8 OBSERVATION TECHNIQUES

Overview

Almost every search and rescue operation requires the use of observation techniques in some form or other. This module covers the more common aspects, and factors that must be taken into consideration when conducting a search.

As an integral member of a SAR team it is vital that all Coastguard Crew are able to understand tasking instructions, and the requirements and techniques for effective observation.

Search Preparation

Crew are often made aware of an impending search operation at short notice, so there may be little time available to prepare.

If you are on a roster for call-outs, it is essential to maintain a state of readiness. This means remaining sober, and fit for the duration of the roster period. If for any reason your physical health or mental state is impaired, you should inform the Skipper.

There should be suitable equipment stored on the CRV or at the base, but you may also need a bag already filled with your own personal items. (See Module Personal Safety)

Briefings

A brief will be given by the CRV Skipper as to the details of the operation. This should include all the information that the Skipper has, and may cover aspects such as:

- The target type, size, colour, general description (and any other relevant information such as if the person missing is known to be wearing a lifejacket).
- Allocating crew roles, positioning, and roster.
- Equipment required.
- Communication set-up.
- Search pattern to be used.
- Weather / sea conditions.
- Other vessels or agencies involved.

Search Considerations

The success of a search depends on the ability to detect the target.
As with the requirements of the collision regulations to keep a look out with all available means, observing should be carried out with all appropriate means i.e.

- Visual (including optical aids such as night sights & thermal imaging).
- Aural (listening).
- Radar.

There are many different factors that will affect the ability to detect the target;

- Ambient light.
- Weather conditions.
- Sea Conditions.
- Observer's height of eye.
- Target size and shape.
- Target colour / contrast.
- Target movement.
- Target ability to make sound.
- Target Radar reflection.
- Search vessels speed.
- Observer fatigue.

Ambient Light

Whether the search operation is being carried out during the day or night will obviously affect target detection, but there are other factors that should be taken into consideration.

- Bright sunshine can produce a lot of glare from the water surface.
- Variable surface shadows caused by scattered or broken clouds will make it more difficult to detect targets due to the contrast / dulling effect of the shadows, and the mottled appearance of the water surface.
- The greater the amount of cloud cover, the less ambient light in the search area.
- Searching towards shore lights (as from a town) can be dramatically more effective than looking away. When travelling away from the lights, an observer (if available) looking astern into the shore lights can be very effective.
- Searching for a target 'up sun' into bright reflected sunlight can be difficult and tiring. 'Up sun' implies looking into the sun. 'Down sun' implies looking away from the sun.

Weather Conditions

- In high winds, distress flares and smoke flares are rendered less effective. Surface visibility is also reduced due to salt spray.
- Heavy rain can seriously affect both visibility and Radar detection.
- Aural detection (listening) will also be affected with increasing wind speed. The chances of hearing a distress signal from a position up wind of the CRV will always be greater than from a position downwind of the CRV.
- Fog not only reduces visual detection, but because of its distorting affect on sound can make estimating the direction and distance of a sound difficult.

Sea Conditions

Sea conditions will affect visual and radar target detection.

- Dye markers tend to dissipate rapidly.
- Whitecaps and foam streaks on the water break up the uniformity of the surface and markedly reduce target detection.
- Reflection of the sun off breaking seas and whitecaps.
- The increase in sea clutter on a Radar screen will affect target detection. Adjusting the sea clutter control will reduce the effect, but possibly at the risk of missing the target. (Refer CBES Radar course)

In moderate or rough seas it is more effective to sight along wave tops and troughs, by adjusting the angle at which Observers are searching, or it may require a reorientation the search pattern to ensure the CRV spends the majority of the time running with or driving into the waves.

Height of Eye

The higher the observer is above the water, the greater the sighting distance. A small increase in height of the observer can often result in a dramatic increase in the area effectively searched – an increase of approx 66% in the example below.

