U.S. Coast Guard

National Motor Lifeboat School

Basic Coxswain Heavy Weather Course

Heavy Weather Course

Class material used in this course is for <u>training use only</u> and does not replace approved instructions or common sense. Information in this course is updated as often as needed any information found to be outdated will be pointed out by your instructor and you should note the changes. This is yours to use and to take home.

Section I Team Coordination

Section II Heavy Weather Towing

Section III Engineering

Section IV Casualty Control

Section V Search Patterns

Section VI Surf

Section I

Team Coordination

NMLBS

Team Coordination Training for Boat Crews

Basic and Heavy Weather classes

Updated June 2003

Terminal Performance Objective: Upon completion the student shall be capable of **DESCRIBING** the seven critical skills for effective teams and be aware of the constructive behaviors expected of effective team members.

Enabling Objectives:

Attend classroom Instruction/PowerPoint presentation.

2. **Watch** mishap video.

3. **Acting** as boat crews, critique mishap and identify shortcomings utilizing the seven critical skills covered in class.

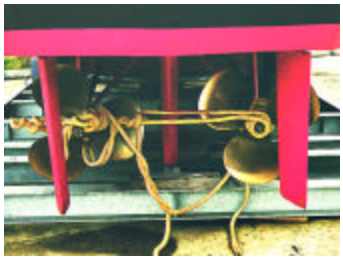
The photos used in this presentation are for the purpose of learning. We need not concern ourselves with who or where. Our primary focus must be on the content and process. As the worlds premiere maritime service we must be able to take a long, hard, critical, look at ourselves, when mishaps occur. For the betterment of all; we must endeavor to find out not only why, but how mishaps occur. Once armed with this knowledge, we must implement needed changes to policies and procedures, continue on in our mission, and remain ever vigilant.

References:

Team Coordination Training Instructor Guide (8/98),

Team Coordination Training Exercises & Case Studies Boats, Cutters, & Aton (8/98),

Team Coordination Training (TCT) Is a program that focuses on reducing the probability of human error by increasing individual and team effectiveness. This training assumes that individual team members are technically proficient in their assigned tasks. (Qualified)

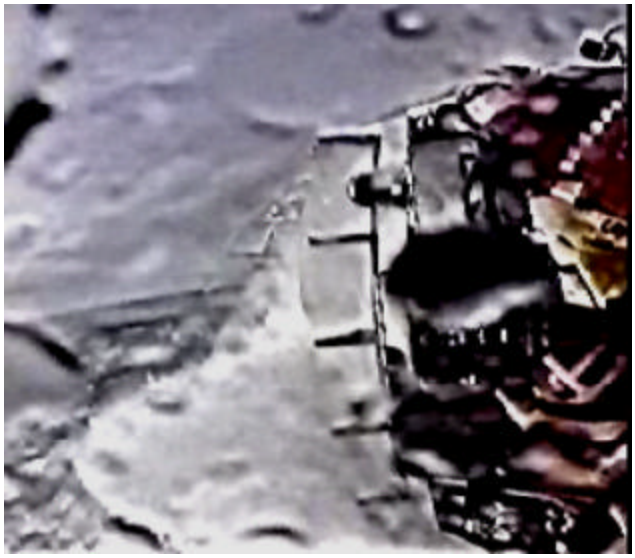


Human Error Continues to Be the Most Significant Cause of U.S. Coast Guard Mishaps. In the FY 2001 Afloat Safety Report, 62% of Cutter and 78% of Small Boat Operational Mishaps Had Human Error As a Contributing Cause. Ninety Percent of the Human Error Caused Mishaps Were Due To:

- **Poor judgment** (67%), which includes: not knowing or understanding the situation, loss of situational awareness; inadequate assessment of risks or environment, made **GO** when **NO-GO** decision may have been prudent; using incorrect information in decision-making.

- **Inattention** (more than 16%), which includes: failing to monitor displays; not maintaining a good lookout; forgetting to do something; doing something improperly; negligence.

- **Ineffective Supervision** (more than 5%), which includes: lax enforcement of standards, and procedures; inadequate oversight or not verifying that the job was done correctly.



What is a Team?

A team is a collection of people, built primarily on the technical capabilities of its members, working in pursuit of a common mission. They have each been assigned specific functions to perform. This course is directed at Motor Lifeboat Crews. Examples used in this training will focus on small boat operations, but the concepts are applicable elsewhere.

What is Team Coordination?

It is the process of coordinated action among team members that enables them to interact effectively while performing mission tasks. Seven critical team skills have been identified that can be employed to reduce the probability of human error. These skills are:

1. Leadership
2. Mission Analysis
3. Adaptability and Flexibility
4. Situational Awareness
5. Decision Making
6. Communication
7. Assertiveness

Notes

Seven Critical Skills

1. Leadership	Directing and guiding the activities of other team members, stimulating personnel to work together as a team, and providing feedback to team members regarding their performance.
2. Mission Analysis	Making long-term and contingency plans, and organizing, allocating, and monitoring team resources.
3. Adaptability and Flexibility	Altering a course of action to meet changing demands, maintaining constructive behavior under pressure, and working effectively with other team members.
4. Situational Awareness	Knowing at all times what is happening to the team, the vessel, and the mission.
5. Decision Making	Applying logical and sound judgment based on information available.
6. Communication	Clearly and accurately sending and acknowledging information, instructions, and commands; and providing useful feedback.
7. Assertiveness	Actively participating, stating, and maintaining a position until convinced by the facts (not the authority or personality of another) that your position is wrong. Taking action when necessary.

Notes

Situational Awareness

Definition

Situational Awareness is the ability to identify, process, and comprehend the critical elements of information about what is happening to the team with regards to the mission.
More simply, it's *knowing what is going on around you.*

Consequence of Loss

When we lose Situational Awareness we increase the potential for human error mishaps. A 1993 Coast Guard analysis of navigational mishaps for cutters and boats between 1987 and 1992 revealed that 40% were due to a loss of situational awareness.

Barriers to Situational Awareness

The following barriers reduce our ability to understand the situation. Recognizing these barriers and taking corrective action is the responsibility of all team members.

Perception based on faulty information processing.

Excessive motivation.

Complacency.

Overload.

Fatigue.

Poor communications.

Perception

Perception is our mental picture of reality. Some things that affect our mental picture are:

Past experiences: We react on information based on our knowledge. Experience may assist you or cloud your judgment in situations that are similar.

Expectations: We often see what we expect to see not reality.

Filters: We don't use information. We don't pay attention to information that doesn't fit our mental picture.

Excessive Motivation

Excessive motivation imposes expectations and filters that affect our ability to fully asses the situation and any safety risks. A common example is we have to go out, or respond to a distress call. The first thought is not, is this safe, it is light off the boat and lets get going.

Complacency

When things are slow, tasks are routine, and/or when your crew is unchallenged complacency can occur. Challenging yourself and your crew to be prepared for contingencies can deter complacency.

Overload

Overload causes distraction; fixation; increased errors; and high stress. As a coxswain you cannot do everything onboard a boat underway, delegate tasks.

Fatigue

Fatigue affects vigilance.

Poor Communications

The level of situational awareness achieved is related to the level and quality of communications observed in the team. Your crew must be trained to communicate freely. Communication is listening as well as speaking. Use acknowledge “Roger” communications.

Notes

Symptom	Treatment
Confusion or gut feeling.	Resolve the conflict. Trust your feelings.
No one watching for hazards.	Reestablish supervisory control.
Use of improper procedures.	Follow Checklists. Follow your training.
Departure from regulations.	Provide mission oversight.
Failure to meet planned targets.	Determine why! Don't just play catch up.
Unresolved discrepancies.	Search for more information.
Ambiguity.	Obtain details.
Fixation or preoccupation.	Know your crew.

Maintaining Situational Awareness

Maintenance of situational awareness occurs through *effective communications* and a combination of the following actions:

Make others aware when the team deviates from standard procedures.

Monitor the performance of others.

Provide information in advance.

Identify potential or existing problems.

Demonstrate awareness of task performance in what others do and what you see in others.

Communicate a course of action.

Demonstrate on going awareness of mission status.

Stress

Stress is the effect that a stimulus has on the body. Stress is anything that thrills us, worries us, prods us, scares us or threatens us. In doing our operational tasks, we routinely deal with stress and have learned to use it to our advantage. Stress can improve performance, but it can just as easily degrade it. In understanding the relationship between stress and performance, it is important to first consider the effects of stress on the body.

Physical Affects Of Stress

When an individual experiences stress, a natural physical response occurs, preparing the body to cope. There are three stages associated with this response: *The Alarm*, *Resistance* and *Exhaustion* stages.

Alarm Stage Fight or Flight

The Alarm Stage allows us to cope on a temporary basis; as long as the body can produce hormones to deal with the stress.
Symptoms of this stage include headaches, fatigue, sore muscles, rapid heart rate, shortness of breath, and loss of energy.

Resistance Stage Adaptation, But At A Cost

As the body fights the original source of stress, the symptoms gradually disappear. The body pays a price for this outwardly normal appearance. We adapt to higher levels of stress but our ability to cope with other stressors is diminished. Eventually our ability to cope with stress begins to fade and we move to the next stage.

Exhaustion Stage Health Depleted

This occurs when the body's resources (stress hormones) are depleted. Unless a way is found to alleviate stress, serious loss of health or complete collapse occurs.

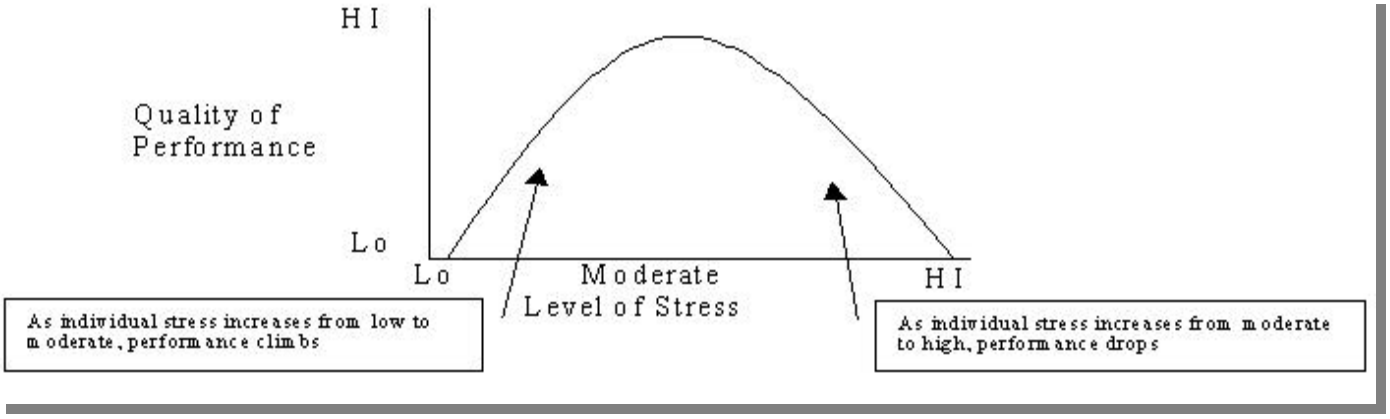
AROUSAL

Arousal is the alertness of an individual, and directly affects the way we process information.

Stress versus Performance

Arousal of the nervous system is a consequence of stress. Stress has two affects on us:

Energizing	Increases Performance
Interfering	Detracts from Performance



Each person has their own optimal level of stress which dictates their peak performance.

We each have our own curve defining what is low, moderate and high. Experience, level of proficiency and training all play an important part in this. What is low for one person may be high for another.

Notes

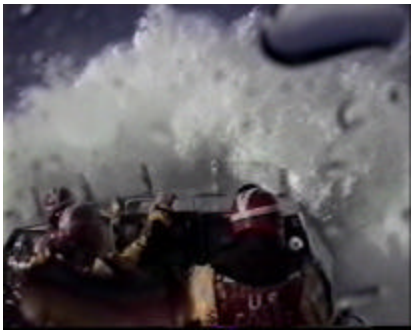
How Much Stress

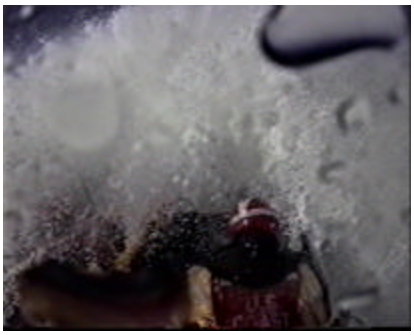
Too Little Stress

This can occur when the mission requires *infrequent activities.* Individuals and teams may:
Become bored or complacent. Team members could be unaware of stimulus. *Low workload can degrade performance in* 20-30 *minutes.*
Fail to take action. They react rather than anticipate the need for action.

Too Much Stress

Very high stress greatly affects the performance of individuals and teams.





Attention or focus narrows and tunnel vision occurs. Ability to infer what is happening around him/her is diminished causing a reduction of situational awareness.

Doesn't remain open to discussion of alternatives to control the situation. Often implements one of the first alternatives considered.

Relies on past experiences and knowledge for a solution. Will apply an alternative that closely resembles a solution found for a similar problem in the past. The superficial search for alternatives may result in the best alternative being overlooked.

Fails to see things that individuals under less stress would see.

Becomes hyper vigilant. Hyper vigilance, which is a form of panic, may occur during emergencies when a lot of conflicting information is being received. It diffuses attention and limits concentration. Hyper vigilant individuals also become more compulsive.

The group becomes susceptible to group think. This is when the team shifts its goal from solving problems to achieving consensus in its decisions.

Optimal Stress

Optimal stress is such that the crew members are engaged in activities over which they have control. The workload provides time to plan. You and your crew are:

Monitoring the situation
Anticipating potential problems and developing contingency plans.
We are *vigilant!*

VIGILANCE

It is the mental process that takes place in the absence of stimulus, being alert when nothing is happening, maintaining a "proper lookout". Optimal stress provides the greatest opportunity to be vigilant.

Stress verses Tasking

Simple tasks are better performed under higher stress.

Complex tasks are performed better under lower stress.

Example: To ensure safe night time operations you need to keep your crew's stress level lower than during daytime operations to achieve the same level of safety.

ADAPTABILITY AND FLEXIBILITY

Information Processing

Our effectiveness in processing information (i.e. making sense out of it) and taking action is affected by our ability to adapt and be flexible under different levels of stress. By effectively processing information we can:

1. Better understand the present situation.

2. Quickly recognize changes in the situation that will affect the team.

AND

3. Trap errors to minimize decision based on bad information.

To effectively process information we must become more aware of how we respond to stimuli and how we often filter information or
subconsciously choose not to act.

Sensory Threshold: Detection

The nervous system (our 5 senses) is designed *to* detect stimulus. To detect the stimulus the intensity must be high enough to break through a minimum level (threshold).
Example: Someone has to speak loud enough to be heard; light must be bright enough to be seen.

Perceptual Threshold: Awareness

How much information can we perceive or be aware of at one time? We are not conscious of all the things going on around us. A great deal of information is not important enough to get to the
perceptual level. To reach the perceptual level information needs to be considered important or the stimulus intensity needs to be higher.

Example: Hearing is not listening for meaning; seeing a traffic "red" light may not be recognizing it as a warning.

Action Threshold: Assessment

Just because we are aware, do we take action? It depends. Often we want a higher level of stimulus, or more information, before we act.

Example: Have you ever had a fire alarm go off and you did not leave the building? You probably looked for additional
information to confirm a fire existed.

Notes

Fatigue

Fatigue is defined as the state of feeling tired, weary, or sleepy that results from prolonged mental or physical work, extended periods of anxiety, exposure to harsh environments, or loss of sleep. Boring or monotonous tasks will increase feelings of fatigue. Generally, fatigue interrupts attention and causes slow inaccurate performance.
Fatigue affects individual vigilance and performance. It is the cause of 80% of all transportation accidents. Unfortunately, our 24-hour society is habitually sleep deprived. 8 hours of sleep is normally required to avoid creating a sleep debt but few of us ever obtain this amount.

Affects On The Body

Fatigue slows several mental processes, including:

Decision-making and memory tasks.

Example: Applying the Rules of the Road.

Visual perception

Example: Maintaining a proper lookout.

Mental arithmetic

Example: Navigation solutions.

Reaction times slow for both simple and complex tasks.

Alertness is difficult to sustain. *Between* 0300 *and* 0700 *we are biologically at our lowest alertness.* Tasks performed during this period have a higher probability of error.

Impairment is Undetected

Fatigued individuals are at high risk because they are unable to determine their level and duration of impairment. They do not know when they started being affected or for how long they were affected.

Symptoms of Fatigue

Some signs of crew fatigue include:

Many fatigued people forget to do something. Errors of omission.

Slower task performance or lower productivity.

Decreased morale and motivation. Fatigued people often become moody.

Poor communication. They talk less.

Sleeping on watch. They can also be sleeping with the eyes open. Stimulus is perceived, but reaction time is greatly slowed.

Difficulty concentrating and thinking clearly.

Inattention to minor, but potentially important, details.

Complaints of headaches or stomach aches.

Notes

Control of Fatigue

While underway, fatigue is a constant factor for boat crews. The environment and noise rapidly bring on fatigue. Below are the fatigue standards for Coast Guard small boats as it appears in COMDINST M16114.32 BOAT Manual Vol I.

While underway for long periods, attempt to rest. If personnel allow bring a second coxswain or experienced break-in coxswain to relieve you of constant watch. Keeping dry and warm will help reduce fatigue in cold environments. Carry extra clothing to allow you to get dry (i.e. a second pair of gloves, polypropylene long underwear to change into when you feel chilled due to exertion). Drink water and eat nutritional food when underway.

Duty days can be stressful and hard to get good rest or nutrition. Make an effort to be well rested prior to going on duty. Maintain a high level of physical fitness. Eat nutritional food before during and after work. Periodically take breaks to allow you to mentally and/or physically recover.

Boat Size	**Maximum Underway Hours** [1]			**Rest**
	Seas < 4 ft	Seas > 4 Ft	Heavy Weather [2]	Required [4]
40’ and above [3]	10	8	6	8
30’-39’	8	6		8
Less than 30’	8			8

Notes:

1. Maximum hours within a 24 hour period.
2. Heavy Weather is defined as wind speed of 30 knots or greater, or continuous wave height greater than 8 feet
3. Time spent at sheltered anchorage can reduce the maximum underway hours for crew on watch by 50%. Time at sheltered anchorage need not be counted for crew not on watch.
4. A minimum of 10 continuous hours of crew rest is required in every 24 hour duty period. (Para.6.a.(1)).

Copied from BOAT Manual Vol I COMDINST M16114.32

Monitoring Performance

Team members may look well and appear to be fully conscious, when they may not be aware of, or capable of, rationally evaluating a problem. Recognizing this condition is difficult because we commonly assume that affected individuals have a purpose for everything they do, even if they do nothing.

Early recognition of individual performance problems is essential for small boat operations. The best way to identify a problem is to look for deviations from normal behavior or standard performance. Some symptoms to look for include:

- Deviations from established procedures
- Low standards for the required tasks
- Lack of discipline, greater tolerance for error
- No monitoring or crosschecking
- No response to inquiries by others
- Frequent minor errors by team members
- Extreme tiredness
- Unusual irritability
- Obvious physical problems
- Increased lapses of attention
- Overall reduction in performance

Risk Management

Risk management is a process by which we can maintain an acceptable level of safety during the conduct of our mission. Safety is defined as: *"The identification and control of risk."* Risk management is the identification and control of risk, *according to a set of preconceived parameters.* The parameters and the acceptable limits vary with the type of operation. Rescue operations, buoy tending, ice breaking, law enforcement, etc., all have different risk. Controlling the risks means we eliminate or educe hazards that can lead to mishaps.

Assumptions

The Risk Management program assumes:

Every event/evolution has some degree of risk exposure.

All the risks will never be known.

Every event/evolution requires balancing risks by applying adequate risk controls.

Resources available to identify and manage risk are limited.

The goal is to control or eliminate all *unacceptable* risk in each event/evolution.

Risk Management Steps

Every event requires that we manage risk to keep it within acceptable boundaries. Example: In fog slowing to a safe speed and posting additional lookouts. How we keep risks in check is therefore very important. The following steps provide a systematic approach to managing risks.

Define the Mission

Identify Hazards

Assess Risks

Identify Options

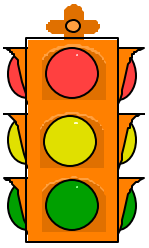
Evaluate Risk vs. Gain

Execute Decision

Monitor Situation

Define the Mission	Break down the operation into bite sized pieces. Examples like crossing the bar, transit to a disabled vessel, evaluation of scene, tow approach, etc.
Identify Hazards	Consider known hazards. List inherent hazards associated with a mission or task. Look for potential failures (things that can go wrong) like equipment, environment, or personnel.
Assess Risks	Risk must be assessed as it applies to you and your boat crew. Risk assessment is accomplished by evaluating the specific hazards, and general hazards involved in a mission or task.
The Questioning Technique for Risk Assessment -	*Why* am I doing it at all? *What* could go wrong? *How* will it affect my boat and crew? *How* likely is it to happen to me? W*hat* can I do about it?
Identify Options	Start with the greatest hazard or obstacle and identify as many risk control options as practical. Try to reduce risk to an acceptable level. Some risk control options include: Spread Out, Transfer, Avoid, Accept, Reduce.
Evaluate Risk vs. Gain	Determine if the benefits of the operation now exceed the levels of risk that the operation presents, consider all the risk and consequences involved with the operation. A common saying is “Us, our stuff, them, their stuff.” What is the gain to be had and how likely are you or your crew to be injured or your boat disabled. When in doubt run it up the chain of command. The chain of command is part of your team, use them.
Execute Decision	Take action! Reduce your risk! This may mean waiting for additional resources, reassigning crew members, or limiting your response. You must ensure that your crew knows what the risk controls are.
Monitor the Situation	React to changes in the situation. Are the controls working to reduce the risk? Reevaluate as changes in the environment, operation, equipment, and/or people occur. Risk management is a continuous process.

Gar Model



A survey of Coast Guard accidents identified 6 elements that affect risk in operations.

Supervision
Planning
Team Selection
Team Fitness
Environment
Task Complexity

These elements are incorporated into the GAR Risk Assessment Model. This model provides the crew with a way of assessing risk.

Supervision

Supervisory Control considers how qualified the supervisor is and whether effective supervision is taking place. Even if a person is qualified to perform a task, supervision acts as a control to minimize risk. The higher the risk, the more the supervisor needs to be focused on observing and checking.

Planning

Planning and preparation should consider how much information you have, how clear it is, and how much time you have to plan the evolution or evaluate the situation.

Team Selection

Team selection should consider the qualifications and experience level of the individuals used for the specific evolution.

Team Fitness

Team fitness should consider the physical and mental state of the crew. This is a function of the amount of quality rest a crewmember has had.

Environment

Environment should consider factors affecting personnel performance and factors affecting performance of the boat. This includes, but is not limited to, time of day, temperature, humidity, precipitation, wind and sea conditions, and proximity of hazards (both navigational hazards and hazards to people).

Event or Evolution Complexity

Event/Evolution complexity should consider both the required time and the situation. The longer exposed to a hazard, the greater are the risks. The situation includes considering how long the environmental conditions will remain stable and the complexity of the work.

Color Coding Risk

The mission risk can be visualized using the colors of a traffic light. If the total falls in the green zone, risk is at a minimum. If the total falls in the amber zone, risk is moderate and you should consider adopting procedures to minimize the risk. *If the total falls in the red zone, you need to implement measures to reduce the risk prior to starting the event/evolution.*

Notes

Risk Calculation Worksheet

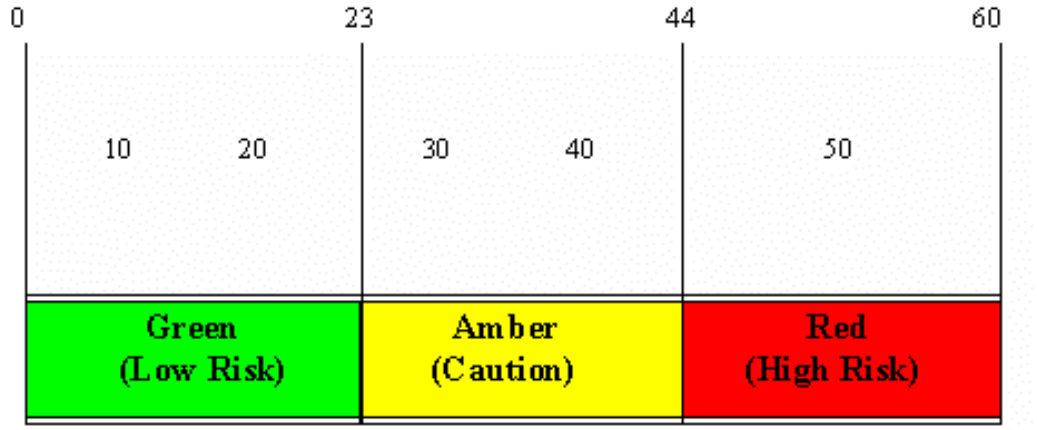
Supervision	_____
Planning	_____
Crew Selection	_____
Crew Fitness	_____
Environment	_____
Event/Evolution Complexity	_____
Total Score	_____

Assign a risk code of 0 (**for no risk**) through 10 (**for maximum risk**) to each element this is your personal estimate of each element add the risk scores up for a total risk score.

Calculating Risk Using GAR Model

To compute the total level of risk for the preceding six elements, assign a risk code of 0 (For No Risk) through 10 (For Maximum Risk) to each element. This is your personal estimate of the risk. Add the risk scores to come up with a total risk score. *For elements that receive high risk scores, it is prudent to take additional action.*

Gar Evaluation Scale for Color Coding the Level of Risk



Briefings

Briefings

Briefings fall into two categories: Brief and Debrief. Briefs include not just what you will be doing but how it will be done. Debriefs should include not just what was done but how to improve our procedures and abilities.

Brief

The Brief sets the stage for what is to follow. It clarifies expectations for team members and establishes the ground rules for the task. Make the following process part of your routine Brief:

Specify desired results

Set expectations

Clarify responsibility

Identify available resources

Establish a climate for learning

Accept/encourage input from team members

Maintain a positive attitude

Make team members accountable

Specify Desired Results

What is the desired result or goal? What do you want in terms of quality and quantity.
Example: "We are getting underway to locate an overdue vessel. This will require us all to be alert as lookouts. We are looking for ..."

Set Expectations

Explain what you expect from other team members and make all team members aware of what they can expect from you, as well as from the mission. This is also your opportunity to ensure that your expectations of fellow team members are accurate and that there have been no changes in personnel, equipment, etc. that will affect the outcome of the mission.

ClarifyResponsibilities

Discuss with the team whatever principles, policies, and procedures are considered essential to achieving the desired results. Review lessons learned to determine critical tasks and "No-No's". When identifying "No-No's", also identify what level of initiative is expected from specific team members (i.e. Wait until told; Ask whenever there is a question; Always provide a recommended course of action; Do it and report your actions immediately; or, Report back routinely).

Example: The coxswain states "We are going to be taking this vessel in tow, Engineer, you will work the tow bit. Don't make up the line till I tell you."

Identify Available Resources

Ensure the team has all applicable information and equipment capabilities are understood. Ensure all personnel who have a need to know have been included in the team planning process. For major evolutions, that means several levels of the chain of command need to be represented at planning briefs.

Example: Before launching on a heavy weather towing case, discuss options and information with your OINC/CO, and Group Duty Officer.

Establish A Climate For Learning

There is a learning opportunity available during each and every task or evolution. Create a climate for learning by ensuring that all team members understand learning is an objective and take advantage of the opportunities as they arise.

Accept And Encourage Input

If you truly want team members to be assertive, you must give them permission to do so. The time you spend encouraging and accepting input during the Brief will set the stage for the rest of the mission.

Maintain A Positive Attitude

Your attitude as a team leader is contagious. A positive attitude demonstrated by the leader will lead to positive attitudes by all team members. This is especially critical during high risk, high stress missions.

Make Your Team Accountable

Ensure team members understand the standards for performance (e.g. Navigation Standards, Standing Orders, SOPs, Training Assessment/Ready For Operation Checklists) that will be used in evaluating the results. Set aside a specific time when you will debrief the team.

Debriefs

The Debrief provides an opportunity to evaluate and recognize teams or individuals for their performance. This includes identifying areas where performance needs improvement. It is a feedback session. Make the following behaviors part of your routine Debrief:

Conduct self-critique.

Accept/encourage feedback and suggestions.

Focus on process.

Demonstrate consistency.

Conduct Self Critique

Openly critique your actions and determine what you can learn from them. Encourage similar behavior on the part of other team members. This should be approached as an opportunity to learn from recent experience. Unless you are aware of your performance, you cannot know what you should continue doing or what you should change.

Encourage Feedback

Begin Debriefs with junior members first. Allow them to give honest constructive feedback from their experience. Be open to feedback and actively solicit it.

Focus On Process

It is important that the team understands its effectiveness in the process. Doing the right thing is only half way to effective team coordination. Doing *"the right thing right"* is the ultimate goal. In describing process, address: what, why, how, when, where, as well as who. When evaluating individual or team, apply Effective Feedback principles.

Descriptive, *not* Evaluative.
Well intended, *not* Hurtful.
Specific, *not* General.
Well timed, *not* Delayed.
Balanced, *not* One-Sided.

Demonstrate Consistency

Talk is cheap; behavior is believable. Ensure that what you say and do are consistent.

Section II

Heavy Weather Towing

Notes

Updated 2002

Towing

Terminal Performance Objectives
Basic Coxswain

While underway on a 47 ft. MLB, in 4-6 ft. seas, DEMONSTRATE the ability to take a boat in tow. IAW COMDTINST M16114.33

1. **Make** proper approach to the disabled vessel.
2. **Station keep** for a sufficient period of time to pass a drogue and towline to the disabled boat.
3. **Pass** a drogue to the disabled boat.
4. **Maneuver** the 47 ft. MLB to increase and decrease the safe working distance during station keeping.
5. **Increase** scope of towline.
6. **Decrease** scope of towline.
7. **Exercise** effective communications and crew control.

While underway on a 47 ft. MLB, in calm seas, DEMONSTRATE the ability to take a boat in alongside tow and moor to a dock. IAW COMDTINST M16114.33,

1. **Make** proper approach to the disabled vessel.
2. **Station keep** for a sufficient period of time to pass a drogue and towline to the disabled boat.
3. **Maneuver** the 47 ft. MLB to increase and decrease the safe working distance during station keeping.
4. **Exercise** effective communications and crew control.

While underway at night on a 47 ft. MLB, in 4-6 ft. seas, DEMONSTRATE the ability to take a boat in tow. IAW COMDTINST M16114.33,

1. **Evaluate** the weather conditions (wind and current)
2. **Determine** which side to take the boat alongside.
3. **Determine** how many side lines are needed.
4. **Maneuver** the MLB alongside the towed vessel.
5. **Connect** the side lines to the towed vessel
6. **Adjust** the side lines to minimize surging and shock-loading
7. **Moor** the disabled vessel to a dock.
8. **Exercise** effective communications and crew control.

□

Terminal Performance Objectives
Heavy Weather Coxswain

While underway on a 47 ft. MLB, in seas greater than 8 ft., DEMONSTRATE the ability to take a boat in tow. IAW COMDTINST M16114.33,

1. **Make** proper approach to the disabled vessel with bow square to swells
2. **Make** proper approach to the disabled vessel with stern square to swells
3. **Station keep** for a sufficient period of time to pass a drogue and towline to the disabled boat.
4. **Maneuver** the 47 ft. MLB to increase and decrease the safe working distance during station keeping.
5. **Increase** scope of towline.
6. **Decrease** scope of towline.
7. **Demonstrate** corrective action to be taken for a “hard chine” lock up.
8. **Exercise** effective communications and crew control.

While underway at night on a 47 ft. MLB, in seas greater than 8 ft., DEMONSTRATE the ability to take a boat in tow. IAW COMDTINST M16114.33,

1. **Make** proper approach to the disabled vessel with bow square to swell.
2. **Stationkeep** for sufficient time to pass a drogue and tow line to the disabled vessel.
3. **Maneuver** the 47’ MLB to increase and decrease the safe working distance during stationkeeping.
4. **Exercise** effective communications and crew control.

While underway on a 47 ft. MLB, in seas greater than 8 ft., **Pass** a dewatering pump to a disabled vessel. IAW COMDTINST M16114.33,

1. **Demonstrate** ability to direct pass a pump
2. **Exercise** effective communications and crew control.

NATIONAL MOTOR LIFEBOAT SCHOOL
U.S. COAST GUARD

47 FT MLB
Heavy Weather Towing
Outline

Duty Day Preparations
Pre U/W Preparations
On Scene Preparations
Crew Communications
Types of Approaches
Selection of Approach
Optimum Position
Station Keeping
Opening and Closing
Towing Transition
Shortening Tow
Review

Notes

Duty Day Preparations

Your Boat- Knowledge of your boat's condition and equipment begins everyday with boat checks. If duties prevent you from supervising boat checks take the time to walk through the boat and check on the equipment you may need in heavy weather.

Thorough outfit - condition checks. Ensure all required equipment is onboard and stowed properly. Loose gear underway in heavy weather creates a hazard for the boats crew and stability of the vessel.

Discrepancies. Ensure all systems are operating within required parameters. No restrictive discrepancies that could affect the mission or disabling discrepancies are reported. If a waiver is in place you must know the conditions of use.

Pending Work. Know if maintenance is scheduled. If heavy weather is forecasted, and no other heavy weather boat is available, maintenance may need to be postponed.

Electronics. Know if your electronics are in working order. Ensure your waypoints are entered and have not been altered. Know your settings for radar ranges (NM, KM, KY). Know if your GPS is configured properly (Loran Mode, Display screens disabled?)

There should be no question in the mind of the crew that the boat, and its equipment are one hundred percent ready for operations.

Notes

Some Definitions

- Sea State – is both the sea swell as well as the significant wave height of the wind waves.

- Significant wave height –is the average height of the largest third of the wind waves observed or expected in an area. This means that 33% of the waves will be less than the given height, but 33%, about one in seven, will be higher. Even occasionally twice as high as the upper end of the forecasted range

- Combined seas - is the realistic conditions you will encounter.

Different Forecast Zones.

Near Shore - Often the area is designated by geographical reference and out as far as 60 nm offshore
Offshore - Generally covering the area from 60 to 250 nm. The forecast and a synopsis of weather conditions will provide you with a picture of what is coming.
High Seas - This zone covers areas like the North Pacific or North Atlantic and provides information on storms systems.

The Weather- Heavy weather is determined to exist when seas exceed 8 feet and/or winds are greater than 30 knots. If heavy weather is forecasted it should be considered mission planning. Reliable and up to the minute information is critical. There are many sources of information available to you.

Tides - Knowledge of the tides and how they effect your operating areas is very important. If you are going on a long mission or run the risk of seeking shelter in another port, write down the tidal information before you get underway. If you do not have the information request it before you arrive. You may need to adjust your speed or divert to another harbor to arrive during a favorable tide.

Sea State - Know what to expect before you get underway. Check the conditions in your operating area often. Use all means available to get accurate information. The internet is a valuable tool with information from weather stations and buoys. Be prepared!

Wind direction - The 47 ft. MLB is greatly effected by the wind; and sea conditions change rapidly as the wind changes in contrast to the swell. Station keeping becomes more difficult as wind speed increases. The same information sources can be used to prepare.

Bar / Inlet Conditions - Conditions on the inlet or bar change rapidly due to weather and tides. The change of tide from flood to ebb may drastically change the conditions. Frequent checks should be made. When and how often you should check conditions in your operating area is dictated by experience and guidance from your command.

Information Resources - There are many sources of weather information:

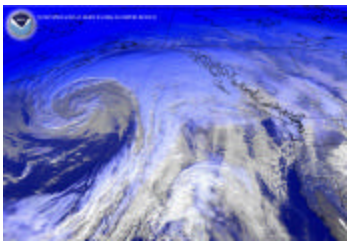
Weather messages,

Local news organizations,

Local mariners and fleet reports,

Eyewitness reports,

As well as the internet.



Local Area Familiarity - Knowing your AOR will help you prepare for possible cases. When transiting to a case at night knowledge of danger areas and potential surf zones will make transiting safer and less stressful.

Knowledge of what type of boats and what commercial traffic you have in your area lets you anticipate possible problems you will encounter. Knowledge of fishing or recreational seasons and the hazards involved with them will make preparing for search and rescue cases easier and less stressful.

Crew Selection for heavy weather operations should be done with care. Operations in heavy weather or surf are fatiguing and stressful. Some factors to consider are:

Experience level of coxswain. If a coxswain is uncertain or anxious about the conditions they may encounter, requesting a more experenced heavy weather coxswain or surfman to assist may be the best option.

Experience level of crew. All operations in heavy weather have an increased level of risk. It may not be appropriate to take inexperienced crewmen without an experienced crewman as a safety observer. The coxswain/surfman will need assistance to safely maintain crew control and communications.

Physical condition of crew. Operations in heavy weather are extremely fatiguing and physically challenging . Crews should be well rested and in good physical condition before getting underway. Heavy weather operations are no place for a sick crewman. If there is any doubt about the condition of a crewman they should be replaced if personel allow.

