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Agenda item [2] n.n

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Singapore's Trial of Dual Intensity LED Lanterns

1 SUMMARY

The Maritime and Port Authority of Singapore (MPA) recognises the need to enhance safety of navigation by improving the conspicuity of Aids to Navigation (AtoNs) when there is strong background lighting. MPA explored the use of Dual Intensity Lights (DILs), lanterns, along the approaches to the Singapore's terminals where there is strong background lighting over three phases of trials from 2017 to 2020. The objectives of the trials were to review the feasibility; advantages and disadvantages; and practicability of DILs including early detection, recognition and identification of AtoNs in environments with strong background lighting. Together with Zeni Lite Buoy Co., DILs were installed on selected AtoNs and harbour pilots and mariners participated in these trials. Up to 85% of those participated gave positive feedback and stated that DILs improved ' detection, recognition and identification of AtoNs against strong background lighting for safe navigation.

1.1 Purpose of the document

This paper describes the trials conducted by Maritime and Port Authority of Singapore (MPA) using DILs and requests IALA recommend the development of standardised charting and display symbology for DILs.

1.2 Related documents

G1073 Conspicuity of AtoN Lights at Night

2 BACKGROUND

MPA conducts annual marine services survey (AMSS) and the survey includes adequacy and reliability of AtoNs in the port and Singapore waters. The feedback collected from these surveys are used to improve our AtoN provision services. Feedback from mariners indicated that there were areas where strong background lighting caused difficulties in the visual detection of AtoNs.

These areas included the approaches to Singapore where oil and container terminals are situated along the nearby coast. These oil and container terminals are lit throughout the night with bright lights and flares which interfered with mariners' ability to visually detect, recognise and identify AtoNs in a timely manner while

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transiting the area (**Figure 1**). Hence, MPA explored ways to improve the conspicuity of AtoN lights against strong background lighting.

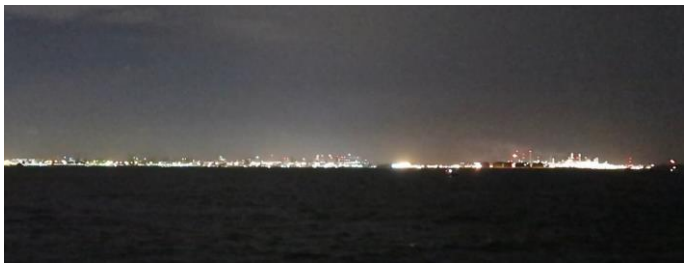


Figure 1: Strong Background Lighting at the approaches to Singapore

3 DISCUSSION

"There are three concepts to consider when judging conspicuousity of an AtoN: detection, recognition and identification. Typically, an AtoN light would first be detected and after a further period it would be recognised as an AtoN, but not until its rhythmic character has been fully understood would the AtoN be identified. - During the night, the task of the mariner is to visually identify and ascertain the purpose of an AtoN using the features of the AtoN's light. The time taken to undertake this task should be as short as possible. By increasing the conspicuousity of an AtoN, the time taken to complete the visual task would be reduced."

(IALA, 2017)(G1073 Conspicuity of AtoN Lights at Night, Edition 2.0, page 6).

MPA has been continuously exploring ways to improve the conspicuity of AtoNs. Our team trialled options such as illuminating the topmark using (LEDs) and illuminating the beacon's structure using lighted tubes in 2009 and 2010, respectively. However, the results were unsatisfactory as these were insufficient to overcome the strong background lighting.

MPA continued to look for other solutions and observed that the intensity of the rotating light character of a lighthouse varying from nil to peak allowed the marine AtoN lantern to be easily distinguishable from a normal marine AtoN lantern. This simple yet effective concept of varying light intensity made the light more distinguishable and attracted the human eye to visually detect, recognise and identify more easily. Thus, MPA decided to test if the use of a marine lantern with two different peak intensities (i.e. DILs) as this would likely improve the conspicuousity of AtoNs against strong background lighting and enable the mariners to detect, recognise and identify AtoNs more effectively.

MPA consulted several lantern manufacturers for the provision of a tiered marine lantern which allowed for two different peak intensities. We identified a suitable lantern capable of allowing alternate flashes of light in varying intensities to be programmed from Zeni Lite Buoy Co.. During our discussions, Zeni Lite Buoy Co. proposed to design the marine lantern with two different peak intensities by combining the existing hardware and software technologies used in standard single peak intensity marine lanterns.