UNCORRECTED VISUAL SWEEP WIDTH

GUIDELINE ONLY

	Length		Height of eye 6'- 8'/ 1.8 - 2.4m						Height of eye12'- 14'/ 3.6 - 4.2m					
	Feet	Meters	Visibility in (NM)						Visibility in (NM)					
SEARCH OBJECT			1	3	5	10	15	20	1	3	5	10	15	20
Person in Water (PIW)			0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.5	0.5	0.5
Raft 1 Person			0.7	1.3	1.7	2.3	2.6	2.7	0.9	1.8	2.3	3.1	3.4	3.7
Raft 4 Person			0.7	1.7	2.2	3.1	3.5	3.9	1	2.2	3	4	4.6	5
Raft 6 Person			0.8	1.9	2.6	3.6	4.3	4.7	1.1	2.5	3.4	4.7	5.5	6
Raft 8 Person			0.8	2	2.7	3.8	4.4	4.9	1.1	2.5	3.5	4.8	5.7	6.2

Size & Shape

The size and shape of a target will have a large affect on both visual and radar detection. The bigger the target then obviously the easier it is to detect, but its shape may also be important. An irregular / angular tall shape may be easier to detect visually compared to a smooth round low shape. The same is true for Radar detection - flat / angular surfaces usually produce a better echo than round smooth surfaces.

Colour / Contrast

Colour aids detection due to its contrast with background colour. Yellow, red, or orange colours provide good contrast against a water background. Fluorescent and reflective colours will be sighted at greater distances.

Target Movement

A target is more easily detected if it is moving. A waving arm, flag, light, or moving vessel will catch the eye well before a stationary object.

Target Ability to Make Sound

S.O.S or continuous sounding of a whistle, horn etc, are internationally recognised distress signals. Shouting or any other means of making noise may be used by a target to attract attention. ***If appropriate to the search / target, searches should be periodically paused, engines turned off, the target hailed e.g. "Coastguard Rescue can you hear me?" and a period of silence then observed.***

Targets Radar Reflection

While the size and shape of a target affects Radar detection, equally important is the construction / material of the target. The more electrically conductive the material, the more reflective the target will be.

- Vessels made of steel or aluminium make good Radar targets.
- Wood is a poor reflective material.
- GRP / Fibreglass is virtually invisible to Radar. For a GRP (glass reinforced plastic) yacht it is the alloy mast and deck / rigging hardware, not the hull that will be reflecting a Radar pulse.

A 5m 'tinny' may be a better radar target than a dismasted GRP yacht twice its size.

Search Vessels Speed

Search operations must be carried out both effectively and quickly. The search speed must suit the target and the conditions at the time. The CRV should be maintaining the best speed it can while still conducting an effective search.

Observer Fatigue

Crew roles, especially observers, should be rotated regularly (approx every 30 minutes) to ensure adequate rest. Ideally there should be periods of complete rest on an extended operation. To achieve this it may be necessary to suspend the search for a short period. In which case the CRV must;

- Inform the IMT.
- Note the time.
- Activate a waypoint on the GPS.
- Deploy a floating datum.
- 'Shout out' and then observe a period of silence if appropriate.

All of the above factors can be taken into consideration when formulating a realistic and effective Sweep Width in a search operation. (See Module Search Techniques)

Observer Positions & Procedures

Visual Observation

The vessel layout, configuration of Nav & Comms equipment, number of crew available (and their level of experience / competence) will all have a bearing on the positioning and roles of the crew.

Visual searches place a great responsibility on crew. Observers should assume that no one else is scanning their search sector - they must stay alert and be thorough.

The angle of the individual search sectors should not need to be greater than approx 60°, and Observers must inform the Skipper if they think the vessel speed or angle of the search sectors should be adjusted to maintain adequate coverage.

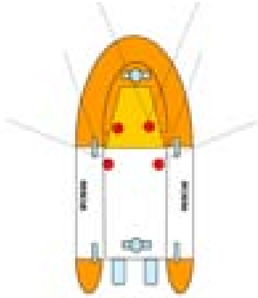
On a typical CRV (with four crew), positions would be;

- The Helmsman looking (generally) ahead as they would normally.
- A Crew member in charge of the navigation / comms and / or search pattern (who is usually too preoccupied to be considered a reliable and effective observer).
- One Observer on each side.

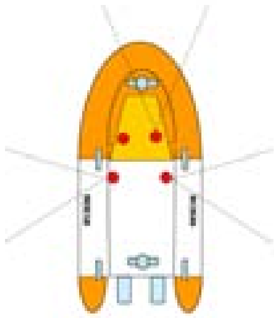
For a search to be carried out effectively, the only observers that can be relied upon are those who are left to observe free of any disruptions or distractions.

