# Drone SAR System

PRESENTED BY GOTOLONDON

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## BACKGROUND

· Mortality in MOB Situation

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·MOB Detector
· Auto-search planner on ECDIS
· SAR DRONES SEARCH PERSON (15MIN)
· SAR Operation(Within half an hour)

## CONCLUSION

# GLOSSARY

| Abbreviations & Acronyms | meaning |
|---|---|
| CSP | Commence Search Point |
| ECDIS | Electronic Chart Display and Information System |
| IAMSAR manual | International Aeronautical and Maritime Search And Rescue manual |
| IR camera | Infrared camera |
| MOB | Man Over Board |
| NM | Nautical Mile |
| OSC | On-Scene Coordinator |
| PA | Public Addressor |
| ROT | Rate Of Turn |
| SAR drone | Search And Rescue drone |
| SOLAS convention | Safety Of Life At Sea convention |
| USCG | United State Coast Guard |

| Term | Meaning |
|---|---|
| Datum | a standard position or level that measurements are taken from in geographic surveying |
| Doppler effect | the change in frequency or wavelength of a wave for an observer moving relative to its source |
| Hypothermia | their body temperature has become dangerously low as a result of being in severe cold for a long time. |
| Muster | they gather together in one place in order to take part in a military action |
| Penetration depth | a measure of how deep light or any electromagnetic radiation can penetrate into a material |

# BACKGROUND

- Mortality in MOB Situation

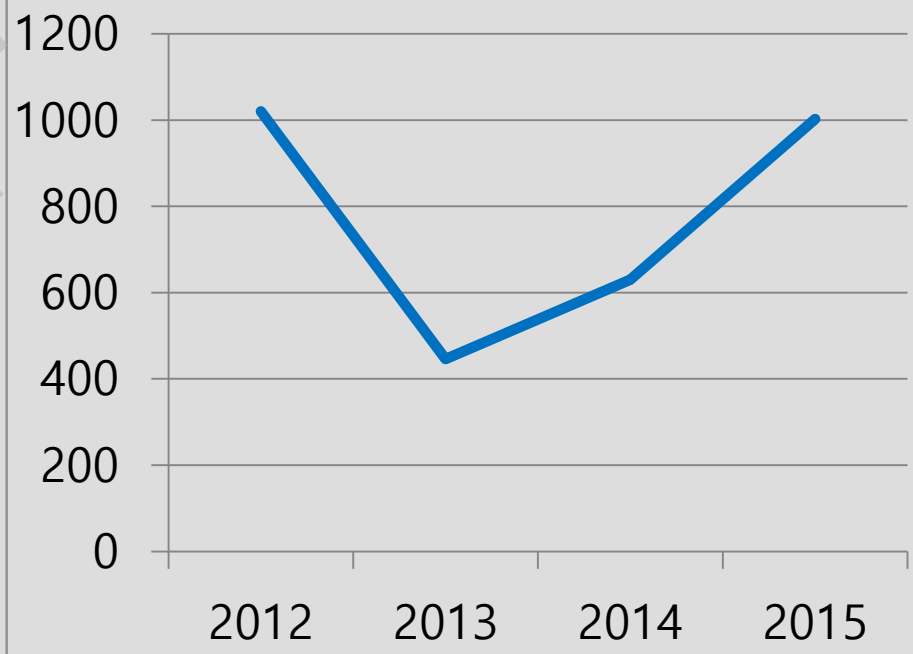
# BACKGROUND

## Mortality in MOB Situation

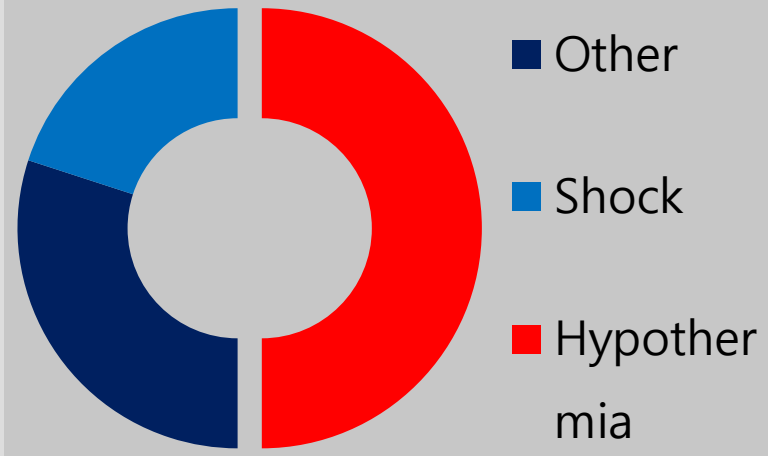
IMO



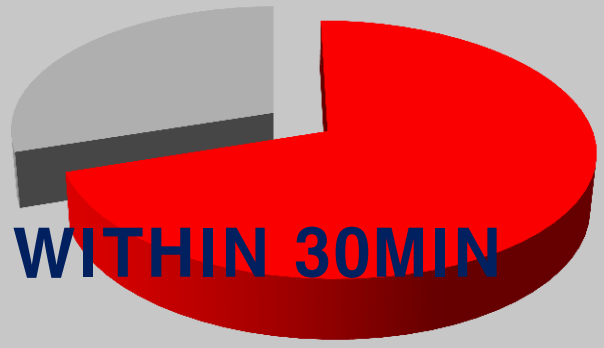
### 1) The death toll by MOB




### 2) Reason




### Due to Hypothermia




**References as below**

https://www.tradewindsnews.com/casualties/
http://www.shipwrecklog.com/log/
https://www.fleetmon.com/maritime-news/
http://www.wkwebster.com/content/casualties.asp
https://icc-ccs.org/piracy-reporting-centre/live-piracy-report

# BACKGROUND

## Mortality in MOB Situation



### Life saving appliance

These appliances are not utalitarian unless man overboard is detected immediately

**Case.1**

**Case.2**

# SUGGESTION

·MOB Detector
· Auto-search planner on ECDIS
· ·SAR DRONES SEARCH PERSON (15MIN)·
· SAR Operation(Within half an hour)

# SUGGESTION General Idea

IMO

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· Goal: Grasp position of person overboard in 15minutes
Rescue within half an hour after falling accident.