The project started in 2017 and spanned over 3 phases:

1) Phase 1: Pre-trial observations and site assessment
2) Phase 2a: First onsite trial at Sebarok Beacon
3) Phase 2b: Second onsite trial at Sebarok Beacon
4) Phase 3: Third onsite trial at Cyrene Beacon

Phase 1: Pre-trial observations and site assessment

In 2017, MPA conducted night observations of AtoNs marking the approaches into the Port which are affected by strong background lighting, leading to difficulties in detecting, recognising and identifying AtoNs at night. Sebarok Beacon, which is located at the southern tip of Pulau Sebarok, was identified to be an ideal AtoN for the first and second phase of the trials of the DIL. Firstly, it is an important reference point for vessels navigating in the Jong Fairway. Secondly, mariners on vessels turning into Jong Fairway while navigating westerly along the Traffic Separation Scheme (TSS) in the Main Strait have faced difficulties in detecting, recognising and identifying the beacon against the background lights of the oil terminals located at Pulau Sebarok (**Figure 2**). The location of the onsite trial appears as **Annex A – Location 1**.

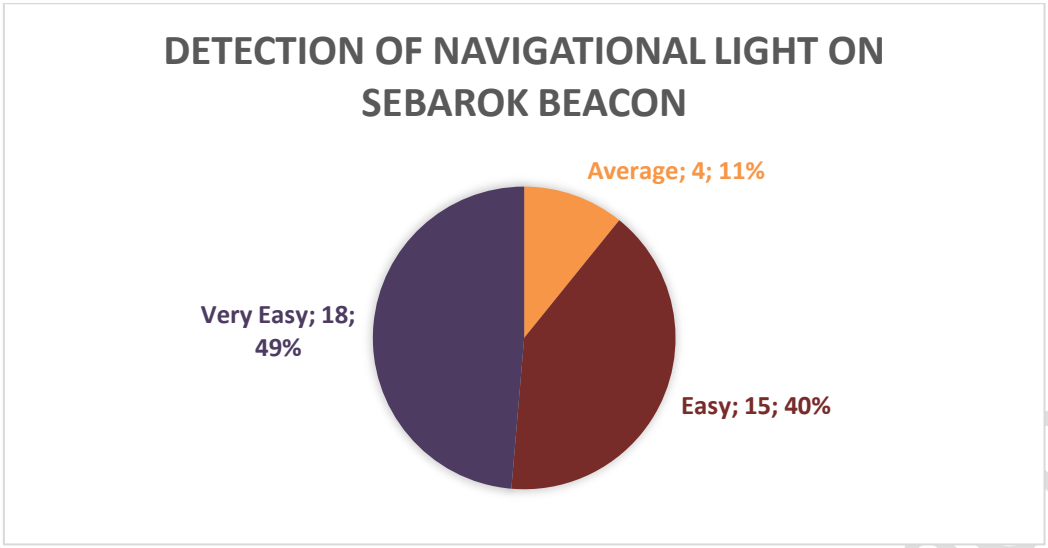
Figure 2: Strong Background Lighting from Pulau Sebarok
(A lit marine AtoN lantern is enclosed by the red circle)

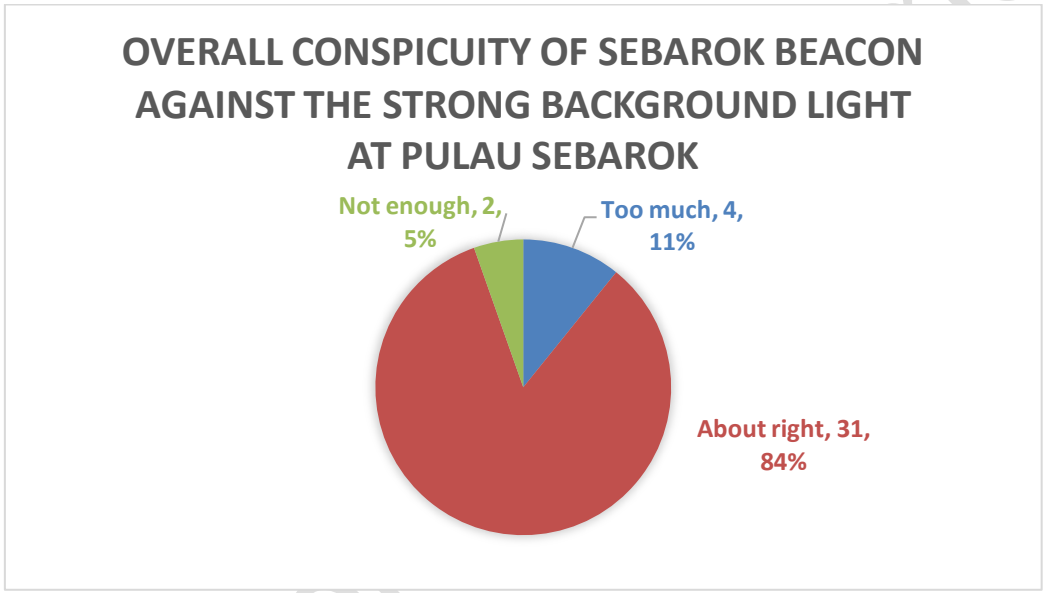
Phase 2a: First onsite trial on Sebarok Beacon