The angle or orientation of the Observers search sector can vary depending on several factors.

If the Observers are looking forward of the beam this can have a distinct advantage. The water ahead of the Observer will appear to be moving slower (than if looking straight out the side), and hence easier to scan. Any target sighted ahead will get closer, gradually appear larger, and may be easier to spot.

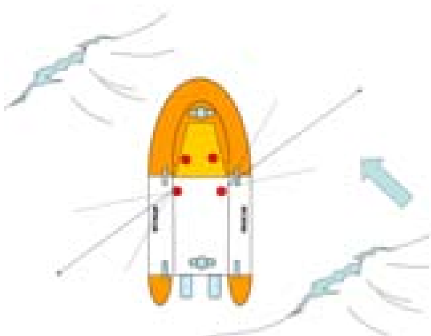


Spray from the CRVs bow wave, and the Observers eyes beginning to water due to the combined air temperature and vessel speed, may mean that looking ahead is not viable. In which case the Observers may have to adopt a more sheltered position, and look more to the side rather than ahead.



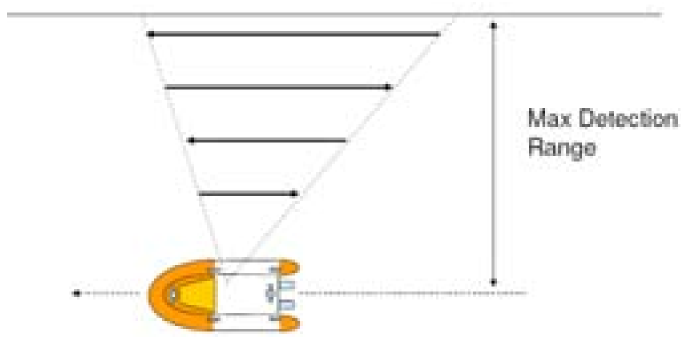
The Observers may adapt the angle of their individual search sectors in response to the sea conditions, angle of the sun, location of any shore lights, or reflected moonlight.

There is no rule that says the Observers should be observing at identical angles, and the Observers are the only crew who can judge their effectiveness, and if necessary request any changes to vessel speed & course. Observers must inform the CRV Skipper if the estimated distances that they are searching (Sweep Width) still hold true if conditions change.



A system must be used to ensure the assigned sector is searched effectively. Start a 'scan' near the vessel and work outwards in a series of parallel lines to the maximum detection range (See Module Search Techniques)

With the eyes focused straight ahead, the Observer should move their head to search the assigned sector. Using eyes alone, without any head movement, can lead to overexertion of the eye muscles causing early fatigue. At the start of each scan, pause briefly to allow the eyes to re focus.



Night Vision

At night it takes about 20 - 30 minutes for the eyes to become fully adapted to the available light. Any exposure to bright light either directly, or by reflection will instantly destroy night vision.

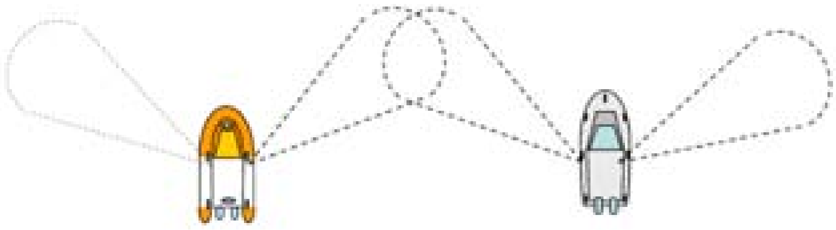
There are two types of sensors in the eye: rods and cones;

- Cones work well in bright light, can perceive colour, and are found predominantly in the centre of the eye.
- Rods are far more sensitive than cones, so work well in poor light. They do not distinguish colour, (only black, white & shades of gray) and are found around the periphery of the eye. Rods are also very insensitive to red light (hence the use of red lights to help preserve night vision).
- At night observation is far more effective either side of the eyes centre. Looking directly at an object can cause the object to 'disappear'. This is because at night the eye has blind spot in the centre due to the predominance of cone sensors.

