No two oil spills are the same because of the variation in oil types, locations and weather conditions involved. However, broadly speaking, there are four main methods of response.

- Leave the oil alone so that it breaks down by natural means.
- Contain the spill with booms and collect it from the water surface using skimmer equipment.
- Use dispersants to break up the oil and speed its natural biodegradation.
- Introduce biological agents to the spill to hasten biodegradation.
- Often the response involves a combination of all these approaches.

i. Natural Dispersion

If there is no possibility of the oil polluting coastal regions, the best method is to leave it to disperse by natural means. A combination of wind, sun, current and wave action will rapidly disperse and evaporate most oils. Light oils will disperse more quickly than heavy oils.

ii. Booms and Skimmers

Spilt oil floats on water and initially forms a slick that is a few millimetres thick. There are various types of booms that can be used either to surround and isolate a slick, or to block the passage of a slick to vulnerable areas such as mangrove fish breeding grounds or other sensitive locations.

- Boom types vary from inflatable neoprene tubes to solid, but buoyant material. Most rise up about a metre above the water line. Some are designed to sit flush on tidal flats while others are applicable to deeper water and have skirts which hang down about a metre below the waterline.
- Skimmers float across the top of the slick contained within the boom and suck or scoop the oil into storage tanks on nearby vessels or on the shore.
- However, booms and skimmers are less effective when deployed in high winds and high seas.

iii. Dispersants

These act by reducing the surface tension that stops oil and water from mixing. Small droplets of oil are then formed which helps promote rapid dilution of the oil by water movements. The formation of droplets also increases the oil surface area, thus increasing the exposure to natural evaporation and bacterial action.

Dispersants are most effective when used within an hour or two of the initial spill. However they are not appropriate for all oils and all locations. Successful dispersion

of oil through the water column can affect marine organisms like deep water corals and seagrass. It can also cause oil to be temporarily accumulated by sub-tidal sea life Decisions on whether or not to use dispersants to combat an oil spill must be made in each individual case. The decision will take into account the time since the spill, the weather conditions, the particular environment involved and the type of oil that has been spilt. Note that some dispersants are potentially toxic in themselves.

iv. Bioremediation

Most of the components of oil washed up along a shoreline can be broken down by bacteria and other micro-organisms into harmless substances such as fatty acids and carbon dioxide. This action is called biodegradation. The natural process can be speed up by the addition of fertilising nutrients like nitrogen and phosphorous which stimulate growth of the micro-organisms concerned.

However, the effectiveness of this technique depends on factors such as whether the ground treated has sand or pebbles and whether the fertilizer is water soluble or applied in pellet or liquid form.

7.5.3.6 Oil Spill Response

i. Containment Equipment On-site

Types of equipment include oil spill control booms of varying types and sizes, self propelled oil recovery vessels, static oil recovery devices and sorbents. A range of storage devices including free standing tanks and towable storage bladders and bags complement recovery devices.

Equipment used for chemical spills depends on the type of chemical. Chemical substances have properties that vary widely and can damage or cause failure to some types of equipment. Appropriate chemical response and clean up equipment is identified by the chemical industry and fire authorities. Suitable oil response equipment may be used in a chemical spill. Following containment equipment made available at the port:

- Booms large enough to contain the volume of the largest predicted spill potential
- Skimmers
- Pillows (number)
- Pads (number)
- Gloves
- Goggles
- Coveralls
- Hazardous material disposal bags

ii. Inspections

- Automatic fuel cut off devices will be installed on fuel transfer hoses.
- Equipment and hoses will be inspected regularly
- Barges will be tested annually for leaks and overall soundness
- Tanks will be tested annually for leaks and overall soundness – shell thickness will be tested every other year
- Above ground piping will be visually inspected weekly and logs kept of
- inspections
- Valves, gaskets, flanges will be inspected weekly and monitored for leaks
- and/or stains and logs kept to record this
- Bunded areas will be monitored daily. Accumulated water will be inspected for oil sheen. Areas will drained, recording date, time and approximate quantity discharged, noting no oily discharge released. Appropriate sumps and oil –water separators will be utilized.
- Spill response equipment will be inventoried monthly or after use and inventory replaced immediately.

iii. People, Training and Exercise Programs

A core group of facility personnel will be properly instructed in the operation and maintenance of all equipment used to prevent and/or respond to oil discharges, as well as their roles and responsibilities in the Oil Spill Contingency Plan. Staff will be organized into teams of 8 people, with one team per shift. All Team Leaders will be trained to Incident Control level and all Team Members to Equipment Operator level.

Regular exercises will be undertaken, involving Straits personnel, external agencies and organizations, tenants and local industry. These exercises will test the effectiveness of the Plan, to obtain feedback on outcomes and to highlight possible improvements.

Oil spill response briefings will be conducted regularly twice per year and employees will be aware of where oil spill response equipment is stored, where the list of contact names is displayed, the notification procedure and how the spill response equipment is to be deployed.