

USER MANUAL – BREAK BULK

RAPID
RESPONSE
DAMAGE
ASSESSMENT



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If you need Emergency Stability and Strength Analyses, call RRDA now at +1-(281)-872-6161 and email the most recent loading computer output to rrda@eagle.org.

- All pages of the output should be sent.
- State the voyage number
- State date and time of the condition.
- Note fuel burn and any other significant revisions to the condition.

SECTION

1

RRDA Program

1.1 General Information

The ABS Rapid Response Damage Assessment (RRDA) Program is administered from ABS headquarters in Houston, Texas, USA. The facility provides rapid response damage assessment support during an emergency incident affecting an enrolled vessel's stability and hull strength.

RRDA maintains an agreement with the vessel managers, to provide this service and vessel-specific data for your ship is stored electronically at ABS. This data is provided for responding to an emergency on board. RRDA should be considered an extension of the ship's own shoreside emergency response team capability.

RRDA is activated when the Master or other owner-authorized person calls the RRDA 24-hour emergency number and requests assistance with a vessel emergency incident.

The time required for RRDA to provide accurate analyses for any given scenario affecting stability and strength is dependent on:

1. Receipt of the vessel load condition and damage reports
2. The complexity of the problem

The RRDA Program does not cover salvage engineering, class surveys, or surveys in connection with repairs, damages, conversions, compliance with outstanding recommendations, extensions, lay-up or reactivation, modifications/alterations, riding ship, change of flag or new installations.

When requested by a flag Administration, ABS is obliged to provide details of its evaluations and files. When a vessel is classed or issued with a Load Line by ABS, the ABS Classification department will be advised that the RRDA team is evaluating damage on an ABS-classed or Load Line-only vessel. The ABS RRDA team will review the most recent available survey status for the vessel and will communicate response activity to the ABS Classification department for consideration. However, a survey by the class surveyor continues to be a requirement for subsequent evaluation of damage and repairs or when a Certificate of Fitness to Proceed¹ is to be issued.

ABS does not act as a principal in the matter of salvage or repairs. ABS can only act in an advisory capacity, leaving it always to the client to accept or reject such recommendations as ABS may make. ABS has no authority to order or contract for repairs, salvage or other matters.

¹ Class authorization for the ship to transit, issued after recommendations made by the attending surveyor have been completed.

1.2 Types of Analyses for Response

Using the RRDA HECSALV™ model for the ship, the following useful analyses can be made:

1. Ground reaction and force to free with allowance for tide
2. Deadweight to be lightered or shifted to refloat
3. Effect on stability due to flooding, grounding, wind heeling, cargo loss or shifting, liquefaction (bulk carriers)
4. Oil outflow
5. Bending and shear stresses caused by pinnacle loads with the ship aground
6. Hull girder strength with wave loading
7. Local strength in the damaged area
8. Evaluation of the plans for offloading, ballasting or cargo transfer
9. Other calculations as appropriate for the vessel's condition

1.3 Drills

Knowledge about the RRDA program may be improved with regular drill activity. Drills correctly align mutual expectations and promote a more efficient level of response should an actual incident occur.

Vessel managers usually exercise their response capability annually and invite RRDA to participate at the appropriate level. Drills may connect RRDA and the ship directly but it is more usual that RRDA communicates with the ship manager DPA/response team ashore, who relay related information to and from the vessel. This relieves the Master of the need to duplicate calls and ensures all parties are using the most current information. (This is most relevant in an actual response)

RRDA's capacity for response may be tested at any time and to the extent the vessel manager deems appropriate. Generally though, provision of drill activity is contingent on the following:-

1. Notification is given to RRDA by email (rrda@eagle.org), with at least one week notice.
2. Any charges to be incurred by the vessel manager are agreed in advance.
3. RRDA may decline a proposed drill time if the drill activity is in conflict with other scheduled drill activities previously agreed to by RRDA.
4. RRDA may cease drill activities if RRDA is activated for an actual ship incident.