Man-overboard Detector ▶ Auto-search planner on ECDIS ▶ SAR Drones Search person (15min) ▶ SAR Operation (Within half an hour)

## CHECKPOINT

### MOB DETECTOR

- Thermo-graphic camera(IR Camera)
- Motion recognizer
- Laser Sensor

### AUTO-SEARCH PLANNER ON ECDIS

- Marking man-overboard position
- Computing datum(CSP)
- Calculating a Search Area

### SAR DRONES SEARCH PERSON(15Min)

- Locate the person overboard
- Keep on positioning
- Prolong survival time

### SAR OPERATION(30Min)

- Single turn
- Muster all crew
- Rescue Boat Stand-by

# SUGGESTION Details

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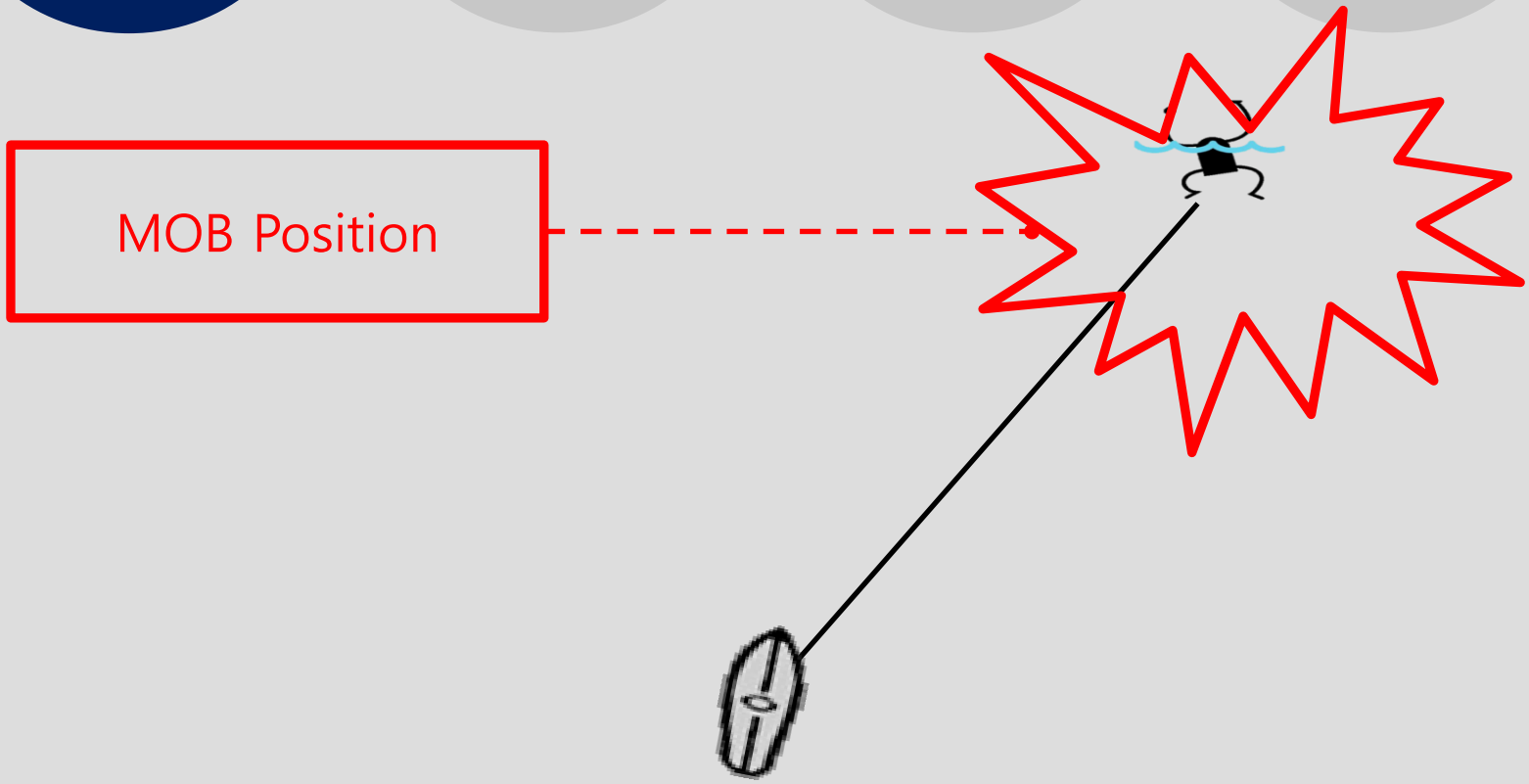
CONCLUSION

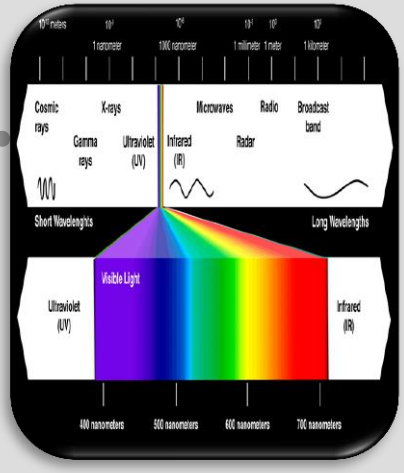
**Man-overboard Detector** → **Auto-search planner on ECDIS** → **SAR Drones Search person (15min)** → **SAR Operation (Within half an hour)**

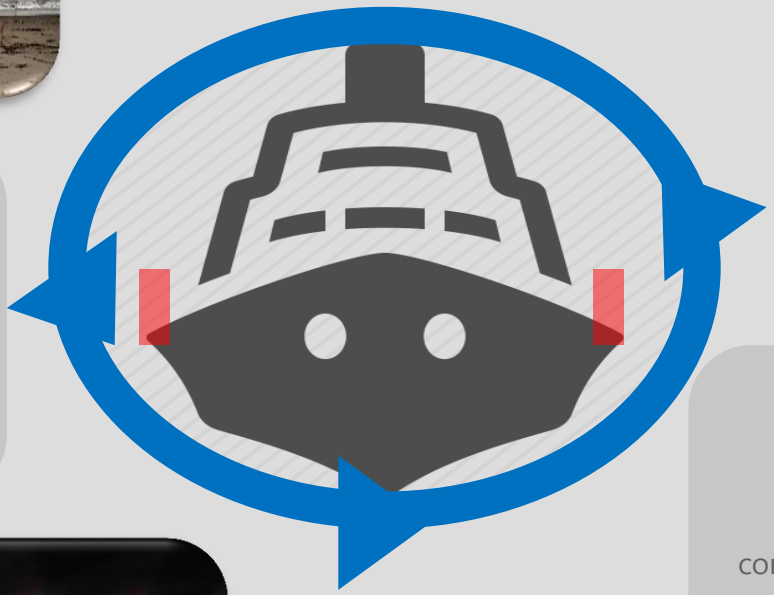


# SUGGESTION Details

## Infrared

: similar to light but has a longer wavelength, so we cannot see it without special equipment.