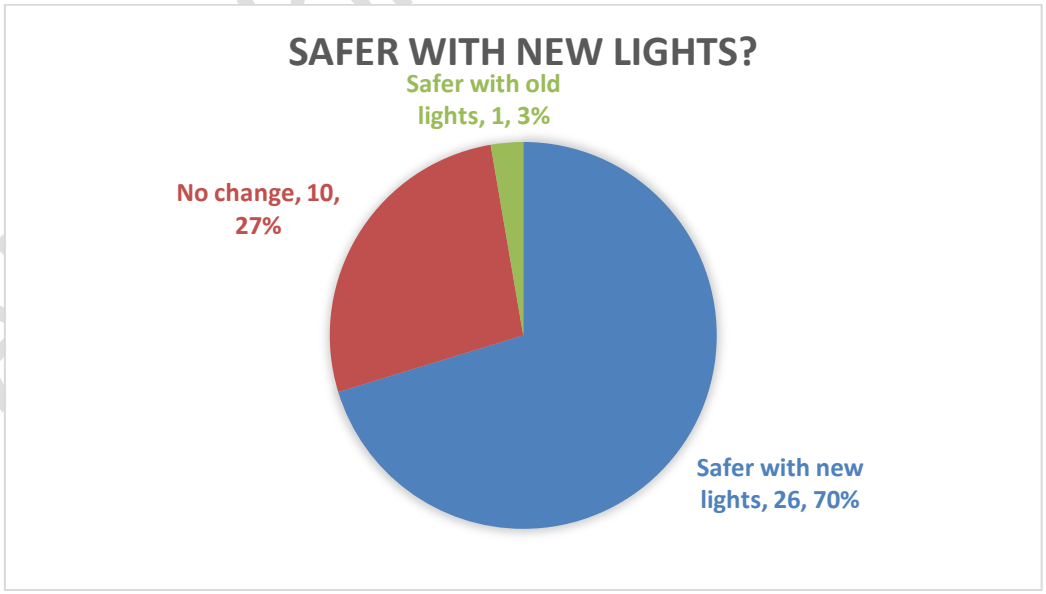
MPA conducted tests with Zeni Lite Buoy Co. to identify and develop a prototype DIL that can perform to the required specifications. After the onsite survey, an integrated power system lantern (IPSL) solution was deemed to be unsuitable due to the higher power requirements of a DIL. A separate solar power system was needed to meet the power requirements. A prototype two-tiered DIL was then developed which was able to produce an effective intensity of 78cd (5NM) for the first, higher intensity flash and 389cd (7.5NM) for the second flash when T = 0.74 (**Figure 3**).

Figure 3: Prototype two-tiered Dual Intensity Lantern installed during Phase 2a of Trial on Sebarok Beacon (Fl.R.5s8m5M)

MPA conducted the first onsite trial of the prototype two-tiered DIL on Sebarok Beacon. It was installed for a period of 6 months from February 2018 to August 2018 during which its performance was evaluated. The evaluation involved disseminating and collecting feedback forms to pilots and mariners bi-weekly as well as performing night observations of the prototype DIL in action. A sample of the feedback form appears as **Annex B**. At the end of the trial, a total of 37 feedback forms were received. The feedback are as follows:







The feedback indicated that while the first onsite trial (Phase 2a) was a success, we needed to further test if increasing the intensity of the second flash would further improve the detection of the light.