The extent that RRDA is involved in a drill can vary depending on the operator's requirement. Variations are:-

1. Live drill role play. RRDA is activated and provides analyses reports and recommendations according to the scenario and information provided by the operator. This tests RRDA's capacity to respond.
2. Pre-drill analyses. RRDA contributes to a drill scenario developed by the operator, providing accurate input data with respect to how the ship will react to a grounding or collision or other serious event. This is done in advance and allows the operator to script a scenario and use RRDA's reports to inject accurate results. For the operator, this validates that RRDA has an effective model of the ship and that accurate analyses can be completed and reports generated.

3. Post-drill reporting. RRDA is requested to provide analyses reports after a drill is completed, using data provided by the operator. This will validate that RRDA has an effective model of the ship and can provide analyses of the conditions communicated by the operator.
4. Communication drill. Ship or management office calls RRDA's emergency number for a communication drill. This validates the number is correct and that RRDA can be activated. This is done by speaking with RRDA staff directly or, if after normal office hours, by speaking with an RRDA call center operator.

All drill activity is logged with RRDA.

1.4 Training

RRDA offers short training sessions that can be delivered remotely via the Web or by office visit. Contact rrda@eagle.org for details.

SECTION

2

Communications

2.1 Activating/Notifying RRDA Team

To activate the ABS RRDA team, the client is to establish verbal communication using the phone numbers provided below. RRDA is most commonly contacted by the Designated Person Ashore (DPA) but may also be contacted directly by the vessel Master.

24-hour Emergency Numbers

Primary: +1- (281)-872-6161

Alternate: +1- (713)-935-2886

For Consideration.

1. Do not wait to collect all information before calling. Initiate contact with RRDA immediately and provide additional information when it is available.
2. Always establish verbal communication with RRDA first. RRDA email is monitored during normal office hours only so email communications received after normal office hours will probably not connect to RRDA personnel within the time needed for an effective emergency response.

MOST IMPORTANT - Do not attempt to initiate an RRDA response using email only.

2.2 Time to Respond.

The RRDA team will respond immediately for calls received during office hours. After office hours and during weekends or holidays, your call will be taken by a call center representative who will then alert RRDA and relay message details. That process is expected to take about 30 minutes. It may be less. An RRDA Team Leader will call you back using the contact details given, and when it is confirmed that the RRDA team is required, the Team Lead and other staff will immediately travel to the RRDA facility. It is expected that RRDA will be in attendance at the office within two (2) hours after the initial call is made. It may be less.

2.3 Office Hours

The normal office hours are as listed below. During these normal office hours, a member of the ABS RRDA team can be expected to answer the incoming call directly. If personnel are temporarily unavailable, the line will automatically transfer to a call center operator who will take note of critical details and then relay that information to RRDA personnel directly.

Monday through Friday 7:30 a.m. to 4:30 p.m. (0730 to 1630) – Central US Time

Note:

Non-emergency inquiries relating to RRDA are welcomed by phone or email. Such inquiries should be made by email (rrda@eagle.org) or using the ABS main number (+1-281-877-6000).

2.4 After Office Hours

After office hours and during holidays, any emergency call directed to RRDA using the +1 (281) 872 6161 and the +1 (713)-935-2886 numbers, will be answered by the ABS RRDA call center. The caller will be asked for a contact name, vessel name and IMO number, call back number and nature of the incident. The call center operator will then connect directly with RRDA personnel to initiate the RRDA response and you will be called by the RRDA Team Leader directly thereafter.

2.5 Action After Voice Notification

After the initial phone contacts have been established and you know RRDA is activated, an email confirmation of the vessel status should be sent to RRDA.

FOR INFORMATION THAT RRDA NEEDS - GOTO Section 4.

Email:[**rrda@eagle.org**](mailto:rrda@eagle.org)
Fax:**+1-(281)-877-5964**

SECTION

3

Information Sharing

3.1 Information Requirements

Emergency incidents are not prescriptive. In an emergency, phone conversations and email exchanges with RRDA will develop the mutual communications and information requirement that is relevant to the incident. Priority will be discussed with respect to the incident and what information is most important for RRDA to receive. Effort will always be made to ensure that information requested from the vessel is important and relevant to the requirement. Early and transparent sharing of information is key.