## Motion

: human motion sensor be able to distinguish human's motion from non-human's motion

## Laser

: a narrow beam of concentrated light produced by a special machine

# SUGGESTION Details

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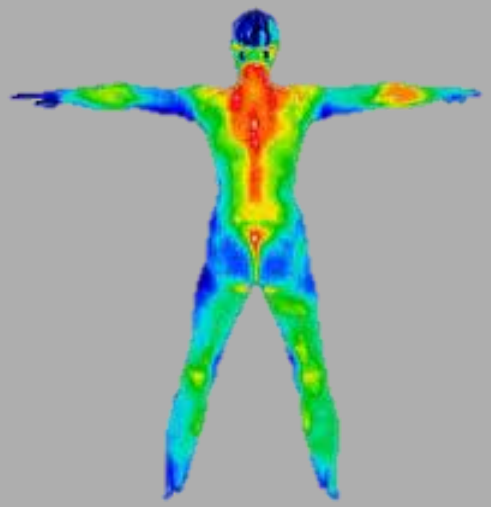
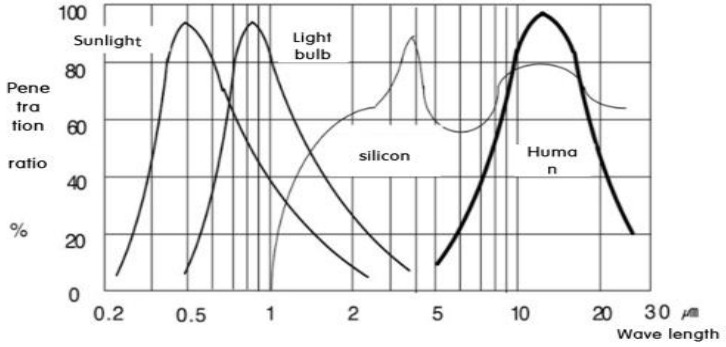
Infrared and human falling motion detecting camera

# SUGGESTION Details



## Sensing Infrared






Graph

## Application example

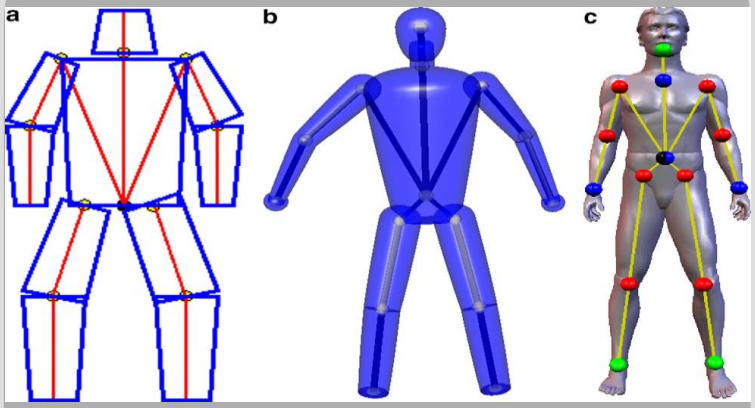
Example. 1

Example. 2

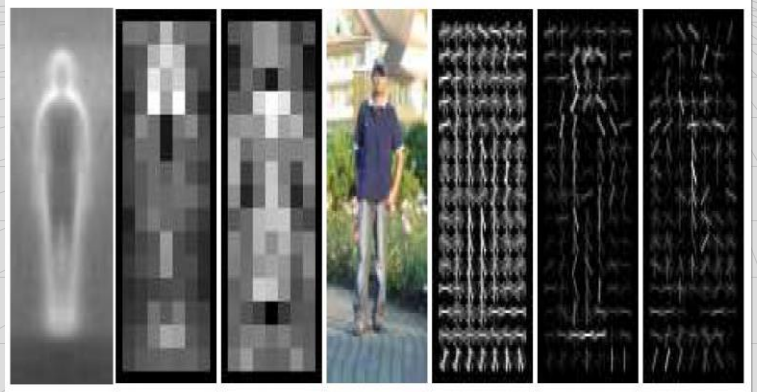
# SUGGESTION Details



## Sensing Motion




Computer vision-based human motion



Histograms of Oriented Gradients

## Application example

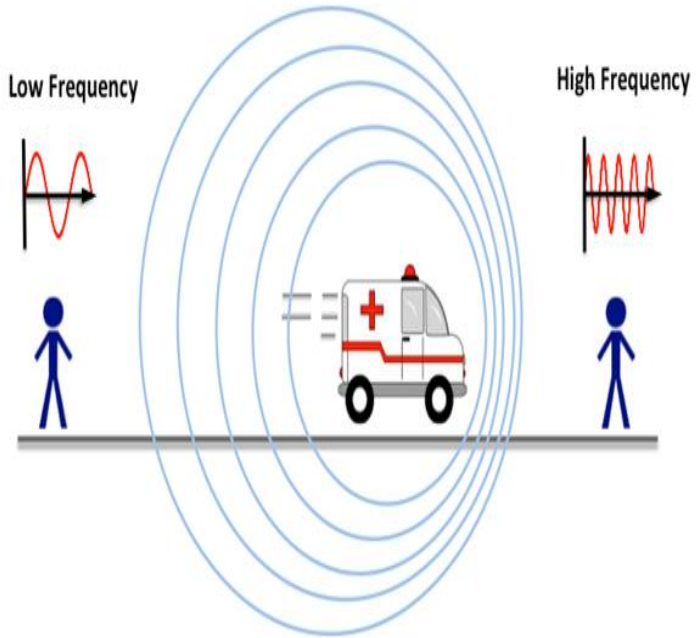
Example.1

Example.2

# SUGGESTION Details



## Sensing speed




Principle

## Application example

Example. 1

Example. 2

$$v = \sqrt{2gh}$$

(Where v = velocity , g = gravitational acceleration , h = freeboard height)

