 Input paper: [[1]](#footnote-1) ENG4-9.13

Input paper for the following Committee(s): check as appropriate Purpose of paper:

**□** ARM **□X** ENG **□** PAP **□X** Input

**□** ENAV **□** VTS **□** Information

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Technical Domain / Task Number 2 TD#1 - Light and vision physics, Visual Signalling / 26

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Group Flashing Light Viewing Trial

# Summary

On the 3rd Session of the IALA ENG Committee Pärtel Keskküla received the task to verify the statement in the draft of „Guideline on selecting light characters“ that „in order to maintain spatial awareness, eclipse length of a group flashing light should not exceed 8 seconds”.

The viewing trial was held on the evening of Tuesday 1st March 2016 in Tallinn.

The trial ended with the conclusion that due to interrelation of effects of lengths of eclipse and other elements of a light character on spatial awareness as well due to dependency on navigational situation there is no clear justification for selecting a single number as limit for recommended length of eclipse between groups in a group flashing light.

The results of the trial are presented in the Report of Group Flashing Light Viewing Trial annexed to this input paper.

# Action requested of the Committee

The Committee is requested to:

1. Review the input paper during the discussion of eclipse length recommended by the new IALA Guideline No. #### On Selection of Rhythmic Characters of Lights on Aids to Navigation.

1. Report of Group Flashing Light Viewing Trial

Estonian Maritime Administration

# Group Flashing Light Viewing Trial

## Report

06/03/2016

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# Introduction and background

On the 3rd Session of the IALA ENG Committee Pärtel Keskküla (Estonian Maritime Administration) received the task to verify the statement in the draft IALA Guideline On Selection of Rhythmic Characters of Lights on Aids to Navigation that *in order to maintain spatial awareness, eclipse length of a group flashing light should not exceed 8 seconds*.

The viewing trial was held on the evening of Tuesday 1st March 2016 in Tallinn.

# Objective

Objective of the trial was to evaluate the effect of the length of an eclipse between groups in group flashing lights to the spatial awareness of an observer. (“Spatial awareness” was interpreted as “feeling of retaining the sense of direction where the light should be”.) Besides that the effect of the number of flashes in a group, with both constant and proportionally extended length of eclipse, was evaluated. Also the effect of the length of flashes in a group, with both constant and proportionally extended length of eclipse, was evaluated.

# Viewing Conditions

Location: Katariina pier, Tallinn

Visibility: 20 km

Weather: -6 °C, wind 6 m/s

Background Lighting: Substantial

Observation time: 18:45 – 20:30, started after dusk



Figure 1. Atmosphere in the observation place



Figure 2. View from the observation location to the location of the light. Location of the light is shown with red circle.

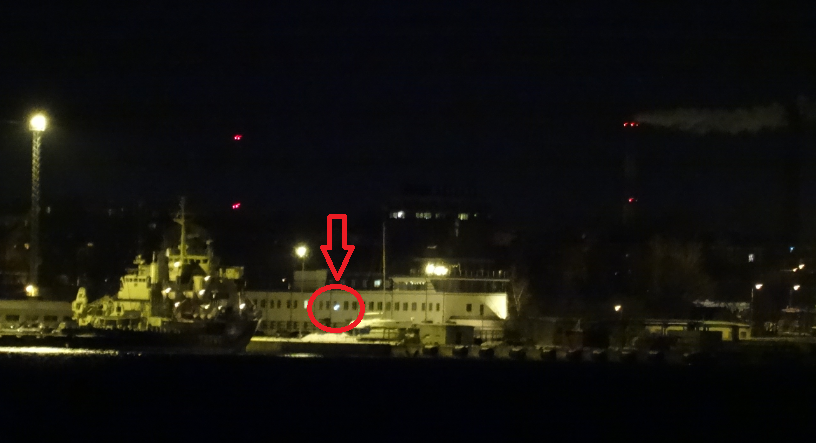


Figure 3. The location of the light zoomed in. Location of the light is shown with red circle.

# Method

Observations were taken from Katariina pier from a distance of 1.0 NM (1.84 km) to a lantern on a window of the office building of Hundipea harbour in Northern Tallinn. Intensity of the light was selected to be clearly visible to all the observers but not specifically conspicuous from the background lighting.

Besides the initial hypothesis that length of the eclipse between groups of flashes may affect spatial awareness, additional hypotheses arose when planning the trial. These were that also number of flashes in a group, the length of the flashes and also the ratio of duration of flashes and eclipse(s) may have an effect on spatial awareness of an observer. Based on all these hypotheses different sets of characters to be observed were chosen.