INFORMATION THAT RRDA NEEDS - GOTO Section 4.

3.2 Load Condition Before the Incident.

MOST IMPORTANT!

The vessel's loaded condition has to be provided to RRDA; without it, analysis results will not be reliable. Summary and detailed stowage plans should be provided, including deck stowed cargo with container stowage details when applicable.

The load condition should be sent to RRDA as output from your loading computer with corrections offered as appropriate for bunkers or other significant changes like ballast. If your system includes CARGOMAX software (a brand of loading computer), the exported load-case (.LC) file should be sent to RRDA. If the loading computer is other than CARGOMAX, a .pdf of the output is preferred.

3.2.1 Departure Load Condition

You are encouraged to routinely send RRDA the departure load condition report so that it can be used by RRDA in an emergency. This will do away with the need for the condition to be sent by the vessel or manager during an emergency incident but, to ensure that no error occurs, the Voyage Number and departure port with date must be clearly identified on the report.

3.3 Collision/Damage/Flooding (Not a Grounding Event)

The goals of RRDA are to identify the resulting damaged state, to maintain stability, monitor hull stress and consider pollution. The main focus of a significant collision event is the sensitivity of the ship to reduced stability caused by buoyancy loss and increased free surface, particularly where ingress has occurred into the hold spaces. Conditions may worsen when cargo shifts or is lost overboard, resulting in asymmetric loading with induced list and increased likelihood of deck

edge immersion and down flooding. Consideration must also be given to limiting the potential for pollution by transferring fuel oil away from the damage.

3.3.1 Comments and Considerations

- a. Uncontrolled ingress should be managed to the extent possible and water ingress to large hold spaces has to be considered very carefully. Free Surface Effect cannot, under any circumstances, be underestimated.
- b. Unless it is clear that pumps are incapable of bettering the ingress rate into damaged compartments, the default condition should be to keep pumping, at least until alternate recommendations have been considered.
- c. If the hull side is breached to the extent that seawater passes freely into the hold, the space is considered to no longer contribute to buoyancy or stability. If the space boundary is intact but contains water due to another cause like ballast tank or piping failure or via an opening on deck, the space remains intact and continues to contribute to stability however, the effect of free surface and reduced righting moment, will be of particular interest.
- d. When the ship is operating in freezing conditions, allowance for ice buildup on deck cargo and superstructure should be made and that information passed to RRDA.
- e. Consideration should be given to the possibility that sea water taken on deck, may be held on board by certain cargo types, either by containment or drainage restriction.
- f. The rate of seawater ingress to a space will decrease as water depth in the space increases, because the pressure differential reduces as hydrostatic balance occurs. Therefore, initially, the pumping capacity to discharge a flooded space may not be adequate to prevent flooding, but the same capacity might prevent the space from becoming fully flooded as the ingress rate slows. This may be of no concern or advantage for tank spaces that can be allowed to flood completely but, managing ingress to the lowest possible height in machinery spaces will be critical and this could provide a measure of advantage that makes the difference. Also, depending on type, pump efficiency may increase as the water level in a space adds pressure at the pumps inlet.
- g. For spaces well outside the parallel mid-body and with significant flare in the hull shape, such as an aft engine room, internal volume changes considerably with height above the tank top. Therefore, for a steady ingress flow rate, there will be a decrease in the rate at which water depth in the space rises as flooding progresses. Use this to be aware that you should not estimate the time it will take to flood the compartment, on the rate at which the water level rises initially.
- h. If the engine room is located toward the aft end and is flooding, immediate consideration must be given to trimming the ship using ballast to the extent possible. This will reduce draft at the engine room and thereby also reduce ingress. RRDA will pay particular attention to hull stresses in this case.
- i. Oil outflow from damaged fuel tanks (and deep-tanks if applicable) depends on the induced movement of oil either because its height in the tank creates a head pressure compared to sea level or (and) it is displaced out of the tank by ingress of seawater with a higher specific gravity. If seawater ingress into the tank is rapid, normal tank suction arrangements will be covered by seawater, preventing suction. Therefore, if oil is to be transferred out of a damaged tank successfully, pumping must be commenced

without delay. The effectiveness of the transfer will depend on water ingress rate versus pumping capacity.