Using Searchlights

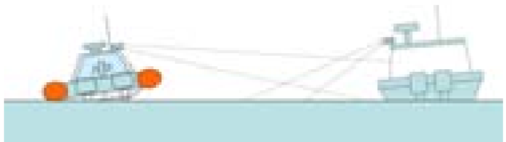
Observers with searchlights must take care not to cause reflection from own vessel, or shine their lights onto other vessels involved in the operation.

- When searching in-line abreast at night, keep searchlights off the other vessels by aiming the beam into the middle of the vessel spacing and slightly ahead.



The exact angles at which searchlights are deployed when working with other vessels, is something which needs to be worked out on a case by case basis – so long as the area between vessels is being searched effectively and the searchlights are not 'flashing' other vessels.

- Turning the search pattern can result in other vessels being 'flashed' by searchlights. Dipping the lights, or turning them off just before the turn can avoid this problem.



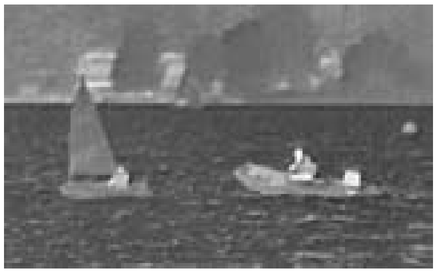
- When searching for any small targets such as a person in the water it is vital that there also be a forward looking searchlight.

Locating the search target by running over them would not be considered a successful conclusion to an operation.

There may be occasions where a search is being carried out with Radar and visual observation, but without the continuous use of searchlights (i.e. for a distressed vessel). In this situation, if a searchlight is to be used for any reason, then to preserve the Observers night vision they should be instructed to close their eyes while the searchlight is in use.

Optical Aids

- Sunglasses affect the adaptation of the eye to light, and may enhance or suppress colours or contrasts. Polarised lenses are very effective at reducing glare, and are recommended for bright conditions.
- Binoculars (standard is 7 x 50mm) should be used with discretion as they narrow the observer's field of vision dramatically. Additionally they tend to tire the eyes and can bring about nausea. ***Once an object has been located, they may be used to identify it, but continuous use of binoculars as the primary method of observation should be avoided.***
- Using binoculars at night to best effect can take practice. The binoculars should be aimed straight ahead, but the eyes turned slightly to the side to make use of peripheral vision (rod sensors).
- Some CRVs may be equipped with 'Night Sun' searchlights or thermal imaging (Infrared) equipment.
- Night vision equipment, used in conjunction with a searchlight can be very effective for locating reflective material such as lifejacket tape over long distances.



It should always be remembered that persons in distress may use any means available to attract attention, and therefore any unusual sights or sounds should be investigated.

Radar Observation

Radar can be an invaluable aid in target detection, but as with any equipment Coastguard crew must be aware of its limitations as well as its features that can help a search operation. Radar operation is covered in greater detail in the CBES Radar course. The following notes are to highlight certain aspects of Radar operation that have particular relevance to search operations.

Radar Horizon

The first limitation that every Radar operator should be familiar with, is the Radar horizon for their vessel. The height of the Radar scanner / antenna dictates the Radar horizon. The curvature of the earth means that the Radar will not detect targets beyond a certain distance unless they are sufficiently high enough to project above its 'blind area'.

In the diagram opposite, the area underlined in red shows the 'blind area', only the very top of the land mass (in green) will be visible on the Radar.

To work out the Radar horizon for particular Radar, take the square root of the scanner height in metres, and multiply by 2.2 to obtain the Radar horizon in nautical miles.

- I.e. scanner height 4m above waterline – $\sqrt{4}$ = x 2.2 = 4.4NM

The Radar horizon can also be determined almost as effectively by using the Geographical Range Tables in the NZ Almanac, and adding 10%

- I.e. Height of eye (scanner height) 4m = horizon of 4.1NM Add 10% (0.41) = 4.51NM

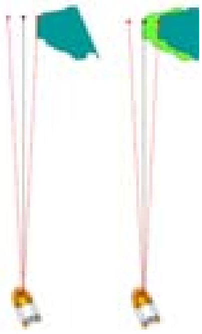
For most search operations (unless the target is especially large / high) the Radar horizon would normally be considered the maximum detection range.

Beam Width

The scanner / antenna concentrates the radio waves generated into a narrow 'beam'.