Phase 2b: Second onsite trial on Sebarok Beacon

For the second onsite trial (Phase 2b) on Sebarok Beacon, we increased the intensity of the second flash from 389cd to 700 cd (equates to luminous range of 8.5 NM when T=0.74) to have greater differentiation from the first, which required a three-tiered DIL. The three-tiered prototype DIL was installed from October to December 2018. Due to the short duration of three months, only 6 feedback forms were received at the end of the trial. As the feedback received was insufficient to conduct a complete analysis with the results from the phase 2a, it was thus decided to extend the trial into a third phase. Unfortunately, Sebarok Beacon together with the DIL was damaged at the end of December 2018. As such, a new three-tiered prototype DIL was acquired, and an alternate trial site identified.

Phase 3: Third onsite trial on Cyrene Beacon

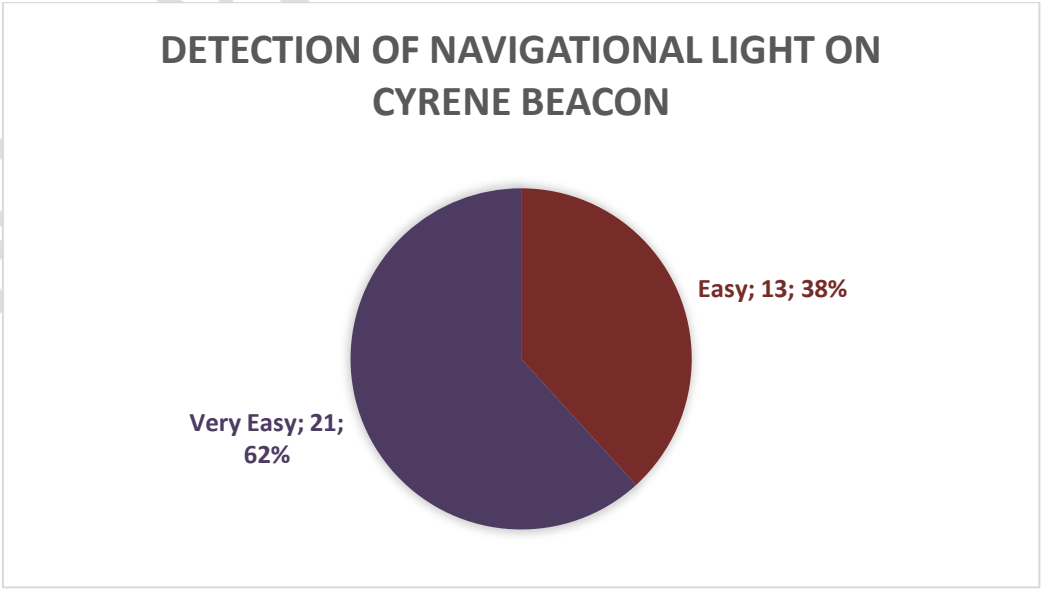
Cyrene Beacon was identified as the new site for the third trial (Phase 3) as it faces similar strong background lighting conditions like the Sebarok Beacon. Mariners on vessels transiting the Sinki Fairway will see Cyrene Beacon against the background lights of the Pasir Panjang Terminal while mariners transiting the Jong Fairway will see the Cyrene beacon against the background lights of Jurong Island. The location of the onsite trial appears as **Annex A - Location 2**. The new three-tiered prototype DIL was installed at Cyrene Beacon (**Figure 4**). This new three-tiered prototype DIL also consisted of three lens tiers which flashed together for the first, higher intensity flash (700 cd) , with only the bottom lens tier flashing for second flash (78cd) and the peak intensity of the first, higher intensity flash is approximately 9 times of the second flash (**Figure 5 and 6**).