Mental condition of crew. Operations in heavy weather are mentally fatiguing and challenging, as well. Crews should be mentally prepared for the conditions they will encounter. Crewmen that are distracted by family crisis, personal conflict, or extreme apathy for the service should not be your first pick for a heavy weather crew.

Anticipated length of mission. Missions requiring boats to be underway in heavy weather for long periods are extremely fatiguing. COMDTINST M16114.32 BOAT Manual Vol I, lists fatigue standards for small boats. If personnel permit, consider taking a second qualified coxswain to act as a relief. If no relief is available, consider the use of multiple resources.

Boat Size	**Maximum Underway Hours**			**Rest**
	Seas <4 ft	Seas > 4 ft	Heavy WX	Required
40' and greater	10	8	6	8
	Copied from COMDTINST M16114.32 US Coast Guard Boat Operations and Training Manual Volume I			

Pre Underway Preparations.

Gathring Information The standard information needed to begin a SAR case must be gathered for a heavy weather case too. You should take greater care to get the information correct.

Position. Knowing where to find the disabled boat is critical. In heavy weather the disabled boats crew may be sick, or fatigued or both. Confirming the position and asking for a geographical reference may help to clear up potential mistakes.

Nature of Distress. Heavy weather may be a contributing factor to the distress. It can often make a minor breakdown into an extremely dangerous situation. Getting the whole picture before you leave the dock is important. Extra equipment may be needed to safely assist the disabled vessel, such as extra pumps.

Persons On Board / Condition. Know how many people you are going to assist. As an example; arriving on scene and the vessel has sank. You need to know how many people you are looking for in the water. Being in heavy seas brings on extreme fatigue, sea sickness, and possibly hypothermia. If everyone on the disabled boat is too sea sick to assist your crew in hooking up the tow, you need to be prepared.

Description of the vessel and its condition. The towing capacity of the MLB is effected by sea state. A vessel at the upper end of the towing limitation can be a challenge in heavy weather. The material condition of the boat is critical in heavy weather and will influence the decision to tow, or not to tow.

On Scene Weather. Careful consideration should be given to the conditions under which each phase of the operation will occur. Remember on-scene conditions may differ dramatically from those en-route. Keep a record of the present and forecasted conditions (do not try to rely on memory), and update as necessary. Necessary information on conditions are:

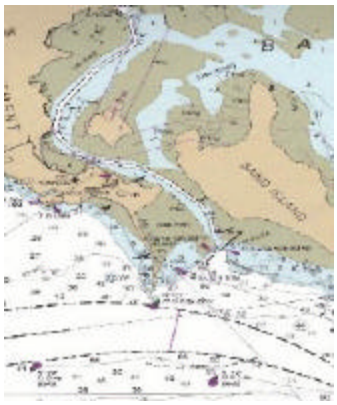
Existing and forecast marine weather (including winds, seas, bar conditions).

Currents and tide (next high/low, slack/maximum).

Daylight/Darkness (sunrise/sunset, twilight).

Navigation - The distinction between "piloting" and "navigation" is outlined in many respected publications, including Dutton' s *Navigation and Piloting* and Bowditch's *Practical Navigator*.

The importance of sound piloting is well described in Dutton' s: "Piloting requires the greatest experience and nicest judgment of any form of navigation. Constant vigilance, unfailing mental alertness, and a thorough knowledge of the principles involved are essential. In pilot waters there is little or no opportunity to correct errors. Even a slight blunder may result in disaster, perhaps involving the loss of life."



Notes

The three - minute rule is used to determine speed, in knots, or distance in yards.
Distance traveled in Three minutes divided by 100.
Example:

Distance	2000 yards.
Time	3 min
Speed	20 kts

The six - minute rule is used to determine speed, in knots, or distance in nautical miles.
Distance traveled in Six minutes multiplied by 10.
Example:

Distance	.7 nm
Time	6 min
Speed	7 kts

Chart Work. Having a "piloting" chart prepared prior to the SAR alarm going off will give you additional time to evaluate the mission. If time, and the nature of distress permit, lay out all track lines, with courses clearly labeled, and any information relative to the case at hand. Minutes spent preparing your chart in the controlled environment of the station operation center may save you hours of discomfort underway. At a minimum a "piloting" chart should include the following:

Clearly readable track lines and courses, out of and into your harbor,

Radar ranges,
Danger ranges,
Turn ranges, and bearings.

The "piloting" chart should be checked as well as used in calm conditions before it is used for heavy weather. Although it may sound trivial, learn to fold your chart properly. Making your chart water resistant using laminates or a chart case will help keep it useable in storm conditions.

Plotting. Heavy weather brings additional problems to navigation and piloting, which are not found in calm conditions. Not the least of these is the mental approach to the problem. The physical exhaustion found in heavy weather can make it extremely difficult to concentrate, and the chances of making mistake are much higher. The pitching and rolling of the lifeboat makes precise calculations difficult, at best, and sometimes impossible.

Use all the resources available to you. You should have a radio guard with your unit or group, ensure they are maintaining a plot, and have them confirm your conclusions. Your crew should be able to double check your work. If there is a conflict in your conclusions resolve it immediately. Your ability to safely return home lies in your experience and your ability to pilot in the worst conditions with the knowledge and tools you bring with you.

Notes

En route Considerations

Brief Let your crew know as early as possible of the case and what you expect to encounter. Get feed back from your crew. A crewman will often notice things you may have overlooked. Use the knowledge of TCT to keep stress levels down and your crew focused on the mission.

Double Check Conditions While transiting to the disabled boat keep aware of the weather conditions. Talk to the disabled boat, let them know the conditions you are encountering and compare them with what they are seeing. If you must transit a long distance, weather radio broadcasts can let you know of changing forecast conditions.

Towers / Shore Lookouts Some units have lookout towers that must be manned when boats are crossing the bar. These observers can give you a report of conditions and traffic on the bar. Never be hesitant to ask a senior person to man the tower or observe your transit out to sea. Experience and knowledge will allow them to help you as you make your way through hazardous conditions. If you do not have a tower available use a shore party from a good observation point or a backup boat as a second set of eyes.

Establish Communications Contact the disabled vessel as soon as you can maintain reliable communications. Let them know you are en route and give them a estimated time you will be on scene. Double check the information you have received and confirm that they are making thorough rounds of their boat. If you have good confirmed information don't ask repeatedly for it. Repeatedly asking for information may have the effect of shutting down the operator, keep them from effecting repairs, or carrying out tasks you have asked them to accomplish.

On Scene Preparations

Circle the Vessel Watch the vessel's movement (pitch, roll) in the seas and determine the effect of wind and current on the distressed vessel's drift rate and lateral movement. Compare it to your own drift. Knowing the different drift rates will help determine the best approach.

Evaluate the location and any abnormal condition of deck fittings.

Confirm the number of persons on board.

Note any unusual conditions that may affect towing procedures, i.e., loose gear, rigging, or debris in the water.

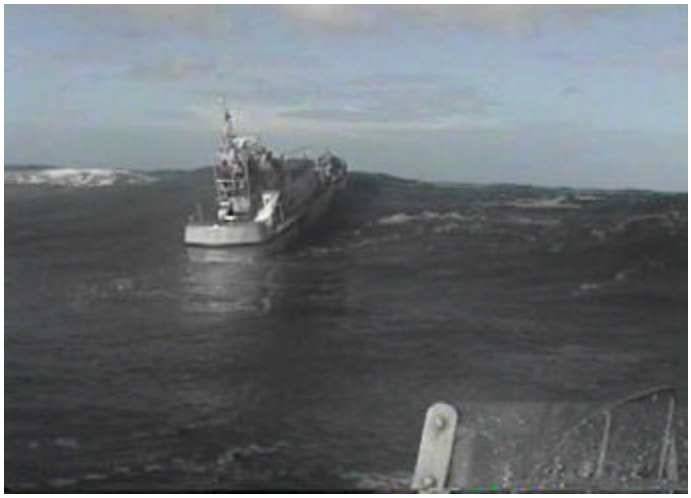
Communicate any concerns to the distressed vessel and direct all personnel on the distressed vessel to put on PFDs.

Decide whether to put one of your crew aboard the distressed vessel.

Decide if it is best to remove the crew from the distressed vessel.

Determine if an equipment transfer (drogue, pump, radio) will be necessary.

After evaluating the on-scene situation and assessing the risk, decide whether to tow or not.



Communications .

Get details of deck layout and fittings. Ask about the size of chocks and cleats to determine size of towline, bridle or drogue.

Determine if anything has changed since the distressed vessel's initial contact with the operational commander.

Ascertain any sense of heightened urgency.

Ask if the distressed vessel has been towed before and how it was done. This can give you important clues about the boat and potential problems.

Inform the distressed vessel that you will observe the conditions and make final preparations. You will provide further instructions before taking them in tow.

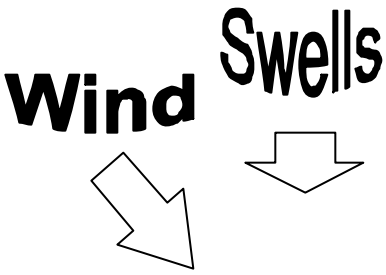
Establish emergency procedures and back up communications. As an example; flash lights, wave life jacket or sound a horn if communications cannot be established.

Establish a communications schedule. Stress that you will monitor the frequency at all times and they should contact you if anything changes.

Brief the Disabled Boat Inform the disabled boat of procedures you will use to pass the tow line and tow the boat.

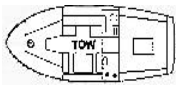
Setting Up for Approach.

Brief Your Crew Let them know you are going to maneuver.
Maneuver Up or Down Swell. Make a short run to get some distance away from the boat. When you are in the field use the power necessary to complete the maneuver. You do not need to make long runs to get maneuvering room, less than 500 yards is generally sufficient.



NOTE: When Maneuvering down swell. While here at the school we want to see you use the heavy weather turn. Run down swell with the seas directly off your stern at full power

Procedure	
1.	Notify your crew
2.	Maneuver to put the disabled boat directly off your stern.
3.	Bring up your power to make down swell/ups well run.
4.	Look behind you.
5.	After making your run use the Heavy Weather Turn to come about.
6.	Stop the boat.



Refresher !!

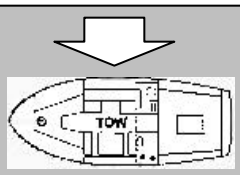
The heavy weather turn is the fastest way to bring the boat about. It should be used when you are turning 180 degrees and it should not make noises. Improper procedures will damage the boats reduction gear.

HINT:
On step 4 we tell you to wait until you are 90 degrees through your turn before placing the throttle in reverse. *Use your wake as a gauge.*

Warning:
If you place the throttle in neutral it will allow the propeller to free spin at the speed of the boat. That is much faster than clutch engine speed. When the reduction gear engages at higher speeds it will cause damage and wear.

Procedure	
1.	Notify your crew!
2.	Look behind you.
3.	Put your helm full to the direction of turn and bring your inboard throttle to clutch ahead.
4.	When you are 90 degrees through your turn place the inboard throttle in clutch reverse. **DO NOT STOP IN NUETRAL.**
5.	Allow the reduction gear to engage then apply power astern to complete your turn.
6.	Do not over steer your turn!! Then stop your boat. Bow/Stern into the swell.

Wind Swells



Definition: Danger Zone.– The area down wind and swell where the disabled boat is going. It also includes a smaller area up wind and swell that you may be pushed onto the disabled vessel.

Station Keep

While station keeping observe conditions and elements. Observe the set and drift. Note the swell direction and compass heading of the swell. This is very important when it comes to night operations. Observe the effects of the waves and winds on your boat. (The 47 ft MLB is greatly effected by wind) Observe the effects of the waves and wind on the disabled boat. Use all this information to help you determine the danger zone or area.

Brief Crew

While station keeping brief your crew and let them prepare the deck. Make sure everyone is briefed on their position and duties. Let your crew know what towing rig you are planning to use and make sure it is properly set up. Let the crew know what side you will be approaching on and who will have the primary heaving line and the secondary heaving line.

Notes

Towing Approaches

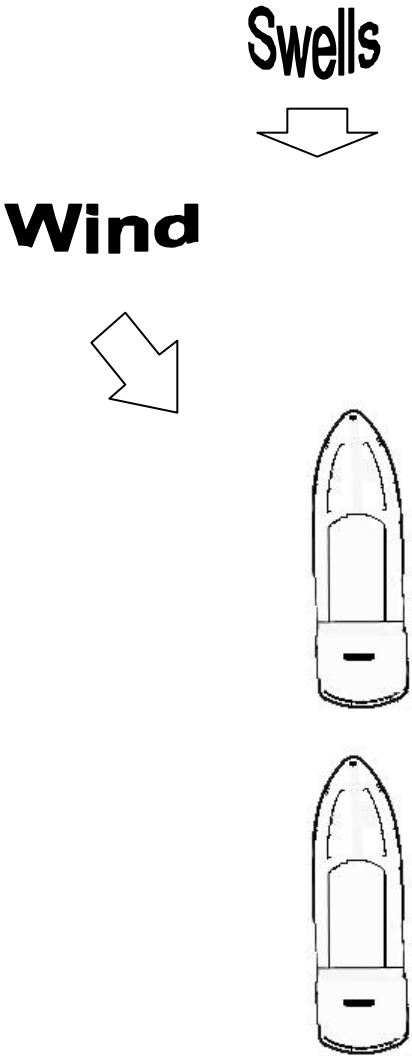
Bow to Swell Approach

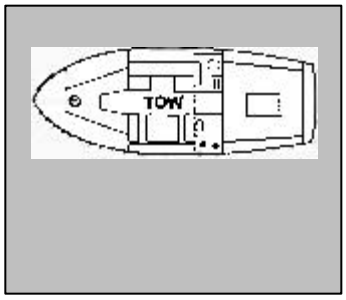
Bow must be kept square to the seas. By keeping your bow square into the sea conditions you will maintain better control of your boat. This position also gives you the safest approach and best visibility of your boat, your crew, the disabled boat, and the sea conditions.

Keep the rudders centered. Use your Rudder Angle Indicator (RAI). By using the RAI you will know exactly where your rudders are set. The 47' MLB has enough power and side force to maintain position using just throttles. In heavy weather attempting a maneuver with the rudder the wrong direction will often begin the chain of errors that may lead to a mishap.

Use the appropriate steering station. Use steering station that will give you the best visibility of the disabled boat. The 47' MLB has steering stations on both sides of the open bridge. Practice operating the boat from both sides with both steering controls.

Push ahead slowly. From your position station keeping down swell push ahead and approach the disabled vessel. With the 47'MLB you may need to give the boat a brief shot of power using both engines to move in without zig-zagging. Once you gain steerage way, reduce power and move slowly into position. Get feed back from your crew on the approach and whether they will be able to pass a line.

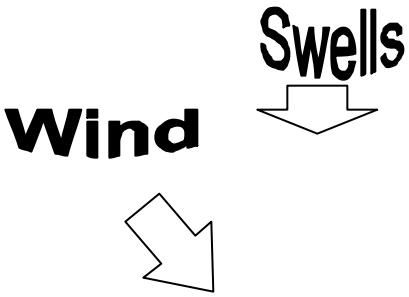




Stern to Swell Approach.

Sea conditions up to 12 feet (non breaking). In larger sea conditions your crew is exposed to larger seas boarding your boat. This is extremely dangerous for your crew. Constant watch must be maintained when operating stern to conditions to protect your crew and to safely pass the towline.

Stern must be kept square to the seas. By keeping your stern square into the sea conditions you will maintain better control of your boat. This position also gives you the safest approach and best visibility of your boat, your crew, the disabled boat, and the sea conditions.



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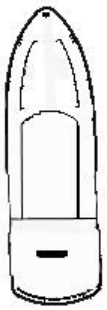
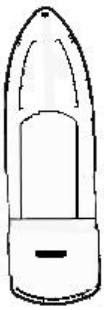
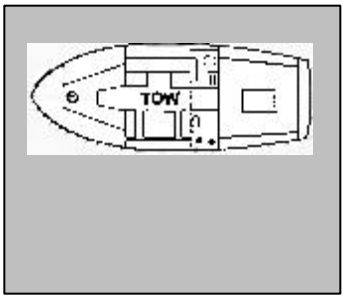
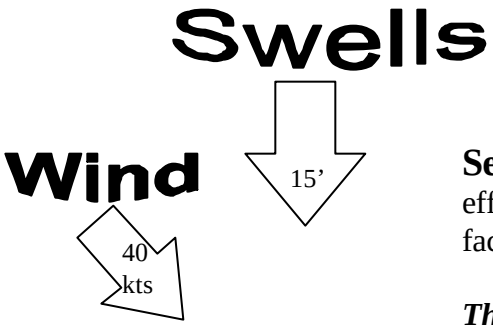
Use the appropriate steering station. Use steering station that will give you the best visibility of the disabled boat. The 47' MLB has steering stations on both sides of the open bridge. Practice operating the boat from both sides with both steering controls.



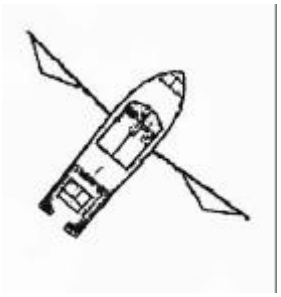
Push ahead slowly. From your position station keeping up swell push ahead and approach the disabled vessel. With the 47'MLB you may need to give the boat a brief shot of power using both engines to move in without zig-zagging. Once you gain steerage way reduce power and move slowly into position. Get feed back from your crew on the approach and whether they will be able to pass a line.







Selection of Towing Approach. Many factors are going to effect your decision on which towing approach to make. Some factors include.



The Prevailing Weather. Stern to approach should not be used in seas larger that 12 feet. In smaller conditions with strong winds the stern to approach may be the better choice. Large seas or breaking seas the bow to approach must be used to protect your crew.

Nature of Distress. Depending on many factors the Nature of Distress may effect your approach.

Type/Size of Vessel. Size and configuration will greatly influence your towing approach. A large vessel with high freeboard at the bow may make passing a line to the bow difficult. Many commercial fishing vessels have stabilizing outriggers that must be left down in heavy weather to prevent loss of stability. Other challenges may include the skiff with a trailer eyebolt, a ferry boat, and crowded charter vessels to name a few.

Hazards. There are potential hazards in any towing evolution. Some serious potential problems that may effect your towing approach could be; nets or lines in the water, rocks or shoals, outriggers and other gear, boat taking on water, logs and debris in the water.

Vessels Attitude to the Winds and Seas. Use the pictures to visualize the different approaches you would have to make for the each example.

Set and Drift. Some factors to think about include; getting set into a dangerous area, or the disabled vessel being set onto your boat.

Your Skill and Experience Level. Your skill and experience are going to greatly effect your decisions. No two Coxswains/Surfman will see the situation the same or make the exact same decisions in heavy weather.

Procedure	
1.	Notify your crew!
2.	Move slowly ahead. Bow square to the swell.
3.	Avoid zig-zagging during the approach.
4.	Decrease speed to bare steerageway as you close to *optimum position*.
5.	Boat must be **Stopped** before passing the heaving line. (You may need to position yourself below or above optimum position to pass the heaving line)
6.	Once the heaving line is across and your crew has control of the line. Move into optimum position to pass the towline.

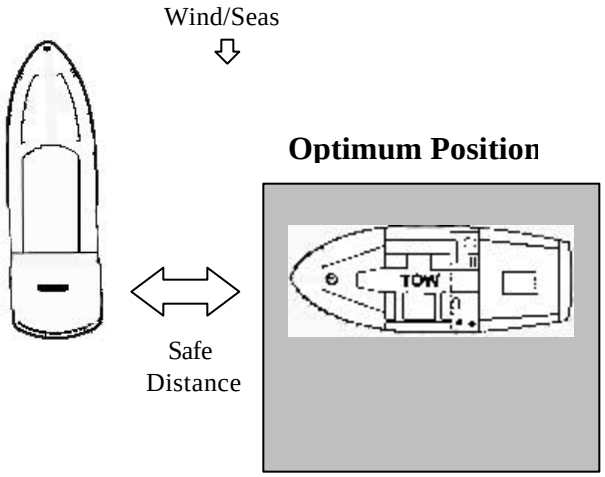
Optimum Position

Definition: The position taken by the 47 ft MLB which allows the crew the maximum amount of time to pass the heaving line and put the tow line over without getting in a hurry. This position gives the coxswain the ability to see the tow rig attachment point and supervise the crew while passing the tow rig.

Notes

Safe Distance.

Keeps you out of the danger zone. It gives your crew time to pass the towing rig. It minimizes stress levels and increases situational awareness. Safe distance is different for each operator. You may have to close to get a heaving line across in heavy weather, but regain that safe distance before attempting to pass a towline.



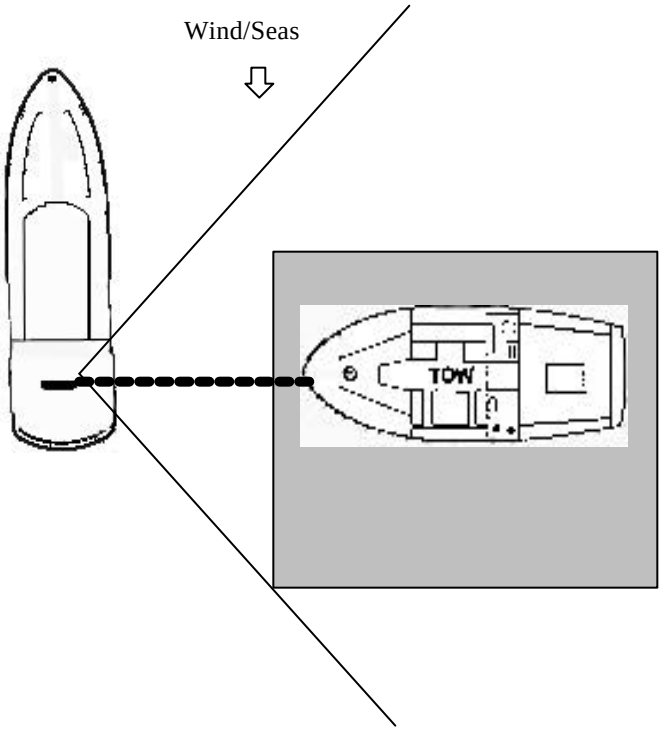
Bow to the seas approach

Notes

Maneuvering Zone

Maneuvering Zone is a 90 degree arc; 45 degrees forward and 45 degrees aft of your tow bitt. It is a guide to keep you in optimum position and allow you to safely maneuver the boat. Staying in the maneuvering zone keeps you out of the danger zone and gives you a way out if you encounter problems while station keeping. Use the heaving line, your towing bitt, and the disabled boats attachment point as a reference. You need to keep your attention divided between the disabled boat and the seas 50%- 50 % .

Warning!
All maneuvering should be conducted prior to sending the towline across. Do not risk fouling your propellers with the towline.

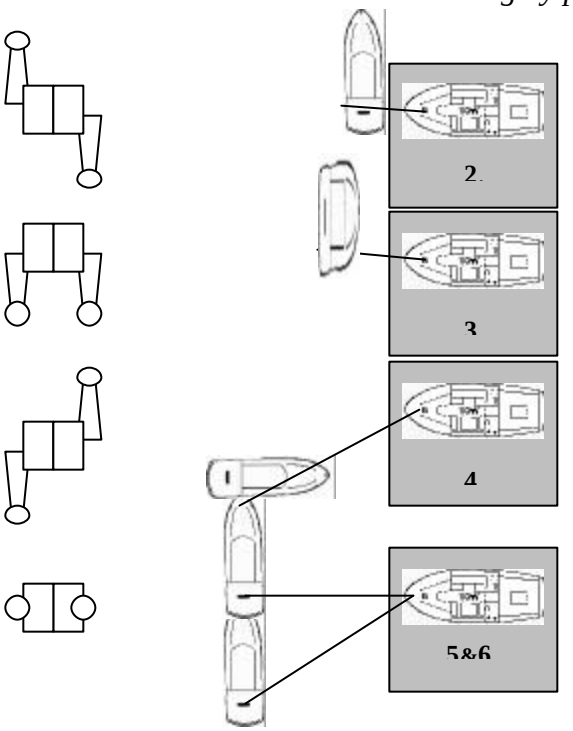


Station Keeping

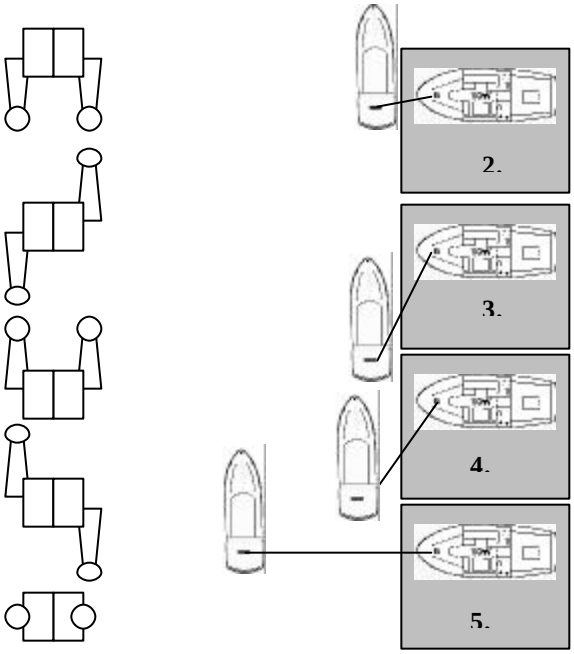
Definition: Is maintaining a relative position in relation to the disabled vessel and the sea conditions, outside the danger zone, for a period of time to pass a tow and/or rescue equipment. To station keep a coxswain must divide their attention between the disabled boat, the seas, and their crew. Maneuver inside the maneuvering zone to maintain your position.

Opening and Closing Maneuvers

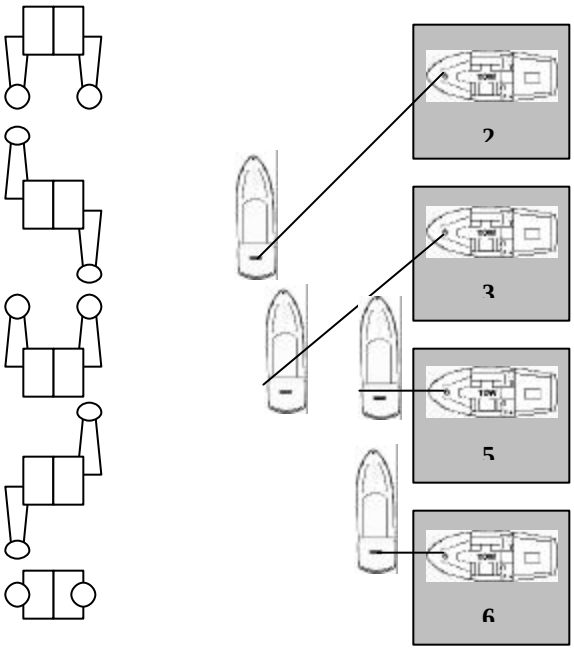
Maneuvers used to maintain optimum position and stay inside the maneuvering zone. Done prior to passing the towline across. Use power consistent with conditions. Opening maneuvers consist of *opening by pivoting* or *opening by backing*. Closing maneuvers consist of *closing by pivoting* or *closing by quartering*.



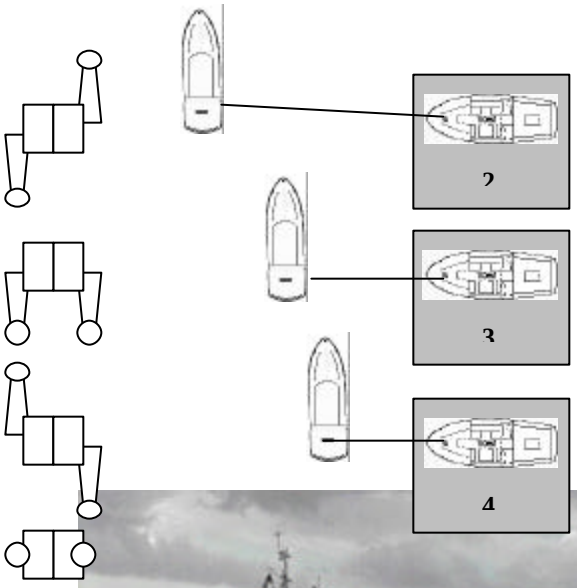
Open by Pivoting Procedures	
1.	Notify your crew!
2.	Pivoting your boat so your bow moves toward the disabled boat.
3.	When you reach an angle of approximately 45 degrees begin backing away.
4.	Once your bow becomes even with the disabled vessels bow, pivot away from the disabled vessel.
5.	Put your bow into the conditions (square) and drive back into optimum position.
6.	Stop the boat in optimum position.

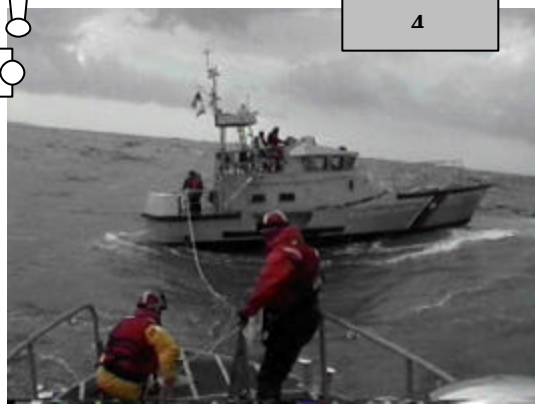


Open by Backing Procedures	
1.	Notify your crew!
2.	Back square to the conditions, rocking your throttles.
3.	When your bow is clear of the disabled vessel pivot away from the disabled vessel.
4.	Move ahead.
5.	When you approach optimum position pivot back into the conditions.
6.	Stop the boat in optimum position.



Closing by Backing Procedures	
1.	Notify your crew!
2.	Back square to the conditions. Rocking the throttles
3.	Pivot your boat so your bow moves toward the disabled boat.
4.	Move ahead.
5.	As you approach pivot away from the disabled vessel.
6.	Stop the boat in optimum position.





Closing by Quartering Procedures	
1.	Notify your crew!
2.	Pivot away from the disabled vessel.
3.	With the heaving line tending off your quarter back.
4.	When enough line has been recovered stop and square up.
5.	If you still need to close, close by backing.
6.	Stop the boat in optimum position.

Passing the Towline

Definition:
A Working Turn begins with one full figure eight on the towing bitt. A working turn allows the crew to control the tow line as it is paying out. More than one full figure eight may be needed for control with heavy boats in heavy seas. Lighter boats may require only half a figure eight.

Passing the Towline

First you must pass a heaving line. Once the heaving line is across, complete any maneuvers required and stop in optimum position. The coxswain has to determine when to pass the towline and give the command. Do not allow your crew to just send the line across before you give the command. On command from your crew, the crew of the disabled vessel hauls in the towline. Train your crew to ensure the line is attached to the disabled boat properly and will not come off the attachment point. If you are using a bridle, ensure it is attached to the boat the same on both sides for an even pull. There should be no turn on the bitt until coxswain gives the command. Ensure the bow is clear before you give the command to take a working turn on the bitt.

Towing Transition

Towing Transition Is the maneuver from station keeping to towing astern. This is the most hazardous period in heavy weather. You have to move from the safety of the maneuvering zone to put your tow behind you. Take your time and don't maneuver away during the series.
Transition is when you have the greatest likelihood of surging the towline through the bitt.

***Basic Rules of Transition*.**

Communicate with your crew.

Take your time.

Start from Optimum Position.

Utilize the weather. Pay out line quartering the swell or in the trough.

Get distance between you and the disabled vessel.

Leave the disabled vessel where it is while paying out towline.

Payout line providing the best ride for your crew.

Towing Astern

Warning! Never allow the towed vessel to overtake the towline.

Towing Astern

In open water, getting both boats in step will also dramatically reduce the forces on the towed vessel. Changing course to reduce wave action is often the next safest technique. This will reduce the yawing and surfing of the towed vessel. Reducing speed or changing the scope of the towline will also lessen the forces on the towed vessel, which in turn are transferred to the towing vessel.

When approaching the coast, or nearing an inlet or bar, keeping the tow in step as water depth changes becomes very difficult. Plan to approach with seas on the quarter to reduce shock loading. The following technique should be used to maintain control and reduce the forces affecting of your tow.

Constantly adjust towing speed to prevent a tow from surfing on a wave or broaching.

If a large wave approaches the stern of a tow; increase towing vessel speed to keep ahead of the tow as it is pushed by the swell.

As a tow reaches the crest of a swell, reduce speed. Keep the towline taut. The coxswain must constantly watch the seas astern and the towed vessel until in sheltered waters or course is changed to reduce influence of the seas.

Deploy the drogue.

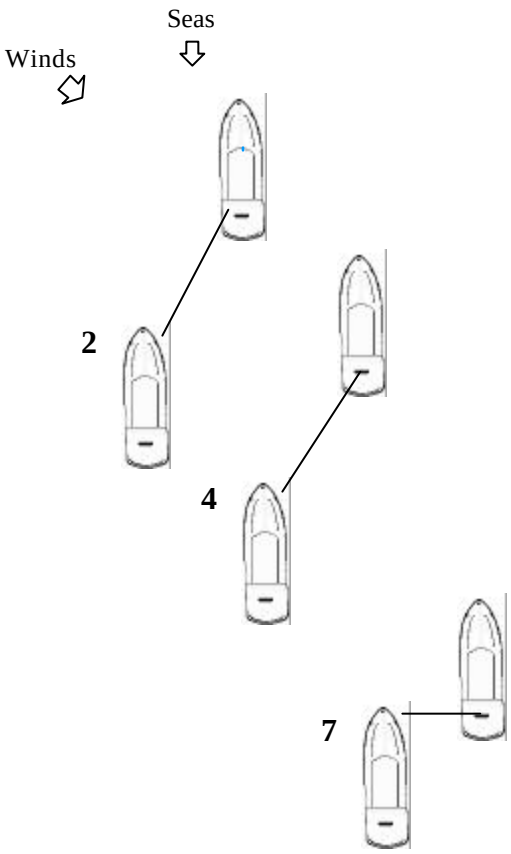
Standing off shore and waiting for better conditions is the safest alternative if controlling the tow or the safety of the tow is in question.

Common Problems	***Corrective Actions***
Shockloading the Towline	Adjust scope of towline, use a drogue, change course, adjust speed.
Vessel Overtaking Towline	Adjust scope of towline, use a drogue, change course, adjust speed.
Poor Ride	Adjust scope of towline, use a drogue, change course, adjust speed.
Eliminate need to Throttle Jockey	Adjust scope of towline, use a drogue, change course, adjust speed
Attachment point stress	Use a bridle, adjust scope of towline, use a drogue, change course, adjust speed .
Yawing	Use a bridle, use a drogue.

Shortening Tow

Shortening Tow

Coxswains shorten tow for many reasons; prior to entering a narrow channel, to investigate loss of communications with the towed vessel, preparing to pass the tow to another lifeboat. Great care must be taken to prevent disabling your lifeboat by fouling your propellers with your towline. Shortening tow can be done all at once or in the case of a long tow, or challenging conditions, in multiple quick attempts. The procedure is the same for any scenario.



Shortening Tow Procedures	
1.	Notify your crew!
2.	Take up a course approximately 10 to 15 degrees off the weather and seas. Move to the appropriate steering station.
3.	Slow to all stop.
4.	Push your bow square to the Conditions. (swell)
5.	Give the command to break the tow bitt and tend the towline.
6.	Crewmember on aft deck hauls in line, crewman on tow bitt tends the slack through the horns of the tow bitt.
7.	Back in a straight line rocking the throttles to keep square.
8.	Divide your attention 80% Aft - 20% on conditions/forward.

Precautions

Crew Communications, Are extremely important. Ensure your crew can hear you and they understand there assignments.

Always tend the towline through the tow bitt. If you have an emergency the crewmember can make the bitt and you can get underway again.

Keep towline in sight.

Know where your rudder is, use your R..A..I.

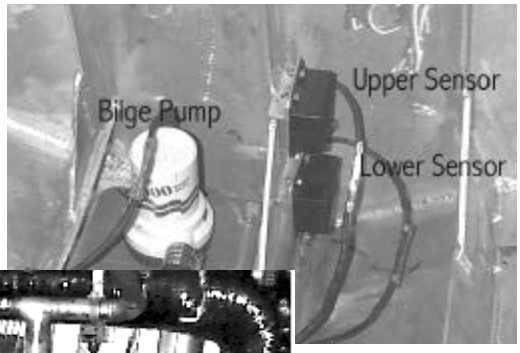
Make the bitt and pull ahead in case of emergency. This is your escape route.

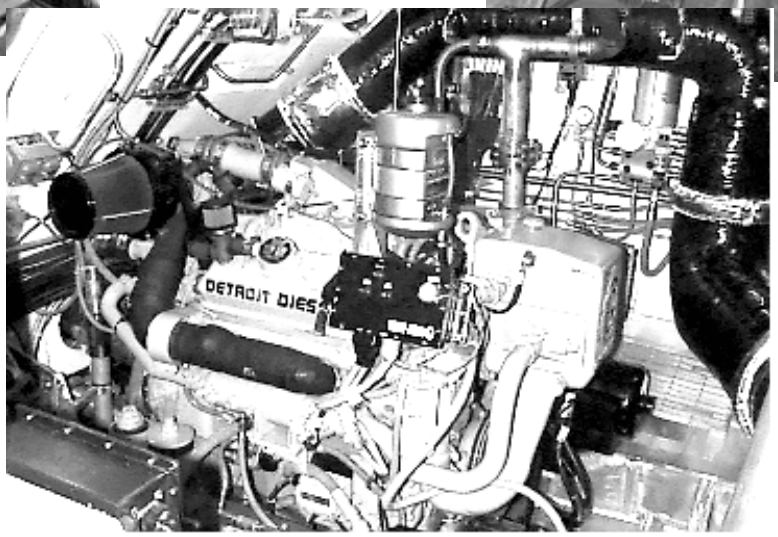
Do not let the towline loop pass the recess. Excessive line in the water puts a heavy strain on your crew. Slow down and work at a pace your crew can recover the line.