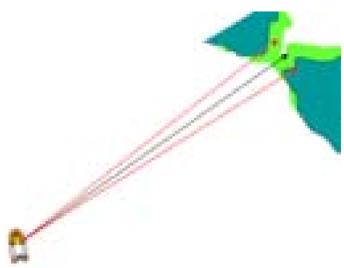
- The larger the scanner, the narrower the beam.
- A typical beam width for small boat radar with a 450mm wide scanner would be approx 6°. The width of the beam can have a large affect on the Radars ability to detect targets.

In the diagram opposite (using a 6° beam width) the Radar scanner is pointing North. Because of its beam width, it is getting reflected radio waves from the headland approx 3° to the NE. As far as the Radar is concerned this reflection is from the North, so it shows the headland on the Radar screen as being North.



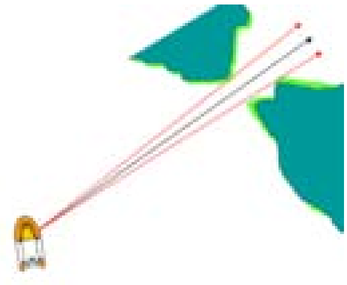
Radar will always distort / extend targets on the screen by approx half the beam width either side of the target. (Beam width is one of the reasons that Radar / GPS overlays never quite match up, especially at longer range)

Beam width will affect the Radars ability to see into coves, bays or harbour entrances, unless the Radar is sufficiently close that the beam width is narrower than the entrance to the bay. Any target within a small cove, or nearby a land mass may not be detected simply because the Radar is unable to see the 'gap' between the headlands, or the 'gap' between the target and the shore.



A 6° beam width will mean that;

- At 1NM the beam will be 0.1NM (approx 200m) wide.
- At 2NM the beam will be 0.2NM (approx 400m) wide.



The width of the beam will increase in the same proportion to the distance;

In the diagram opposite, the distressed vessel is anchored less than 200m from the shore, and because of the beam width its radar image merges into the image of the nearby headland. At a distance of a mile the CRV may not be able to see the vessel.

Radars will have a note of their approx beam width in the operator's manual. Every competent Radar operator should be aware of the beam width, and its affect on target detection at varying distances.

Echo Stretch / Expansion

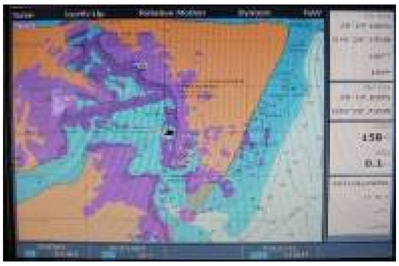
Most Radar sets have an Echo Stretch or Expansion function that will make contacts on the Radar screen appear larger than normal. This can be very useful when trying to locate a small or poor Radar target.

Long Pulse

Some Radars offer the facility to change the length of the Radar pulse. This means that the Radar will transmit each pulse for a longer period of time before switching to receive mode. The longer it transmits a pulse, the more radio waves transmitted, the greater the chance of receiving a returned signal from a target. Like Echo Stretch / Expansion, the Long Pulse function can be very effective when searching for a small or poor Radar target.

Radar Overlay

Many Radar sets have an overlay function to enable the Radar screen to be superimposed on the chart plotter. This can be invaluable when trying to identify a target, especially in areas with many buoys, beacons or off lying rocks.



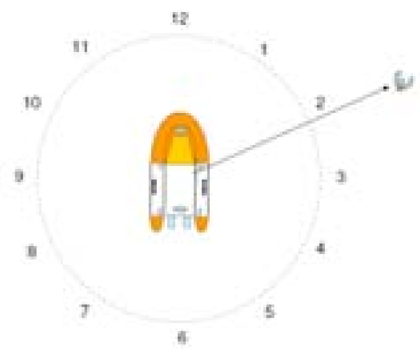
Reporting Targets

Having spotted an object which may be the target of your search, you need to communicate this to the other crew whilst retaining the target in sight / identified on the Radar screen.

Visual Targets

There are several methods of communicating an object's position to other crew.

- When reporting a target is vital to keep the target in sight. This should be done by constantly pointing with an outstretched arm, as for man overboard.
- The easiest and most common is the 'clock face' method, with 12 o'clock being dead ahead, 5 o'clock being off the starboard quarter and so on.
- The estimated distance to the target should also be included in the communication. i.e. "*Target two o'clock at 500 metres".*



Radar Targets

The method for reporting Radar targets to other crew members will depend largely on the equipment set up on board, and the Radar functions available.