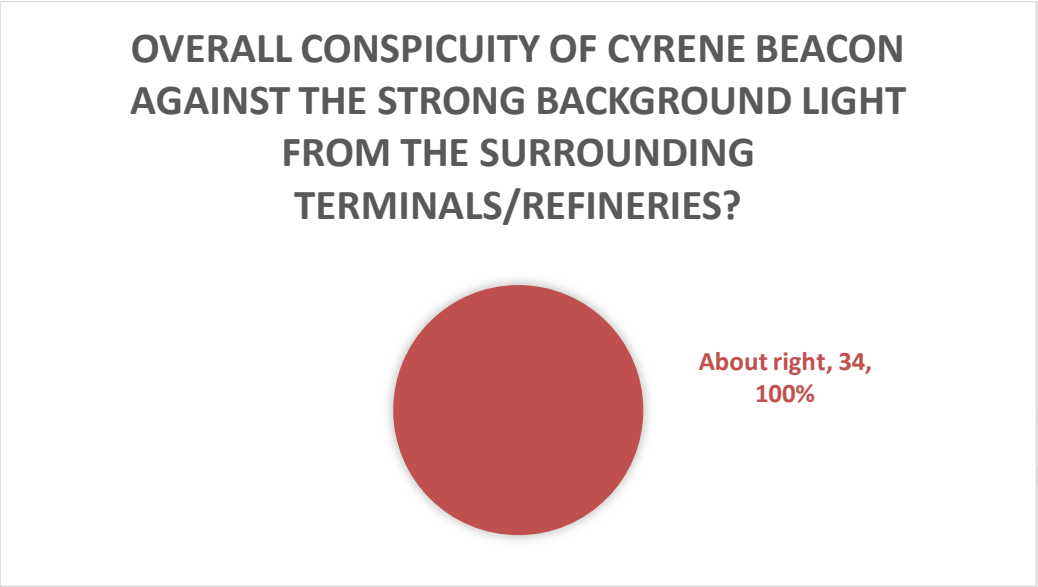
Figure 4: Prototype three-tiered Dual Intensity Lantern Installed on Cyrene Beacon for third onsite trial (Phase 3). (Fl.R.2,5s8m10M)

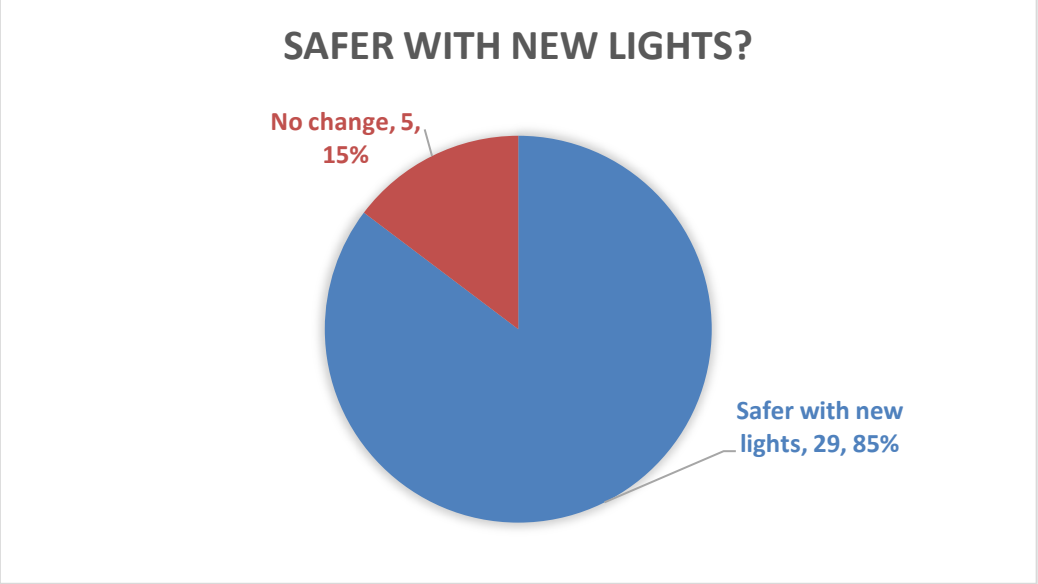
Figure 5: Prototype three-tiered Dual Intensity Lantern Installed During Phase 3 of Trial at Cyrene Beacon (Low intensity flash)(Fl.R.2,5s8m10M)

Figure 6: Prototype three-tiered Dual Intensity Lantern Installed During Phase 3 of Trial at Cyrene Beacon (High intensity flash)(Fl.R.2,5s8m10M)

Although Phase 3 was planned for 6 months from January to June 2020, complications due to the Covid-19 outbreak resulted in the trial being cut short in March 2020. Even so, an adequate number of feedback forms (34 in total) were received. The results are as follows:







The third onsite trial (Phase 3) received more positive feedback as compared to the first onsite trial at Sebarok Beacon. There was a 15% increase (85%, up from 70% in first trial (Phase 2a)) in the number of pilots and mariners surveyed indicating the new DIL was safer. We also noted similar positive increase in feedbacks of 13% (60%, up from 49%) for the detection of the navigational lantern and increase of 16% (100%, up from 84%) for the overall conspicuity of the new DIL against strong background lighting.