# SUGGESTION Details

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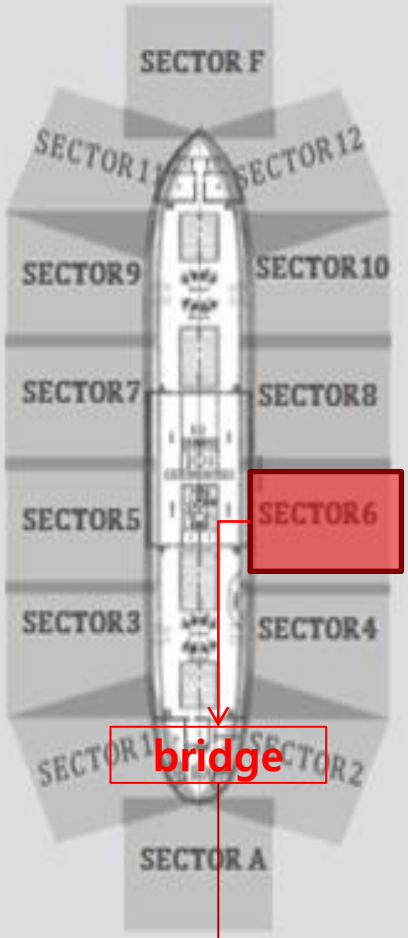
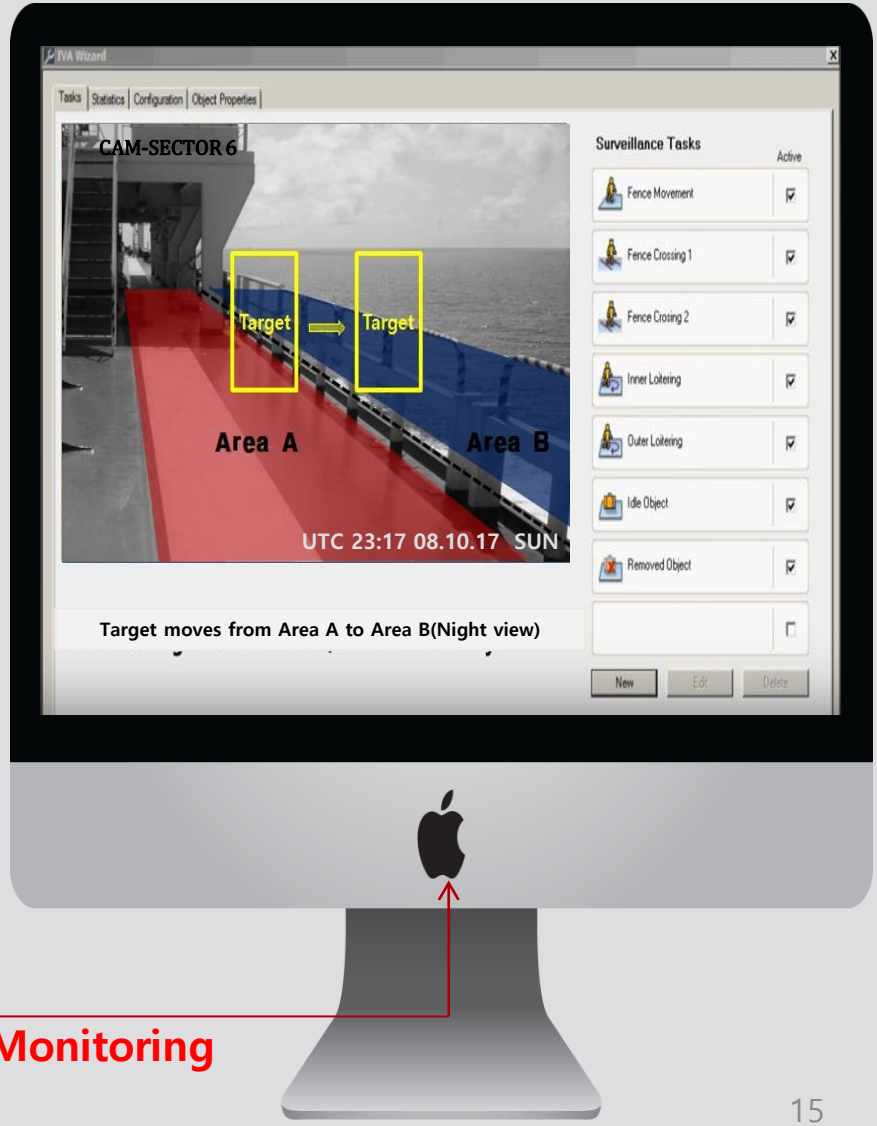
CONCLUSION




Monitoring

# SUGGESTION Details

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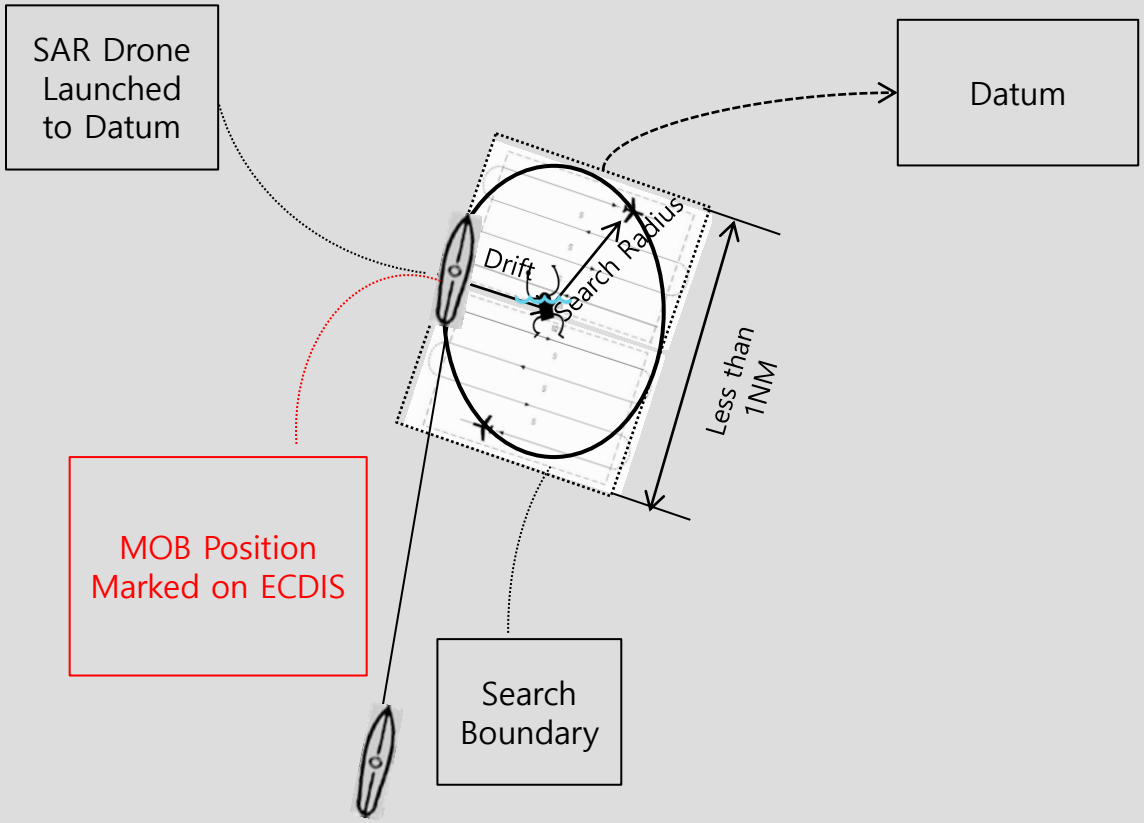
CONCLUSION