3.3.2 Useful questions and things to consider

- a. Was this a T-bone or side-swiping contact?
- b. What is the other vessel name and IMO number? (RRDA will do a quick search of the Web to source a photograph of the ship)
- c. Other vessel draft at the bow. This information is useful when considering location and extent of damage. For example, damage sustained from contacting a cruise ship with an enormous bulbous bow and extensive bow flare is expected to be different to that of a more vanilla shaped bulk carrier.
- d. Did your ship take a list? How much? Why? Is the ship still settling?
- e. Is oil being lost from a tank? At about what rate? Take ullages.
- f. Is seawater entering the ship? Take soundings. If spaces are dry, damage may be isolated to above the waterline. It is critical that damage isolated above the waterline remains above the waterline. If, for whatever reason, the ship is listing toward to damaged side, the condition should be checked and options weighed.

3.4 Grounding

INFORMATION THAT RRDA NEEDS GO TO Section 4.

Ships are robust structurally and often capable of recovering well from the conditions presented by grounding. The RRDA team's first goal in a grounding situation is to accurately determine the ground reaction. This lends to determining if the ship can be refloated without lightering or the extent to which lightering arrangements must be planned. Reported flooding and the effect of tide will be considered, as well as whether there is internal capacity to change load distribution by transferring cargo, fuel or changing ballast. Consideration for the measure of stress in the hull will be made based on bottom contact details you provide to RRDA or/and as provided in the divers report.

Groundings range from soft/low impact bottom contact with no damage to fully stranded conditions and total loss. The severity of the grounding event depends on vessel velocity and inertia as the ship takes the bottom, hull shape, how much vertical reaction is developed as the ship takes the ground, sea bottom characteristics, buoyancy loss due to breaches in the hull, tidal details and subsequent exposure to the environment. For obvious reasons, an exposed and isolated rocky shoreline in higher latitudes during the winter with contact made at High Water spring tides, introduces much higher risk to the vessel than a low impact grounding onto a muddy bottom in a river environment. Fortunately, most groundings tend to occur in the restricted maneuvering environment of port approach channels and fairways, which limits exposure and provides improved access to tugs and other resources.

3.4.1 Comments and Considerations

a. Own propulsion

(Upper seawater cooling intakes should be used where possible)

In the stress and urgency of a grounding situation, there is a likely optimism that the ship can be moved using its own propulsion. Generally though, the amount of thrust

generated by the propeller, especially when running astern, is relatively small compared to ground reactions likely to develop and little or no change is expected. There are exceptions. If the ship is grounded on a hard isolated pinnacle and has deeper water about the stern, immediate action to trim the ship by the stern, if available, may well allow the vessel to come off. Another example is a low reaction event with no loss of buoyancy and with the advantage of favorable tide. Even so, unless adequate heading and position control can be achieved immediately after refloat, influences of wind, current and propeller induced side forces will increase the likelihood of subsequent grounding, including damage about the stern. A proper measure of tug capacity is highly recommended any time a vessel is refloated.

b. Drafts

Your initial report to RRDA should include a best estimate of the drafts aground and the time that the drafts were taken. RRDA’s analyses result is contingent on the accuracy of drafts and the change that occurred when the ship grounded. We fully acknowledge that drafts may not be easy to obtain and with wave action on the hull, confidence in the accuracy of draft readings may not be high. Even so, the data is critical. Best efforts are needed to establish a baseline and tuning for improvement can always be done as the situation settles, as daylight comes and as support arrives.