Range and Bearing from Vessel

The range and bearing of a target is found by using the Cursor, EBL (Electronic Bearing Line) / VRM (Variable Range Marker) function or a combination of these functions.

- If the information from the Cursor or EBL / VRM is in 'relative' i.e. an angle from the vessels bow, it may be easier to report its position by using the clock face method.
- If the information is in True or Magnetic degrees then this will be of use to crew who can view a Chart plotter, or to the helmsman who can see the compass, but it will not be of help to any other crew such as the Observers.

Whatever reporting system is used it must ensure there is no confusion between the Radar operator and the other relevant crew members.

There is a good case for reporting a target by using both clock face method, and True or Magnetic degrees. This will ensure that what ever the configuration of the Radar and Chart plotter, the description of the targets position will be of use to everyone.

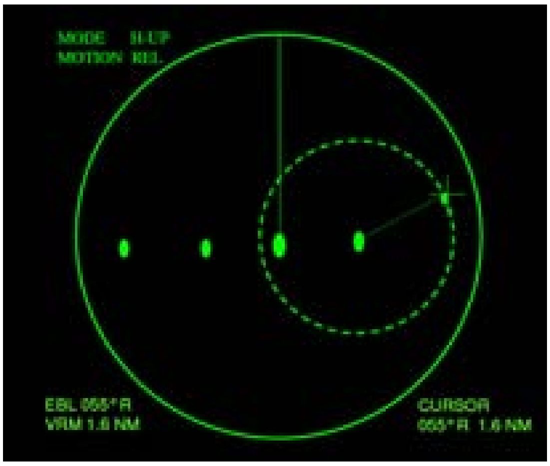
- "*Target two o' clock, range two decimal five miles, zero five zero degrees."*

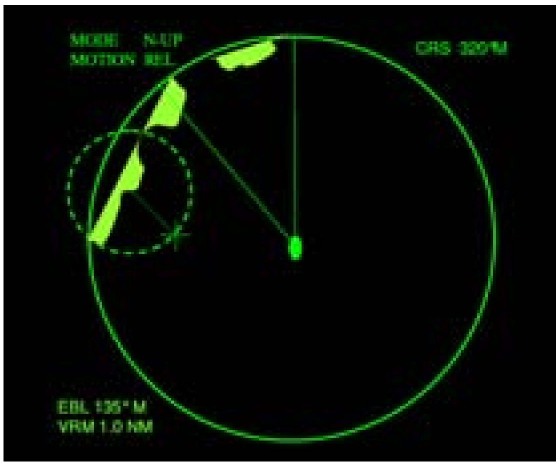
Range & Bearing from another Vessel / Position

When another vessel reports a target, or gives a position in terms of range and bearing from known point, the ability to 'offset' or 'float' a Radar's EBL / VRM can be very useful.

The EBL / VRM can be placed on another point on the Radar screen (the reporting vessels position or the point of land used as reference) and used to obtain range and bearing information from that point. Using the EBL/VRM in this way can help identify targets or areas where the target is likely to be.

- In the diagram below left a vessel in a search (which is maintaining the same course as the CRV) has reported a possible Radar contact with the target at 055° relative, range 1.6NM.
- In the diagram below right a vessel has reported its position as being 1NM SE of a known point.





Once any target has been spotted and identified, a sit-rep should be made to the IMT. Full and accurate details must be supplied to allow confirmation of the target by the IMT.

Crew Management in a Search

A search is perhaps the most demanding of marine SAR operations. It requires a technical knowledge of search planning, and a high degree of concentration that must be maintained throughout the search. The latter can be very physically demanding, and crew must be aware that their performance will deteriorate over time.

- Motivation is a very important factor affecting the performance of search crew. Tiredness greatly reduces motivation.
- Food and fluids are important to maintain concentration, and to protect against hypothermia.
- Seasickness is always a possibility, especially when vessels are under way at reduced speed during a search in uncomfortable seas.
- The requirement to rest and rotate crew members puts an added strain on the management of the crew especially when coupled with the need to preserve night vision.

If a CRV's normal complement is four crew, then in a search operation, especially at night it would be prudent to increase the number of crew to allow for these requirements.