Notes

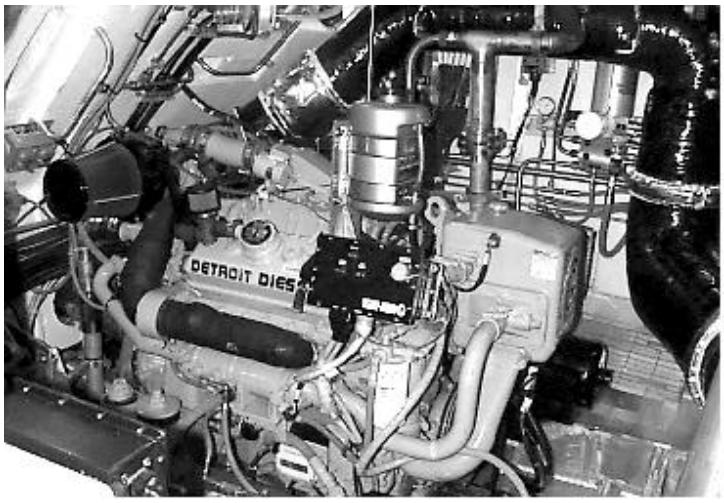
Vessel Systems

Updated Jan 2003



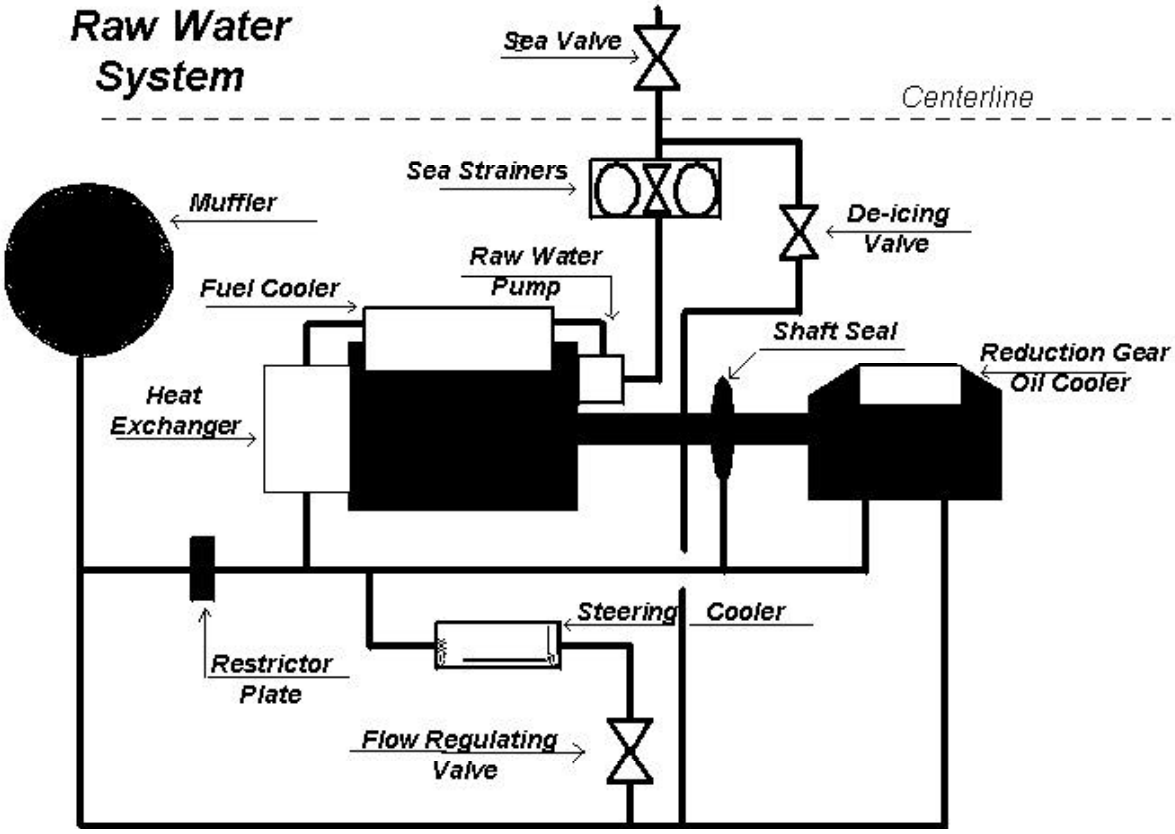


- **6V92TA Engine**
- **Raw Water System**
- **Engine Jacket Water System**
- **Engine Lube Oil System**
- **Fuel Oil System**
- **Airsep System**
- **DDEC III Engine System**
- **DDEC III Vessel Components**
- **Reintjes Reduction Gear**
- **Hydraulic Steering System**
- **Heating, Ventilation and Air Conditioning**
- **C02 Fire Suppression System**
- **Electrical System**
- **Dewatering System**
- **Emergency Window Release System**



Main Engines *6V 92 TA*

To break down the numbers 6V 92 TA. **6V** -The engine has six cylinders in a V type configuration. **92** - Each cylinder has 92 cubic inches of displacement for a total of 552 cubic inches.
TA – Turbo Charged / After cooled; the after cooler is located after both the turbo and the blower. Thus all air is cooled prior to entering air box.
DDEC III- Detroit Diesel Electronic Control System controls the engine and constantly monitors performance. The maximum engine RPM is 2200. Both engines are right hand rotating and produce 435-horse power at 2100 RPM. Rotation is viewed from front of engine at expansion tank.

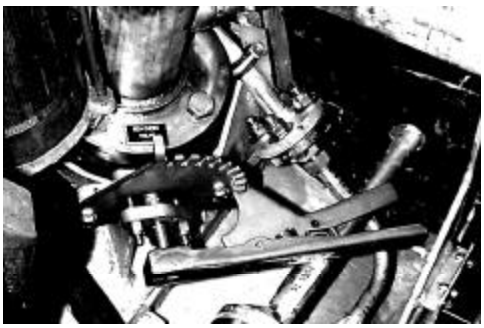


Major Components

Sea valve
Sea strainer
R/W pump
F/O cooler
Heat exchanger
Restrictor plate
Steering system cooler
Shaft seal
R/G oil cooler
Deicing valve
Muffler

Sea Valve

The sea valve on the 47' MLB is a butterfly type valve with a replaceable Teflon seal. It is made of stainless steel and is open if the handle is inline with the piping. Due to the limited space in the bilge the sea valve is located on the opposite side from the engine it supplies, i.e. the valve on the starboard side of the centerline supplies the port engine.



Sea Strainer

The sea strainers are made of bronze and are a vertical duplex system. The strainer baskets can be checked by looking through the Plexiglas viewing cylinders. Inside each strainer is a four-inch monel strainer basket. To change strainers move the lever to the opposite strainer.

Warning! Never open the strainer if it is selected to supply the system. Flooding of the engine room will result.

Raw Water Pump

A raw water pump is mounted on the back of each engine (forward end of engine room). It is a Jabsco pump driven off the camshaft and rated at 67 gallons per minute. Two spare impellers and gaskets are carried in the Spare parts kit.

Fuel Cooler

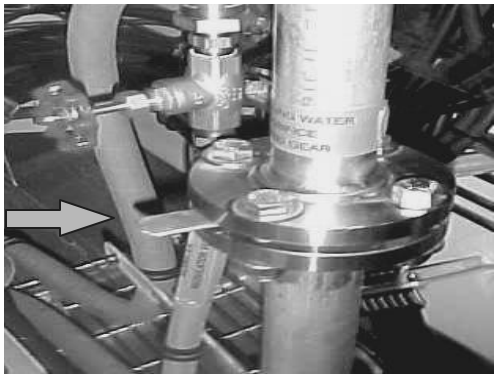
The Fuel cooler cools the fuel before it returns to the fuel tank. It maintains the fuel temperature below 90 degrees F. The fuel is returned to the forward end of the fuel tank to allow the heat to dissipate further.

Heat Exchanger

The heat exchanger is located at the front of the engine (the aft part of the engine room). It allows the jacket water to be cooled by the raw water. The system is simular to a radiator on a car only the engine water is cooled by sea water instead of air.

Restrictor Plate

The restrictor plate diverts water to the shaft seal and reduction gear cooler, while still allowing some flow to the mufflers for cooling. The restrictor plate has a hole approximately one inch in diameter.



Steering System Cooler

The steering system cooler is located on the starboard side of the engine room and is supplied by the starboard engine. The cooler maintains the system to proper operating temperature. However there are no known manufacturer specifications or a gauge installed to determine exactly what that proper temperature is.

Shaft Seal

Raw water provides flushing and cooling. Raw water enters through the vent line and exits out through the stern tube.

Reduction Gear Oil Cooler

Raw water cools reduction gear oil after oil reaches 150 degrees.

De-icing Valves

Heated raw water can be directed back to strainers for cold water operations.

Mufflers

Raw water discharges overboard through mufflers. Mufflers are cross connected between the two engines to allow discharge even if one side of MLB is under water.

Jacket Water System Components

The jacket water system has a capacity of 12 gallons, a 50/50 mixture of Power Cool and distilled water.

Temperature range of 160-205 F

<140	Major
160-192	Normal
193-204	Major
205-211	Restrictive
212>	Disabling

Coolant recovery bottle

The coolant recovery bottle is mounted above the expansion tank in order for the jacket water level sensor to operate properly. The location of the bottle keeps the expansion tank completely full. Coolant level shoud be visible in sight tube.

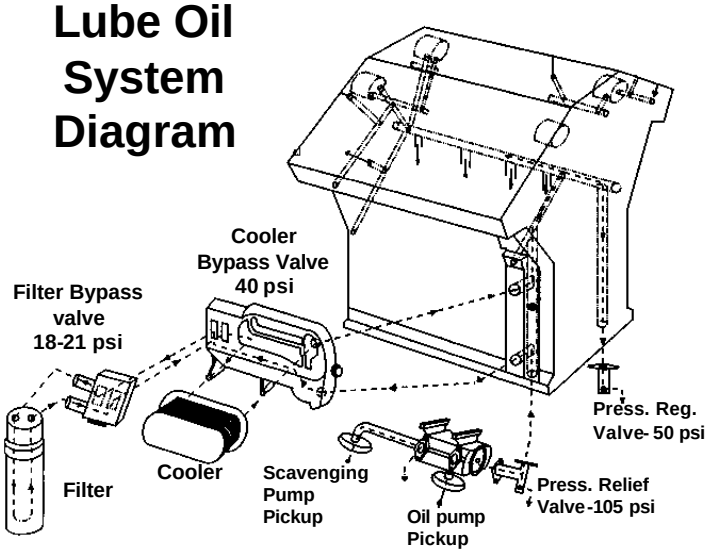
Aftercooler

Located beneath blower,cools intake air.
Air leaving turbo charger is over 300 degrees,
Aftercooler lowers temp to below 200 degrees.

Jacket Water Pump

Driven off the right bank front
cam gear.Is rated to pump 160 gallons per minute.
It has a weep hole to tell if either the internal oil or jacket water seal has failed

Lube Oil System Diagram



Characteristics

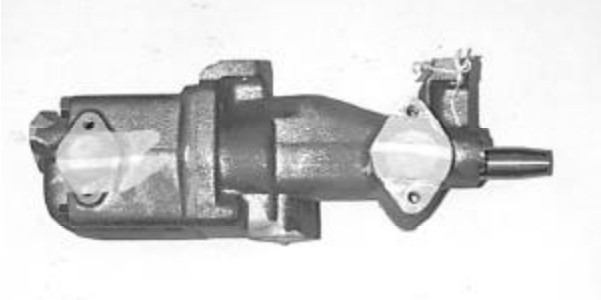
40 WT Oil
5.5 Gal Capacity
Dual Oil Pumps
The system has 2 bypass valves one at the oil filter in case of blockage and one at the cooler.
The system has one pressure relief valve at the oil pump and one pressure-regulating valve on a vertical gallery. See the diagram

Oil Pressures

Cruising	49 to 70 psi
Minimum @ Idle	5 psi

Lube Oil Pump

The lube oil pump on the 6V92 TA is a dual pump system. As you know the boat does not always sit level in the water. The dual pump system ensures oil pressure when the boat is in heavy seas. The scavenging pump takes oil from the aft part of the oil sump and supplies it to the forward part of the sump to supply the main pump. The Lube Oil Pump is rated at 37 gallons per minute.

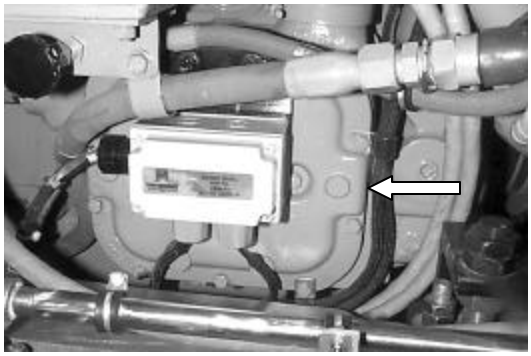


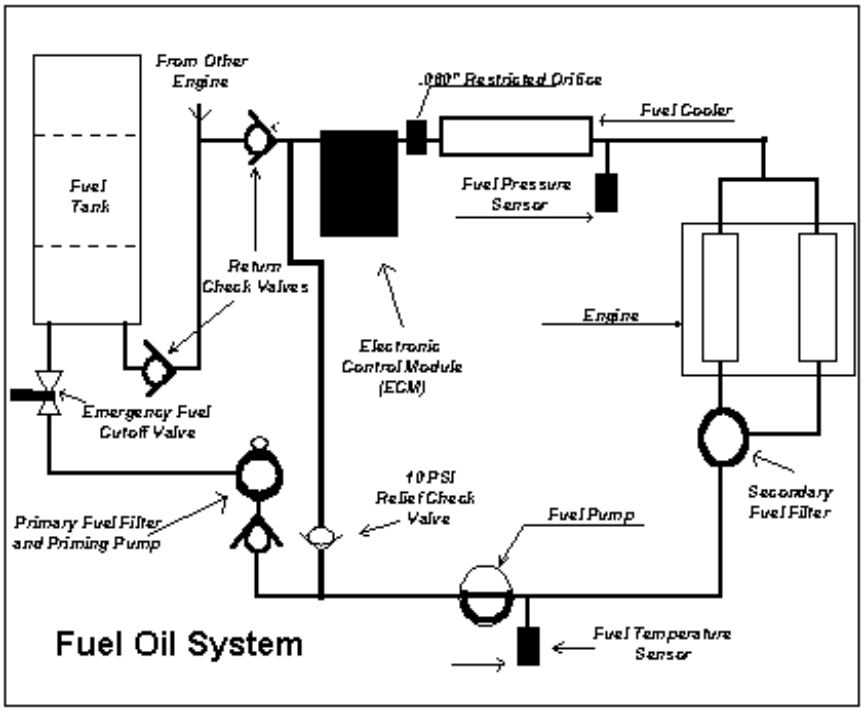
Lube Oil Filter

The lube oil filter is remotely located in the bilge centerline next to the engine it services. It is a simplex spin on type filter rated at 10 micron. An oil sample fitting should mounted to the inlet side of the filter housing.

Lube Oil Cooler

The lube oil cooler is cooled by the jacket water system. It is a 24 plate cooler that maintains oil temperature between 200 and 250 degrees F.





Components

Fuel tank

Fuel tank vent

Emergency cutoff valve

Primary filter with Priming pump

Fuel pump

Secondary filter

Restricted orifice

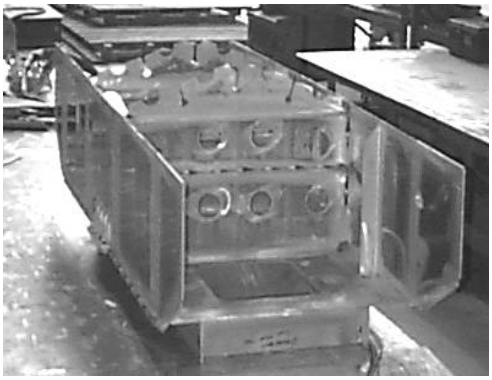
Fuel cooler

ECM fuel cooler plate

Back pressure relief check valve

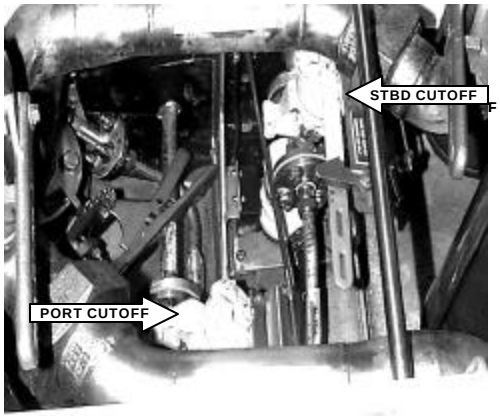
Fuel Tank

The fuel tank has a capacity of 394 gallons at 100%. The fuel tank is only filled to 95% capacity or 373 gallons to allow for expansion. Of the 373 gallons 16 are unusable due to the placement of the fuel suction piping. The tank is centered on keel between frames 5 and 8. It has 3 inspection covers. Baffles are installed at frames 6 and 7 to reduce free surface effect. Suction piping is at frame 6. The suction inlet is inside a fuel suction box. The fuel suction box ensures constant supply of fuel in case of knockdown or rollover. 80% of the fuel is returned to the fuel tank after being used for cooling and lubricating. The fuel return is located between frames 7 and 8 to allow the heated fuel to cool before being taken up again.



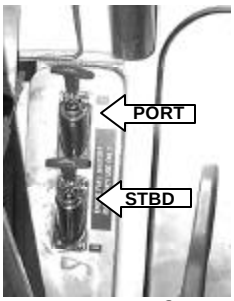
Fuel Tank Vent

The Fuel tank vent is located in the port recess under the forward ladder. It is a ball in box type vent. It is not designed to keep the fuel in the tank but it is designed to keep water out of the fuel tank. This means in a knockdown to port you may have fuel discharge from the vent.



Emergency Fuel Cutoff Valves

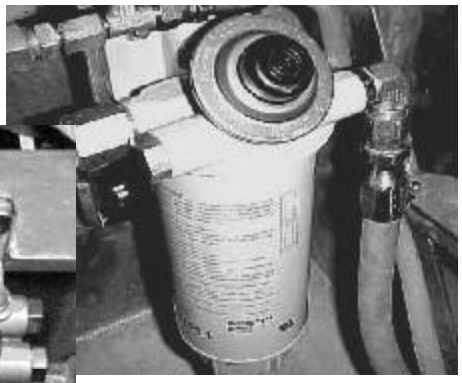
The emergency fuel cutoff valves are located under the ladder in the engine room between frames 4 and 5. They are spring loaded stainless steel ball valves. They are pull cable actuated from the survivor's compartment. The engines may run as long as 5 min at idle and 30 seconds at full speed

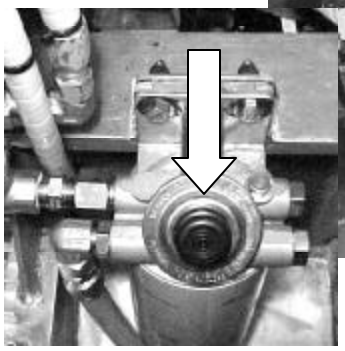


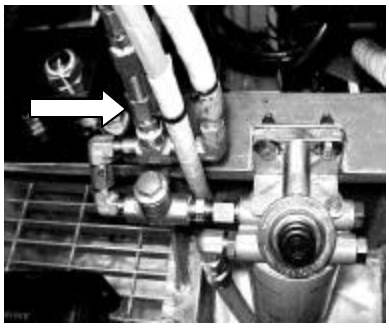
Warning!
The Emergency Fuel Cutoff Valves are spring loaded and personal injury will occur if you are in the path of the lever when activated.

Primary Fuel Filter and Priming Pump

The primary fuel filter is located in the bilge aft of the oil filter next to the engine it services. It is a Racor duplex filter. The one filter removes sediment as well as water contamination. Located on the filter assembly is the fuel system priming pump.





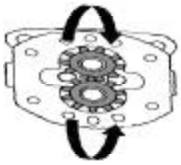


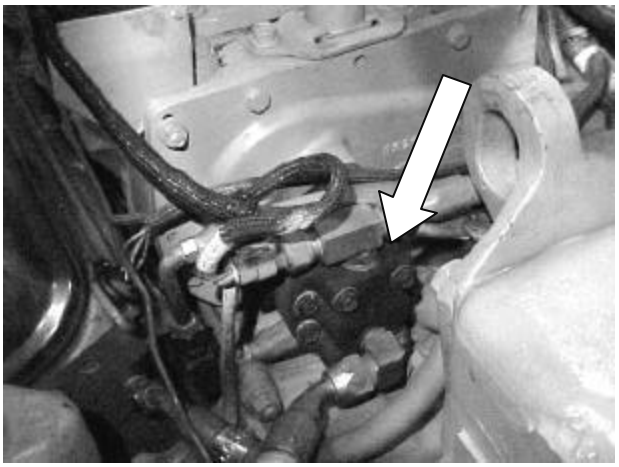
Back Pressure Relief Valve

Part of emergency boat alt 3 this relief valve allows for fuel to be sent back to the fuel tank before pressure is great enough to damage the lip seals in the fuel pump.

Fuel Pump

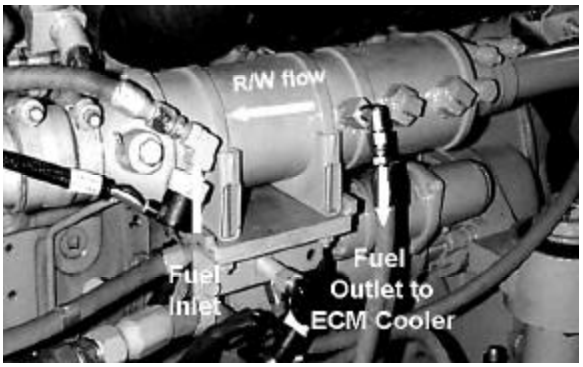
The fuel pump is gear type positive displacement pump driven off the blower. As the gears rotate the fuel is moved around the outside of the cogs. A pressure relief valve allows the fuel to relieve back to the inlet side of the pump if pressure reaches 65 to 70 psi. The normal operating pressure of the fuel system is 50 to 70 psi.





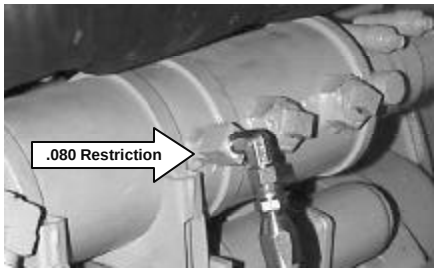
Secondary Fuel Filter

The secondary fuel filter is a spin on type filter rated at 2-4 microns. It is mounted on the inboard side forward on the engines.



Fuel Oil Cooler

The fuel oil cooler uses raw water to keep the fuel temperature below 90 degrees. For every 10 degrees of temperature above 90 degrees there is a 1% loss of horsepower.

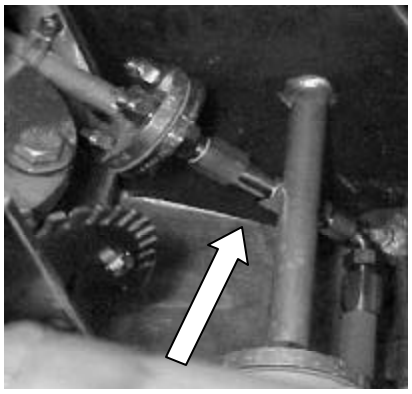


Restricted Orifice

The restricted orifice provides a .080 restriction in the fuel system. This restriction provides backpressure to maintain proper system pressure and cooling.

ECM Cooler Plate

The ECM is a computer and being in a hot engine room it must be cooled for proper performance. The fuel system provides cooling for the ECM. The fuel does not touch the circuit boards it is completely contained in the cooler plate. The ECM should not be repainted. It is painted with special paint to aid in the cooling.



Fuel Tank Return Check Valve

The fuel tank return check valve makes maintenance on the fuel system easier by preventing the fuel from flowing from the tank if the system is opened. It is located below the ladder on the port side of the keel in the engine room.

The AirSep System

The system consists of the following components:

Cotton Filter Element

Air Inlet Restriction Indicator

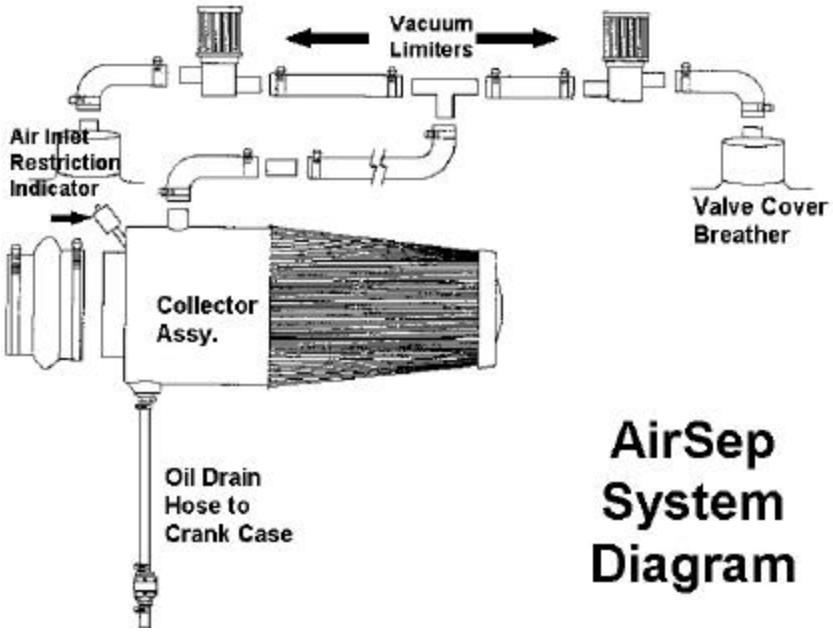
Vacuum Limiters

Collection Assembly

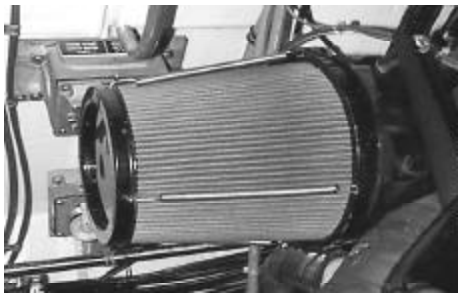
Check Valve

Drain Hose

Air Box Check Valve

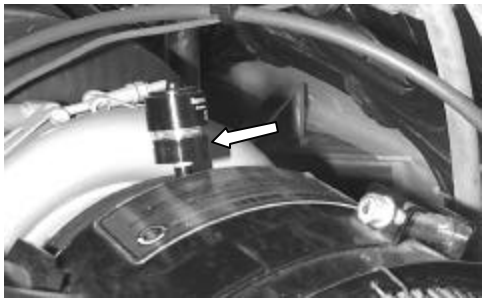


AirSep System Diagram



Cotton Filter Element

The cotton filter element is the air filter for the engines. It is a reusable filter held on by four springs and an end plate. It removes particulates from the air before they are taken into the engine.



Air Inlet Restriction Indicator

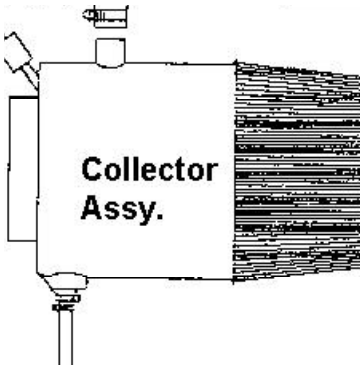
The air inlet restriction indicator is similar to a clogged filter indicator on a vacuum cleaner. It will show red as the cotton filter element becomes dirty eventually it will lock showing red continuously when the filter needs to be cleaned or replaced. To clear the indicator push down on the top button.

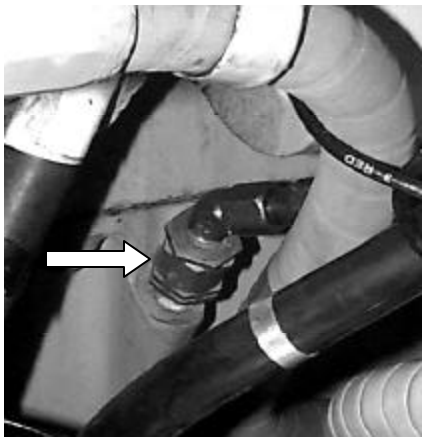
Vacuum Limiter

The vacuum limiters allow air into the system. Basically the vents from the crankcase are piped to the collection assembly. As the engine RPMs increase the need for air increases too. The Vacuum limiters prevent the air intake from creating a vacuum in the engine by allowing air from the engine room into the system.

The Collection Assembly

The collection assembly separates the oil vapors from the air before it is sent into the turbo. The oil drains into the oil sump through the oil drain hose.



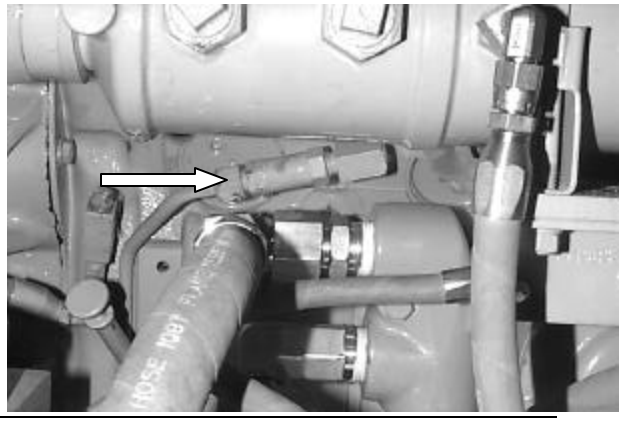


Oil Drain Check Valve and Hose

The oil drain check valve and hose allow the oil collected in the collection assembly to drain into the crankcase. The check valve ensures the oil cannot travel up the hose from the crankcase if over pressurized.

Air Box Check Valve

The air box check valve opens at idle to drain excess oil from the air box. When the engine RPM reaches approximately 1400, the check valve closes to prevent air from blowing down the drain line pressurizing the crankcase, also robbing the engine of power.



Notes

Detroit Diesel Electronic Control (Engine System)

DDEC III

What is DDEC III and why do we need it? DDEC is like most modern engine control systems. It controls combustion and performance and reduces emissions. Some of the features of the DDEC System on the 47 ft MLB are:

Computerized Electronic Engine Governing System
Electronic Fuel Injection System
Self Diagnostics
Improved Engine Performance
Rapid Warm-Up
Precise Engine Synchronization
Low Idle Operation
Engine Stall, Transmission and Overload Protection

DDEC Engine System Components

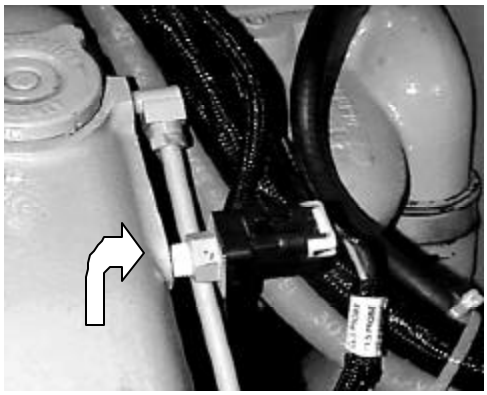
Electronic Control Module (ECM)
Electronic Unit Injector (EUI)
Sensors:
Synchronous Reference Sensor (SRS)
Timing Reference Sensor (TRS)
Turbo Boost Sensor
Coolant Temperature Sensor
Coolant Level Sensor
Oil and Fuel Temperature Sensor
Oil and Fuel Pressure Sensor

Electronic Control Module (ECM)

There is an ECM on each engine. The ECM is the computer for the engine. It takes input from sensors and the operator and precisely regulates engine performance. It conducts diagnostic checks of engine systems and controls basic engine functions.

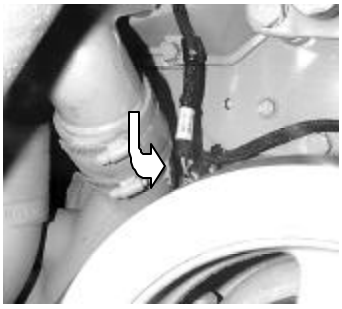
Turbo Boost Sensor

Monitors the turbocharger compressor discharge. It provides data to ECM for smoke control during engine acceleration.



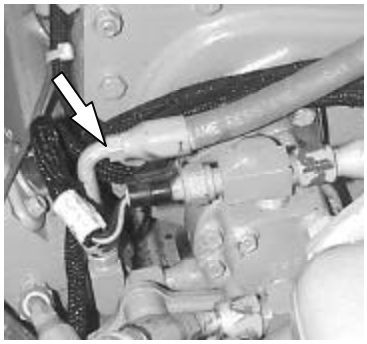
Coolant Level Sensor

The coolant level sensor is an optical eye that senses shadows. It triggers the alarm if coolant level drops. Bubbles in the coolant can also trigger it. It is mounted on the expansion tank and can be damaged if leaned on



Oil Temperature Sensor

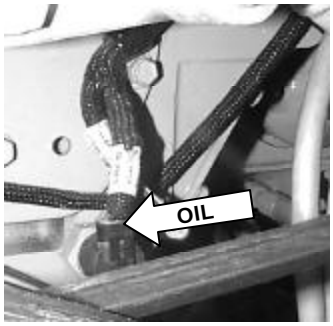
The oil temperature sensor, used by the ECM to improve cold starts and reduces white smoke.



Fuel Temperature Sensor

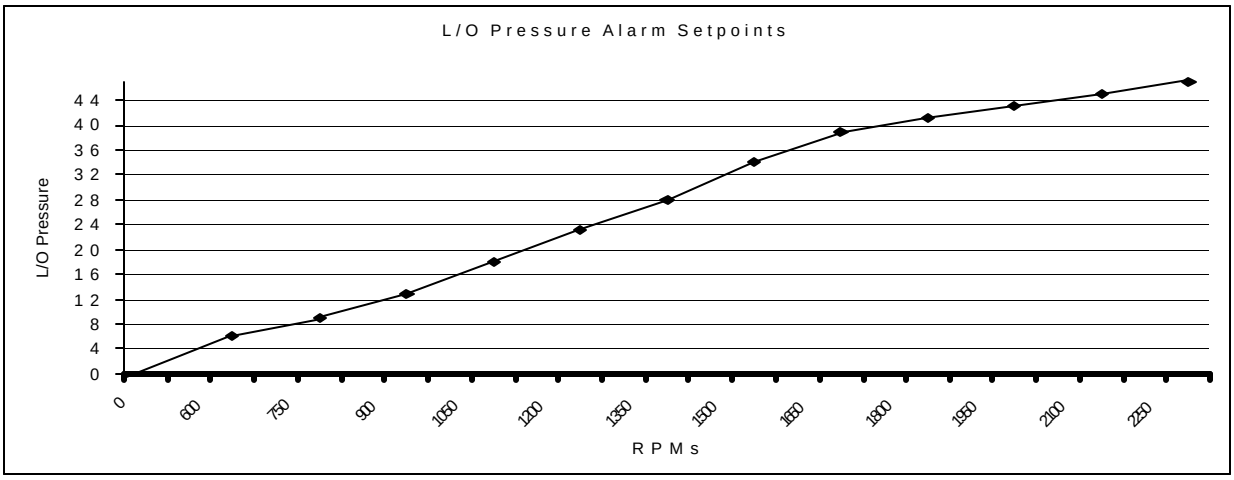
Provides the ECM with data to maintain horsepower based on fuel temperature.

Note: For every 10 degrees of temperature above 90 degrees there is a 1% loss of horsepower.



Oil Pressure Sensor

The oil pressure sensor triggers the alarm. The alarm is a variable alarm triggered when the pressure drops below a set point for the engine RPM. The chart below shows the set points for the low lube oil pressure alarm.