Conclusion

With the feedbacks gathered from both Phase 2a and 3, we conclude that there was a positive impact of the developed DIL when deployed on AtoNs affected by strong background lighting. The potential benefits of the DIL allows for the mariners to navigate safer and more expeditiously.

Following the successful trials, MPA and Zeni Lite Buoy Co., Ltd recommend the development of international specifications, recommendations and guidelines for the development, charting and usage of DILs, particularly for critical AtoNs where strong background lighting interferes with the detection, recognition and identification.

4 REFERENCES

[1] G1073 Conspicuity of AtoN Lights At Night

5 ACTION REQUESTED OF THE COMMITTEE

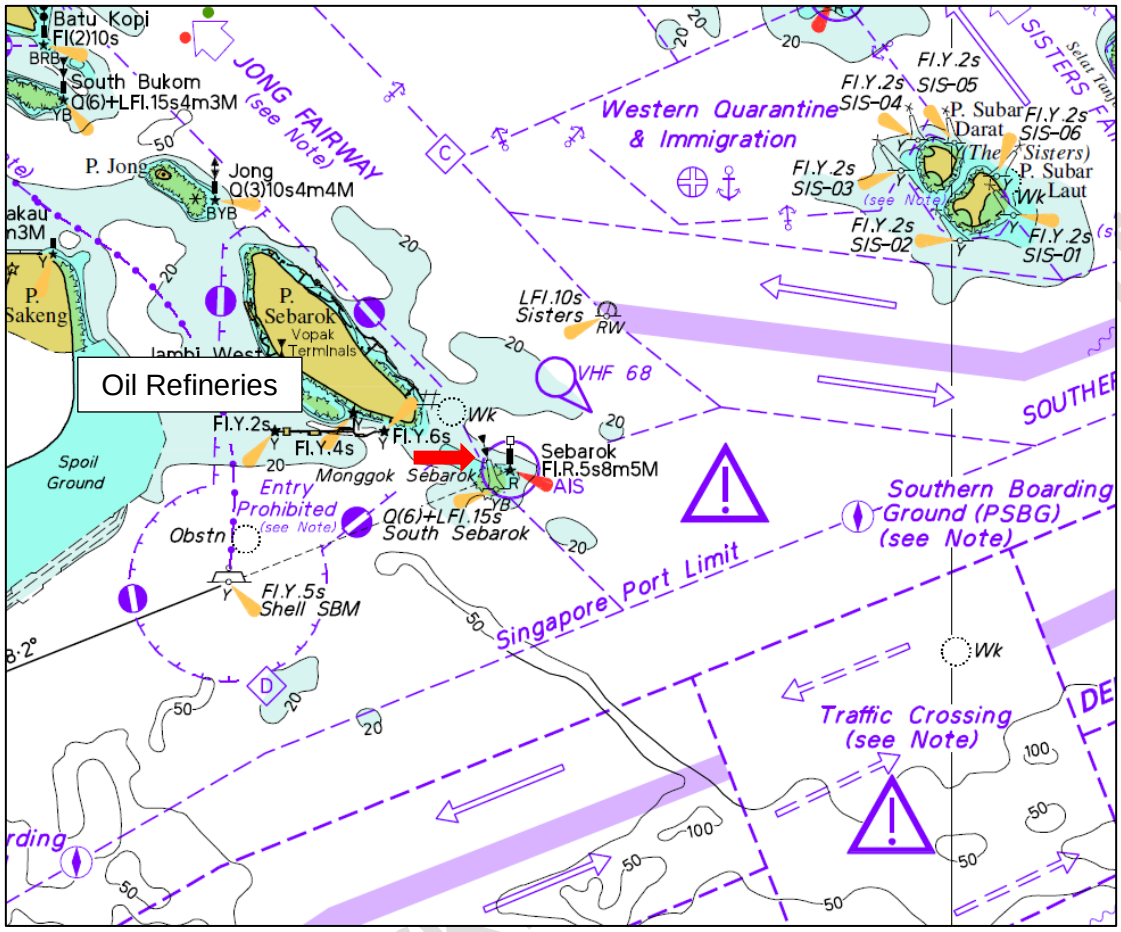
The ENG Committee are requested to review the information of this paper and:

(1) For ENG Working Group to develop new international technical specifications for DILs;