**Man-overboard Detector** → **Auto-search planner on ECDIS** → **SAR Drones Search person (15min)** → **SAR Operation (Within half an hour)**



# SUGGESTION Details

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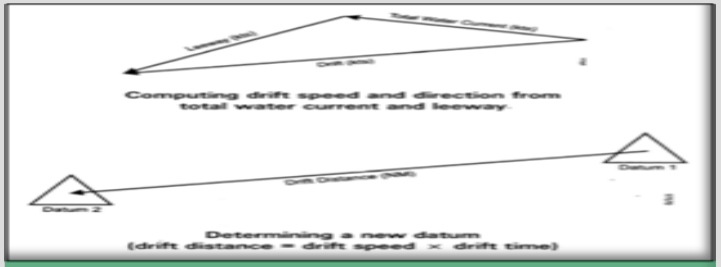
**Marking man-overboard position**

The sensing system gives a signal to ECDIS so that it can mark MOB Position on the chart promptly.




**Computing the datum**

According to IAMSAR Section 3 On scene co-ordination Planning and conducting the search Datum

**Calculating a Search Area**

At the same time, it determines which search pattern is the best way to find the person overboard.

# SUGGESTION Details

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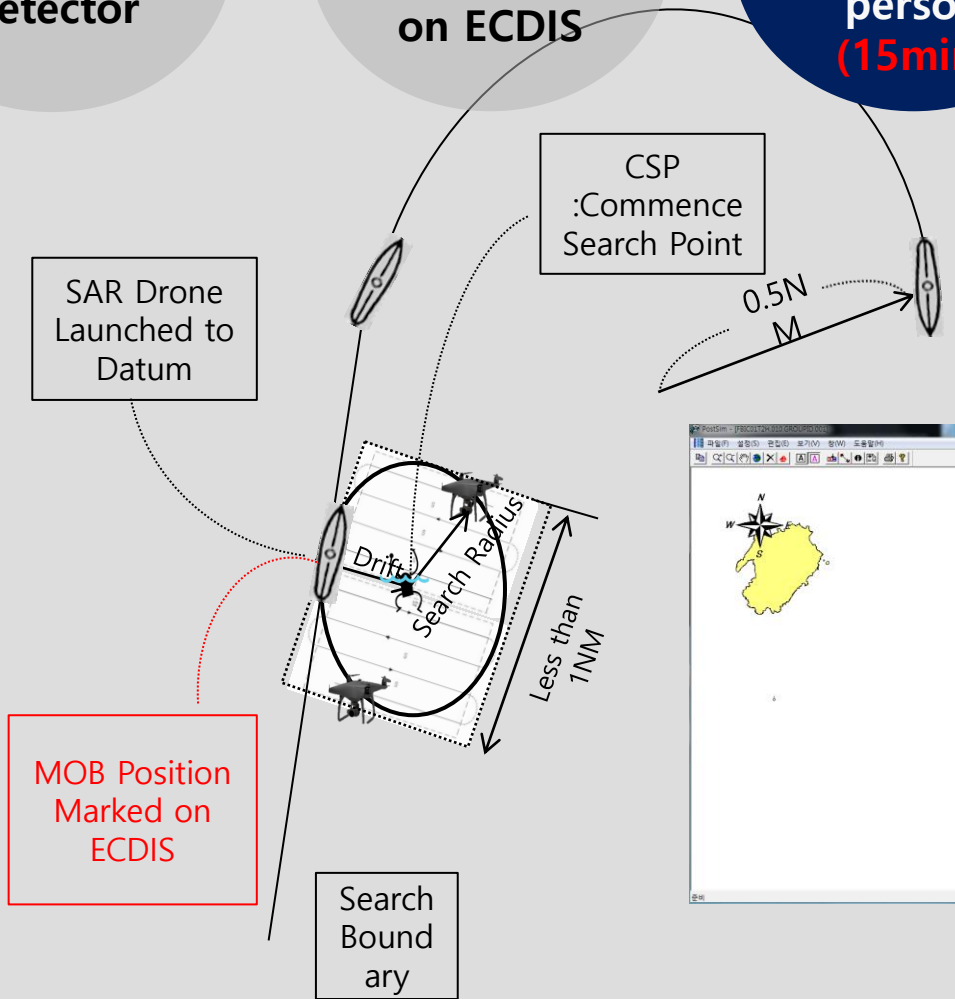


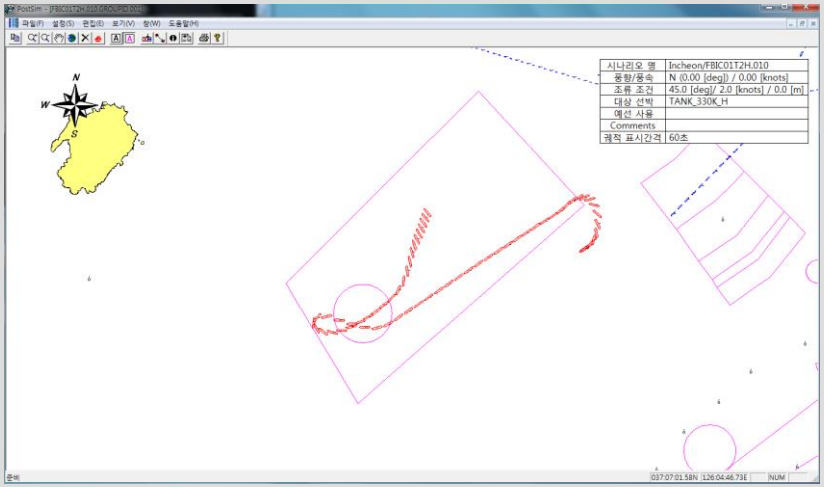

# SUGGESTION Details

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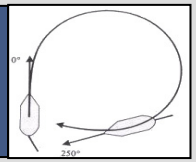
Man-overboard Detector → Auto-search planner on ECDIS → SAR Drones Search person (15min) → SAR Operation (Within half an hour)

"Comprehensive understanding of the situation" by analyzing monitoring records is required

**SAR Operation**
: Recovery of the person in the water

Single turn



Muster all crew By announcing(PA)

Everyone on-board?