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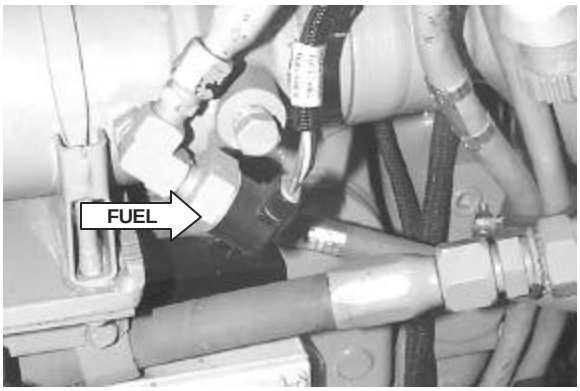
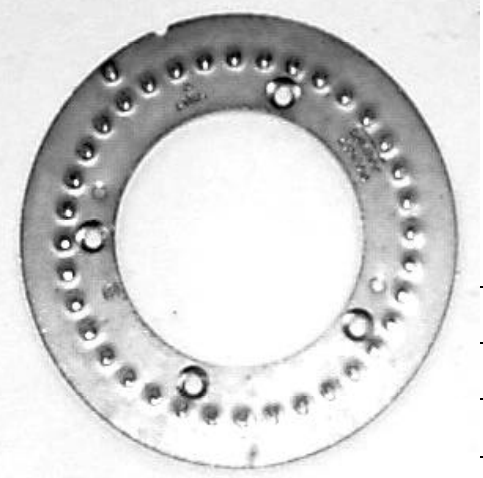


Electronic Unit Injector (EUI)

The ECM controls the injectors on the DDEC engine electronically. They are solenoid-operated poppet valves. The ECM controls injection timing and metering functions

Synchronous Reference Sensor (SRS)

The SRS is used for engine start up. The SRS tells the ECM when cylinders are in correct position to start the firing sequence. The sensor uses the pulse wheel pictured here. The pulse wheel is mounted to the left bank cam shaft pulley. You can see the raised button on the outside of the wheel. This is what the SRS senses.



Timing Reference Sensor (TRS)

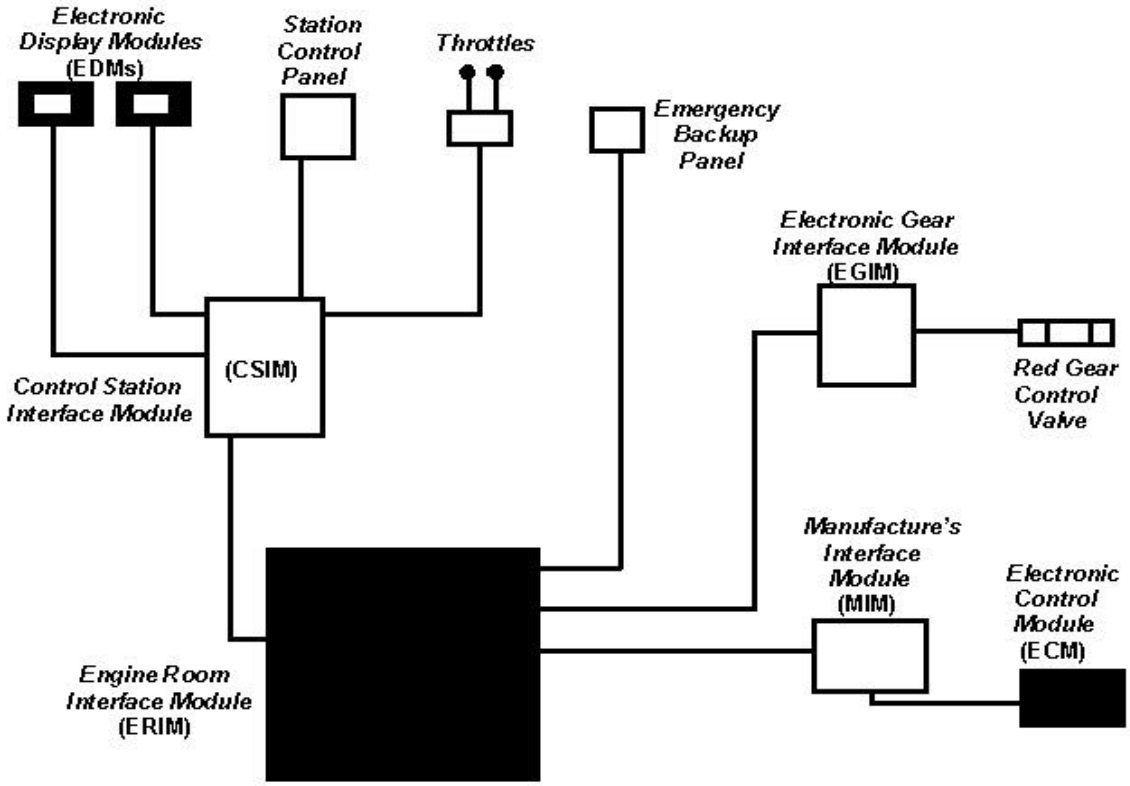
The TRS takes over after starting. It tells the ECM the crank position of every cylinder to determine when to fuel each cylinder. The TRS uses the pulse wheel also. It senses the inner ring of 36 raised buttons.

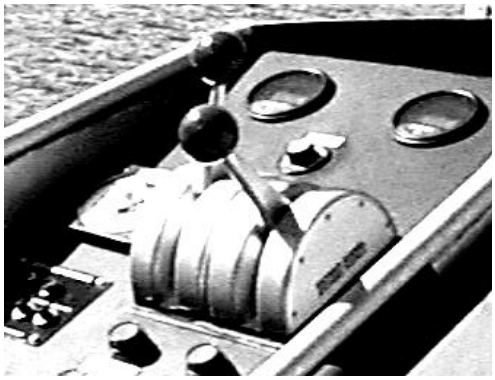
Notes

DDEC Vessel Components

DDEC Vessel System Components

Throttles
Station Control Panel
Control Station Interface Module (CSIM)
Electronic Display Module (EDM)
Engine Room Interface Module (ERIM)
Electronic Gear Interface Module (EGIM)
Manufactures Interface Module (MIM)
Emergency back-up panel
Diagnostic Data Reader (Pro-Link)





Throttles

The throttles are single lever controls meaning one lever controls both the reduction gear and the engine. The throttles are actually close cousins to a dimmer light switch. The reduction gears are operated by switches (the detents). The engine RPM are controlled by potentiometers (like a dimmer). Only one throttle station can be operated at a time. When not active the throttles do not control anything.

Station Control Panel

Is the 4-button control panel located at each throttle unit. It allows you to set various operation modes. To take control of the throttle stations push the red active button.

Low Idle reduces rpm to 600 for better control. Still allows full throttle range.

Sync Synchronizes the speed of both engines under one throttle. It does not synchronize clutch detents.

Caution! Ensure your throttle station is not in SYNC mode when mooring or in close quarters maneuvering.

Eng Ovr restores full power range for an additional two minutes. The button can be pushed as many times as necessary.

Note: Every time you override the overload protection it is logged in the system memory.

Engine Overload Protection

Unlike strictly mechanical engines the DDEC system provides protection from overloading the engines. When engine output exceeds the maximum allowed torque limit for more than one minute. The EDM Alarm will sound and display OVERLOAD WARNING across the bottom of the screen.

After two additional minutes, if nothing changes. The EDM alarm will sound and display TORQUE OVERLOAD. The engines will now ramp down to the maximum allowed torque limit. If during the two minutes between alarms you reduce RPM to below the maximum allowed torque the alarm will clear. If you cannot reduce RPM or need to maintain RPM at the overload level you must push the Eng Ovr button.

Neutral Throttle Operation

The throttle station can be placed in neutral throttle by pressing and holding the Sync and Low Idle buttons for 1 second. When in the neutral throttle mode the throttle levers will control the engine RPM but not the reduction gears. The sync and low idle lights on the station control panel will be flashing when in neutral throttle. Remember if a station is in neutral throttle and you activate another station it will be in neutral throttle mode as well.

Control Panel Operation

Throttle Station Transfer First match throttle levers to clutch detent of active station. Second press the station active button. When the station active button is pushed the red led light will begin to flash. If the active station is at clutch ahead or in neutral the light will come on and you will have control. If the previous station is at a higher RPM meet or exceed that RPM you will have 5 seconds to complete this procedure

Note: When transferring stations the mode the station is in transfers with control. As an example if the previous station was in Sync mode the new station will be in synchronize mode as well.

Electronic Display Module

The **EDM** displays the information for the reduction gears and the engines. The Engine Temperature, Engine Oil Pressure, Voltage, Fuel Consumption, Reduction Gear Temperature, and Reduction Gear Pressure are always displayed. The soft keys allow access to more information and features such as Trip Fuel, Maintenance Reminders, and much more. It also displays any alarm codes and either Check Engine or Stop Engine warnings. It has an audible alarm, which can be silenced by pressing the alarm off soft key. It has a dimmer mode for night operations. The best way to learn the many functions and displays is to open the manual and push the buttons.
Never erase information without checking with your EPO or Engineer. Information may be used for PMS Scheduling or Historical records.

Control Station Interface Module

A CSIM is required for each throttle station. They are located in the enclosed bridge. The two for the open bridge are located in the overhead port and starboard side. The one for the enclosed bridge is located below the kick plate on the port side helm chair. The CSIM receives all the signals from the throttles and the control panel and relays them to the **Engine Room Interface Module (ERIM)**

Engine Room Interface Module

The ERIM is the central processor of the control system. It receives input from the CSIM and sends it on to the engines and reduction gears. You can think of it as the translator. It takes the input from the operator and translates it into German (reduction gears) and Detroit (the engines). Do not be fooled by its name it is located in the Auxiliary Space on the starboard side.

Electronic Gear Interface Module

There are two EGIMs located directly below the ERIM in the Auxiliary Space. The EGIM takes signals from the ERIM and moves the sliding spool valve to make the reduction gears go from neutral to forward or reverse. The EGIMs also relay information for the EDMs to the ERIM.

Manufactures Interface Module (MIM)

This is the junction box connecting the ECM to the ERIM. It is located on the inboard side of each engine. The MIM has three diagnostic lights. A green light should be on when everything is good to go. If you have a check engine warning on the EDM you will see a yellow light on the MIM. If you have a Stop engine warning on the EDM you will see a red light on the MIM. There is also a connector for the Diagnostic Reader PROLINK.

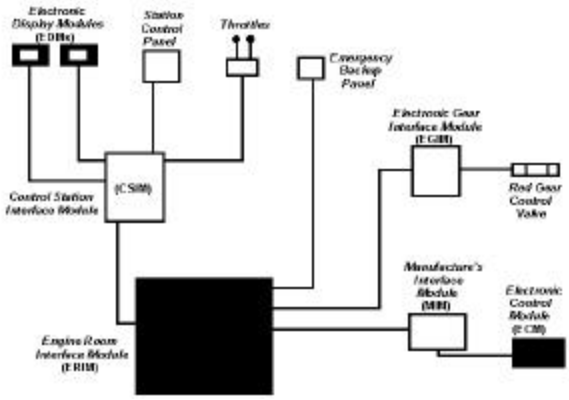
Emergency Backup Panel

The emergency backup panel is used in the event the throttle stations cannot control the reduction gears or engines. It is located in the enclosed bridge. The emergency backup panel is wired through the ERIM but does not require the ERIM to be functioning. It sends input directly to the EGIMs and the ECMs to take control of the boat. The throttle knobs allow full RPM range. The three way toggle switch allows control of the reduction gear.

Note: There is no safety feature on the Emergency Backup Panel if the reduction gear switch is engaged the boat will engage at any RPM.

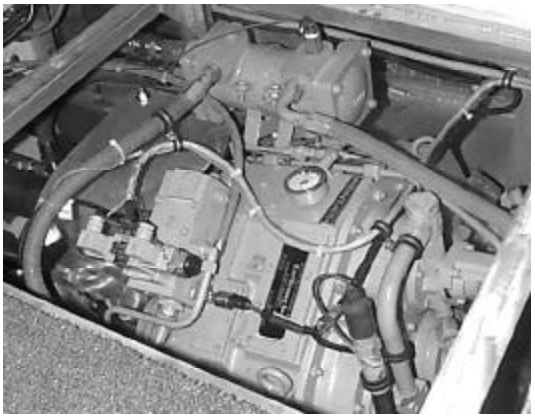
Diagnostic Reader PROLINK

The PROLINK is the tool the EPO and the engineers use to read the diagnostic codes on the engines and the reduction gears. It is connected to the MIMs and the EGIMs and can retrieve historic information such as how many times the engine override button has been pushed. Using the PROLINK the engineers can do many diagnostic tests to determine potential problems with the system.



Reintjes Reduction Gear

General Information



Reintjes WVS 234 UP what does this mean?
Reintjes (wrenches) is the manufacture **WVS 234 -** is the model **U -** means U drive configuration and **P -** is a product code.
The reduction gear is made in Germany and requires (metric) tools. It has an aluminum-cast housing.
The U drive means the input and output shafts are vertically offset. Roughly a U shape. The disc clutches are hydraulically operated. The ratio is 2:1 forward and reverse. The gears take 30 WT oil with a 5.2 gallon capacity.

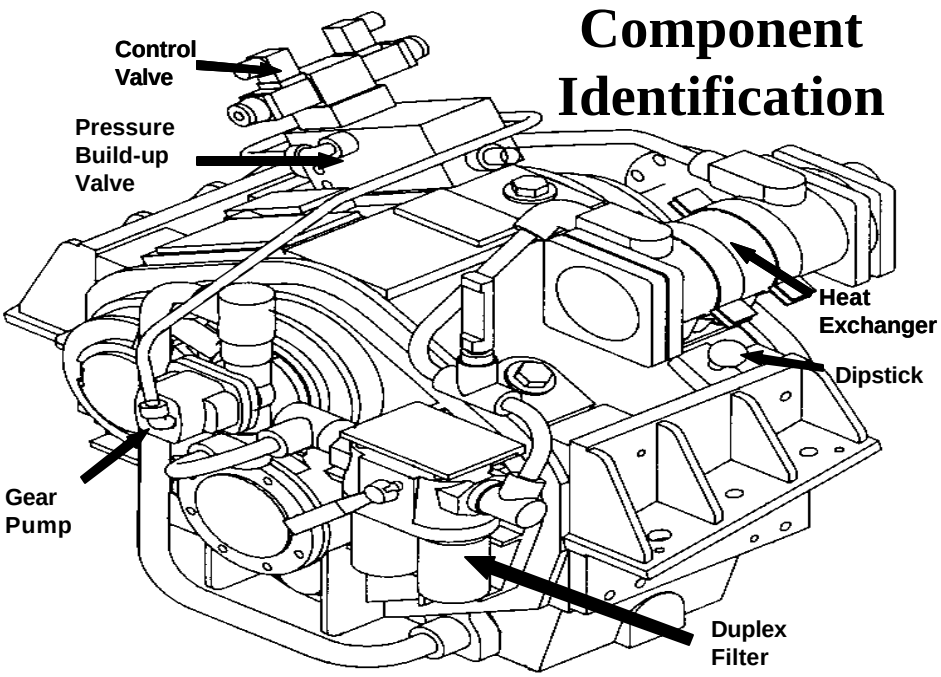
Parameters

The normal operating pressures are:
230 to 290 psi engaged
58 to 66 psi disengaged
With the low oil pressure alarm 174 psi

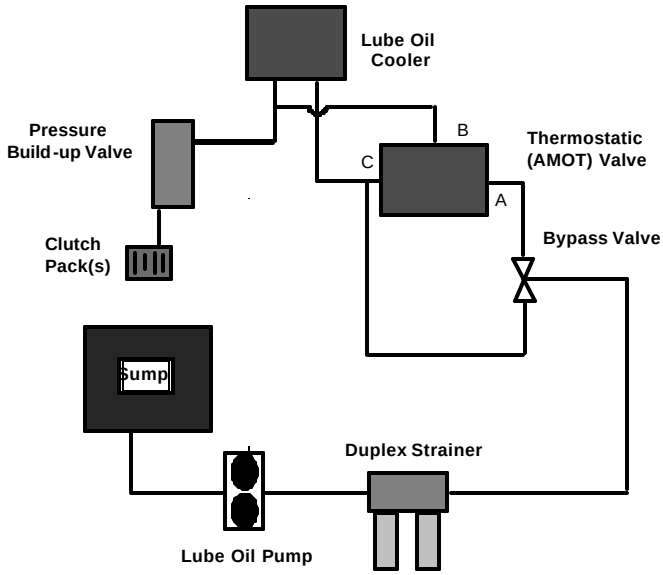
The normal operating temperatures are:
140 to 176 deg. F with high oil temp alarm 194 deg F

Components

Gear type pump
Oil filter
Thermostatic Valve
Heat exchanger
Pressure build up valve
Control valve
Come-home feature

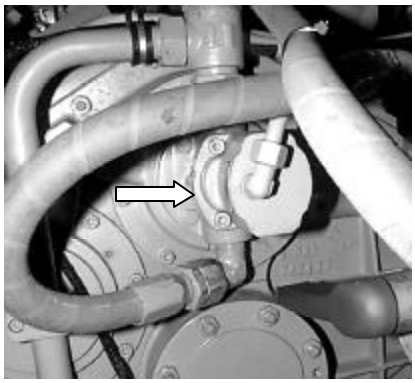


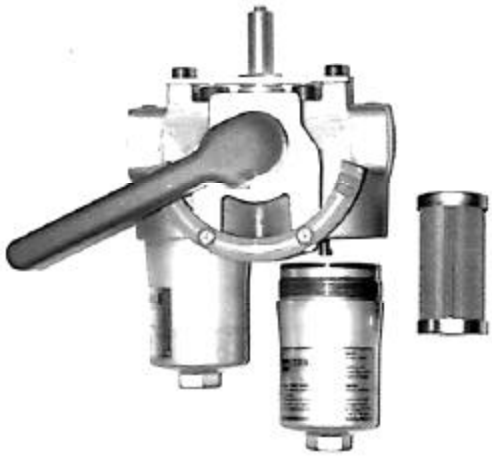
Red Gear L/O Drawing



Lube Oil Pump

Is a gear type pump. It provides flow for the hydraulic system used to engage the clutches.



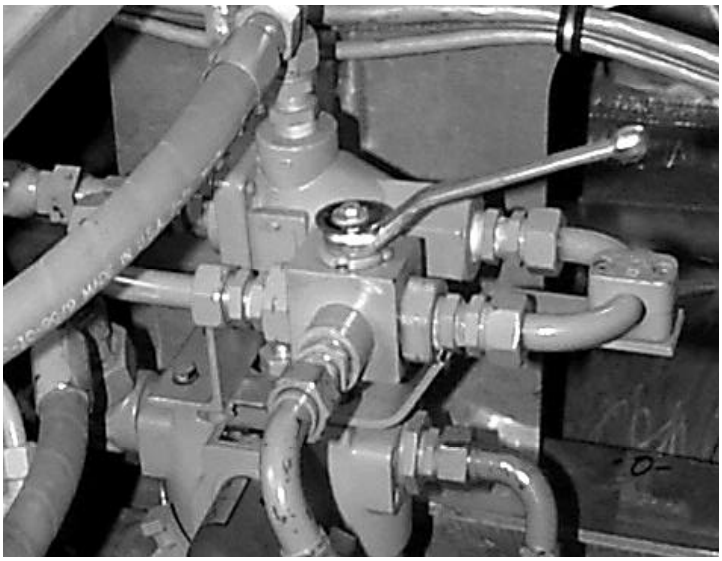


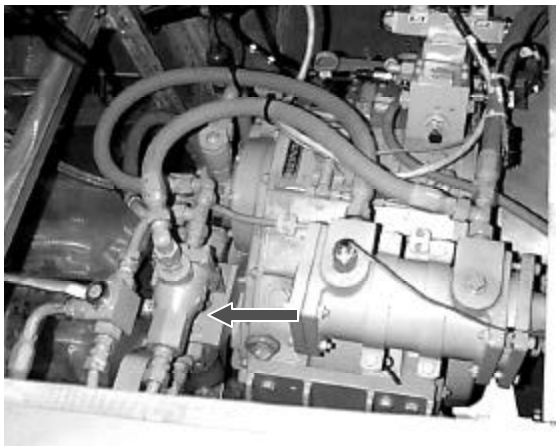
Duplex Filter

This system is similar to the raw water strainer in that it has two filters and a change over lever to select which filter is in use. The lever points to the filter in use. The filters are reusable 60 micron mesh elements. When the filter element becomes clogged and the pressure reaches a 72 to 76 psi differential the dirty filter indicator button pops up.

Bypass Valve

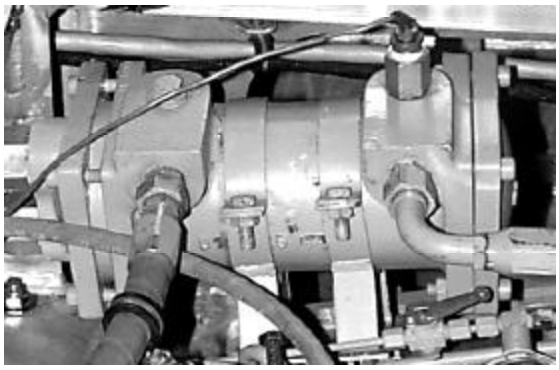
The bypass valve diverts oil flow past the thermostatic valve to the cooler in case of failure.





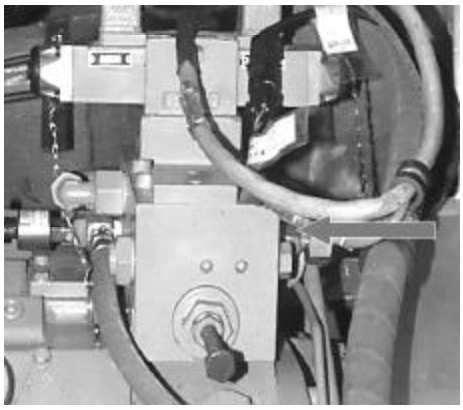
Thermostatic Valve

The thermostatic valve maintains the gear lube oil temperature. The thermostatic valve allows the oil to bypass the lube oil cooler until the temperature reaches 150 degrees.



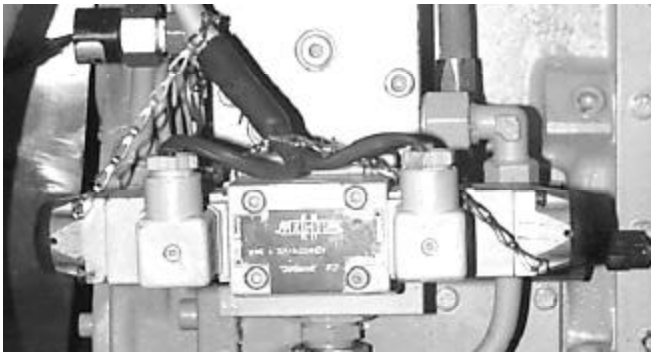
Lube Oil Cooler

The lube oil cooler is cooled by raw water. It is a bundle of copper tubes that acts as a heat exchanger. It is cleanable and must be reassembled properly or it will reduce the flow.



Pressure Buildup Valve

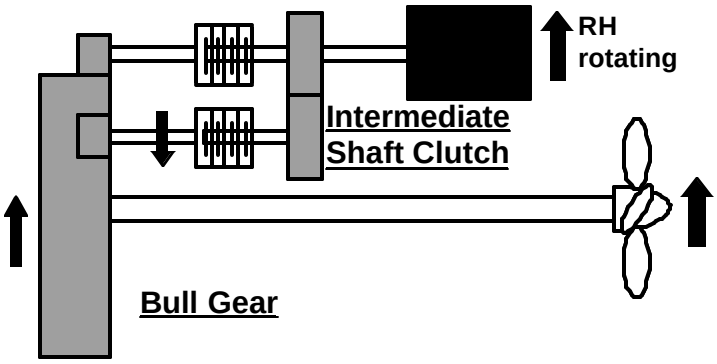
Is a hydraulic block mounted directly to the gear housing. It directs flow to the clutches or returns to the sump. It provides clutch engage pressure to lock the reduction gear in forward or reverse. It also performs time delay when engaging the reduction gears. Excessive delay can be caused by low oil temperature.



Directional Control Valve (DCV)

Is an 24v, electrically activated, axial sliding spool valve. It is spring loaded to return to the neutral position when no power is applied. If power is interrupted it will automatically return to neutral. Pushing in on the valve at either end can manually activate it. To lock the valve into forward or reverse remove the rubber boot on the end of the valve and lock it using the pin attached to the chain. There are two pins one at either end if the valve. It may be difficult to push the valve when the engine is running.

Gear Rotation Stbd Engine FWD Identical

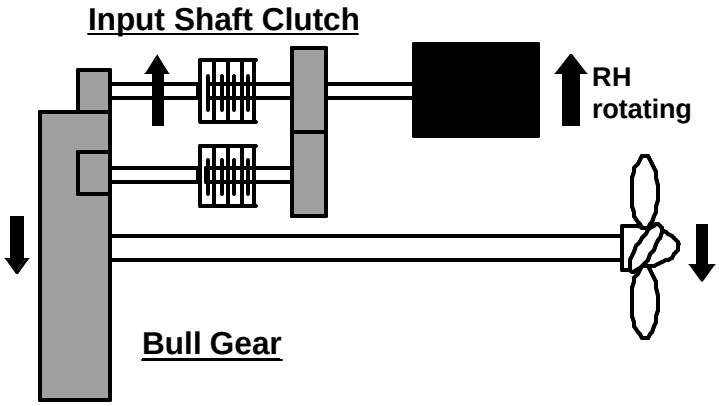


Gear Rotation

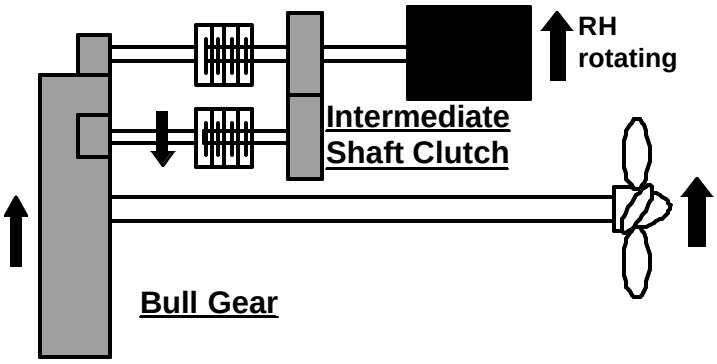
With both engine turning in the same direction, to the right, the reduction gears have to operate in opposite directions to give the boat standard twin screw propulsion. Gear rotation is determined by the oil line routing to the clutch packs from the power build up valve. The clutch packs are the; Main input shaft clutch and the Intermediate shaft clutch.

As seen in the illustration, the starboard engine uses the intermediate shaft clutch when operating in forward gear. This makes the propeller turn outboard. The port engine uses the main input shaft clutch when operating in forward gear. Again making the propeller turn outboard.

Gear Rotation Port Engine FWD Opposite



Gear Rotation Stbd Engine FWD Identical



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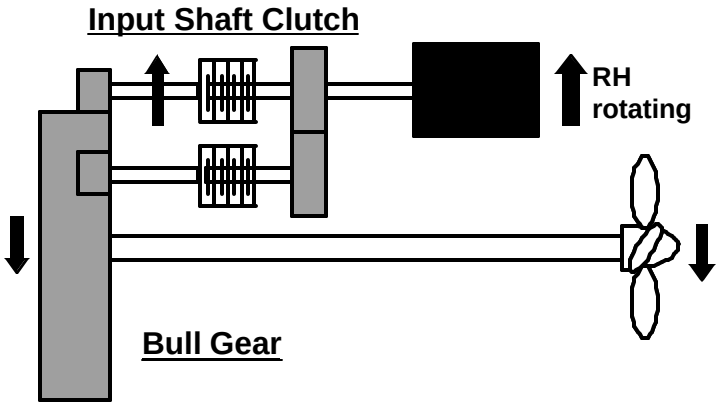
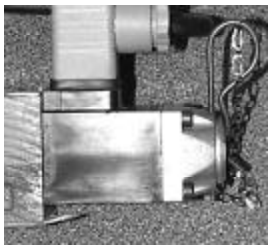


Emergency Operations
Failure Categories



Electric control failure is the loss of control due to one of the electronic components. The EGIM, the Control Valve, or any part of the DDEC system for controlling the reduction gears. As discussed earlier the control valve can be manually operated by pushing in on the valve in the desired direction. Remember to lock the valve into gear remove the rubber boot and use the attached pin.

Pressure oil supply failure. In cases of a oil pump failure or lube oil loss, the reduction gears are equipped with a come home feature. It is complicated and difficult to use. The come home feature is not recommended for use due to the difficulty engaging it. If the feature is used the reduction gear has to be removed and reconditioned. If the come home feature is used you must not operate over 70% of rated speed.

Shaft Seals

The shaft seals are located on bulkhead five in the reduction gear space. The shaft seals are drip less and should not allow water into the boat.

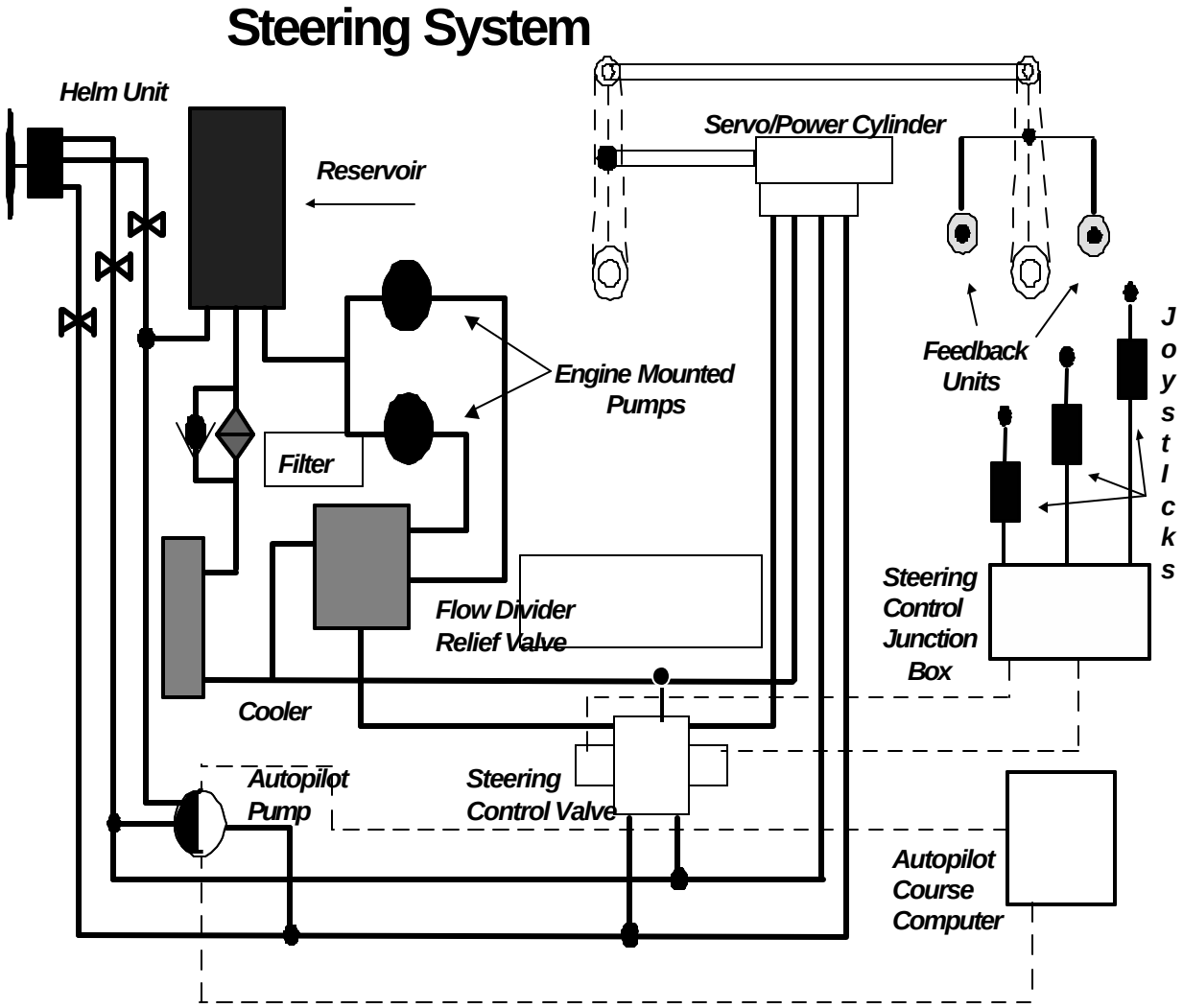
The PSS is a self adjusting mechanical seal. It is held in place by two set screws. It uses the compression of the bellows to maintain the seal. Raw water is used to cool and flush the seal. The seal is maintenance free.

Steering System

The most confusing system on the boat, the steering system can be understood if it is broken down into smaller pieces. Look at the system below and try to identify the manual side of the system and the power side of the system. Originally designed to be two independent systems they are now connected at the steering control valve and the reservoir. This allows the manual side to have power steering by tapping the powered system.

Steering System Components

Helm unit
Joystick
Reservoir
Steering pump
Filter
Cooler
Steering control valve
Power cylinder
Feed back units
Auto pilot pump
Rudders
Steering pressure alarms



Helm Unit

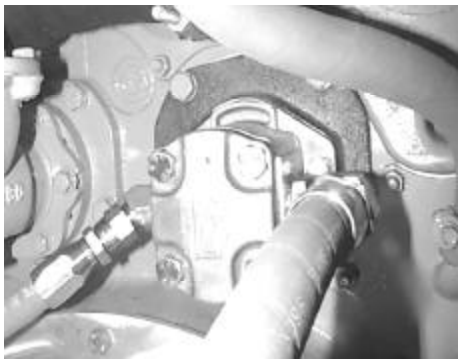
If it helps, remember there are four pumps in the system and the helm unit is number one. It is an axial piston pump powered by the operator (Coxswain). It supplies fluid to the servo cylinder. **Note:** The hydraulic lines to the helm unit run through the enclosed bridge. There are three valves to isolate the helm pump when work on the system requires the head pressure to be released.

Joy Stick

The joysticks use the power side of the system. They are single axis follow up levers. Meaning the levers go left and right only and as soon as you release the lever it returns to the rudder amidships position. The joysticks electrically send a signal to the steering control valve. The call up button energizes the station.

Reservoir

The reservoir holds one gallon of Tellus T-15 hydraulic fluid. The capacity of the entire system is two gallons. The hydraulic fluid is colorless but a dye is approved for use to make seeing the level easier. To check the level look at the sight glass, pictured here. The system has to be pressurized to 20 to 30 psi the gauge is on top of the reservoir. To add pressure use the bicycle pump from the spare parts kit and attach it to the Schrader valve next to the gauge.
Caution—Before opening the reservoir the head pressure must be released. Do not exceed 30 psi on head pressure or helm pump seals will be damaged.

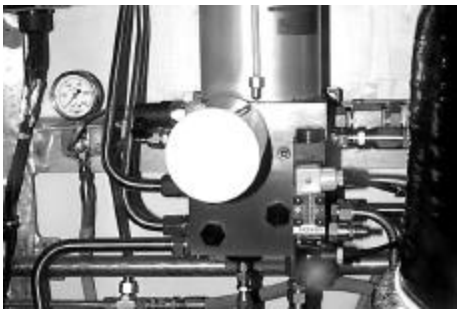


Steering Pump

As mentioned before there are four pumps in the system, one is mounted on each engine. They provide the pressure for the steering system pumping up to six gallons per minute per engine. Developing pressure in the power circuit to change the rudders position. Pressure is regulated by the flow control valve. Under steady conditions the pumps circulates fluid freely in the power circuit.

Filter

A spin on type filter rated at 10 microns. All fluid is filtered before returning to the reservoir. The block has a built in bypass valve.

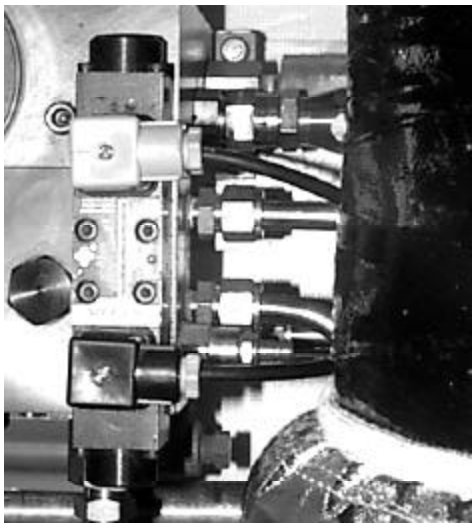


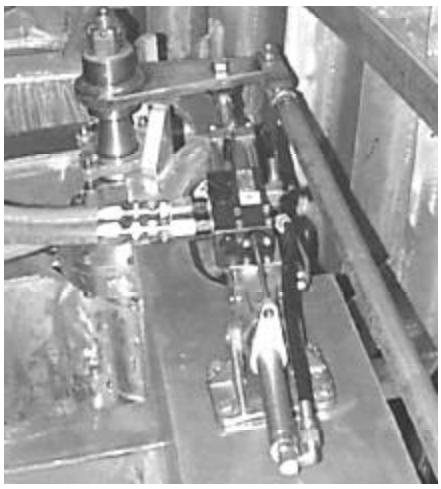
Cooler

The cooler is located directly below the block and filter. As discussed in the Raw Water system the cooler maintains proper system temperature.

Steering Control Valve

The steering control valve is a sliding spool valve similar to the valve on the reduction gear. It is electrically activated by the joysticks. When the valve is activated a small amount of fluid is sent from the fluid circulated in the power circuit into the lines connected to the helm circuit. The pressure then moves the rudders.





Power Cylinder

The power cylinder or hydraulic ram is attached to the starboard tiller. It can produce up to 3500 pounds of thrust. The cylinder has two internal pressure relief valves one that relieves at 950 psi. in the manual circuit and one that relieves at 1000 psi in the power circuit.