- i. An attending boat or tug is probably the best way to acquire good drafts and soundings about the hull.
- ii. If boats are not available, depending on conditions and equipment on board, the drafts may best be determined by observing the freeboard or height from the waterline to the deck or another feature such as a gunwale top. In this case, the location of each reading has to be carefully notated, preferably by frame number but other notable feature or structure on the deck will also be good, so that the hull depth dimension for the ship at these locations can be found from RRDA’s model, the general arrangement or other plans.

c. Ground definition

An accurate ground definition must be provided when possible. When known, the shape of the contact area can be applied into the RRDA model and this allows for a more detailed assessment of how the ship will react to changes in loads. It is also important in determining a more complete assessment for hull stresses that are greatly influenced by bottom support and is essential for planning and monitoring purposes.

- i. Divers may be used for reporting the contact area. Divers are absolutely essential for determining the location of single or multi pinnacle contact areas.
- ii. Contact area can also be reported by sounding around the ship using a lead line or other device. Use the form provided for reporting. Sketches are greatly encouraged.
- iii. Use an attending pilot boat, tug or FRC to obtain soundings about the ship.
- iv. Be aware that softer bottom materials like mud and clay tend to mound and rise against the bow and will create what appear to be odd or doubtful depth readings. Trust what you have and report same.
- v. Be aware that sand can be moved about the hull by strong currents with resulting changes in the sounding due to scouring and deposit.

d. **Damage**

Structural bottom damage frequently occurs during grounding. This can be local buckling with hull plate cracks and tearing and having little effect on longitudinal strength. Alternatively, it can be as gross deformation over large areas of the bottom with impact to the inner bottom structure and bulkheads. Identifying the extent of damage under these circumstances will undoubtedly be hindered due to limited or zero access. Voids and tank spaces may be flooded and inaccessible and other internals may be covered with cargo. Diver support though very useful, also has significant access limitations.

e. **What if?**

Consideration must be made to the potential for conditions on board deteriorating, specifically with respect to the integrity of ship systems that are intact and operational initially but which fail later. Piping as an example. It may be that fuel oil could have been transferred away from the damaged area early on but later, with subsequent buckling loads on the lower structure, piping becomes disabled and ceases any opportunity for transfer or lightering the fuel, which then can require special effort by salvors to remove and has the potential to become a pollution event.

f. **Engine failure and a Lee Shore** –The case of a ship losing propulsion whilst being set down onto a lee shore can be dire, particularly when a high sea state and rocky shoreline complicate the situation. Under such circumstances, the Master will likely attempt to arrest the ship using anchors.

When weighing options, consideration may be made to determine if the ship can be ballasted to increase draft so that it takes the ground in deeper water and further from the shore than it would otherwise. This of course is contingent on loading and ballast capacity and varies with vessel design and load plan. Ideally, the resulting condition would allow the ship to be refloated after removing ballast and with suitable tug support in attendance.

g. **Ballasting down** – If lightering is required to refloat, ballasting the ship to ensure it remains hard aground may be recommended. This allows for the lightering to be completed with no chance that the ship will unexpectedly move and create an unsafe condition. In this way, after the lightering is completed and all associated equipment and personnel are cleared away, the ship can be deballasted and refloated at an agreed and most suitable time.

h. **Stability** – Like dry-docking, when ground reaction occurs, there is a virtual rise of the center of gravity that reduces stability and influences heel, perhaps significantly when stranded on a pinnacle with falling tide. Vulnerability to excessive heel and possible

temporary patches can be applied and the vessel dewatered to the extent needed to meet the requirements of the recovery plan.

j. **Unaccountable list after refloating?**

The drafts, list and trim will be determined by RRDA prior to the refloat, with results based on the known loaded condition. If there is good confidence regarding weights on board and the extent of flooding, but the ship refloats with a “mystery list”, consideration should be made to the possible taking-on of heavy sea floor material into damaged spaces. The extent to which such unintended loading affect list and trim, depends on the heeling moment, the measure of the ship’s initial stability and the volume and relative density of the material deposits.

3.5 Lightering

Lightering the vessel may be required for refloating after a grounding event or to mitigate risks associated with hull stresses, stability and pollution. It is the vessel that will develop the plan for lightering and RRDA will assist in the plan development with the provision of supporting analyses that considers effects of damage.