No

Yes

Rescue Boat Stand-by

Finish Mustering

"Ship should be heading for the datum"

# SUGGESTION Details

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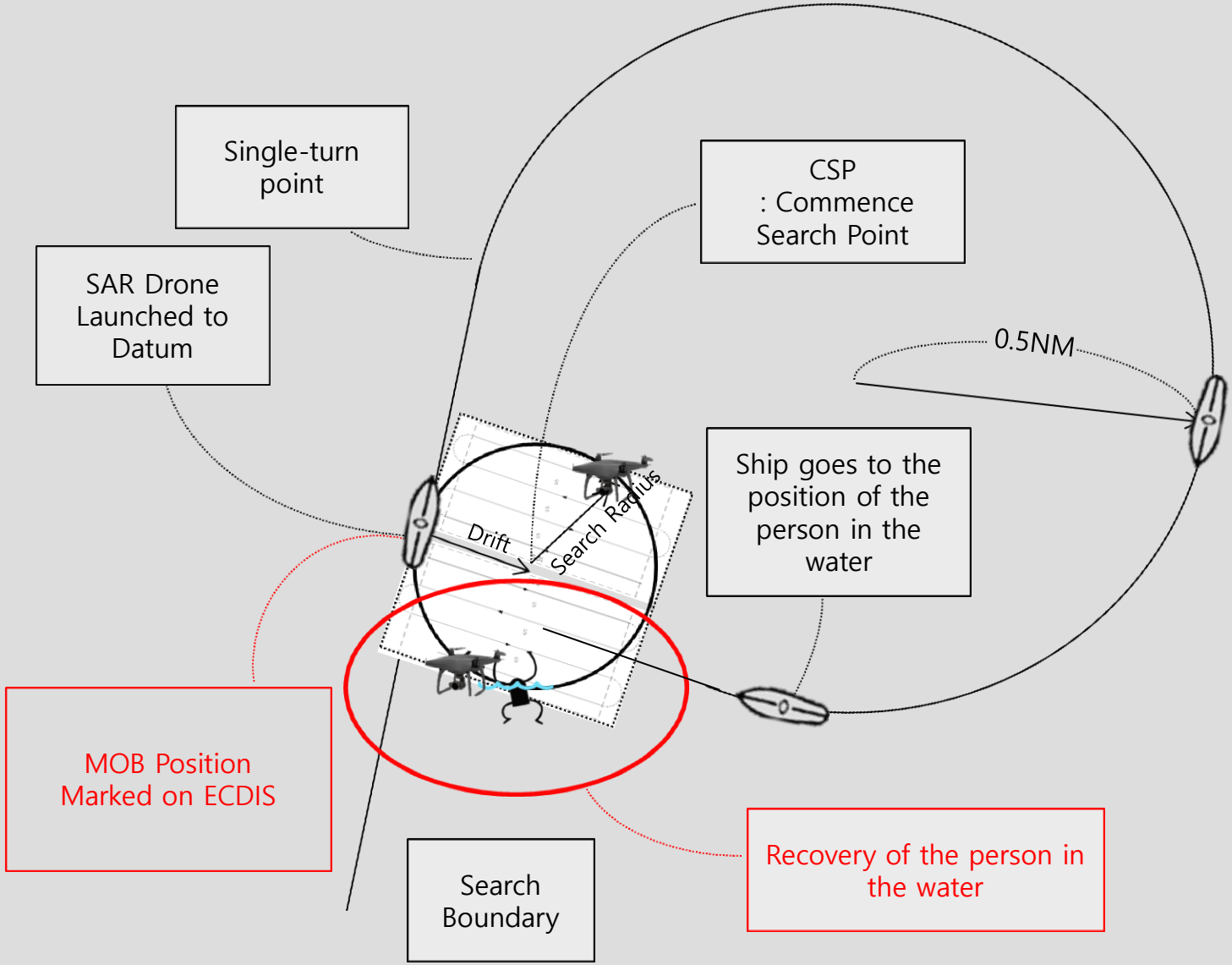

# SUGGESTION Details

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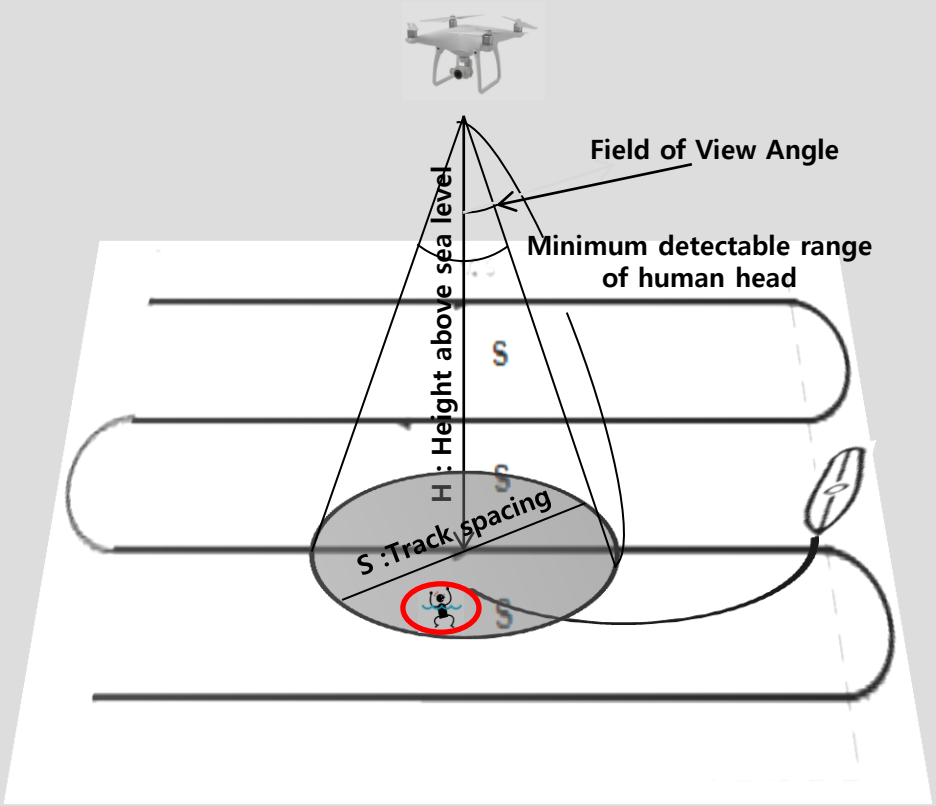
## THE IAMSAR MANUAL VOLUME III SEARCH THE AREA