Feedback Units

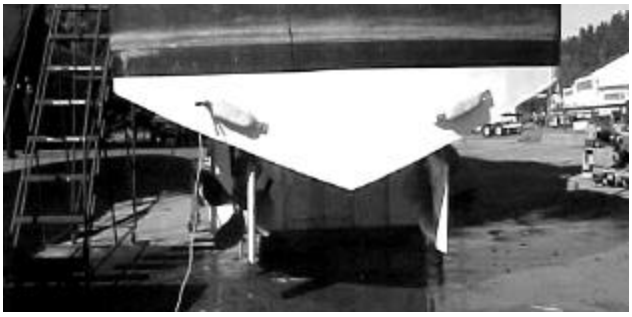
There are two feedback units one for the auto pilot and one for the rudder angle indicators. They are attached to the port tiller and act as potentiometers.

Autopilot Pump

The Autopilot pump is the fourth pump in the system. It takes commands from the autopilot course computer. It is connected to the helm circuit of the system and controls the rudders the same way the helm pump does.

Rudders

The rudders on the 47' MLB are unbalanced spade type rudders. The majority of the rudder surface is aft of the rudder post. The rudders and rudder stocks are made of stainless steel. The full arc of travel is 70 degrees 35 degrees to port and 35 degrees to starboard. The rudders are set slightly inboard of the propellers as seen in the picture.



Steering Pressure Alarms

As discussed in Casualty Control the engines cannot be run without fluid in the system. This alarms mounted on the center console of the open bridge and the overhead console of the enclosed bridge will sound if pressure in the steering system pressure drops below 45 psi.

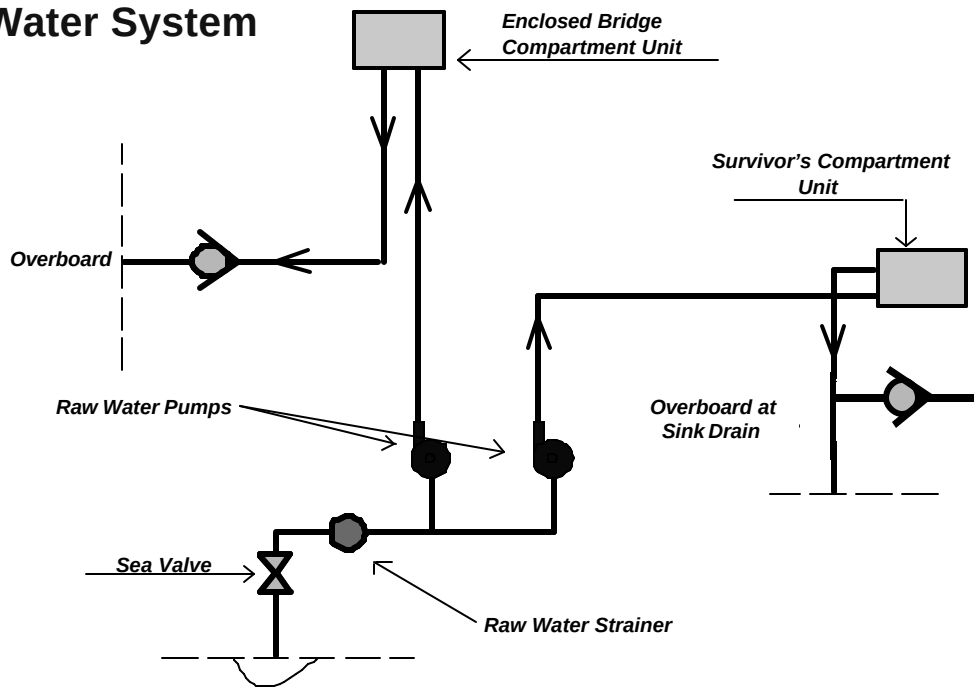
Heating Ventilation Air Condition (HVAC)

System Components

Sea valve
Strainer
R/W pumps
R/W system piping

Self contained units
Control panel
Compartment ventilation

HVAC Raw Water System

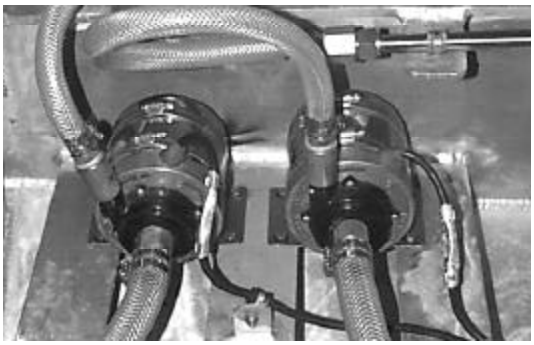


Sea Valve and Strainer

The sea valve is a quarter turn ball valve located in the starboard side of the bilge in the auxiliary compartment. It connects to the simplex sea strainer. Located just aft of the valve.

Raw Water Pumps

There is a pump for each self contained unit. The pumps are 1 /12 horsepower rated at 390 gallons per hour and use 115 VAC.



Self Contained Units

The self-contained units are located in the survivors compartment above the engine room door and in the enclosed bridge above the door to the survivors compartment. They contain all the air conditioning and heating components and are rated at 1.375 ton or 16,000 BTU. They are powered by the 115VAC system. The A/C uses a 8 oz charge of R-22 refrigerant. They contain an electrical heating element. The system uses raw water in the A/C mode. Either the shore power system or the sea power generators power the system. The units also circulate the air in the compartments.

Control Panel

The control panels are located in the survivor's compartment and the enclosed bridge. They have an LED display panel and keypad. The control panel controls heating and cooling modes as well as the auto mode. In the auto mode the temperature is thermostatically controlled. There is also a fan mode that circulates air continuously. The system can be programmed for climate control. The programming mode can bring the temperature to a desired level at a specific time and maintain the temperature over a period of time.

Compartment Ventilation

All major compartments have fresh air natural ventilation.

Forpeak and Lazarette

The forpeak and lazarette are vented through 2” check ball type vents. The forpeak vent is located forward of frame 15. The lazarette vent is located inside the starboard aft deck box.

Forward Compartment

The forward compartment uses a dorade vent and a pilot house vent. The pilot house vent is the forward vent on the port side.

Auxilary Machinery Space

The auxilary machinery space uses a ventilation fan to remove battery fumes. The air is taken in on the port side of the pilot house and discharges out the starboard side of the pilot house. The fan cycles on whenever the batteries are being charged.

Survivors Compartment

The survivor’s compartment uses a vent located between the crewman jump seats on the open bridge. The vent discharge is below the starboard open bridge console.

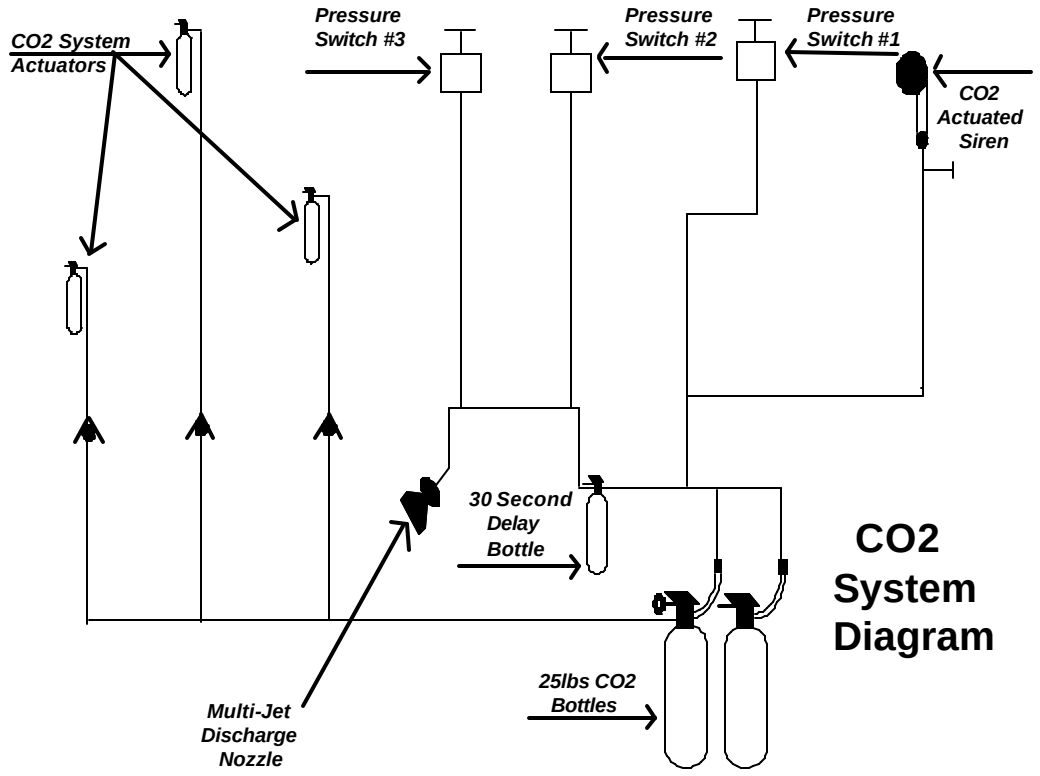
Enclosed Bridge

The enclosed bridge uses the vent under the port open bridge console to supply air and discharges out the deck drains.

Engine Room

The engine room uses the main air intake behind the ladder from the aft deck to the open bridge and the two vents located in the aft buoyancy chamber one in the port stowage box and one in the starboard stowage box.

CO2 Fire Suppression System



CO2 System Diagram

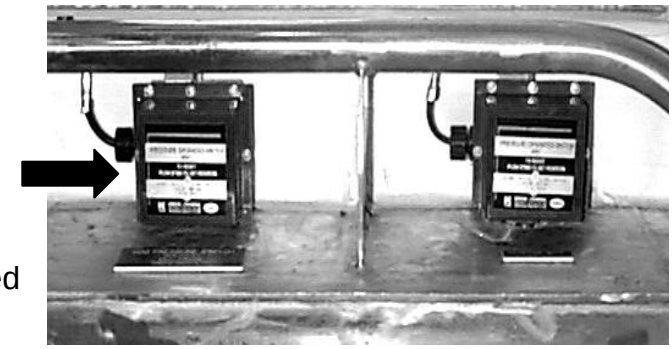
CO2 System Actuators

There are three actuators on board the 47' MLB. One on the open bridge, one in the enclosed bridge, and one in the survivors compartment, next to the engine room door. To activate the system pull the safety pin and push down on the plunger. The actuators use nitrogen to break the seal on the first twenty-five pound CO2 Cylinder.

Notes

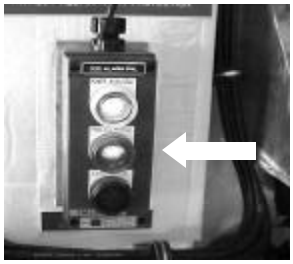
CO2 Bottles

There are two 25 pound CO2 bottles in the auxiliary machinery space. The 25 pound number is the weight of the CO2 charge not the actual weight of the bottles. The inboard bottle can be activated manually by pulling the safety pin and rotating the handle up. The CO2 from the first bottle releases the CO2 from the second bottle. The CO2 then travels to the pressure switches.



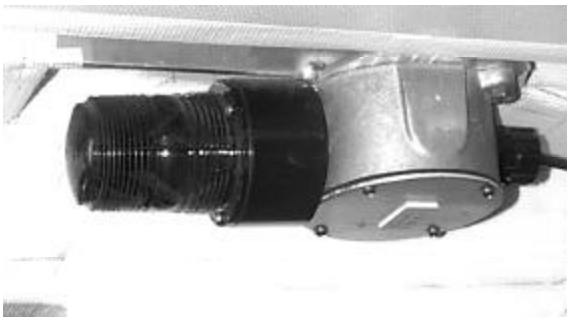
Pressure Switch One

Pressure switch one is the red box forward in the survivors compartment. It does three actions when energized. It energizes the pre discharge light, the red strobe in the engine room, and it closes the air intakes on the engines by tripping solenoids.



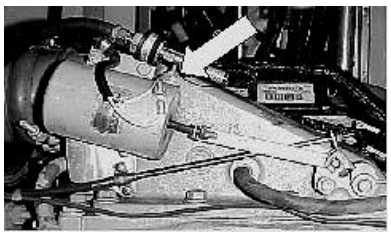
CO2 Pre Discharge Light

Flashing red light used to warn personnel of eminent C02 discharge. Located above engine room door.



CO2 Engine Room Strobe Light

Triggered by pressure switch one, the strobe light is used to warn personnel in the engine room of eminent CO2 discharge. It is located in the overhead in the center of the engine room.



Engine Shut Down Solenoids

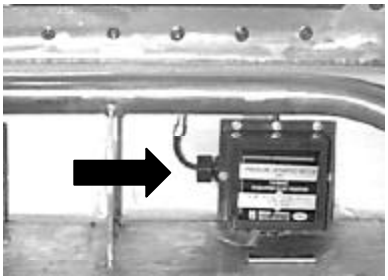
The engine shut down solenoids is electrically tripped by pressure switch one. They close the air intakes on the engines. If the system is tripped for maintenance it must be properly reset or it can close when underway in heavy weather.

CO2 Siren

The siren is located on bulkhead 5 in the engine room. It is pneumatically operated by the CO2. When the system is activated and the siren is sounding it can displace up to 10% of the oxygen in the engine room before the 30 second delay has passed.

Delay Cylinder

The delay cylinder is located just inside the survivors compartment on the starboard side aft next to the steps. The delay cylinder takes approximately thirty seconds to fill and develop enough pressure to lift the valve off the seat. The thirty second delay bottle can be bypassed by pulling the safety pin and rotating the valve open.



Pressure Switch Number Two

Pressure switch number two turns on the red discharge light above the engine room door.

Pressure Switch Number Three

Pressure switch number three is mechanical and located next to the tow reels. This switch allows the main air intake for the engine room to close preventing the CO2 from escaping. When sufficient CO2 pressure builds in the system the pressure forces the pin to drop and allows the weighted arm to fall closing the air intake.

Notes

Smoke/Heat Detector

The detector is located in the overhead of the engine room. It detects smoke or obscurity as well as heat. The alarm will sound when heat reaches 225 degrees. The smoke detector can be triggered by smoke, exhaust, steam, or particulates such as fiberglass exhaust lagging. Not every alarm will be a fire but every alarm should be treated as one until investigated.

Fire Alarm Indicator and Silence

Located on the overhead console of the enclosed bridge and the center console of the open bridge. When the alarm is triggered the red light will energize and an audible alarm will sound. To silence the alarm push the switch to silence. The light will remain on as long as the detector is being triggered. The Push To Test function is for PMS and should not be used while underway to prevent confusion or false alarms.

Forward Compartment Alarm

Located on the aft bulkhead of the forward compartment port side, the alarm warns crewmembers in the forward compartment of a fire alarm. The alarm is the smaller speaker mounted outboard of the intercom speaker. Both speakers are located above the head.

Notes

Electrical System Components

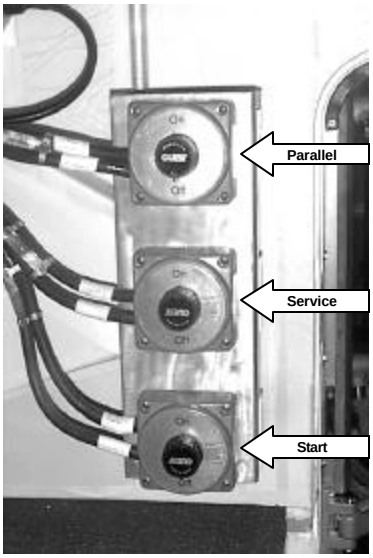
Batteries
Battery isolation switches
Battery charger
Alternators
24V DC panel
12V DC panel
12V power converter
Shore tie
Sea Power generators
Sea Power user panel
Sea power conversion units
120V AC panel

Batteries

Located in the auxiliary space, below the deck gratings there are two battery boxes. Inside the boxes are two banks of batteries one for starting and one for craft systems. Each bank is made up of two 12-volt gel-cell batteries connected in series.

Battery Isolation Switches

The isolation switches are located in the survivors compartment, on the port side of the auxiliary space door. They allow battery banks to be disconnected. They also allow battery banks to be paralleled.



Battery Charger

The battery charger is located on bulkhead ten, starboard side, in the auxiliary space. It uses the 120V AC shore tie to keep the batteries charged while in port. It provides up to 60 amps of 24V DC power to the batteries. It has automatic overload protection and automatic power regulation. To provide power to the batteries the isolation switch for each bank must be on.

Alternator

The alternators are mounted on the forward end of the engines. (Aft part of the engine room) They are belt driven and supply full output at idle speed. Each alternator produces 25.5 volts and 220 amps. The alternators supply power for lighting, electronic and electrical equipment, and to the batteries for charging underway.

DC Power Panels

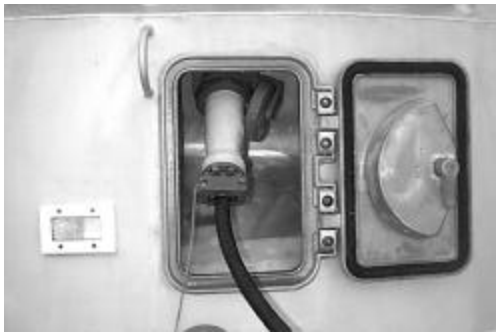
The DC power panels distribute all DC power. There are two DC power panels the 12V and 24V. These panels have gauges for DC Amps and Volts.

The 24V panel is located on bulkhead ten to port of the watertight door. It houses all the 24V electrical service breakers for the boat.

The 12V power panel is on bulkhead ten out board of the 24V panel. This panel receives its power from the converters mounted on the starboard side of the 24V panel. The 12V panel houses the 12V electrical service breakers for the boat.

12 Volt Power Converter

Mounted to the 24V power panel the converter supplies the 12V panel. The power supply is on the 24V panel marked with red placards. Power supply must be energized to use the 12V panel.



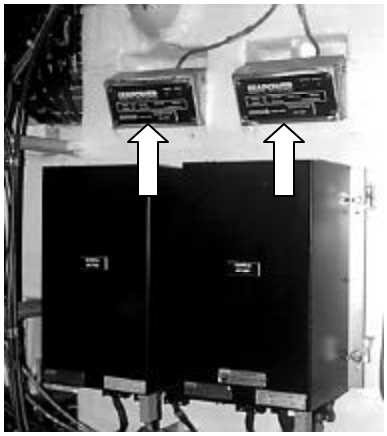
Shore Tie

The shore tie provides 120V AC power while in port. It provides 100 amp protection. The shore tie has a separate circuit breaker and isolation transformer.

Notes

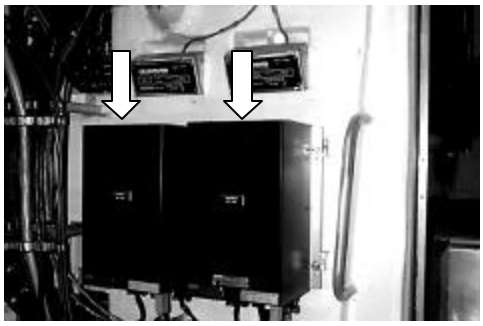
Sea Power Generators

The generators are mounted to the forward end of the engines and are belt driven. Each unit is a 5 KW generator. The generators provide AC power to the HVAC system when underway.



Sea Power User Panels

Located on bulkhead eight, in the auxiliary space, starboard side. The panels provide system information and power status.



Sea Power Conversion Units

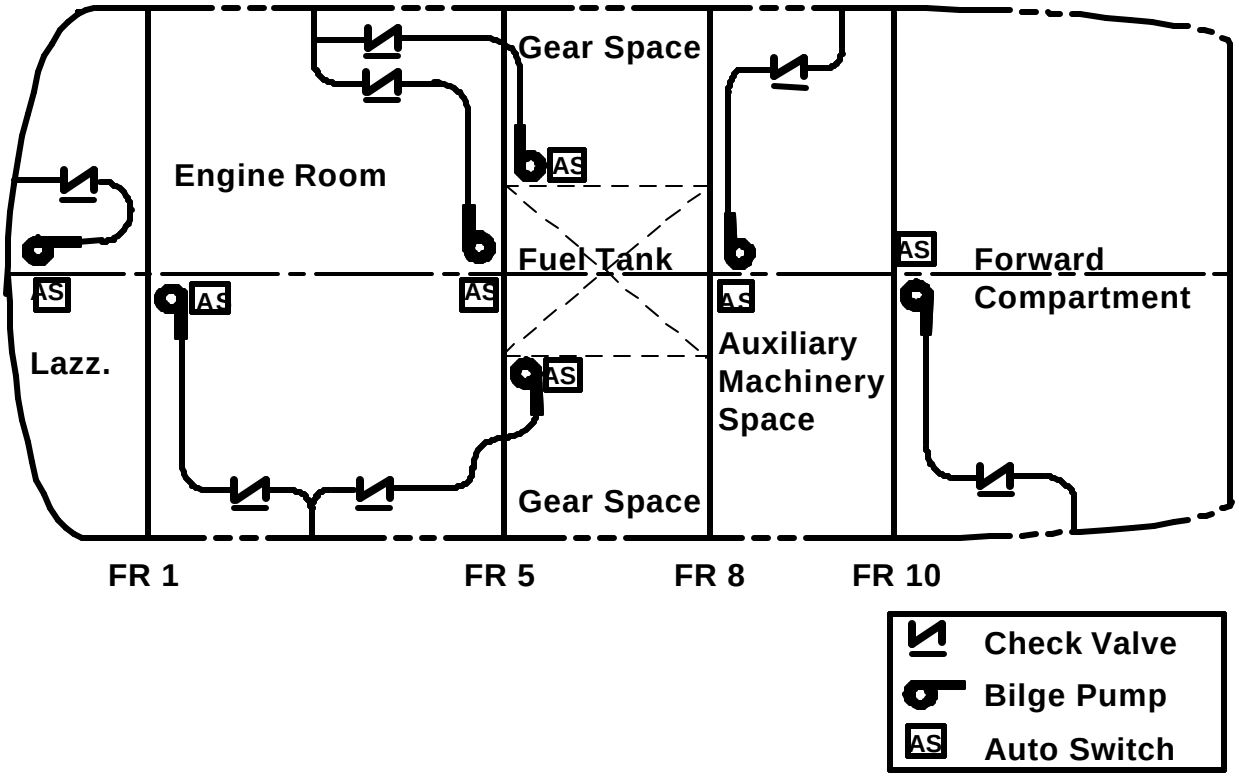
Selects power source from either shore tie or generators. It regulates AC power at 120V 60 Hz.

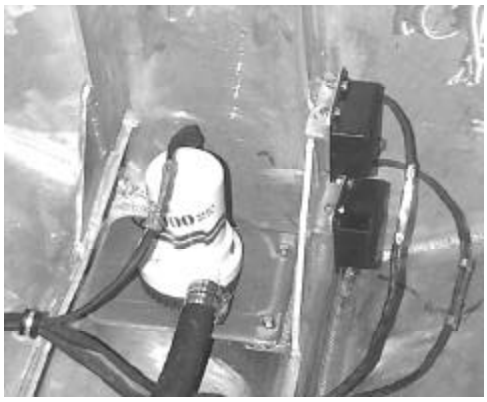
120 VAC Panel

The 120 VAC panel is located on bulkhead eight to port of the watertight door. The panel houses breakers for the battery charger, two receptacles with ground fault protection, the HVAC units, and engine hot starts. The panel has gauges to monitor voltage and amperage. The panel has interlocks on the HVAC shore power/sea power breakers so only one power source may be energized at a time. The HVAC units cannot be run with both breakers on.

Notes

Bilge Pump System





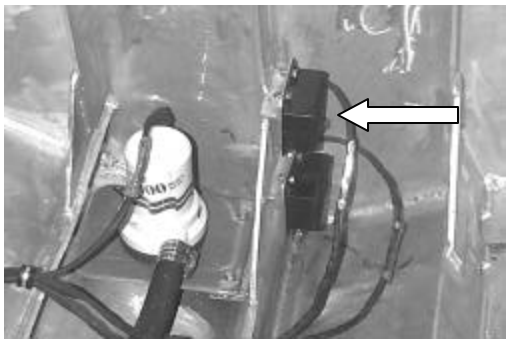
Bilge Pumps

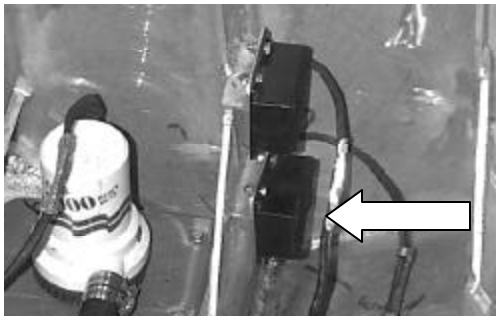
The MLB is outfitted with seven bilge pumps. Each are 24V DC submersible pumps. The pumps are located in the lowest point of the spaces they are installed in. With the exception of the pump forward in the engine room. Each pump is rated at 2000 gallons per hour, or 33 gallons per minute.

Notes

Automatic Pump Switch

Each pump is fitted with a automatic switch. It is located approximately ten inches above the keel, and six inches above the pump. It will automatically energize the pump if water is sensed when the pumps are in the auto mode.



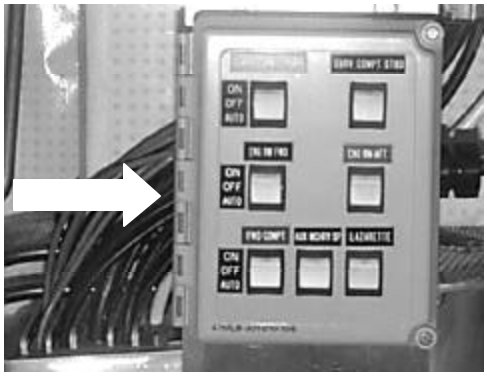


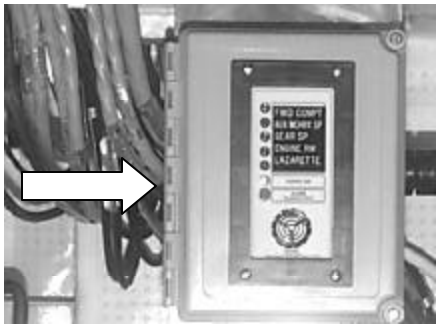
Flooding Alarm Sensor

These sensors are mounted approximately five inches above the keel. They sense water and will activate the MLB's alarm prior to the automatic pump switch. When the alarm is activated a light is illuminated on the bilge alarm panel showing the location of the alarm and the MLB's horn will sound.

Bilge Pump Control Panel

The bilge pump control panel is located on the aft bulkhead, starboard side of the enclosed bridge. Each bilge pump can be controlled from this panel. The switches have three positions OFF, ON, or Auto. In the Auto position the pumps will be energized when the Automatic Pump Switch senses water.





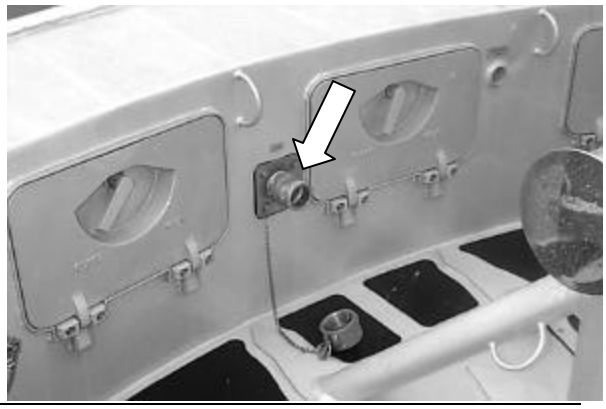
Bilge Pump Alarm Panel

Located directly above the control panel, the bilge alarm panel has six lights. A green light is illuminated whenever the system has power. The next five lights are red, and indicate the space or spaces where bilge flooding has occurred. Below the power light is the alarm test/silence button. When flooding is occurring an audible alarm will sound from the panel. To silence the alarm push the alarm test/silence button.

Notes

Engine Room Dewatering Stand Pipe

The pick up is located starboard of the keel between frames one and two in the engine room. It has a basket strainer to prevent clogging the portable pump. The fitting to connect the pump is centerline on the aft buoyancy chamber.



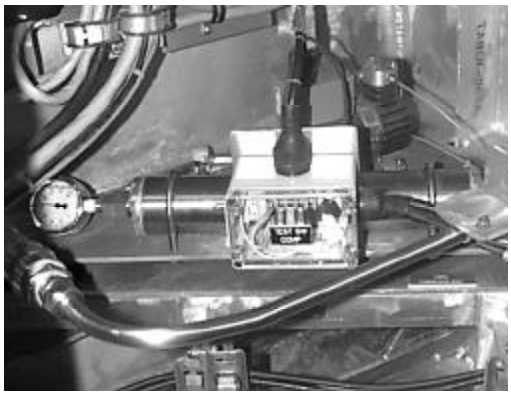
Notes

EWRS Theory

In the case of damage to the pilothouse during a rollover, the Emergency Window Release System (EWRS) provides for automatic or manual opening of the port and starboard aft corner windows on the enclosed bridge. Sensors that are mounted on the port and starboard bulkheads near the overhead trigger automatic opening. When triggered, the EWRS provides for free transfer of water trapped in the enclosed bridge, which may affect stability.

EWRS Components

Compressor assembly
Water sensor assembly
Window latch assembly
Window release test switch
CO2 back-up actuator



Compressor Assembly

There is more than one model of the compressor assembly in the field. The assembly, located in the auxiliary space on the starboard side, consists of the following components.

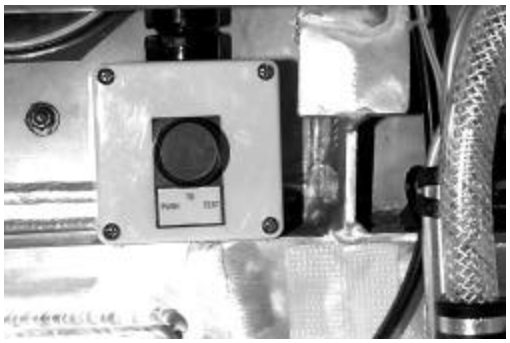
Air compressor
Air reservoir
Solenoid valve
Pressure switch
Compressor run test switch

Water Sensor

Water sensors are located above the windows on the port and starboard side of the enclosed bridge. They operate on 12V DC power and have a have a built in delay switch, with a maximum delay of 3 seconds. The water sensor is similar to the ones for the bilge pumps.

Window Latch Assembly

There is one assembly for each of the two windows.
Each assembly is made up of an actuator cylinder, pneumatic system reset switch, and a two way valve.

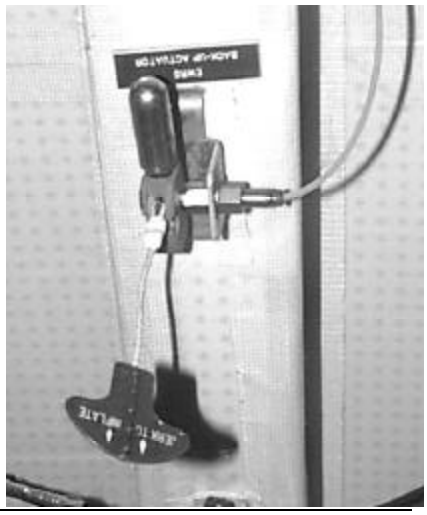


Window Release Test Switch

The test switch is located on the starboard side of the enclosed bridge. It is used to electrically test the EWRS. When the test button is pushed the water sensors are activated and the windows will release. To physically test the water sensor take a damp sponge and touch both sensor pads. The EWRS should activate quickly.

CO2 Back Up Actuator

The CO2 back up actuator is located in the overhead of the enclosed bridge centerline. It uses the small CO2 cylinder attached to operate the EWRS. To activate the back up actuator pull on the lanyard to release the CO2.
Note Never wrap the pull cord for the back up actuator over the assembly to keep it out of the way. Doing so may prevent the system from working properly in an emergency.



Notes

National Motor Lifeboat School

Casualty Control

Common Casualties

Main Engine High Water Temp (Raw Water)
Main Engine High Water Temp (Jacket Water)
Loss of Main Engine Lube Oil Pressure
Loss of Fuel Oil Pressure
Loss of Engine RPM Control
Loss of Steering (Hydraulics)
Loss of Steering (Electrical)

Flooding
Reduction Gear Failure
Collision with Submerged Object (or Bottom)
Hard Grounding
Engine fails to start
Low Voltage Alarm/Loss of Electrical Charging Batteries
Excessive shaft seal leakage
Fire in the Engine Room
Fire in the Auxiliary Machinery Space
Capsizing

Engineering Parameters

Engine Oil Pressures:
- Cruising: 49 - 70 psi
- Minimum Idle: 5 psi

Normal Engine Temperature:
- 160 - 205 deg. F.

<140	Major
160-192	Normal
193-204	Major
205-211	Restrictive
212>	Disabling

Reduction Gear Oil Pressure:
- Engaged: 230 - 290 psi
- Neutral: 58 - 66 psi

Normal Reduction Gear Oil Temperature:
- 140 - 176 deg. F.

Why is it important to have casualty control procedures?

To ensure crew safety! Safety is our most important priority.
To minimize vessel damage. We cannot help others if our boats are broken.
Prevent casualty from getting worse
Crew should know each others billet/job
Know what can realistically be repaired underway
Step by step procedures help gain control of casualty
Aid in troubleshooting casualty

Coxswain's Responsibilities During Casualty

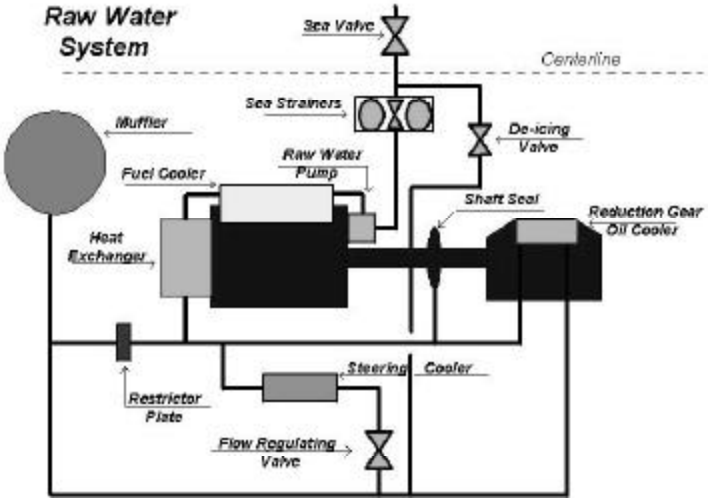
Safety of crew and vessel
When engines will be secured
Keep station informed of situation
Decide if mission can be completed following casualty

If the mission is to be completed following a casualty, the following factors must be considered:

Safety of the crew
Urgency of mission
Limitations due to the casualty
Weather and Sea conditions

Main Engine High Water Temp (Raw Water)

Symptom:
EDM alarm sounds and flashes
"Coolant Temp High"



Normal Engine Temperatures:

160 - 205 deg. F.	
<140	Major
160-192	Normal
193-204	Major
205-211	Restrictive
212>	Disabling

Coxswain:

1. Bring throttles to clutch ahead.
2. Determine which engine has overheated.
3. Inform the crew.
4. Current position verified and situation evaluated.

Engineer:

1. Proceed to Survivor's Compartment and look through Engine Room window.
2. Report what temperature has been reached.
3. If steam is present or temp is above 212 deg. F. secure engine.
4. If no steam is present, with crewman as a safety observer, enter Engine Room and check bilge and engine for obvious leaks.
5. Check brass/painted pipes on inboard sides of engine to determine which system has experienced casualty.

If pipes are cold:

The Raw Water System is probably functioning properly.
Proceed to Jacket Water System checks.

If pipe is hot:

NOTE: If engine has overheated due to a clogged strainer, the other engine may be close to overheating for the same reason.

The brass pipes may often be cool even if the strainers or the pump impeller are faulty.

1. **Check Sea Suction Valve**
2. **Check and shift duplex strainer**
3. **Ensure de-icing system is isolated**
4. **Check R/W pump with back of hand**

If R/W pump cover is hot, SECURE engine and replace impeller.

Main Engine High Water Temp (JacketWater)

Symptom:
Same symptom as before, the entire R/W system has been checked with negative results.

Coxswain:

1. Bring throttles to clutch ahead.
2. Determine which engine has overheated.
3. Inform the crew.
4. Current position verified and situation evaluated.

Engineer:

WARNING!
Antifreeze is toxic when inhaled or ingested

1. Check J/W Level
2. Inspect J/W Pump
3. Check Lubricating Oil for Quantity and Quality
4. Secure engine when

   Leaks are found
   J/W pump inoperative
   Temperature continues to climb

Summary High Temp Raw Water

	1.	Clutch ahead
	2.	Identify casualty, info crew, verify position and evaluate situation
	3.	Check bilges
	4.	Feel R/W pipes
	5.	Check R/W suction valves
	6.	Check and shift strainers
	7.	Check de-icing valves
	8.	Check R/W pump

If pipes are cold: The Raw Water System is probably functioning properly. Proceed to Jacket Water System checks.