3.6 Moving a Damaged Ship

Authorization for a damaged ship to be moved is contingent on reviews by flag, the Classification Society, coastal State and perhaps the Port Authority. Other stakeholders also contribute to the process of recovery. Decisions made will relate to the original voyage plan and whether that plan must be revised to mitigate the risks associated with the damage. Many of these considerations remain outside of RRDA’s scope; however, when damage has been sustained to a ship that affects hull strength and stability, RRDA will continue to provide analyses that determines the margin of strength and stability for the proposed transit route. This work relies on review of accurate damage assessment reports that are usually provided by the attending class surveyor.

SECTION

4

Useful Forms

The following forms and illustrations are intended to be used for efficiently communicating important information to RRDA. The expectation is that these can be quickly completed by hand and copied to .pdf for emailing to rrda@eagle.org.

Initial Incident Report

Vessel Name			
IMO Number			
Type of Ship			
Incident Type			
Voyage No.			
Last Departure Port		Dep. Date	
Destination			
Average Daily Fuel Burn			
Current Position			
Managing Company			
Preferred Contact Name			
Preferred Telephone			
Preferred Email			
CC. Email(s)?			
Last Departure Condition has been sent to rrd@eagle.org? (Most important)	YES	NO	
Correction for bunkers and consumables has been made?	YES	NO	N/A
Departure Conditions are sent routinely on this ship and RRDA has the condition?	YES	NO	N/A
Detailed stowage information has been sent to rrd@eagle.org?	YES	NO	N/A
ENTER COMMENTS RELATING TO THE ABOVE OR OTHER USEFUL INFORMATION HERE:			