$$A_t = N \times S \times V \times T$$

$$S = 2\,D_{min} \cdot \sin\frac{\theta_{FOV}}{2}$$

$$H = D_{min} \cdot \cos\frac{\theta_{FOV}}{2}$$

- Set Values

N = 2
V = 40Knots
T = 15min(0.25 Hour)
S ≥ 100$M$

$A_t$ = Total Search Area
N = Number of SAR Drone
S = Swipe Width (Track Spacing)
V = Search Speed

T = Search Time
H = Flight Altitude
$\theta_{FOV}$ = IR Field Of View Angle
$D_{min}$ = minimum detectable range

# SUGGESTION Details

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## EQUIPMENT SPECIFICATION

**Infrared Camera**
Model : Dinion IP Imager 9000HD
Cost : $ 3,000×14EA = $ 42,000

**Base Drone**
Model : DJI M600
Cost : $ 5,500 × 2EA = $ 11,000

**Speed sensor** for falling object
Model : M0596
Cost : $ 2,000 × 14EA = $ 28,000

**Thermo-graphic Camera**
Model : FLIR – BHM
Cost : $ 6,000 × 2EA = $12,000

**Central Computer Model**
undetermined
Cost : $ 2,000 × 1EA

**Life buoy ring**
**Model** : 30" USCG/SOLAS Orange Life Ring Buoy for use on Bridge Wing with Reflective Tape
Cost : $ 200 × 2EA = $ 400
(Including a Life ring-releaser)

# CONCLUSION

# CONCLUSION Amended SOLAS

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CONCLUSION

## 1) Amendment in SOLAS

| | |
|---|---|
| Title | SOLAS 2016 Amend / Chapter III / Reg. 3 |
| Effective Date | 1/1/2020 |

Regulation 3

Definitions

For the purpose of this chapter, unless expressly provided otherwise:

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.

.

.

.

26 "Detecting sensor" is a sensor which can detects whatever Man-overboard occurred or not.

27 "Infrared and human falling motion detecting camera" is a camera which detects infrared emitted by human and human falling motion.

28 "Falling velocity sensor" is a sensor which can measure velocity of moving object.

29 "Search and Resuce drone" is a drone whose main function is to locate persons overboard during Search and rescue operation

**Insert clauses in regulation 3 in chapter 3**

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## 2) Amendment in LSA code

| | |
|---|---|
| Title | LSA 18 Amend / CHAPTER VII / 7.3 |
| Effective Date | 11/10/2018 |
| | D-SAR system |

**7.3 Man-overboard sensing system**

7.3.1 Regulation 7.3 applies to all passenger ships and to all cargo ships of 500 gross tonnage and upwards.
7.3.2 Detecting Sensor
7.3.2.1 Infrared and human falling motion detecting camera shall be at least installed as the number detecting all around vessel.
7.3.2.2 falling velocity sensor shall be at least installed as the number detecting all around vessel

| | |
|---|---|
| Title | LSA 18 Amend / CHAPTER VII / 7.3 |
| Effective Date | 11/10/2018 |
| | D-SAR system |

**7.4 SAR Drone System**

7.4.1 Regulation 7.4 applies to all passenger ships and to all cargo ships of 500 gross tonnage and upwards

7.4.2 Search and Rescue Drone with equipped thermo-graphic camera

7.4.2.1 Search and Rescue drone shall

.1 be launched automatically when Man-overboard is detected by the sensor in a state of continuous readiness

.2 be launched without interference of cargo and structure of ship

.3 be at least faster than 40 knots in windless weather condition

.4 be capable of being operated longer than an hour above 40 knots

.5 be equipped with a releasing device to drop lifebuoy to a drowner

7.4.2.2 Minimum detectable range of Thermo-graphic camera shall be longer than 130m by standard of view angle 42°.

## Insert regulations in chapter 7

7.3.1 Regulation 7.3 applies to all passenger ships and to all cargo ships of 500 gross tonnage and upwards.

7.3.2 Detecting Sensor

7.3.2.1 A sufficient number of infrared and human falling motion detecting camera shall be installed in order to cover all the boundary of the vessel.

7.3.2.2 A sufficient number of falling velocity sensor shall be installed in order to cover all boundary of the vessel

# CONCLUSION Amended SOLAS

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## 2) Amendment in LSA code

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7.4.2.2 Minimum detectable range of Thermo-graphic camera shall be longer than 130m by standard of the field of view angle 42°.

## 2) Amendment in IAMSAR

**Insert 2.1.1 in the chapter**

**Person overboard**

*Immediate action*

- The persons overboard is noticed from the bridge action is taken immediately

*Delayed action*

- The person is reported to the bridge by an eyewitness and action is initiated with some delay.

*Person-missing action*

- The person is reported to the bridge as missing.