Summary High Temp Jacket Water

	4.	Feel R/W pipes
	5.	Check J/W level
	6.	Check pump
	7.	Check lube oil

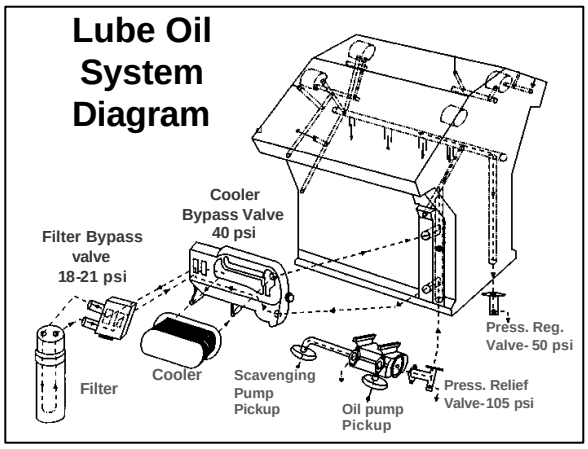
Loss of Main Engine Lube Oil Pressure

Symptom:

EDM alarm sounds and flashes

"Oil Pressure Low"

Engine Oil Pressures:
Cruising: 49 - 70 psi
Minimum Idle: 5 psi



Coxswain:

1. Bring throttles to clutch ahead.
2. Determine which engine has loss of L/O pressure
3. Secure affected engine
4. Inform the crew.
5. Current position verified and situation evaluated.

Engineer:

1. Check E/R status through port light in door, if safe enter Engine Room with a crewman as safety observer
2. Check Bilges for Oil
3. Obvious leaks
4. Check lube oil for quantity and quality
5. Check recovery bottle for contamination

Crewman:

1. Safety Observer/Communication relay for Engineer
2. Standby to rig anchor on Coxswain's command

NOTE:
If cause is not correctable, do not restart engine.

The L/O alarm is variable.

Oil pressure and alarms will be directly related to engine temperature. An overheating engine will have lower than normal L/O pressure.

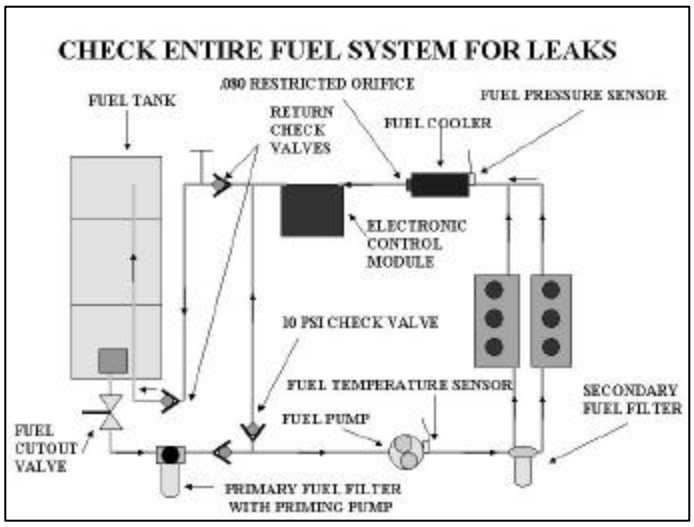
Summary Loss of Main Engine Lube Oil Pressure

	1.	Clutch ahead ID casualty
	2.	Secure engine, info crew, verify position and evaluate situation
	3.	Check bilges/leaks
	4.	Check L/O
	5.	Check recovery bottle

Loss of F/O Pressure

Symptom:
Engine begins to run rough and there is a loss of power. EDM alarm sounds and flashes "Fuel Pressure Low"

Fuel Oil Pressure
50 to 70 psi.



Coxswain:

1. Bring throttles to clutch ahead.
2. ID Casualty
3. Secure affected engine
4. Inform the crew.
5. Current position verified and situation evaluated.

Crewman:

1. Safety Observer/Communication relay for Engineer
2. Standby to rig anchor on Coxswain's command

Engineer:

1. Check E/R status through port light in door, if safe enter Engine Room with a crewman as safety observer
2. Check bilges for fuel
3. Check emergency fuel cutout valves
4. Check primary fuel filter
5. Check entire fuel system for leaks.

Corrective Measures:

1. Replace primary filter if suspect
2. Re-prime system
3. Start engine and check for proper operation
4. If problem still persists, secure engine

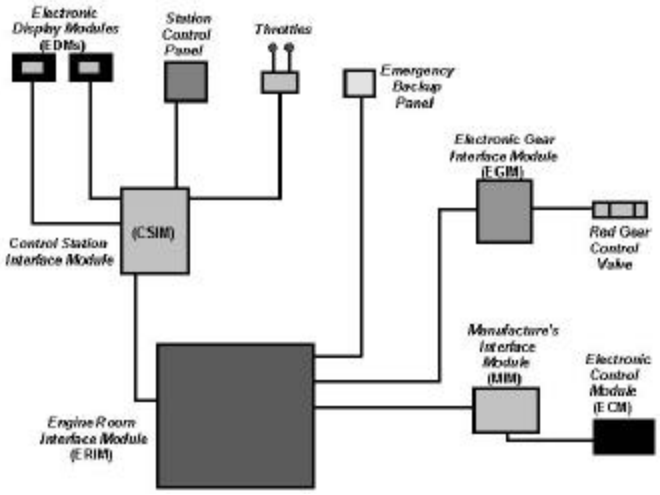
NOTE:
Has work been done on the fuel system recently?
How much fuel on board?

Summary Loss of Fuel Oil Pressure

	1.	Clutch ahead, ID casualty
	2.	Secure engine, info crew, verify position and evaluate situation
	3.	Check emergency fuel cutout valves
	4.	Check bilges
	5.	Check primary fuel filter
	6.	Check entire system for leaks

Loss of Engine RPM Control

Symptom:
Engine RPM cannot be controlled.



Coxswain:

1. Bring throttle
2. Info crew
3. Ensure station is active and sync function is off
4. Switch to another station
5. Energize emergency back-up panel
6. Push and hold engine stop button for affected engine

Engineer:

1. If engine does not secure, proceed to Survivor's Compartment and pull emergency fuel cut-off to the affected engine

Coxswain:

1. If engine still does not secure, pull emergency air shutdown.

NOTE:
Do not use the CO2 system to attempt to shut down the affected engine.

Depleting your fire fighting system could be dangerous.

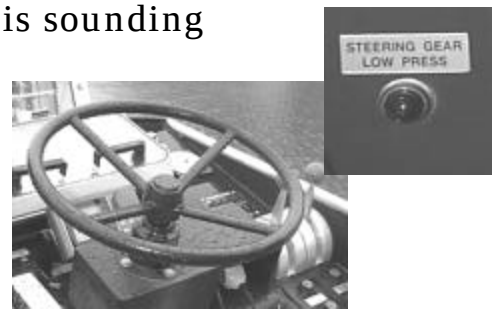
Do not restart engine until problem has been corrected.

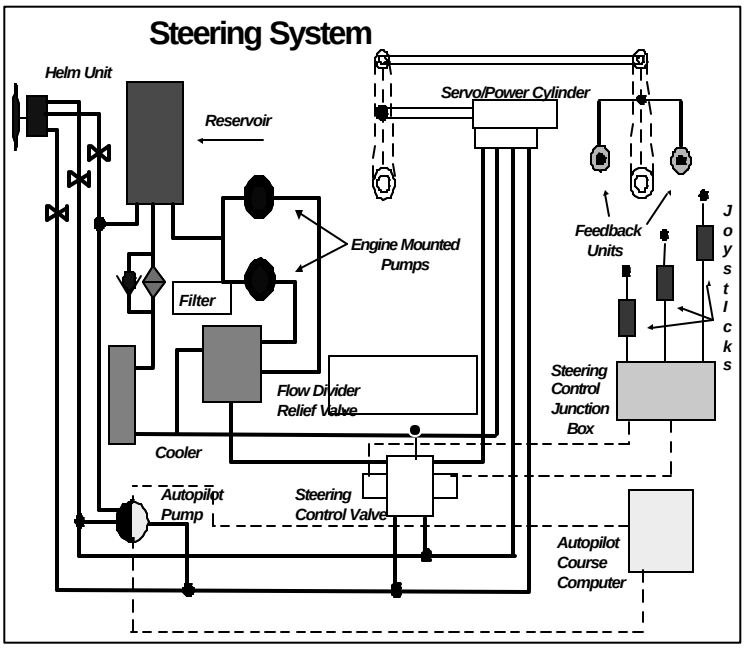
Summary Loss of Engine RPM Control

	1.	Clutch ahead, ID casualty
	2.	info crew
	3.	Switch stations
	4.	Energize emergency back-up panel
	5.	Push engine stop button
	6.	Pull emergency fuel cutout
	7.	Pull emergency air shutdown

Loss of Steering (Hydraulics)

Symptom:
Wheel turns in either direction with no rudder response and the low steering pressure alarm light is illuminated and audible alarm is sounding





Coxswain:

1. Bring throttles to clutch ahead
2. After alarm on console sounds, secure both engines
3. Info crew
4. Current position verified and situation evaluated

Crewman:

1. Safety Observer/Communication relay for Engineer
2. Standby to rig anchor on Coxswain's command

Engineer:

1. Engineer look through port light, if safe, enter Engine Room with crewman as a safety observer, and check bilges and look for obvious leaks

2. Hydraulic Reservoir
   - Fluid level must be at least at low mark on sight glass
   - Check hydraulic pressure:
   - Head pressure between 20-30 psi.

3. Check Remainder of Steering System
   - Steering ram and piping in Lazarette
   - Helm station on open Bridge
   - Console inspection cover and piping in enclosed Bridge
   - Piping in Survivors compartment
   - Piping and Steering pumps in engine room

WARNING!

Engines must stay secured if:
No oil in reservoir
No head pressure on gauge

NOTES:

There is a steering pump attached to each engine.

The helm unit will work only if there is fluid in the system.
The steering pump will be destroyed and possibly cause engine damage if either engine is operated with no fluid in the hydraulic system.
In the event of fluid loss the steering pumps can be taken off, the sun gears connecting the pumps to the engine removed and the pumps then reinstalled thus allowing maneuvering by engines alone

CAUTION:

Due to their location directly under the turbo charger at the front of the Engine Room, removing the Sun Gears underway on a hot engine can be dangerous and will be time consuming

Summary Loss of Steering (Hydraulic)

	1.	Clutch ahead
	2.	Secure engines(after alarm sounds)
	3.	Info crew, verify position and evaluate situation
	4.	Check bilge
	5.	Check fluid level/reservoir head pressure
	6.	Check entire system

Loss of Steering (Electrical)

Symptom:
Jog lever has no rudder response/ is not operating correctly or auto pilot is not responding correctly

Coxswain:

1. Bring throttles to clutch ahead
2. Info crew

Jog lever has no rudder response or is not operating correctly

3. Attempt to select steering station, reactivate jog lever control
4. Check to ensure autopilot is disengaged

Autopilot not functioning properly

3. Check autopilot select button
4. Determine what function the autopilot was in (auto/nav/power sys).

5. Steering control shifted to helm (port side steering station open bridge)
   - If electro-hydraulic system continues to effect hydraulic helm, bring engines to neutral
   - Once control is established maneuver vessel to safe water
6. Current position verified
7. All steering stations checked to isolate extent of problem

Crewman:

1. Safety Observer/Communication relay for Engineer
2. Standby to rig anchor on Coxswain's command

Engineer:

1. Engineer look through port light, if safe, enter Engine Room with crewman as a safety observer, and check bilges and look for obvious leaks.
2. Check sight glass and pressure gauge on reservoir, if no oil or pressure, secure engines
3. Check electrical connections at electro-hydraulic steering valve (steering control solenoid actuator)
4. Check power servo cylinder (steering ram) connections
5. Check auto pilot and rudder angle indicator mechanical and electrical connections
6. Check steering system breakers on 12 volt panel in auxiliary machinery space
7. Secure steering control breaker if faulty jog lever continues to interfere with helm
8. Secure autopilot breaker if autopilot continues to interfere with hydraulic helm

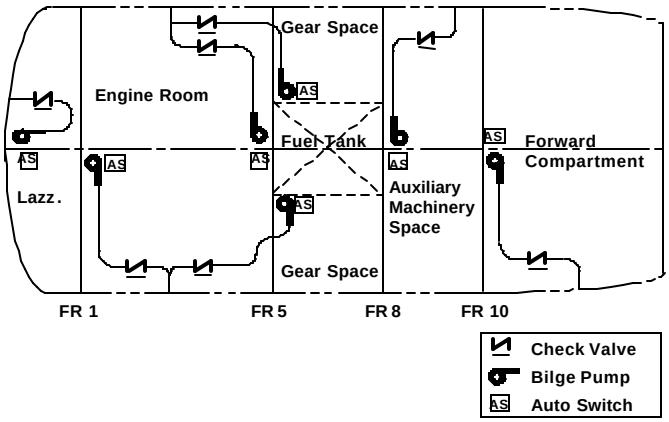
Summary Loss of Steering (Electrical)

	1.	Clutch ahead/info the crew
	2.	Reactivate jog lever and ensure autopilot disengaged or check autopilot select button
	3.	Shift to hydraulic helm, if electro-hydraulic side continues to adversely effect bring engines to neutral, establish control and maneuver to safe water
	4.	Check all stations, verify position and evaluate situation
	5.	Check bilges, look for leaks
	6.	Check steering control valve
	7.	Check steering ram, autopilot and rudder angle indicator connections
	8.	Check steering system breakers and secure if necessary

Flooding

Symptom:
bilge alarm sounds (horn) indicating that there is flooding

Bilge Pump System



Coxswain:

1. Maneuver MLB into a safe area

Engineer:

1. Proceed to Enclosed Bridge, check status panel to determine which compartment has flooding, notify coxswain and hit reset button on panel
2. Proceed to flooded space, look through port light, report status to coxswain
3. If directed by coxswain, enter space and investigate
4. Report extent, cause and take corrective actions to control or stop flooding

Crewman:

1. Safety Observer/Communication relay for Engineer
2. Ready P-5/P-6 pump and or Damage Control kit as needed
3. Check material condition of all compartments, report results to coxswain

Coxswain:

1. After damage has been assessed determine whether it is safe to proceed with mission or to return to unit

Summary Flooding

	1.	**Identify which compartment has been compromised**
	2.	**If safe, enter, investigate, and take corrective actions**

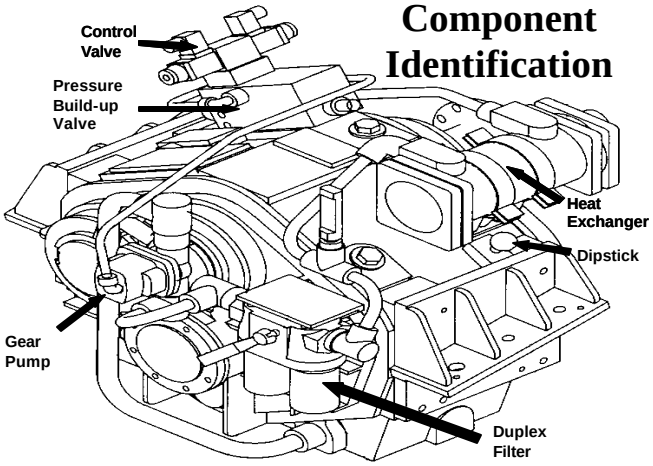
Reduction Gear Failure

Symptom:
Boat does not respond when Throttles are operated in forward and reverse

The normal operating pressures are:
230 to 290 psi engaged
58 to 66 psi disengaged
With a low oil pressure alarm of 174 psi (when engaged)

The normal operating temperatures are:
140 to 176 deg. F
With high oil temp alarm 194 deg F

Component Identification



Coxswain:

1. Bring throttles to neutral
2. Info crew
3. Current position verified and situation evaluated
4. If R/G oil pressure is not within parameters, secure affected engine
5. Ensure active light is lit at control station
6. Switch to another throttle station
7. Energize emergency back-up panel
8. If unable to gain control, secure engine

Crewman:

1. Safety Observer/Communication relay for Engineer
2. Standby to rig anchor on Coxswain's command

Engineer:

1. Check EGIM breakers on 24 volt panel
2. Check red gear bilge for oil
3. Check red gear lube oil level
4. Check Red Gear control valve connections
5. Check dirty oil filter indicator on duplex filter, if indicator has popped up, shift handle to other filter
6. If no leaks are present and the oil level is full, restart the engine and check clutch apply pressure
   If pressure is not sufficient, secure engine

NOTES:

- In the event of a electronic control failure, the control valve can be operated manually
- In the event of fluid/pressure failure, if a long distance must be traveled to return to station, each R/G is fitted with a "come-home" device
- The Boat Crew Seamanship Manual requires shaft tests prior to leaving a mooring

Summary Reduction Gear Failure

	1.	Bring throttles to neutral
	2.	Check R/G pressure, if not within parameters secure
	3.	Info crew, verify position and evaluate situation
	4.	Check control station active light
	5.	Switch stations
	6.	Energize emergency back up panel
	7.	Secure engine
	8.	Check EGIM Breakers on 24 volt panel
	9.	Check bilge, fluid level and pressures
	10.	Control valve manual operation
	11.	“Come-home” device

Collision with Submerged Object (or bottom)

Symptom:
While underway you strike an object or temporarily touch bottom

Coxswain:

1. Bring throttles to neutral
2. Info crew
3. Try to determine what was hit
4. Verify current position, depth of water and evaluate situation

Engineer:

1. Proceed to Survivor's Compartment to check gear spaces and shafting for obvious flooding or damage
2. Assess status through port light, if safe, enter Engine Room with a crewman as safety observer check bilges for flooding and damage (Strut Mounting Bolts)
3. Check R/W strainers for debris and proper water circulation
4. Check lazarette for flooding and rudder or steering system damage

Crewman:

1. Safety Observer/Communication relay for Engineer
2. Check all other compartments for damage

Coxswain:

1. Conduct a steering check at all stations to identify any limitations or isolate areas of damage

Determine if there is a vibration by:

	1.	Bringing RPM's up one engine at a time
	2.	Note which engine and at what RPM vibration occurs
	3.	Do not operate at or above vibration RPM
	4.	If vibration is too severe, place shaft into neutral and secure engine

NOTE:
If possible, boat should be hoisted to determine extent of damage, especially if there is a vibration.

Summary Collision with Submerged Object (or Bottom)

	1.	Bring throttles to neutral
	2.	Info crew
	3.	Try to identify what was hit
	4.	Position, depth of water and situation evaluated
	5.	Check compartments for flooding and damage
	6.	Steering check
	7.	Vibration check

Hard Grounding

Symptom:
While underway the MLB hits bottom and becomes hard aground (unable to initially float free)

Coxswain:

1. Bring throttles to neutral
2. Info crew determine crew's status
3. Verify current position, depth of water and evaluate situation
4. Notify station of position and status

Engineer:

1. Proceed to Survivor's Compartment to check gear spaces and shafting for obvious flooding or damage
2. Assess status through port light, if safe, enter Engine Room with a crewman as safety observer check bilges for flooding and damage (Strut Mounting Bolts)
3. Check R/W strainers for debris and proper water circulation, Secure engines if cooling is insufficient or there is excessive debris (sand)
4. Check lazarette for flooding and rudder or steering system damage

Crewman:

1. Safety Observer/Communication relay for Engineer
2. Check all other compartments for damage
3. Rig anchor for emergency use, if directed by coxswain
4. Take depth soundings to determine deepest water, extent of grounding and the potential for underwater damage

Coxswain:

1. Present and future state of tide, current and weather evaluated with regard to re-floating or salvage options
2. Deploy anchor if danger exists to be set further aground
3. Determine safest direction for extrication

Engineer:

1. Conduct check of propulsion system integrity prior to attempting re-floating or salvage
2. Conduct check of steering system integrity, using hydraulic helm (not jog levers)
3. **Caution should be used to reduce further damage**

Coxswain:

1. Maneuver vessel into safe water (using engines only if steering system has been damaged)
2. Conduct steering checks including helm and jog lever control to identify limitations or isolate areas of damage

Determine if there is a vibration by:

	1.	Bringing RPM's up one engine at a time
	2.	Note which engine and at what RPM vibration occurs
	3.	Do not operate at or above vibration RPM
	4.	If vibration is too severe, place shaft into neutral and secure engine

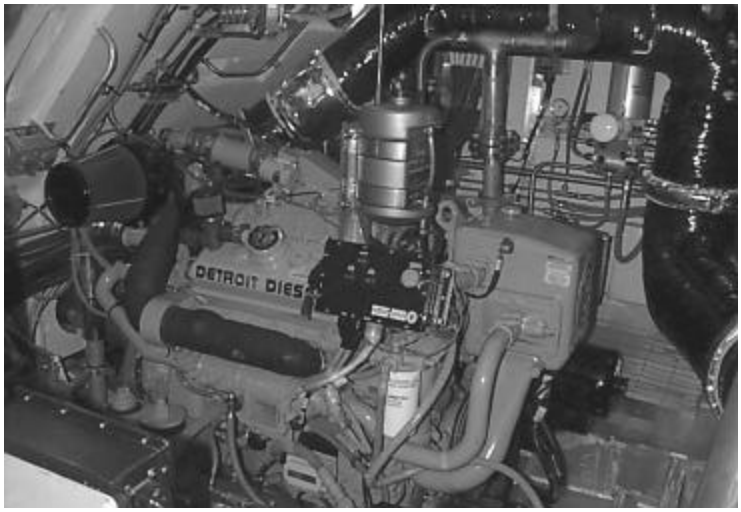
NOTE:
If possible, boat should be hoisted to determine extent of damage, especially if there is a vibration.

Summary Hard Grounding

	1.	Bring throttles to neutral
	2.	Info crew check their status
	3.	Position, depth of water and situation evaluated
	4.	Check compartments for flooding and damage
	5.	Evaluate depth of water, tides and determine safest route of extrication
	6.	Prior to re-floating check propulsion and steering using caution to prevent further damage
	7.	Once in safe water conduct steering and vibration check

Engine Fails to Start

Symptom:
Engine does not crank or engine cranks but does not start



Coxswain:

1. Check EDM for diagnostic codes

Engineer:

1. Ensure engine start switches are on
2. Ensure DDEC ignition switch is on
3. Ensure start battery switch is on
4. Proceed to Auxiliary Machinery Space and ensure all 24 volt DDEC and engine start breakers are energized
5. Check battery voltage
6. Proceed to Engine Room and ensure safety cutoff switches are on
7. Ensure emergency fuel cutout valves are spring loaded into the open position
8. Check Engine Shut-down Solenoids

Batteries may be weak, and have only enough power to start one engine - parallel start and service batteries

Summary Engine Fails to Start

	1.	Check EDM for codes
	2.	Check engine start/safety/ignition switches
	3.	Check battery switches/voltage
	4.	Check breakers
	5.	Check emergency air shut-down

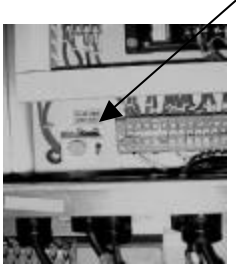
LOW VOLTAGE ALARM/ LOSS OF ELECTRICAL CHARGING SYSTEM

Symptom:
EDM displays a low voltage alarm and/or a drop in voltage is indicated by dimming lights, electronics dropping off line, and or DDEC station control is deactivated

Coxswain:

1. Bring throttles to clutch ahead
2. Info crew

Engineer:



1. Check position of battery isolation switches located in survivors compartment (start and service on, parallel off)
2. Engineer look through port light, if safe, enter Engine Room with crewman as a safety observer, and check electrical components
3. Check alternator reset switches on the starboard bulkhead
4. Check condition of both alternator belts
5. Check electrical connections on both alternators
6. Check electrical connections on lube oil pressure switches on both engines
7. Check fuse in 24-volt start panels (port engine room bulkhead)
8. Check all main battery connections
9. Clean and tighten as necessary
10. Secure all non-vital equipment on the 24 and 12-volt DC panels
11. Place start and service batteries in parallel
12. Determine extent of electrical power loss, probable cause, and expected service duration for platform

Summary Low Voltage

	1.	Clutch ahead, info crew
	2.	Check battery isolation switches
	3.	If safe enter E/R check alternator belts, reset switches and electrical connections
	4.	Check lube oil pressure switches
	5.	Check fuse in start interface panels
	6.	Check connections on batteries
	7.	Secure non vital equipment on 12 and 24 volt panel
	8.	Parallel batteries and determine status

Excessive Shaft Seal Leakage
John Crane/PSS

Symptom:
Survivors Compartment bilge alarm sounds and shaft seal is found to be leaking

Coxswain:

1. Bring throttles to neutral
2. Secure engine

Engineer: (PSS)

1. After investigating casualty, Info crew
2. Secure safety switch for affected engine
3. Check hose clamps for tightness
4. Check to see if seal has backed off
5. Loosen set screws and push seal assembly in a position that properly compresses the seal bellows (one inch past initial contact point)
6. After repositioning seal restart engine
7. If water continues to leak excessively from seal return to station

Engineer: (John Crane)

1. After investigating casualty, Info crew
2. Secure safety switch for affected engine
3. Check to see if clamp rings have backed off
4. Loosen clamp rings and push seal assembly in a position that properly compresses the seal bellows
5. After repositioning seal restart engine
6. If water continues to leak excessively from seal secure shaft, tighten emergency clamp ring and return to station

CAUTION!

Remember, the Engineer will be laying over the cardan shaft from the engine

The propeller shaft cannot turn while repositioning the shaft seal

Summary Shaft Seal Leakage
(John Crane)

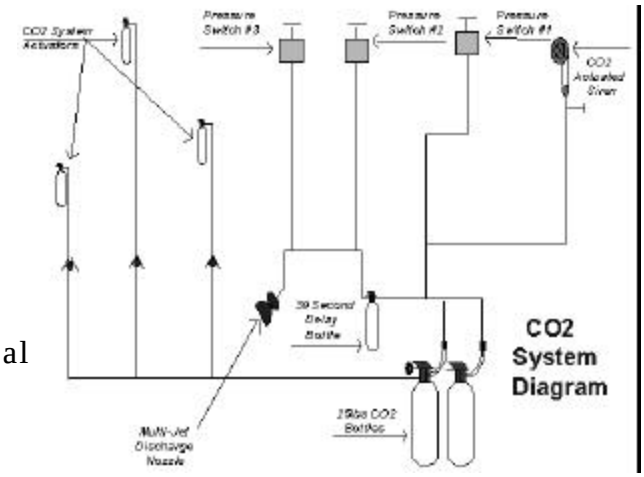
	1.	Bring throttles to neutral
	2.	Secure engine
	3.	Secure safety switch
	4.	Reposition clamp ring
	5.	Emergency clamp ring

Summary Shaft Seal Leakage
(PSS)

	1.	Bring throttles to neutral
	2.	Secure engine
	3.	Secure safety switch
	4.	Reposition seal assembly

Fire in the Engine Room

Symptom:
Fire Alarm Sounds



Coxswain: Bring throttles to neutral
Inform the crew

Engineer: Proceed to Survivor's Compartment check status of Engine Room through port light
Notify coxswain of E/R status (Actual FIRE/FLAMES or smoke, steam, and/or particulate matter)

Coxswain: If FIRE is present secure engines using engine stop buttons

Engineer: Proceed to Survivor's Compartment
Pull emergency fuel cutout valves

Crewman: Ensure both air intake valves in port & stbd aft buoyancy boxes are closed

Engineer: Energize CO2 system by releasing lock pin and depressing handle or pulling ring locally at CO2 bottle

Coxswain: Account for all persons on board
Discuss relocating P-5/P-6 pump forward away from engine space
Notify station of situation and current position

Engineer: Secure electrical breakers on DC panel with the exception of main breaker & VHF-FM radio

Crewman: Rig anchor for emergency use if directed by coxswain

NOTE:

Fire watch established at E/R door, portable fire extinguisher readied, observing through port light

Engine Room door should remain closed

Sensor in the engine room sets off the alarm at 225 deg. F or smoke obscurity

USE COMMON SENSE.

CAUTION!

It is extremely dangerous to enter a compartment during or after a fire without an approved breathing apparatus

MLB should be towed back to station

Compartment should be properly ventilated and the space tested for Oxygen level before entering

Summary Fire in the Engine Room

	1.	Bring throttles to neutral
	2.	Info the crew
	3.	If there is Fire secure engines
	4.	Secure Fuel
	5.	Secure air modifications valves
	6.	Energize CO2
	7.	Inform station of location and status
	8.	Secure electrical
	9.	Deploy anchor if necessary, establish fire watch, wait for tow

Fire in the Auxiliary Machinery Space

Symptom:
Smoke is coming out of Auxiliary Machinery Space vent

Coxswain:

1. Secure engines
2. Inform the crew
3. Notify station of situation and current position

Engineer:

1. Proceed to Survivor's Compartment
2. Secure battery disconnect switches

Ensure both doors to the Auxiliary Machinery Space are always closed

Use common sense

Summary Fire in the Auxiliary Machinery Space

	1.	Secure Engines
	2.	Info the crew
	3.	Info Station
	4.	Secure battery disconnect switches

Capsizing
(rollover, knockdown)

Symptom:
Suddenly, you are under water

Coxswain:

1. After the boat re-rights, look for next wave
2. Position MLB for next wave
3. If boat fails to respond take the following actions
   - **a.** Check to make sure station is active
   - **b.** If needed re-qualify throttles
   - **c.** Look for Codes
   - **d.** Check status of R/G (ahead,neutral,astern)
   - **e.** Check Red Gear pressure
   - **f.** Check station active

Once control is established

4. Determine if everyone is still on board
5. Check for lines overboard that may get caught in propellers
6. Proceed to safe area

Engineer:
(Once in Safe Area)

1. Look through the Engine Room window to investigate
2. Check electric bilge pumps (if needed bilge pumps can be turned from auto to on to dewater spaces, but must be turned back to auto once dewatering is complete)
3. If Engine Room flooding is too severe, rig drop pump on aft deck and de-water through standpipe
4. Check oil level on each engine and R/G

If engines or R/G have lost oil or oil pressures are low the engines should be shut down to check oil level.

Crewman:

1. Crew to check each compartment for damage and flooding
2. Determine status of crew, boat and electronics

Coxswain:

1. Assess damage and determine whether it is safe to proceed with the mission

CAUTION !

A back up means of communication is critical after capsizing or knockdown (portable VHF/FM radio)

Do not hook up shore tie, electronics may be soaked with oil and/or water

Upon returning to station all electronic and electrical equipment must be removed and cleaned, engine room must be washed down, insulation material in survivor's compartment inspected, and any compromised fluids and filters should be replaced as needed

Summary Capsizing

	1.	Look for next wave/maneuver MLB into position
	2.	If boat doesn't respond check station active, re-qualify throttles, and check EDMS
	3.	Account for all personnel
	4.	Check for lines
	5.	Move to safe area
	6.	De-water engine room & all other spaces
	7.	Check engine & R/G oil
	8.	Determine status

Search Patterns

Terminal Performance Objective:

While underway on a 47' MLB, in seas not to exceed 6ft., from scenarios provided, EXECUTE a single unit search pattern (Expanding Square or Sector Search) using the Search Pattern Plotter.

Enabling Objectives:

Choose the search pattern best suited for the conditions.
Deploy datum. (VS only)
Enter datum position into waypoint..
Determine time of each leg.
Identify the direction of the first leg.
Execute search pattern.
Determine set and drift of datum.
Exercise effective communications and crew control.

References:
The information contained in this lesson can be found in the following references:

- National Search and Rescue Manual, Vol 1, COMDTINST M16120.5
- National Search and Rescue Manual, Vol 11, COMDTINST M16120.6
- Coast Guard Addendum to the National Search and Rescue Manual, COMDTINST M16130.2(series)
- Boat Cew Seamanship Manual, COMDTINST M16114.5(series)

Search Pattern Designations

Search patterns are generally referred to by letter designators.

First Letter

The first letter indicates search pattern type:

- Trackline T
- Parallel P
- Creeping Line C
- Square S
- Sector V
- Barrier B

Second Letter

The second letter indicates the number of SRUs in the same search area:

- Single-Unit S
- Multi-Unit M

Third Letter

The third letter indicates amplifying/supplementary information:

- Radar or Return Search R
- Coordinated C
- Loran L
- Aural A
- Non-Return Search N
- Drift Compensated D

Example

The following example describes the meaning of the designator TSR.

If letter designator is...	Then...
TSR	T = trackline S = single-unit R = radar or return search

Definitions

Datum:

Datum is defined as the most probable location of the search object corrected for movement over a period of time.

Track Spacing:

The distance between two adjacent parallel search legs is known as track spacing. The desired track spacing is a function of detection capability. The more difficult the target is to detect due to weather or size of the search object, the smaller the track spacing should be.

Sweep Width:

Uncorrected sweep width is a distance in nautical miles used for measuring detection capability. The distance is such that the probability of detecting the target outside that range is equal to the probability of missing the target inside that range.

Set:

The direction toward which the water is flowing. A ship is set by the current. A southerly current and a north wind are going in the same direction. Measured in degrees (usually True).

Drift:

The rate/speed at which an object moves due to the effects of wind, wave, current, or the accumulative effects of each. Drift is usually expressed in knots.

CASP:

Computer-Aided Search Planning - A computerized system used by search planners to identify probable search areas and plan resource allocation. When supplied with appropriate information (the search object's characteristics and uncertainties of the situation), the computer uses information from on-line environmental databases to simulate drift.

Commence Search Point (CSP):

The location in the search pattern where the SRU begins searching. Specifying the CSP allows the SRU to efficiently plan the en route track, (and ensures that the SRUS begin its search at the desired point and time. CSP also allows multiple SRU's conducting searches in the same area to be safely separated.

Definitions Cont.

Search Leg:

The long leg along the track of any pattern.

Cross leg:

Is the connection between two search legs.

Creep:

Is the general direction in which an SRU moves through rectangular or square area, normally the same direction as the cross legs.

Leeway:

A objects movement through the water caused by wind blowing against its exposed surfaces is leeway. The pushing force of the wind is countered by water drag on the submerged surface of the object. Most marine craft have a portion of the hull and superstructure (sail area) exposed above the water. The more sail area a search object has, the greater the force of the wind on the object. Completely submerged objects are assumed to have no leeway.

Search Area:

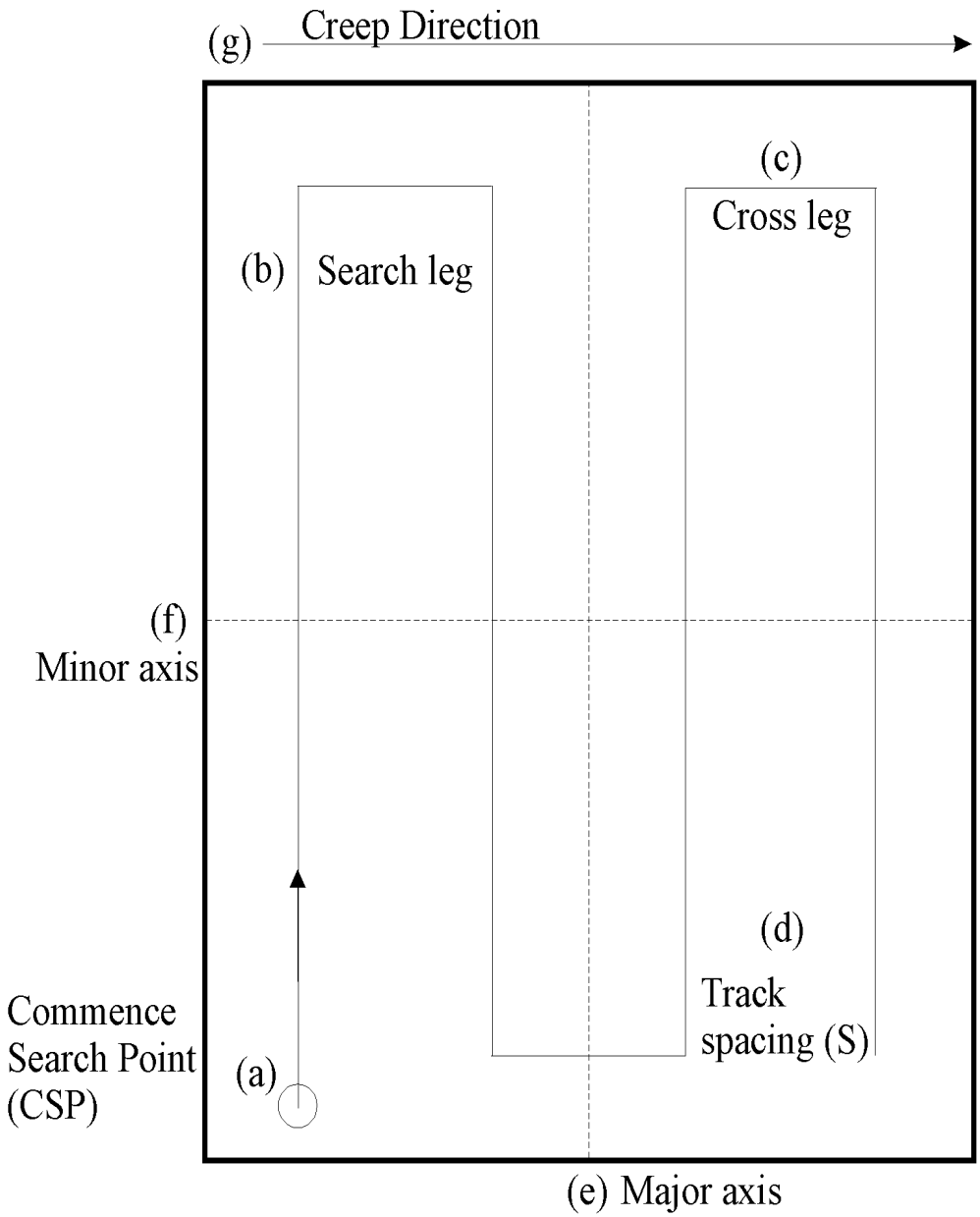
In the coastal environment, if you draw a 6 NM radius circle around datum, the resulting search area is usually large enough to include most targets when 6 or less hours have elapsed.