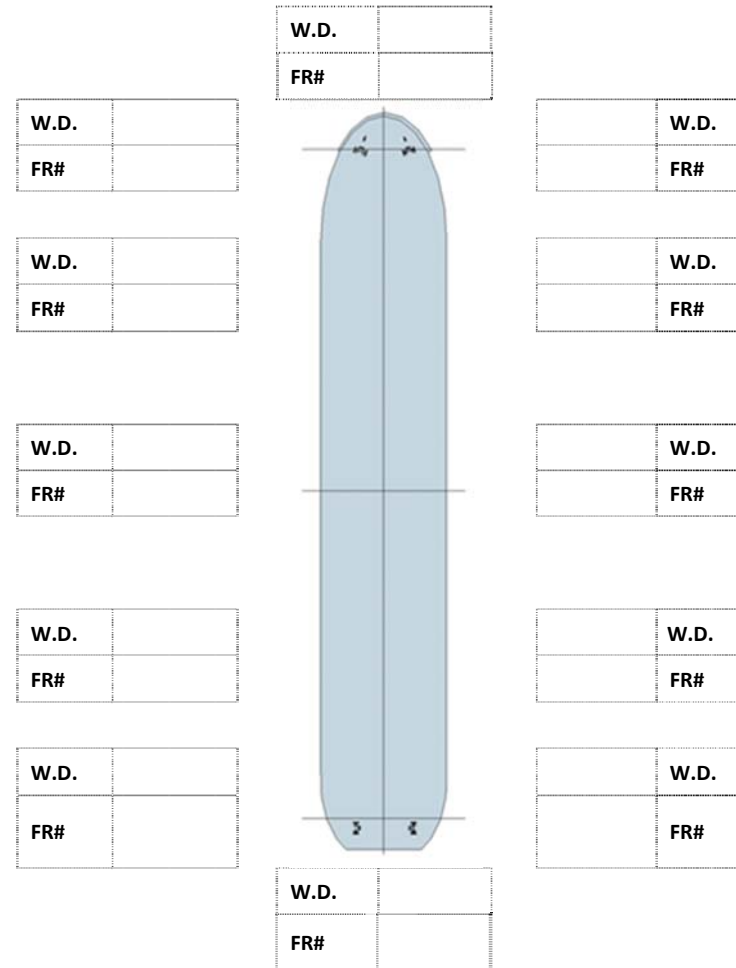
Follow-up Incident Report

Ref. Date and Time				(Local/GMT)
Vessel Name				
Position	Latitude	Longitude		
Nature of Incident				
Contributing Information	Hull spaces are breached	Y	N	(write note below)
	Pollution to the sea	Y	N	(write note below)
	Hull structure is known to be damaged	Y	N	(write note below)
	Has cargo shifted or been lost	Y	N	(write note below)
	Density of water body	kg/m3		
	Ballast system is operational	Y - @	about	m3/hr. N
	Cargo holds bilge is operational	Y - @	about	m3/hr. N
	E.R. bilge system is operational	Y - @	about	m3/hr. N
	Propulsion is available	Y	N	
	Steering is available	Y	N	
	Anchors are available	Y	N	
	Swell height (m) and period (sec)			
	Wind speed (knots) and direction			
	Photos of damage or associated subject	Y	N	
Vessel is Afloat	Under keel clearance	(m or ft)		
	Heel/list (°)	P or S		
	Max. roll angle (°) and period (sec)			
	Approx. steady heading			
	Seas breaking on deck	Y	N	
	Main deck openings secure	Y	N	(write note below)
	Deck edge immersed	Y	N	
	Other vessel I.D. (if collision) Name and ship type			

Vessel is Aground	Time of grounding (very important)	(Local/GMT)
	Accurate drafts (very important)	Notate to vessel sketch below
	Time drafts taken (very important)	Notate to vessel sketch below
	Tides: times and range	If requested by RRDA
	Heel	Y N (Add note below)
	Heading	
	Where is bottom contact	Notate to vessel sketch below
	Soundings about the ship	Notate to vessel sketch below
	Type of bottom material	
	Diver's underwater survey of contact area and damage report	Y N (write note below)
ENTER COMMENTS RELATING TO THE ABOVE OR OTHER USEFUL INFORMATION HERE:		

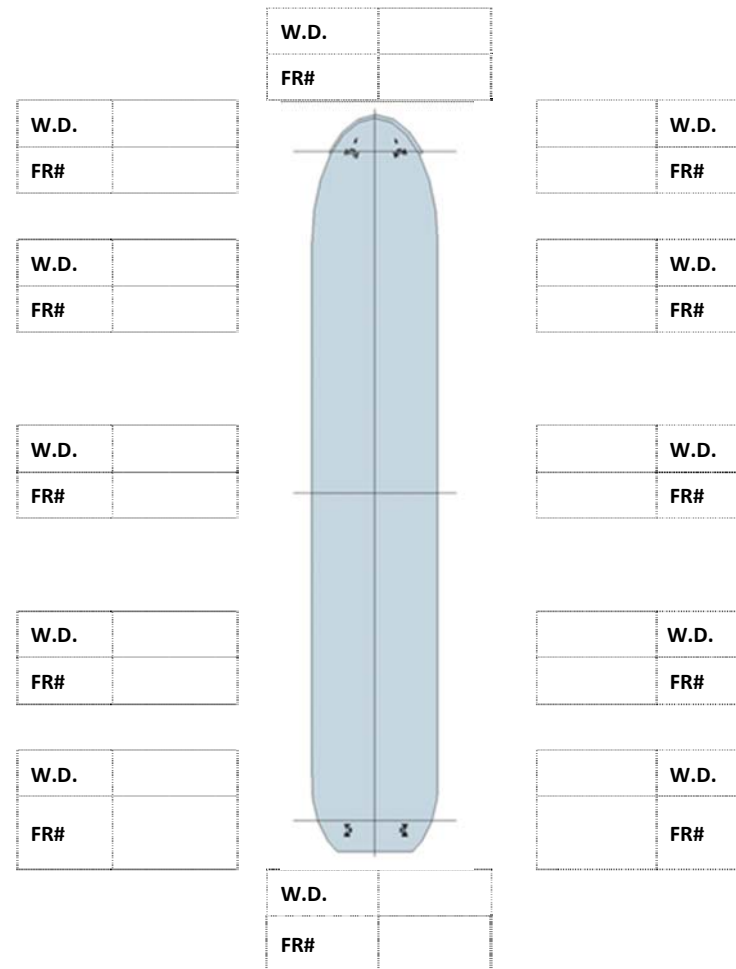
Additional Details About a Grounding Incident