**Insert "Initial Action by SAR Drone"**

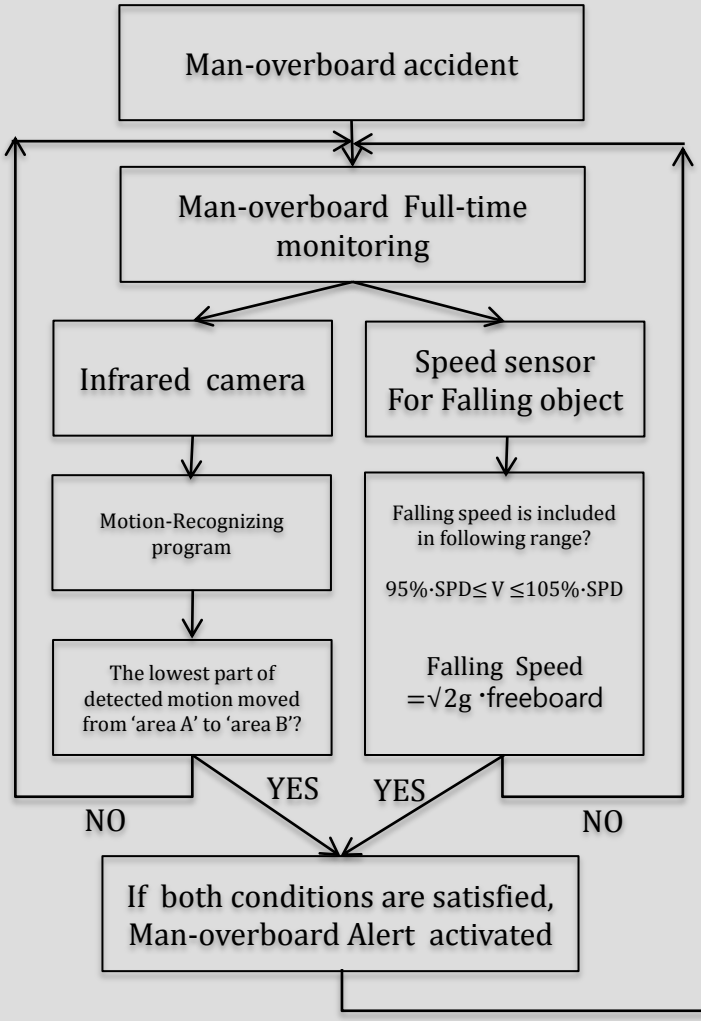
*Initial Action*

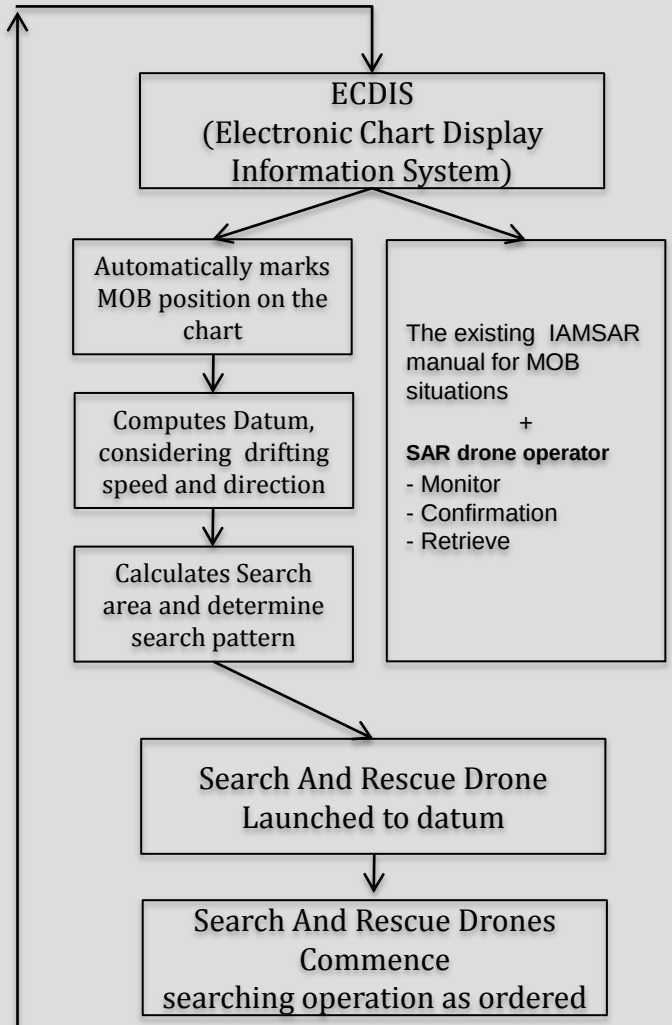
1. Throw a life-ring over the side as close to the person as possible
2. Sound three prolonged blast of ship's whistle, hail "person overboard"
3. Commence recovery maneuver as indicated below.
4. Note position, wind speed & direction, time.
5. Inform master of vessel and engine-room
6. Post lookouts to keep the person in sight.
7. Set off dye marker or smoke flare.
8. Inform radio operator, keep updated on position.
9. Stand by engines.
10. Prepare lifeboat for possible launching

# BACKGROUND

## Mortality in MOB Situation





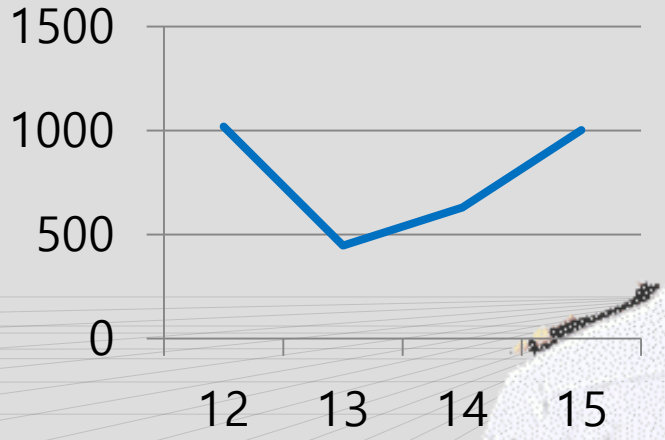



# CONCLUSION

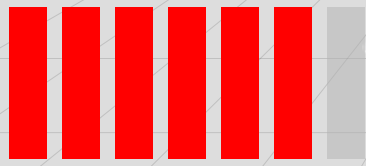


## BEFORE

The death toll by MOB

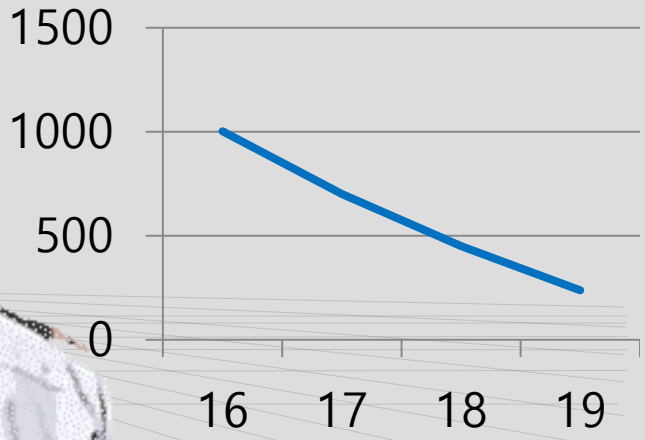


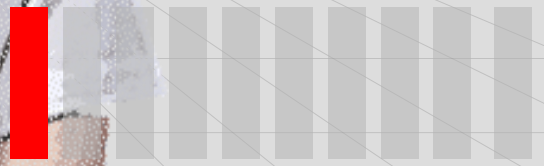

Death rate



## AFTER

The death toll by MOB




Death rate