Initial Track Spacing (NM)		
	Good Conditions	Poor Conditions
Search Object	Wind < 15 kts Seas < 3 ft	Wind ≥ 15 kts Seas ≥ 3 ft
PIW	0.1*	0.1*
< 15 ft	0.5	0.2
≥ 15 ft	1.0	0.5
* > 0.1 up to SRUs minimum navigational accuracy		

Search Pattern Terminology

The following is an example of the terminology used for a generic search pattern.

a) Commence search point (CSP)
b) Search leg
c) Cross leg
d) Track spacing (S)
e) Search area major axis
f) Search area minor axis
g) Creep direction



Search Planning Considerations

Before beginning a search, you must collect all available facts about the case. The SMC should provide most of this information in a search action plan. The checklist below will help you determine whether or not you have everything needed to begin a mission. Once you have collected all available facts and performed the required search planning, you are ready to get underway.

Answers to the following questions will help determine if you have done everything you need to do before getting underway:

- What is the object of this search and what equipment do the personnel aboard have?
- How many people are involved?
- What is the assigned search area?
- What are the circumstances of their distress?
- What search pattern will be used?
- What is the desired search speed?
- What special equipment is required?
- What radio frequencies will you use?
- Are other units assigned? If so:
  - What kind?
  - What are their search areas?
  - What are their search speeds?
  - What search patterns will they employ?
  - What radio frequencies will they use?

Search Object

Position

For drifting search patterns the initial position is crucial because it may be the last known position for a disabled vessel, a visual position for a PIW, or an electronic position determined by LORAN or GPS. The location of the emergency must be clearly established in the most detailed terms possible. This could include any or all of the following, plus all additional information received:

Position (latitude and longitude) of the incident
Bearing and distance from the incident to any points of land or landmarks known or observed.
Last known position of the incident or distressed vessel.

Description

Person in the Water

Locating a person in the water can be a difficult task due to sea state, weather conditions, time of day, and most importantly whether the person is wearing a floatation device. A good description of the person, their clothing, and general health will aid in searching. A PIW wearing a floatation device with reflective materials attached is easier to find than a person wearing a black wet suit. If they are wearing a floatation device, the head and shoulders will probably be visible. If the person is not wearing a flotation device, in most cases all that will be visible is the head.

Vessel

Locating a vessel is easier to accomplish than a PIW. If the vessel sinks, a thorough description of the vessel and its equipment is priceless. Knowledge of the following characteristics will aid in the search.

- Vessel Size
- Color
- Distinctive markings (superstructure, radar, number of antennas, vessel numbers)
- Life rafts or lifeboats
- Visual signals.
- Type of gear or equipment stowed on deck (coolers, cushions, floats)
- Number of persons on board.

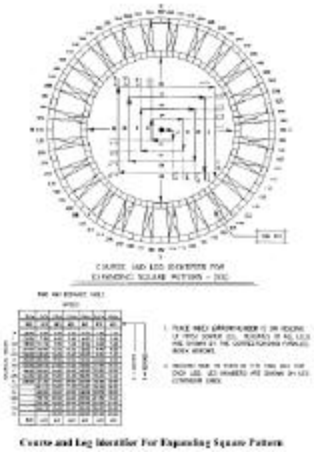
Aircraft

With the exception of seaplanes, aircraft usually sink rapidly after ditching and the only objects found are pneumatic rafts and pieces of debris. A description of the color and identifying numbers may assist in determining a debris field. If the aircraft has crashed, rather than a controlled ditch, there may be nothing more than an oil slick. Large aircraft flying over water have an adequate supply of life rafts, visual signals, and emergency portable radios. The rafts in transport aircraft are, for the most part, the large 20-man type. Single-engine military aircraft will usually be equipped with a one or two-man raft. Small civilian aircraft, if they carry anything, will probably carry only the one-man life raft.

Environmental

The marine environment is dynamic and changing. Environmental conditions such as visibility, sea state, time of day, currents and wind speed will effect the type of search needed to find a search object. While underway a coxswain will not be working with complicated tables to determine leeway or divergence but the information you provide to the SMC will affect the search plan provided by the SMC.

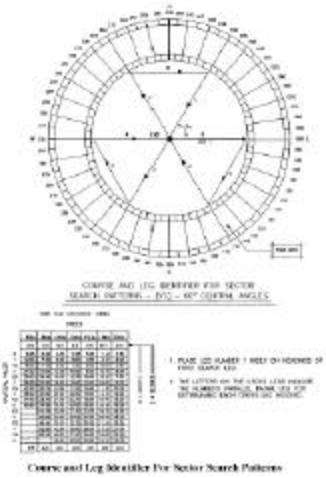
Equipment



Course and Leg Identifier For Expanding Square Pattern

Most of the equipment used for small boat searches is provided as part of the boat out fit. The equipment is the same, as you would need for navigation. Knowing how to use this equipment and its limitations will make conducting searches easier.

The most important tool available for an initial search is the **Search Pattern Slide Rule (SPSR)**. Being familiar with the SPSR is essential before attempting to use it. One of the most common mistakes is not clearly labeling your designated courses so you can read them in heavy weather. Take a grease pencil and clearly label the courses on the SPSR. If it is jostled you will know what your courses should be. Another common mistake is not marking off which legs of a search have been completed. Again using a grease pencil mark the SPSR as you finish each leg.



Course and Leg Identifier For Sector Search Patterns

The **Datum marker** you use should mimic the drift of the object you are searching for. If debris is found use the debris as datum. If possible use a strobe light to mark datum to make it more visible and easier find at night.

This table gives ranges to the visible horizon vs. height of eye.

Height feet	*Nautical miles*	*Statute miles*
8	3.2	3.7
9	3.4	4.0
10	3.6	4.2
11	3.8	4.4
12	4.0	4.6
13	4.1	4.7
14	4.3	4.9
15	4.4	5.1

Crew Brief

Lookouts

Before arriving at the search area, the coxswain should brief all lookouts as to the nature of distress and what type of object they are searching for. This brings the lookouts into the overall picture and establishes the reason for the search. Most searches are the result of an overdue vessel; therefore, the lookout should understand what types of situations the craft may have encountered.

In the maritime environment there may be uncertainty reguarding the precise object of the search. The search object may have started as a 24ft boat, but then shifted to persons in the water or a liferaft. Lookouts should be aware that the search object my change and be informed of the description of the search object and possible debris.

Helmsman

The 47' MLB has five options for steering, three jog levers the helm, and the auto pilot. Before beginning a search, decide which station you are going to use and which compass you will be steering by. Brief the helmsman on how each turn will be made, for example:"all turns will be 90 to the right".

If the auto pilot is to be used, ensure the helmsman understands its operation and how to change course. The auto pilot makes for a quick and steady helmsman. Using the auto pilot can allow the helmsman to act as a lookout. It does not relieve the need for a helmsman.

Square Search Pattern

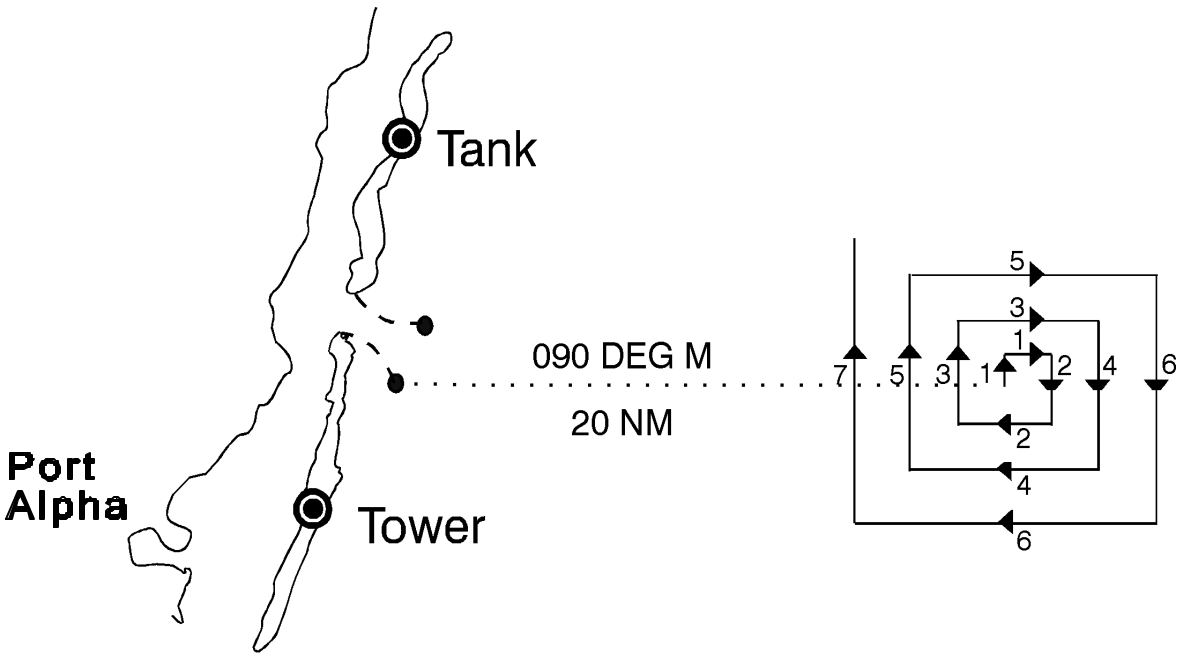
Introduction

A Expanding Square search pattern (S) is used when datum is established within close limits and uniform coverage is desired. The first leg should be ran in the direction of the search objects set. When there is not enough environmental conditions to determine the direction of the search objects set, then a alternate bearing for the first leg may be used. All turn are made 90 to the right, and a second search is performed by shifting the pattern 45 to the right.

Diagram

This diagram shows the Square search pattern.

S = track spacing



Square Pattern: Single Unit

Square Search Calculations

To determine the time required to transit each leg, use the table Square Pattern Computations. Enter the table with the track spacing and SRU speed. Multiply the number from the Table by the length of the search leg shown. This will give time required to complete that leg at the given search speed.

EXAMPLE: Track spacing = 3 NM, speed = 10 kts:

- Find the length of the second southerly leg. Solution: Multiply the length of the second southerly leg (4) by the 3 NM track spacing to get 12 NM.
- Find the time required to complete this search leg. Example: With a track spacing of 3 NM and a search speed of 10 knots and read the value "18:00" (18 minutes and zero seconds). Multiply this value by 4. The result is 72 minutes to complete the leg.

Track Spacing	Speed (kts)								
	3	5	8	10	15	20	60	80	90
0.5	10:00	6:00	3:45	3:00	2:00	1:30	0:30	0.225	0:20
1.0	20:00	12:00	7:30	6:00	4:00	3:00	1:00	0:45	0:40
1.5	35:00	18:00	11:15	9:00	6:00	4:30	1:30	1:075	1:00
2.0	40:00	24:00	15:00	12:00	8:00	6:00	2:00	1:30	1:20
2.5	50:00	30:00	18:45	15:00	10:00	7:30	2:30	1:555	1:40
3.0	60:00	36:00	22:30	18:00	12:00	9:00	3:00	2:18	2:00
3.5		42:00	26:15	21:00	14:00	10:30	3:30	2:405	2:20
4.0		48:00	30:00	24:00	16:00	12:00	4:00	3:03	2:40
4.5		54:00	33:45	27:00	18:00	13:30	4:30	3:255	3:00
5.0		60:00	37:30	30:00	20:00	15:00	5:00	3:48	3:20
6.0			45:00	36:00	24:00	18:00	6:00	4:33	4:00
7.0			52:30	42:00	28:00	21:00	7:00	5:18	4:40
8.0			60:00	48:00	32:00	24:00	8:00	6:03	5:20

Note: All times in minutes and seconds
Note: Interpolation may be used in this table

Sector Search Pattern

Introduction

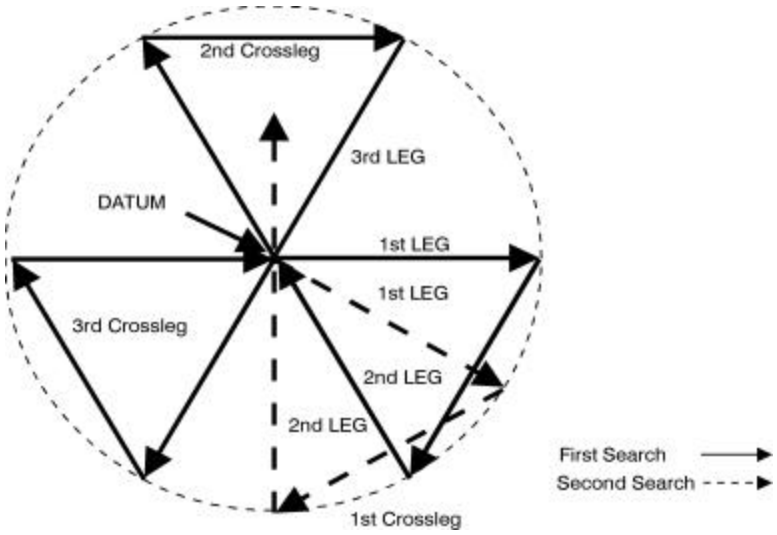
A Sector (V) search pattern is used when datum is established with a high degree of confidence and the target is difficult to detect. The search unit passes through datum several times; each time increasing the chance of finding the target. The pattern resembles the spokes of a wheel, with the center of the wheel at datum. It is the only pattern with a circular area of coverage. The datum may be marked with a floating object such as a DMB. A 60° sector search is normally used which consists of nine legs. The first leg is usually in the direction of the search objects set. Although the center of the search area is covered very well, the outer limits of the area are not covered as well.

Second Search

If you complete one or two Sector searchs with no results, consider using another pattern, i.e., Square or Parallel for more uniform coverage of the area. If a second sector search is performed, shift the pattern 30° to the right. For coverage factor and POD calculations the track spacing of a Sector search is considered to be one-half the radius.

Diagram

This diagram shows the Sector search pattern.



Sector Search Calculations

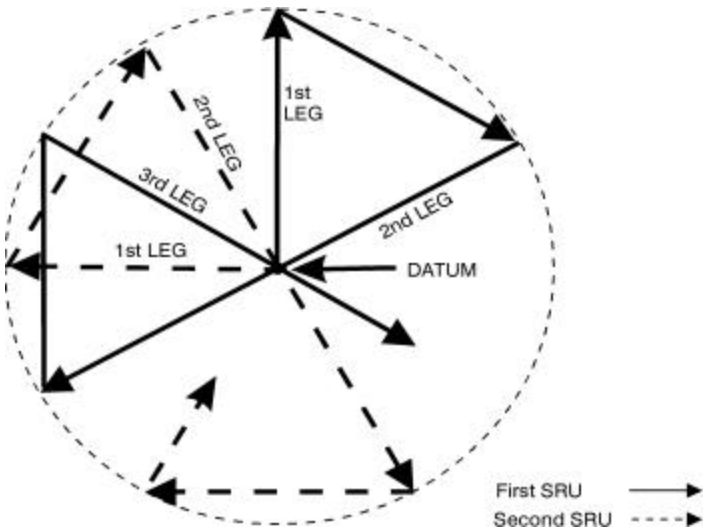
1. To determine the distance traveled in a search, multiply the radius (r) by 9. Total trackline miles = 9r.
2. To determine the total time for a search, divide the total trackline miles by the SRU's search speed.

Radius	Speed (kts)								
	3	5	8	10	15	20	60	80	90
0.5	10:00	6:00	3:45	3:00	2:00	1:30	0:30	0.225	0:20
1.0	20:00	12:00	7:30	6:00	4:00	3:00	1:00	0:45	0:40
1.5	30:00	18:00	11:15	9:00	6:00	4:30	1:30	1:075	1:00
2.0	40:00	24:00	15:00	12:00	8:00	6:00	2:00	1:30	1:20
2.5	50:00	30:00	18:45	15:00	10:00	7:30	2:30	1:555	1:40
3.0	60:00	36:00	22:30	18:00	12:00	9:00	3:00	2:18	2:00
3.5		42:00	26:15	21:00	14:00	10:30	3:30	2:405	2:20
4.0		48:00	30:00	24:00	16:00	12:00	4:00	3:03	2:40
4.5		54:00	33:45	27:00	18:00	13:30	4:30	3:255	3:00
5.0		60:00	37:30	30:00	20:00	15:00	5:00	3:48	3:20
6.0			45:00	36:00	24:00	18:00	6:00	4:33	4:00
7.0			52:30	42:00	28:00	21:00	7:00	5:18	4:40
8.0			60:00	48:00	32:00	24:00	8:00	6:03	5:20

Note: Time to complete one leg (t) in minutes and seconds
Note: Interpolation may be used with this table

Two-Units

Victor Mike (VM). The VM pattern is used when two SRUs are available. As the first SRU begins a Victor Sierra search, the second begins its pattern at datum in a direction 90° to the left of the first leg of the first SRU. If the SRUs arrive at datum to begin the search at the same time, the second starts at a lower speed than the first. When the first SRU is about one leg ahead of the second, the second accelerates to search speed. The slow start of the second SRU prevents the SRUs from arriving at datum at the same time. When both have completed one VM pattern, the coverage is the same as if a single SRU had completed two VS patterns.



The sector search pattern becomes too complicated for more than two SRUs. When more than two SRUs are available, consider using a multi-unit parallel track (PM) search pattern, or dividing the search area into smaller areas and conducting single unit searches.

Initial Search Effort Procedures

Introduction

Both the single unit sector and square searches are used as initial search efforts once on scene. Upon arrival on scene, and deciding a search is necessary, decide which search will be most effective. The following procedures will assist in an initial search.

NOTE: For the 47' MLB .25nm is an effective track spacing for an intial search in good conditions.

1.	Deploy datum [within 100yds of on scene position]
2.	Fix position [use GPS (Event Button – note WPT #)]
3.	Check search area on chart to make sure there are no hazards to navigation.
4	Advise Station(SMC) of On Scene Wx
5	Note Depth of Water
6.	Brief Crew Assign Lookouts
7.	Determine direction of drift. If drift cannot be determined use (000 C) for first leg.
8.	Use Lookouts effectively [for night operations use illumination]
9.	Start Search in direction of Drift [with in 5 min of arrival on scene]
10.	Conduct Search Pattern Safely [Follow Nav Rul, Aton]
11.	Maintain Course and Speed [do not correct for set & drift]
12.	Turns completed within 15 sec of DR
13.	Fix final position of datum. Pass info to Station(SMC) Use GPS to determine Set and Drift.

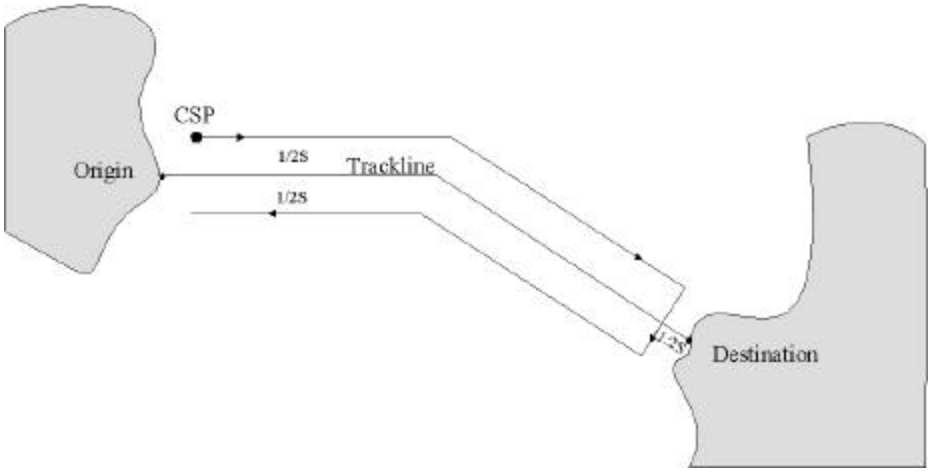
Trackline Search Pattern

Introduction

A Trackline search pattern (T) is used when the only information available is the search target's known or projected trackline. This search pattern is usually the first search action since it is assumed that the target should be near its track where it will be easily seen or can signal the SRU if needed. Searching a datum line (intended trackline corrected for drift) should be evaluated since it can be a return or non-returning pattern. If a single-unit non-return (TSN) is conducted, the SRU searches down the trackline or datum line. For a single-unit return pattern (TSR), offset the search legs one-half track space (S) either side of the track/datum line.

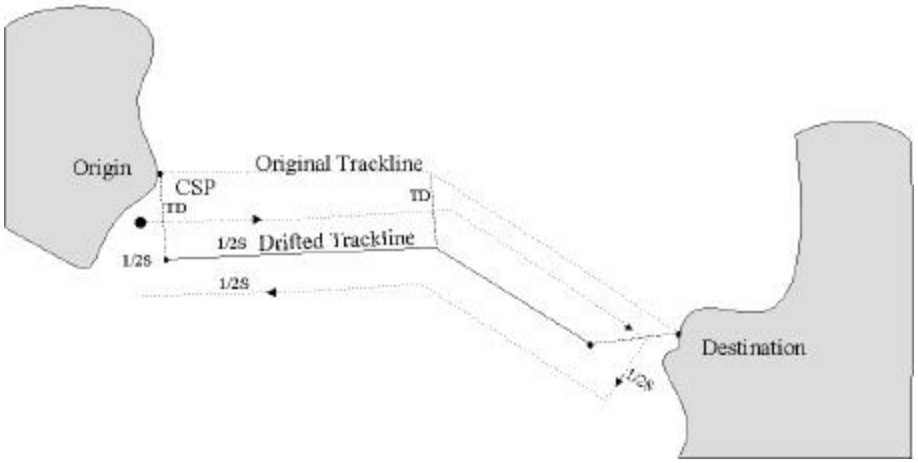
Diagram

This diagram shows the TSR Original Trackline.



Diagram

This diagram shows the TSR Drifted Trackline.



Parallel Search Pattern

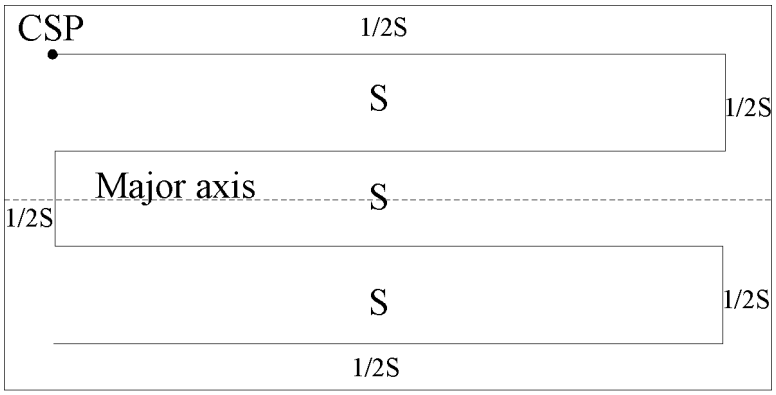
Introduction

A Parallel search pattern (P) should be used when the search area is: large, there is equal probability of the target being anywhere in the search area, datum information is fair, and uniform coverage is desired throughout the search area. This pattern should be used when the degree of detection may have an equal probability of being anywhere in the search area.

The search legs are parallel to the search area's major axis (longest side oriented down the set line). Commence Search Point (CSP) is located one-half track space inside the specified corner of the search area.

Diagram

This diagram shows the Parallel pattern.



Creeping Line Search Pattern

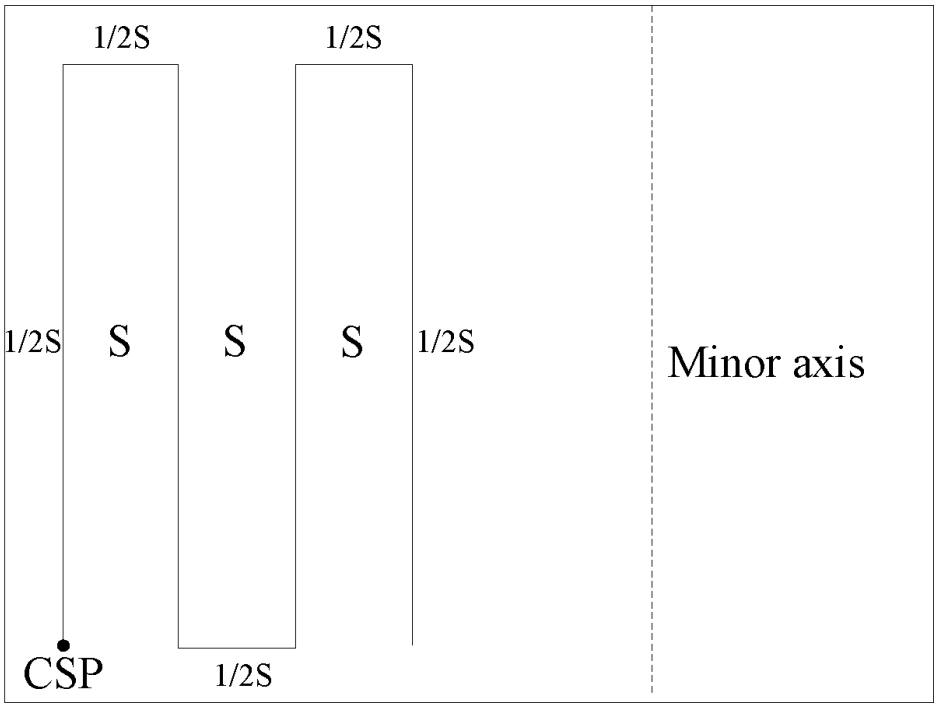
Introduction

A Creeping Line search pattern (C) is used when the search area is large, uniform coverage is desired, datum information is fair, and there is more chance of the target being in one end of the search area than the other.

The search legs are parallel to the search area's minor axis (shortest side of the search area or 90° off of the major axis).

Diagram

This diagram shows the Creeping Line pattern.



Barrier Search Pattern

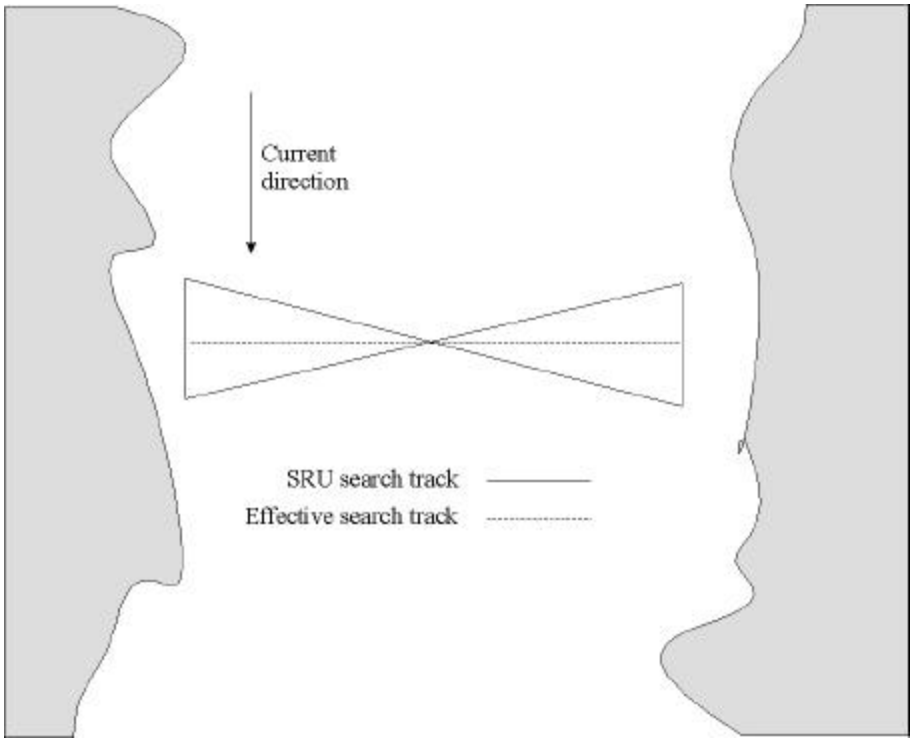
Introduction

A Barrier search pattern (B) is used in an area where a strong current exists. The search area lies perpendicular to the path of the current. There are three versions of this pattern:

- Advancing
- Stationary
- Retreating

Diagram

In this diagram of the Stationary Barrier pattern, the current carries the water past the search barrier. This search is similar to a Creeping Line pattern except the area is moving past the SRU rather than the SRU moving through the search area.



Encl (6) to COMDTINST M16114.24B
UNIT NAME: _____BOAT #_____DATE: _____
COXSWAIN: _____ENGINEER: _____
CREWMEMBER: _____CREWMEMBER: _____
WEATHER DURING DRILL:
WINDS_____SEAS_____CURRENT_____VIS_____
EXERCISE: SEARCH PATTERNS (Drifting Patterns) SCORE: SAT / UNSAT
TERMINAL PERFORMANCE OBJECTIVE: Pilot a CG boat and execute a search pattern.
CONDITIONS: Given a CG Boat with an operational GPS, RADAR, radio, compass, corrected chart of the operating area, certified crew operating within prescribed limitations. The Coxswain will be given a SAR scenario with a position to commence a search pattern.
STANDARD: The Search Patterns shall be commenced within 5 minutes of arrival at CSP within 100 yds of given position. Coxswain shall determine drift prior to starting pattern within 45º of actual drift. Boat shall complete all turns within 15 seconds of stated DR time, in accordance with procedures as set forth in:
Boat Crew Seamanship Manual M16114.5 (series)
Boat Crew Training Manual M16114.9 (series)
41' UTB Operator's Handbook M16114.2 (series)
44' MLB Operator's Handbook M16114.3 (series)
47' MLB Operator's Handbook M16114.25 (series)
Rescue and Survival Systems Manual M10470.10 (series)
Navigation Rules, International-Inland M16672.2 (series)
GPS Operator's Handbook Type specific
RADAR Operator's Handbook AN/SPS 69
CG Addendum to National SAR Manual M16130.2 (series)

Sector search pattern, Single Unit (VS)

STANDARD: The VS pattern will be run in its entirety with track spacing between 200 to 500 yards. The first leg shall be the direction of drift with all turns made 120 degrees to the right, within 15 seconds of their DR time. On the third, sixth, and ninth legs, steer toward the datum marker. The third, sixth and ninth legs shall end at the datum marker regardless of time run, the fourth and seventh legs are run as individual legs.

Expanding Square search pattern, Single Unit (SS)
STANDARD: The SS pattern will be run for a minimum of 5 legs with track spacing provided by the evaluator. The first leg shall be the direction of drift with all turns 90 degrees to the right, within 15 seconds of their DR time.

ENABLING OBJECTIVES:

1. PREPARATIONS: SAT UNSAT REMARKS

a. CSP plotted accurately, safe area determined. (N/P)
b. All courses (compass) and turns calculated accurately within 3º. (P/N/S)
c. DR times and total time to run calculated and stated. (N)
d. Crew briefed on initial SAR check sheet items. (P)
e. Coxswain passed search plans to communications watch. (T/P)

2. SEARCH PATTERN EXECUTION: SAT UNSAT REMARKS

a. Station advised of O/S WX & start time of pattern. (P/O)
b. Crewmember dropped datum marker overboard at CSP. (VS Only) (P)
c. Coxswain determined direction of drift accurate to 45º. (P/N/S)
d. Pattern started within 100 yds of CSP. (P/N/S)
e. Pattern started within 5 minutes of arrival at CSP. (P/N/S)
f. First leg of pattern in direction of drift. (000º C if drift cannot be determined) (P/N/S)
g. Third, sixth, & ninth legs end at datum marker (VS ONLY). (P/S)
h. Sound signals utilized IAW Rules of the Road. (P)
i. Conduct of own vessel IAW the Rules Of the Road. (P)
j. Aids to Navigation identified and utilized. (N)
k. Illumination used. Night vision not compromised. (P/O)
l. Course guidance provided to helm. (N)
m. Speed over ground stated. (N)
n. Turns completed within 15 seconds of their stated DR time. (N/S)
o. On the third, sixth, and ninth legs, steer toward the datum marker. (VS Only) (P/N/S).
p. GPS used as follows: (N)
    1. Save feature used to record position of datum marker. (O)
    2. SOG function used to verify initial speed. (O)
q. Course & speed based on engine RPM and compass course, not adjusted to counter set and drift. (P)
r. Fathometer used to verify depth. (N)
s. Final position of datum marker passed to SMC. (To determine set and drift of datum) (P)

3. CREW TEAMWORK AND COORDINATION: SAT UNSAT REMARKS

a. Coxswain briefed crew of specific job and mission responsibilities. (T)
b. Crew communicated effectively and assertively during evolution. (T)
c. Crew assisted each other as needed. (T)
d. Crew always aware of other's location. (T)

e. Coxswain provided appropriate and timely guidance throughout evolution. (T)
f. Crew safety and survival equipment properly worn. (P/T)
g. Safety of vessel and crew not jeopardized. (T/S)
h. Coxswain kept station informed during evolution. (P/T)

47ft MLB Surf Operations Class

Updated 2003

TERMINAL PERFORMANCE OBJECTIVES

While underway on a MLB in 6-8' surf, with minimal instructor guidance, operate the MLB using breaker avoidance techniques IAW COMDTINST M16114.14, Division One.

Demonstrate ability to station keep in surf.
Demonstrate ability to transit outbound on an inlet or bar.
Demonstrate ability to transit inbound on an inlet or bar.
Demonstrate ability to transit beam seas.
Demonstrate ability to enter, transit, and depart a beach surf zone.
Demonstrate ability to operate 47' MLB with stern square to surf.
Demonstrate ability to recover a simulated person in the water.

SRF-01-09-TYPE	Conduct Pre-Mission Sortie Planning for Surf Operations
SRF-01-02-TYPE	Conduct Safety Rounds, Vessel Systems Checks, and Crew Brief Related to Surf Operations
SRF-01-03-TYPE	Determine the Position of a Boat in 8-15 Foot Surf
SRF-01-04-TYPE	Maintain Stationary Position, "Station Keep", in 8-15 Foot Surf Using the Bow-To Method
SRF-01-05-TYPE	Transit Outbound an Inlet or Bar Through 8-15 Foot Surf
SRF-01-06-TYPE	Transit Inbound an Inlet or Bar Through 8-15 Foot Surf
SRF-01-07-TYPE	Lateral Across a Surf Zone Beam to 8-15 Foot Surf
SRF-01-09-TYPE	Conduct a Person In the Water (PIW) Recovery in 8-15 Foot Surf

Things You Must Understand

Life Saving Vessels fulfill their function under conditions, which, for other craft and equipment, are regarded as extreme – to be avoided, if possible. Thus, the concept of "Acceptable risk of failure", cannot apply. It is when other vessels have failed that the lifesaving vessel must work.

G. Klem, Senior Research Engineer,
Norwegian Ship Research Institute.

Before attempting surf training or surf operations you must have a thorough understanding of your environment, your equipment, your crew and yourself.

Waves

How are waves made?

Imagine a small pond, with no wind blowing on it, just pure calm glassy water. Now toss a pebble into the center of the pond. Once the pebble makes contact with the water, notice that small ripples move out in all directions from the point of impact. The ripples continue traveling away from each other until they encounter land, where they break (if you look real close) and dissipate. There's three things to consider from this example: 1) The ripples have a measurable size or height, 2) They travel towards shore with a measurable speed, and 3) They cover measurable distance that spans from their point of origin until they reach the shore.

After the pond calms down, throw a bigger rock into it. Of course bigger ripples result. Observe that the ripples have a larger height and are moving away from their source faster this time. If you toss yet a bigger rock, bigger and faster waves result.

Congratulations, you know all the basics about wave mechanics. But how does this translate into the real-world of open ocean swells?

Waves Cont.

Simple, the ocean is our pond, and a storm is our rock. All the same principles apply, just on a much grander scale. Our pond is now 3000 or more miles wide and our rock is now 500 or more miles wide.

Seismic

Earthquakes or underwater landslides generate a Tsunami. When a seismic wave is in deep water it may go unnoticed by vessels. When it approaches the continental shelf and shallow water, it rises up dramatically, often causing widespread destruction to low lands and port areas. As a rule, if a seismic wave is forecasted, you should head to water 50 fathoms or greater. If there is no time to reach safe water, move inland to high ground.

Tidal

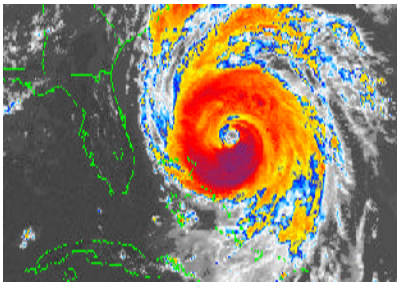
Tidal waves are misunderstood and rarely identified. Not to be mistaken with a Tsunami, the gravitational effects of the Sun and Moon form tidal waves. Rarely will you actually see these waves. Some places in the world these waves take the form of a tidal bore.