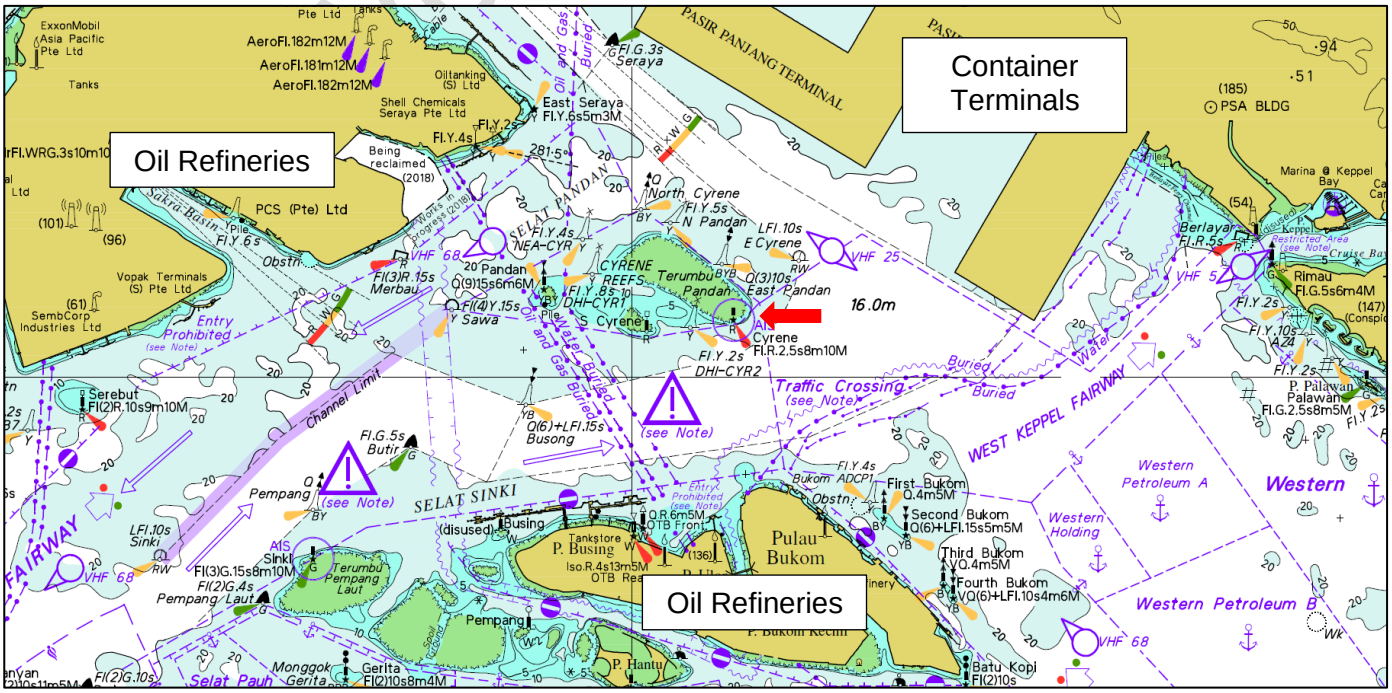
(2) For ENG Working Group to produce guidelines/recommendations for deployment and implementation of the lanterns; and

(3) Establish collaboration within the IALA Committees and with the International Hydrographic Organization (IHO) to produce charting standards.

ANNEX A: LOCATIONS OF ONSITE TRIAL



Location 1: Sebarok Beacon (red arrow) with oil terminal at background (*Fl.R.5s8m5M*)



Location 2: Cyrene Beacon (red arrow) with container terminals at background (*Fl.R.2,5s8m10M*)

ANNEX B: FEEDBACK FORM SAMPLE

HYDROGRAPHIC DIVISION

Cyrene Beacon Aids-to-Navigation (AtoN) Light Feedback Form

To all Masters and Pilots

MPA Hydrographic Division had conducted the Dual Intensity Navigational Lantern project to study the visual detection of Aids to Navigations against brightly lit background over a period of 9 months with trials spreading over two phases in 2018.

As a continued effort to collect further data, an alternate AtoN (Cyrene Beacon) is selected as it is also affected by background lighting. The duration of the third phase of the trial is 6 months; from Jan 2020 to June 2020. The prototype Dual Intensity Navigational Lantern will be installed on Cyrene Beacon and the light character remains unchanged but a higher intensity light will be shown at every alternate cycle of flash.