Vessel Name:			
Date:			
1. Drafts - Aground			
Units	Meters	Feet	
Time	-hrs.	Local	UTC
--	Forward	Amidships	Aft
Port			
Starboard			
List or Heel		Degrees	P S
2. Approximate Area of Ground Contact			
Outline the approx. contact area on the hull outline.			
3. Provide water depths (W.D.)			
Water depth values to the extent needed.			
Measured by a boat or tug?			
Measured from ship's deck?			
4. Vessel Heading			
-Degrees (T)			



Additional Details About a Grounding Incident

Vessel Name:			
Date:			
5. Drafts - Aground			
Units	Meters	Feet	
Time	-hrs.	Local	UTC
--	Forward	Amidships	Aft
Port			
Starboard			
List or Heel		Degrees	P S
6. Approximate Area of Ground Contact			
Outline the approx. contact area on the hull outline.			
7. Provide water depths (W.D.)			
Water depth values to the extent needed.			
Measured by a boat or tug?			
Measured from ship's deck?			
8. Vessel Heading			
-Degrees (T)			



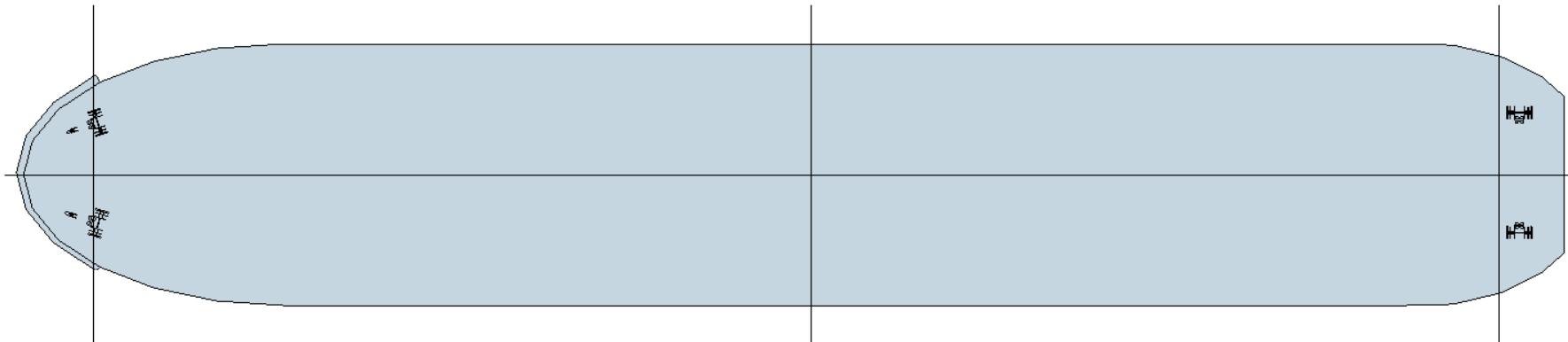
Handy Sketch for Any Incident

VESSEL NAME:

DATE and TIME:

UTC/LOCAL

USE THIS DIAGRAM TO ILLUSTRATE ANY ADDITIONAL PERTINENT INFORMATION LIKE GROUND CONTACT AREA, PINNACLES, AREA DAMAGED, BUCKLING or CRACKS, HULL BREACH, WATER DEPTHS, FREEBOARDS, DRAFTS, OBSTRUCTIONS, ETC.



VESSEL NAME:

DATE AND TIME:

UTC/LOCAL

USE THIS DIAGRAM TO ILLUSTRATE ANY ADDITIONAL PERTINENT INFORMATION LIKE GROUND CONTACT AREA, PINNACLES, AREA DAMAGED, BUCKLING or CRACKS, HULL BREACH, WATER DEPTHS, FREEBOARDS, DRAFTS, OBSTRUCTIONS, ETC.