Wind Generated

Imagine our little pond again, only this time notice a slight breeze is starting to blow towards you (maybe at 5-10 kts). It's starting to texture the surface of the pond, nothing really measurable, but texture none-the-less. How is this happening? In short, molecules of moving air being pushed by the breeze are rubbing against the surface of the water causing some water molecules on the surface to move in the same direction as the wind. As a few molecules of water start moving, they collide with others setting them in motion, as the air keeps moving so does the water. It's just basic friction.

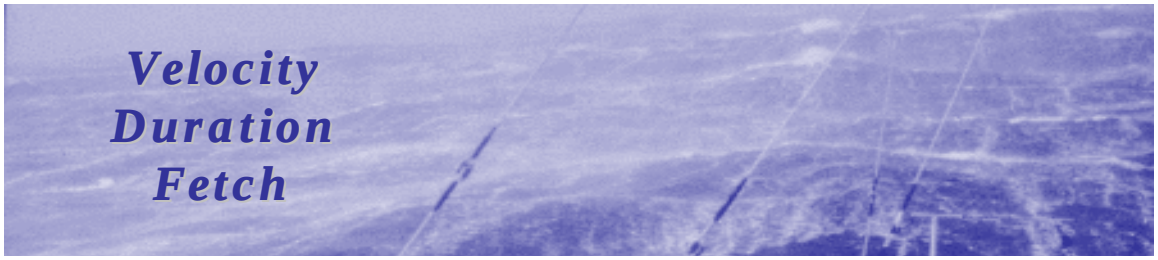
Now imagine the wind is kicking up a bit more, like 20 kts. As would be expected, the water texture turns a bit choppier as more and more molecules are set in motion. Over distance, the little chops start merging to create larger chops. As chops combine, the energy present in each one creates a larger and more energetic chop. The more energy, the faster the chop moves. The little chops have height, and they travel with a measurable speed. If you could follow an individual one, you could measure the amount of time it takes to travel from one side of the pond to the other. As the wind continues to pick up, now to nearly gale force (34 kts), the chops are starting to whitecap and it starts to look downright stormy. The chops start combining into wind waves, and are bigger and faster still, and have more momentum and energy associated with them.

But let's consider a real open-ocean storm. Some storms are small in size but have very strong winds, while others are huge in size but have comparatively less wind velocity. Hurricanes are relatively small storms, that is, they rarely exceed more than 500 nautical miles in diameter, but can have maximum sustained wind speeds of over 150 mph over a small area near the center.



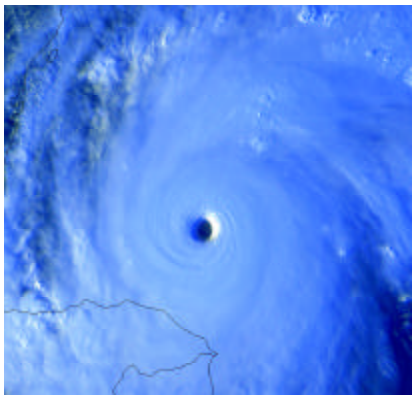
Conversely, strong winter storms can cover well over a thousand miles but typically have sustained wind speeds of only 50-60 kts. Both are capable of making big wind waves, but not all wind waves are the same. Swells are the waves after the wind has died or the energy has left the area of wind.

Wind waves lose energy and height after they move away from the wind that produced them. What? That's right, wind waves start degenerating once they move away from the wind source that created them, unless enough underlying energy is present to transform the wind wave into a swell. If it accumulates enough energy while it's within the influence of the storm, it will be able to survive once clear of it's source. When there is not enough energy, it will dissipate due to friction with the calm water that it moves through. With enough energy, it can travel the entire circumference of the globe with little loss in size!



Wind Velocity, Fetch, and Duration is the speed of the wind, the amount of ocean surface area affected by wind blowing in the same direction, and the amount of time the wind blows over the same part of the ocean. Ideally, to make a huge swell, one would want strong steady winds blowing at maximum velocity over thousands of miles in the same direction for days on end. But, our atmosphere is highly dynamic, and rarely do such conditions exist or persist for long. During a typical open ocean winter storm, one could expect to see winds of 50-60 kts blowing for 600-1000 nm for 36 hours. In such a storm, the highest average wind waves (or seas) can commonly reach 30 ft towards the center of the fetch area.

OK, so storms make large seas, but how does it actually transform into a swell? As the seas build under a storm, the speed of individual wind waves start accelerating as they combine. The higher the wind velocity, the larger the area, and the longer the wind blows, the greater the opportunity wind waves have to combine and grow. Within the storm, waves of many different energy levels are created. Eventually either the storm dies or the wave speed exceeds the forward speed of the storm, and these seas escape into relatively calm waters. However, they are rough, ragged and cover a wide energy spectra.



Each individual wave is a mass of chops, bumps, and unruly, un-groomed energy. Now the waves have inertia and they're moving forward. Earlier it was mentioned that chop has little inertia or energy, so it dissipates when traveling long distances. This works against swell production when a wind wave has little energy, because it dissipates. However, when a wave has lots of time to accumulate energy, inertia works in its favor. In short, as a wind wave moves away from the storm, the choppy components dissipate, leaving only the pure swell energy to travel.

Virtual or Dynamic Fetch

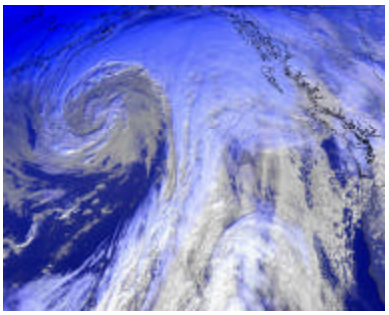
Virtual/dynamic fetch occurs when a storm moves at the same speed as the waves it is generating. An indicator of virtual fetch is rapidly building waves out of proportion to the existing winds. An example of this was seen on March 27 1997, in the gulf of Alaska, when sea conditions built from 12-15 ft to over 40 ft in just 12 hours, while maximum wind speeds recorded were 36 knots over the same period.

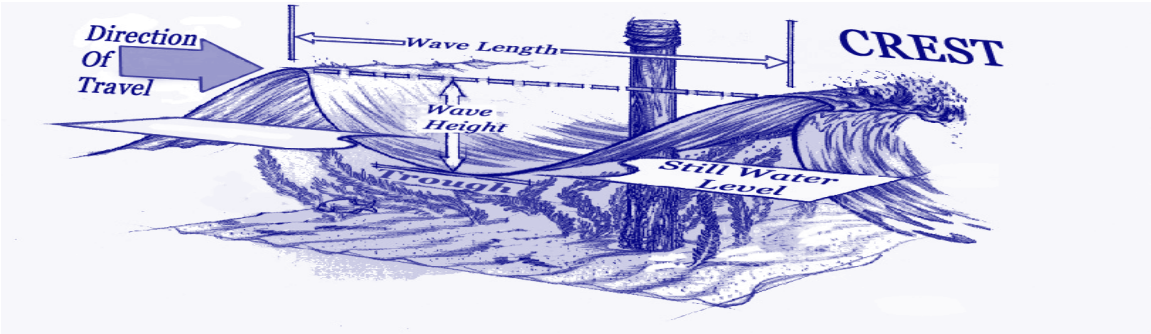
Previously fetch was defined as the unobstructed distance of ocean affected by winds blowing in the same direction. A person might presume that a storm sits relatively stationary or moves slowly over a fixed area of the ocean, blowing up chop and waves equally in all directions. In reality, most large storms (other than hurricanes) typically follow the jet stream, taking a course from west to east at anywhere from 10-25+ kts. In some instances, a storm's forward speed comes close to matching the speed of the waves it's generating. This allows progressively more chop (and energy) to pile up on top of wind waves generated early in the storms lifecycle (providing the waves are traveling in the same direction the storms is heading).

Virtual fetch is bound by meteorology and simple geography. There are only a few west-facing locations in the world which are bordered by several thousand miles of open ocean and positioned near the tracks taken by winter storms. Such locations include the Northwest United States.

To an extent hurricanes create virtual fetch too, but since their fetch area is typically much smaller, the effect is less pronounced. Because some level of virtual fetch occurs in most every storm, this explains why the largest waves come from the front of the storm, and smaller or no waves come from the sides and back of a storm.

For example, a storm might have only 700 nm of fetch. If the storm travels 2,000 miles, heading in a constant direction at the right speed, the effective fetch area becomes 2000+ nm. The wind waves aren't given the chance to escape, but rather, build up to tremendous heights averaging 50 feet or more.





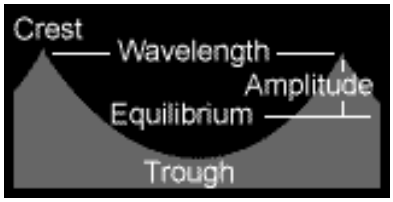
Definitions and Terms

What common units of measure are applied to open ocean waves?

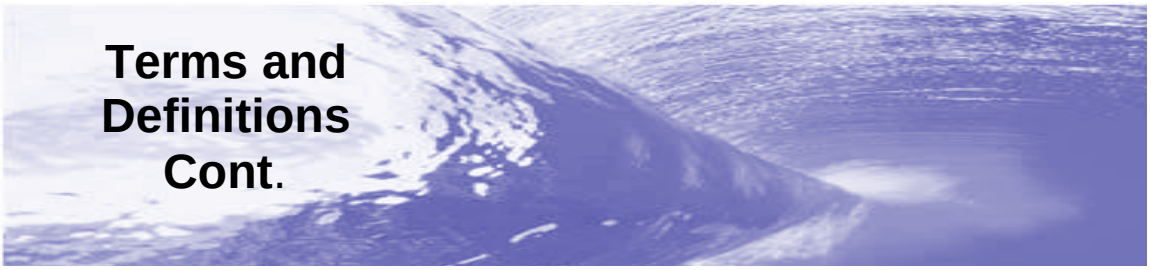
There are two attributes used to measure open ocean waves: **Height** and **Period**. Wave height is the distance from a wave's trough to its crest (i.e. amplitude). The crest is the top of an unbroken wave, the trough is at the bottom of the front of the wave. Wave period is the amount of time (in seconds) it takes from the moment one wave crest passes a fixed point until a second wave crest passes that same point. Typically one will hear waves described like, " It's 5 ft @ 13 seconds". What this means is that the average height of the largest 33% of the waves are 5 ft and that the average period (time between wave crests) of the most prevalent swell is 13 seconds. But waves measurements come in two types:

Significant Seas and Swell.

"Seas" are the combined sum of the heights of all waves present at the reporting station. Think of it as the average wave size. For example, it



there is a 5 ft swell coming from the north, and a 3 ft swell coming from the south, it would be reported as a 6 ft sea. ('Seas' are actually the square root of the sum of the squares of all wave energy present). Add in a bunch of open-ocean chop and it really starts to skew the results. If you're in a boat at sea, significant sea heights are very important. They help set an expectation concerning the size of waves you might encounter. If you're in or near a major fetch area (a storm), waves of different heights and period momentarily combine as they pass through each other to form larger waves. It makes no difference whether it's chop or swell. On average, about 15% of waves will equal or exceed the significant wave height. The highest 10% of waves could be 25-30% higher than the significant wave height.



Terms and Definitions Cont.

If seas heading towards a shore escaped close to land (say 500 nm or so), only some of the bump would have time to dissipate, and a combination of chop and swell energy would hit shore. But if the storm faded 2000 nm from shore, all chop would fade and clean swell energy would result (assuming there weren't local winds to create new chop). Such swells are known as **ground swells**. Ground swells from winter storms off New Zealand travel over 6000 nm to reach the beaches of southern California. Swells that have more energy move faster than those with less energy. Over long distances, the more energetic swells, and eventually over take and pass less energetic swells. Swells that don't have enough energy eventually die. So, when swells pass a buoy or hit a beach after traveling several thousand miles, the ones with the most energy will arrive first, followed by slower moving ones (perhaps days later). For example, the first waves of a new swell might have a period of 20-25 seconds (sec), followed by 17 sec swells 2 days later, then 14 sec periods and 13 sec periods even days later, and so on.

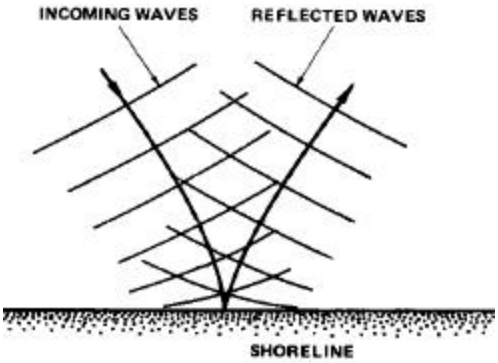
As individual swells move further away from their source (a thousand or more nm), they start to meet up with other swells moving at the same speed. These individual swells start to travel in a group of 2-8 or more waves, known as a **sets**. Traveling in sets actually is more efficient means of moving through water than traveling individually. Each swell takes a turn in the lead position. As the lead swell starts experiencing drag and friction, it falls to the back of the pack, and is replaced by the next wave in-line. If the set has sufficient energy, it can continue with very little loss of size or energy indefinitely, or until it reaches land and breaks. The period from the end of a set to the beginning of the next set is the **lull**. Waves systems maybe made up of multiple sets from more than one direction and more than one wave height.

Warning!
Sets, Wave Trains, or Series, often have a reliable patterns. These patterns change and are effected by the arrival of other sets. Be aware of changing patterns and alert for larger than expected swells.

Terms and Definitions Cont.

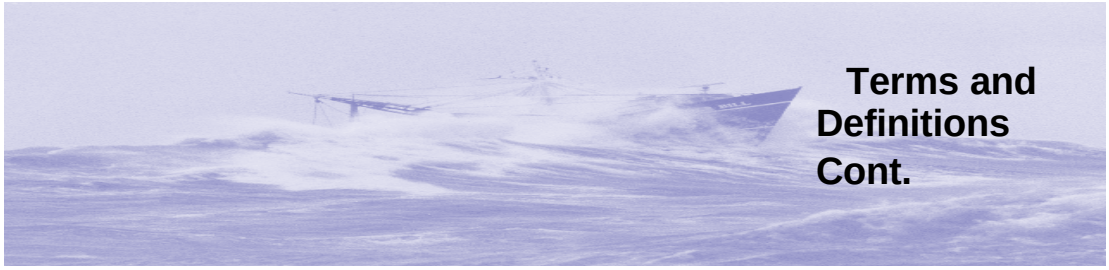
Refraction means bending. Wave refraction occurs when the wave moves into shoaling water, interacts with the bottom and slows down. That is why waves bend or wrap around. Refraction is common in surf zones. The contour of the bottom is the key to refraction. The depth of water and tide state influences these effects.

Reflection occurs when wave energy strikes an object like a cliff or jetty. The wave energy bounces off the object at the same angle it strikes at. The reflected wave energy then moves away from the obstacle and interacts with the other swells.



Interference

Waves, which have been refracted or reflected, can interact with each other as well as with incoming waves, and may be additive or subtractive, resulting in unnaturally high waves. Interference may even result in standing wave patterns (waves that consistently appear to peak in the same spot). Interference can be of particular concern because it may result in a boat being subjected to waves from unexpected directions and unexpected size.



Effects of Current

Flood Current is the horizontal movement of water toward land, caused by a rising tide. The current generally moves in the direction of wave energy. This movement may increase the speed of wave energy at an inlet or bar.

Ebb Current is the horizontal movement of water away from land, caused by a falling tide. An out going or ebb current running across a bar or inlet builds up a more intense sea than an incoming or flood current. The intense sea results because the rush of water out against the incoming ground swell slows the wave speed, wave length, and period. This effect often increases the wave height resulting in breakers.

River Current when combined with a flood or ebb current may cause substantial changes in wave height or generation.

Effects of Wind

Strong winds can have the same effect as strong current. However, wind strength may vary causing shifts in its effect. The main concern with wind may be the effect it has on control of the boat and visibility.

Strong wind has a greater effect on controlling the boat than it does on the bar and sea conditions. With strong winds the 47' MLB tends to lay stern to the wind. This can make handling in the surf or heavy weather more difficult. Care must be taken to maintain control of the bow as it crests through breakers. A strong cross wind will try to take the bow down wind leaving you out of position for the next wave.

Wave Observation

The ability to recognize wave patterns and characteristics is essential to safe operation in surf and heavy weather. A coxswain operating in these conditions must be able to determine the timing of lulls and series, and estimate wave heights accurately. An accurate estimate of wave height is subjective and sometimes difficult to accomplish, but there are a number of methods that, with practice, will give good results.

Height of eye or freeboard

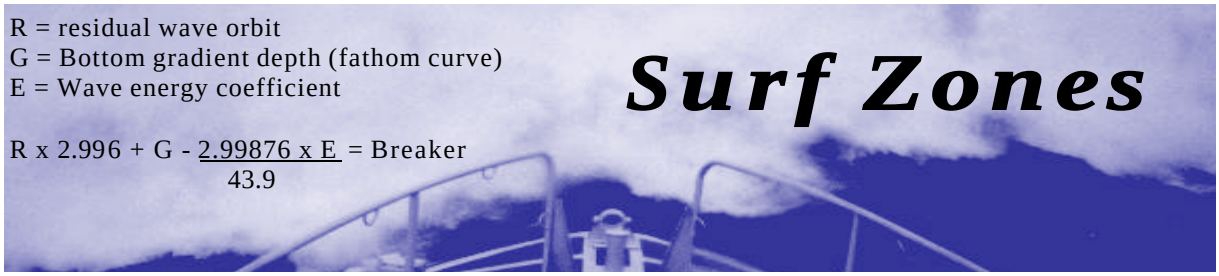
With the boat in the trough and on a level and even keel, any wave that obscures the horizon is greater than your height of eye. The height of eye on a 47' MLB is about fourteen feet while seated at the helm or standing on the open bridge. One can also compare a wave to the deck edge or a structure such as the handrail. Observe the wave face while you are bow into it and in the trough on an even keel. This is also generally the best method for judging surf.

Comparison with floating structures or vessels

This technique is most useful when observing from land, but may be applied while underway. If you know that the freeboard of a buoy is 13 feet, you can use that information to determine the height of the waves passing it. A buoy can also be used to determine the wave period. One can observe a vessel underway and by estimating the freeboard of the vessel and observing its motions on the water, you can gain a fair estimate of the seas in which it is operating.

Comparison with fixed structure

Observation of waves as they pass a fixed structure of known height, such as a break-wall, jetty, or pier, can be very accurate and can also provide wave period.



R = residual wave orbit
G = Bottom gradient depth (fathom curve)
E = Wave energy coefficient

$$R \times 2.996 + G - \frac{2.99876 \times E}{43.9} = \text{Breaker}$$

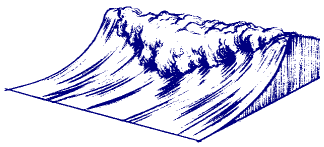
Surf Zones

What Causes Surf?

When deep-water waves move into shallow water, the bottom influences the waves, becoming shallow-water waves. In the approach to shore the interaction with the bottom causes the wave speed to decrease. This decrease causes refractions, and one effect is to shorten the wavelength. As the wavelength decreases, the wave steepness increases and the wave becomes less stable. Also, as the wave moves into water whose depth is about twice the wave's height, the crest peaks up; that is, the rounded crest of a swell becomes a higher more pointed mass of water with steeper sides. This change of waveform becomes more pronounced as the wave moves farther into shallow water. These changes in wavelength and steepness occur before breaking. Finally, at a depth of water roughly equal to 1.3 times the wave height (the actual formula used to determine when the wave will break is when the height is equal to 80% of the depth ratio, H=.8d), the wave becomes unstable. This happens when not enough water is available in the shallow area ahead to complete the crest and the wave's symmetrical form. The top of the onrushing crest is left unsupported and collapses. The wave breaks, resulting in surf

WARNING!
A 6 meter/20 foot breaker will drop 1,362,000 Kilograms / 1500 tons of water on a boat

Plunging Breakers are created when a wave encounters a sudden decrease in depth, such as a reef or a steep rise of the ocean floor. The momentum caused by the breaking top of the wave will cause the water to curl.



Spilling Breakers are created when wave energy encounters a gentle sloping ocean floor. The spilling breakers normally have a crest of white water spreading down the wave face.

Surging Breakers are created on very steep beaches. The wave builds very quickly and expends its energy on the beach. It is unlikely you will encounter surging breakers while aboard a boat unless you are beaching it on a very steep beach.

Surf Zone Characteristics
In normal operations and especially in heavy weather, there are a number of conditions created in the surf zone and in individual waves of which the coxswain must be aware. These include the following paragraphs.

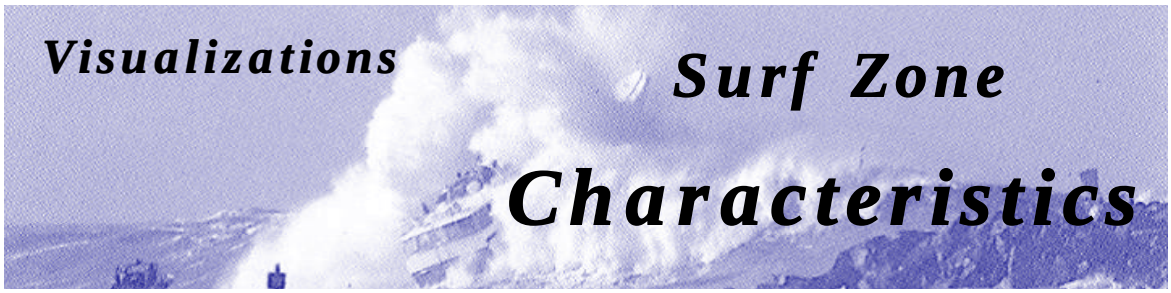
A Window is an area where the waves have momentarily stopped breaking, opening up a safer area of operation for your boat. Windows often form in the area of aerated water where a large set of waves has just finished breaking. The window may remain for a long time or may begin breaking again almost immediately. It is preferable to operate the boat in the windows whenever possible.

The "**High side**" is defined as the section of a wave, which carries the most potential energy. It may be the part that is still building towards breaking point, or it may be the part, which has already broken. The "low side" is where the least potential energy exists and represents the safest direction to turn while running stem-to. These high and low sides often change rapidly, and the ability to quickly navigate the high and low sides is a critical skill for surf operations.

The "**Saddle**" is the lowest part of a wave, bordered on both sides by higher ones. Often it is a small, unbroken section of a wave that is breaking. It is preferable to drive a boat in the saddles if possible, thus avoiding the white water. While saddles are very useful, they must be watched carefully, because they easily turn into "close-outs."

"**Closeouts**" occur when a wave breaks from the ends toward the middle, or two waves break towards each other. The middle may look like a good saddle, but can quickly turn into whitewater. Closeouts should be avoided because they can create more energy than a single break.

The "**Shoulder**" is the edge of a wave. It may be the very edge of the whitewater on a breaker, or the edge of a high peaking wave that is about to break. The shoulder is usually lower in height than the middle of the wave. Driving on the shoulders can be particularly useful in a narrow surf zone because it allows you to drive very close to a break in relative safety.



High Side

Low Side

High Side

Low Side/Shoulder

Window

Shoulder

Close out

Saddle

Surf Zone Characteristics Cont.

Aerated Water

Breaking waves cause aerated water in the surf zone. As the wave breaks, it combines with air, creating "whitewater" on the face of the breaker. As the breaker moves through the surf zone it leaves a trail of pale or white aerated water behind it which takes some time to dissipate. This air-water mix can create changes in a boat's handling, which must be taken into account while maneuvering.

The boat's propellers will not create as much thrust when operating in heavily aerated water. It's response may be greatly slowed. This effect can be recognized by:

Poor acceleration and/or apparently slow throttle response.
Cavitation and/or excessive engine RPM for a given throttle.
Poor turning performance, particularly on a twin propeller boat.

The boat's rudders will not direct the propeller force as effectively, nor will it have as much steering effect while moving through aerated water. This effect can be recognized by:

Poor turning response.
Reduced steering effort, or "light rudders".

Bottom Suction

Operation in very shallow water can be complicated by serious effect on a boat's maneuverability. This effect, caused by resistance to the bow wave as it contacts the bottom, and drag due to the closeness of the bottom to the boat's hull, propellers, and rudders, can be recognized by:

Reduced speed over ground.
Reduced engine RPM for a given throttle position.
Sluggish response to throttle and steering inputs, leading to poor acceleration and poor turning ability.
Larger wake then normal.

Change in trim is caused by the bow riding up on its pressure wave, and stem squat caused by propeller suction. This change in trim can lead to grounding of the stern if the water is shallow enough.

Surf Zone Characteristics Cont.

Ebb Currents

Normally found in surf zones at or near a river entrance. The most dangerous of these for the operator is the Ebb current. This current will make station keeping difficult and can push the boat into an area of larger breaks.

Rips Currents are created along a long beach or reef surf zone. The water from waves hitting the beach travels out to the sides and parallel to the shoreline, creating a "long-shore current" that eventually returns to sea. This seaward flow creates deep channels in the sand offshore that can shift from day to day. In the case of a reef, the channels are permanent parts of the reef, but otherwise behave the same. A rip current may carry a person in the water or a disabled vessel clear of the surf zone or simply carry them in a circle

Warning!
When operating in beach surf special care must be taken to prevent grounding. Cusps are temporary your boat entering a cusp may cause it to close

Cusps are found in surf zones near sandy beaches a “cusp” is an area of the bottom that has been scoured away by wave and current action. In these channels, the waves or surf are usually smaller because of refraction over the deeper water. Because of this, a cusp often represents a safer route into or out of a surf zone. If using a cusp, take great care to stay in the channel by watching the depth sounder. Be alert for debris, which tends to concentrate in these areas.

Shoal Defined by Bowdich is an offshore hazard to navigation on which there is a depth of 16 fathoms or 30 meters or less, composed of unconsolidated material. *Shoal Water*. Shallow water; water over a shoal

Waves break in shallow water. This is obvious when you watch surf breaking on a beach, but it can also occur on shoals where there is still good water in the area. When observing the area you will be transiting look for shoals where breakers are consistent and isolated.

Pay close attention in beach surf zones, a larger than expected series of waves will cause breakers in areas that have not been breaking. Beach surf zones often have irregular bottom contours and the risk of grounding is very real. In beach surf zones look at the color of the water to help determine the water depth. If you see bottom debris, or sand it is very shallow.

Preparations and Tasks

- **Boat Preparations**
- **Crew Preparations and Responsibilities**
- **Lateral Transits**
- **Out bound Transits**
- **Inbound Transits**
- **Man Overboard / PIW Recovery**

Boat Preparations Before leaving the moorings the operator should ensure that:
Complete rounds are made and watertight integrity is set.

All required equipment is onboard and stowed properly. Loose gear underway in the surf or heavy weather creates a hazard for the boats crew and stability of the vessel.

All systems are operating within required parameters. The boat makes full power, apply full power prior to entering the surf zone. It should make full RPMs. The steering is fully functional, operate helm from full port to full starboard to ensure adequate response. It operates astern from full ahead (make sure to stop at detents) apply power astern. The engines should not die and there should be no alarms.

No restrictive discrepancies that could affect the mission and disabling discrepancies should be found.

There is no question in the mind of the crew that the boat and its equipment are one hundred percent ready for operations.

Crew Preparations Any crew operating in heavy weather or surf must be properly equipped.

Required hypothermia protective clothing.
Helmet, (Helmet straps must be secured and adjusted properly).
Boat Crew signal kit properly worn.
Waterproof footwear and gloves should also be worn.

Boat Operations In Surf Cont

Crew Preparations Cont.

Eye protection may be necessary for visibility, particularly for persons wearing glasses, and will also protect against glass shards should a window be broken.

Boat crew safety belt must be worn and adjusted correctly.
Personal seat belt must be worn when in a seat.

The coxswain is responsible for ensuring that all required equipment is worn, and worn correctly.

The crew must be placed where they can use the safety belt pad-eyes, and where they will be protected from the force of oncoming waves. A large breaking wave striking the pilothouse or crewman may cause damage or injury.

The motions encountered in the surf can be extreme, and crewmembers must take care to brace properly to reduce body stresses. A shoulder-width stance with the knees flexed will provide the most safety and comfort. Try to anticipate boat motions, and work with the motion of the boat, rather than against it.

Conduct a Brief

Brief your crew.

Inform them of your intentions and assign positions. Review emergency procedures incase of rollover, knockdown, or mechanical failure. Ensure everyone on board knows where the backup radio is located and what frequency is being monitored. Review emergency procedure for becoming separated from the boat. What to do if you, the coxswain, become separated from the boat. Have everyone double check each others gear for proper wear and condition.

Brief your Unit.

Inform the unit of your intentions. Request a back up resource. Back up resources should be surf capable or able to assist you if you get into trouble.

Brief the Other MLBs.

Let the other boat crews in your immediate area know your intentions. Let other resources in your area know your intentions if a Helicopter is assisting you ensure they know what you are doing and what you need from them.

Boat Operations In Surf Cont

Brief your Shore Lookout.

If you have a lookout, from the beach or a tower, let them know what you are doing. Ensure you have good communications and they have visibility. Have them inform you of large wave sets, debris, or traffic in the area.

Crew Responsibilities

Maintaining a 360-degree watch for approaching waves is critical. The surf zone is a constantly changing, dynamic environment, and the fifth or sixth wave back is often as important as the one that you are immediately faced with. Crewmembers must be alert and familiar with surf characteristics, and a constant high level of communication is vital. The operator must concentrate on positioning the boat to avoid being caught under a breaker, or taking it at the wrong angle. Maneuvering to avoid the breaks is preferable, but if one cannot be avoided, it should be taken bow-on, if possible.

High Side Lookout

Maintains a constant watch to seaward for approaching breakers and any windows that may develop. Area of responsibility is 180 degrees bow to stern.

Low Side Lookout

Maintains a shore side watch, helps the coxswain stay on range. Area of responsibility is 180 degrees bow to stern.

Look Before You Enter

Before entering the surf zone **stop**. Observe the area and look for lulls, windows, wave size, period of waves, and ranges or reference points. Take the time to conduct another round of the boat and engineering plant before you enter the surf.

Boat Operations In Surf Cont

Station Keeping in Surf

Station keeping is maintaining a given position in the surf. Station keeping is necessary to hold position while waiting for a window or lull, or holding position prior to and during recovery of a person in the water. Environmental factors such as the surf, wind, or currents can make station keeping difficult, and good backing skill and proper application of power is essential. The following are guidelines for station keeping:

Use only enough power to maintain position and counteract the force of the oncoming wave. On smaller waves, keeping the bow square with neutral throttles may be all that is needed, while larger waves my require a great deal of power to counteract.

Using too much power will set you out of position and/or launch the boat. Too little power will cause you to be set backwards, or broach the boat. Keep the bow as square to the seas as possible.

Surf Transits

Lateral Transit

It is preferable to make a lateral transit during a lull, when the seas may be smaller. Wait for the last big series of waves to pass and commence the run. In the absence of lulls, great care and patience must be exercised, because you will be dealing with nearly constant beam surf, and the boat is very vulnerable in this position. The operator should use maximum comfortable speed to minimize exposure to beam seas. Speed may be reduced to allow waves to pass ahead of the boat, or increased to avoid a breaker. Good timing, and ability to read several waves back are critical. Any significant waves, which cannot be avoided, must be taken bow-on. There are several techniques to deal with breaking seas on the beam. The suitability of a technique is dependent on the boat type and present conditions.

The operator must have an understanding of the boat's capabilities, as some maneuvers may not be safe or effective in all cases. While here at the National Motor Lifeboat School we will meet breakers on the bow using the following techniques.

Boat Operations In Surf Cont

Lateral Transit Cont.

When it is apparent that the boat is about to be overtaken by a breaker, retain or increase speed and turn to meet it square with the bow. Once square to the wave, the helm must then be returned to amidships and throttles decreased to avoid launching through the crest. Station keep if necessary, and prepare to return to original course.

If a breaker is approaching from ahead of the boat, decrease speed to allow it to pass ahead. Time the maneuver to reach the back shoulder of the wave just as it passes in front. This timing will allow you to quickly get behind the wave and continue the transit, and hopefully avoid the next wave altogether. The crew must be alert for other waves building off the beam.

If a wave is some distance off the beam, you may be able to outrun it by increasing speed. If there is any chance that you will not beat the wave, you must turn to meet it or run away from it if space and time permit.

Outbound Transit

An outbound transit of the surf may be necessary in crossing a bar/inlet or departing a surf zone. The operator should practice wave avoidance by picking a course using windows and saddles, if available, minimizing risk to the boat and crew. The transit should be made at maximum comfortable speed, adjusting to avoid launching over the waves, or avoiding them entirely.

Choose a course using windows as much as possible, zigzagging as necessary to avoid breakers. Stay close to the shoulders of the waves, to take advantage of any window which may open up behind the wave as it passes.

If a breaker cannot be avoided, try to go through the wave at the saddle, where it may not be breaking yet, or the force may be less. If both ends of the wave are breaking towards the saddle, you may be caught in a closeout. Get through the saddle before it closes, or slow down to let it closeout well in front of you.

Any breakers that cannot be avoided should be taken bow-on. Slow down and allow your momentum to carry you through. Do not meet breakers at high speed or you may launch off the back, risking injuries or boat damage.

Boat Operations In Surf Cont

Inbound Transit

It is preferable to transit the surf during any lull period that may exist. Wait until the last big wave in a series has passed and proceed in closely behind it, at maximum safe speed. This reduces the relative speed at which the waves approach, and gives the operator more time to react, as well as getting you through the zone as quickly as possible. It may also provide the best maneuverability for some boats. The operator should attempt to work through the surf zone by driving through windows and wave saddles, thus avoiding the majority of the breakers. Some boats may be fast enough to avoid breakers by maintaining position in a trough or on the backside of a swell while others will eventually be overtaken by every wave as it approaches.

If operating in an area of limiting maneuverability, such as a narrow inlet or bar, the operator may have to rely strictly on timing the waves and make the transit during lull periods. If there is no discernible lull, it may be prudent to wait at sea until conditions improve.

To deal with an overtaking breaker or peaking swell there are a number of techniques, which vary in success and safety based on conditions. An operator must understand the effectiveness and safety of a technique, which is gained from training experience.

Maneuver left or right (lateral) to avoid the breaker completely, by using windows and saddles.

Come about in sufficient time to meet the breaker bow-on.

If you are overtaken by the white water of a breaker, your last resort is to try to get off the wave by applying full throttle, and steering for the "low side" of the wave, hopefully coming out the backside. Do not attempt to ride it out by maintaining course. You must do something. Never forget to drive the boat.

A final option may be to back into the surf zone or across the bar, keeping the bow into the seas. This will be very difficult and time consuming. Excellent backing skills are mandatory. Strong opposing currents in the area may make backing impractical. Also, great care must be taken in shallow water, as the propellers and rudders will hit first if the boat strikes bottom.

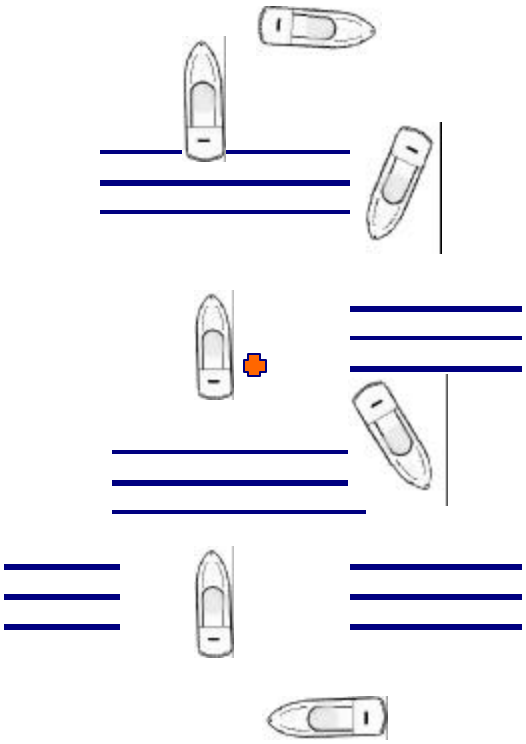
Man Overboard!

Man Overboard/PIW

When faced with a person in the surf you must use all the techniques we have just discussed to get to the person. It is crucial that you not expose your boat or crew to a hazardous situation.

Upon notification of a MOB move ahead and get clear of the PIW. A good rule of thumb is about 50 to 75 feet. A large breaker may push the boat onto the PIW if it is not moved clear. Using the lateral transit and inbound/outbound transit techniques maneuver into position down swell of the PIW.

From this position observe the PIW and the breakers. If the PIW is surfed, back up and stay clear. Maintain your distance until all is ready. When a lull approaches order the crew into the recess. Ensure it is safe for the crew to move into the recess before you give the command. **Communication is extremely important.** Once your crews is in the recess and ready, maneuver into position to recover the PIW. It is extremely important to keep the boat square and to call out breakers for your crew. You have to protect your crew by staying square to the breakers. After the pick up has been accomplished wait for a lull and have your crew move the PIW to the aft deck. Again you must protect your crew, do not allow them to attempt to move aft during a series of breakers.



If you misjudge your approach use the opening and closing maneuvers to adjust you position. If the PIW moves past the aft end of the recess immediately push ahead and get clear. When it is safe recall your crew from the recess and reposition down swell again.