Cyrene Beacon

Lat. N 01°15·300'
Long. E 103°45.538'

Please indicate if you are: ☐ PSA Marine Pilot ☐ Mariner ☐ Others (_____)
Location of observation (in Lat/Long): _____ or
Direction and distance of observation (in Nm and bearing): _____
Direction of transit (eg: Northwest/Southeast bound): _____

1. Are you able to easily detect the navigational light on Cyrene Beacon?

Very Difficult	*Difficult*	*Average*	*Easy*	*Very Easy*
☐	☐	☐	☐	☐

If you can't detect it, why?

_____

_____

2. How would you rate the overall conspicuity of the Cyrene Beacon against the strong background lighting from the surrounding terminals/refineries?

Too much ☐
About right ☐
Not enough ☐

3. Does the high intensity light at every alternate cycle of the flash make you feel safer when you carry out night transit along Sinki and Jong Fairway?

No change ☐
Safer with new lights ☐
Safer with old lights ☐

4. How do you rate the level of AtoN lightings available in Singapore waters?

Too much	*Not enough*	*About right*
☐	☐	☐

5. Which other areas do you recommend to deploy the Dual Intensity lantern?

_____

_____

_____

6. Any other comments

Thank you for taking the time to respond

Please return the completed questionnaire to: MPA Hydrographic Division,
Attn: Noorendi via email to hydrographic@mpa.gov.sg or fax to 6226 1076.

Pilot Name:_____

Vessel Name:_____

Phone number/ Email add for contacting you:_____

Date:_____

If you have any queries about the trial project or this questionnaire, contact Noorendi on 6325 2041 or hydrographic@mpa.gov.sg

ANNEX C: PHOTOS OF PAST PROJECTS

2009

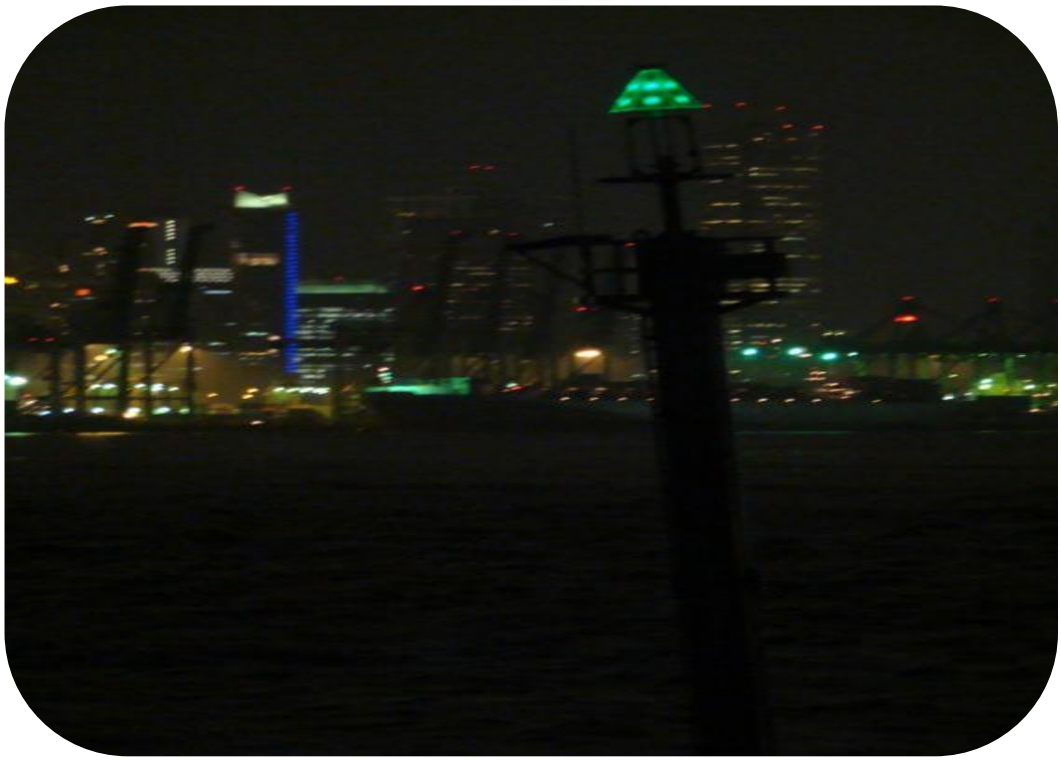
Lighted tubes on Cyrene Beacon

Lighted tubes on Cyrene Beacon at night

ANNEX C: PHOTOS OF PAST PROJECTS

2010

Lighted LED Topmark on Outer Shoal Beacon



Lighted LED Topmark at night