Figure 4. Observing path from Katariina pier to Hundipea harbour

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1. | 1+1+1+3 | 11. | 1+10 | 21. | 0,5+0,5+0,5+8 |
| 2. | 1+1+1+4 | 12. | 1+1+1+10 | 22. | 1+1+1+8 |
| 3. | 1+1+1+5 | 13. | 1+1+1+1+1+10 | 23. | 2+2+2+8 |
| 4. | 1+1+1+6 | 14. | 1+1+1+1+1+1+1+10 | 24. | 3+3+3+8 |
| 5. | 1+1+1+7 | 15. | 1+1+1+1+1+1+1+1+1+10 | 25. | *4+4+4+8* |
| 6. | 1+1+1+8 | 16. | 1+3 | 26. | 0,5+0,5+0,5+1,5 |
| 7. | 1+1+1+9 | 17. | 1+1+1+6 | 27. | 1+1+1+3 |
| 8. | 1+1+1+10 | 18. | 1+1+1+1+1+9 | 28. | 2+2+2+6 |
| 9. | 1+1+1+11 | 19. | 1+1+1+1+1+1+1+12 | 29. | 3+3+3+9 |
| 10. | 1+1+1+12 | 20. | 1+1+1+1+1+1+1+1+1+15 | 30. | 4+4+4+12 |

Table 1. The characters observed during the trial

Purpose of the first set of characters (1-10) was to estimate the effect of **duration of eclipse between groups** to the spatial awareness of the observer based on a typical group flash character with two flashes in a group.

Purpose of the second set of characters (11-15) was to estimate the effect to the spatial awareness of the observer of **number of flashes in a group** with **fixed length of the eclipses** between the groups. The length of the eclipse between groups (10 s) in this set was selected “a bit too long” based on the results of the observations of the first set to allow for some room for spatial awareness to get better with increasing number of flashes.

Purpose of the third set of the characters (16-20) was to estimate the effect to the spatial awareness of the observer of **number of flashes in a group** along with **eclipses** between groups **with proportionally longer duration**.

Purpose of the fifth set of the characters (21-25) was to estimate the effect to the spatial awareness of the observer of **length of flashes** with **fixed length of the eclipses** between groups. Character no 25 was omitted as obviously bad based on the trend after observing the character no 24. The last two characters in this set do not satisfy the condition for group flashing lights in E-110 that “the duration of an eclipse between groups should not be less than three times the duration of an eclipse within a group”.

Purpose of the sixth set of the characters (26-30) was to estimate the effect to the spatial awareness of the observer of **length of flashes** with **eclipses** between groups **with proportionally longer duration**.

Each character was exhibited for a period sufficient for everybody to establish its opinion, approximately 3-5 periods.

# Observations

Six observers took part in the trial of which three were mariners and three with more technical/theoretical background. The observers were familiarized with the purpose of the trial. Visual acuity of the observers was tested but consensus was reached on the light intensity to be used for everybody to see the light satisfactorily.

Observers were asked not to discuss their opinions during scoring of the observations. However, general discussion was held as when and how to proceed to the next characters etc.

An observation sheet was developed based on the observation sheet for UK GLA’s fixed and flashing light viewing trial, the aspects to be tested in the trial and the cognition of the organizer (the number of grades was reduced from seven to five). Periods of the characters were presented on the observation sheets so the observers were able to see the exact build of the characters they were observing.

# Equipment used

White EKTA range lantern E8513.W (from year 2006) with typical intensity 20 000 cd and set to 25% of intensity was used. Due to some losses to reflections on the window the observed intensity was lower than that.



Figure 5. Set up of the lantern. Only one lantern was used and between the tests the lantern was covered with a sheet of cardboard.

# Results and analysis

## Effect of length of eclipse

As seen from the results in Figure 6 the length of the eclipse between groups clearly affects the observers´ spatial awareness. The scores decrease with increase of length of darkness but there is no sharp drop anywhere. These observations don’t seem to give a strong basis for drawing a clear limit at 8 seconds.

Legend for the graphs: blue lines – scores from practitioners (mariners), green lines – scores from theorists, black line – averages of the scores.

Figure 6. Effect of length of eclipse between groups in group flashing lights to spatial awareness of the observers

## Effect of length of number of flashes in a group with constant length of eclipse

The results on Figure 7 confirm the hypothesis that increasing number of flashes in a group increases usability of a light if the length of eclipse remains the same. As the proportion of the light in a period increases this result is logical.

Figure 7. Effect of number of flashes in a group in group flashing lights to spatial awareness of the observers

## Effect of number of flashes with proportionally longer eclipses between groups

The results on Figure 8 show that increasing the length of the eclipses proportionally with number of flashes effectively dampens the positive effect of increasing the number of flashes. At the end of the set very long eclipses between groups dominate over larger number of flashes and overall score tends to be lower than with less flashes but with shorter eclipse.

Figure 8. Effect of number of flashes in a group and proportionally longer eclipse between groups in group flashing lights to spatial awareness of the observers

## Effect of length of flashes with constant length of eclipse

In this case the trend is most mixed as can be seen on Figure 9. It seems that there might be an “optimal peak” where length of flashes with eclipse between them is long enough to dominate over the length of the eclipse but not tediously long to wait for the next flash. Appearance of the character 3+3+3+8 was unanimously considered already too “slow”, therefore 4+4+4+8 was skipped.

Figure 9. Effect of length of flashes in group flashing lights to spatial awareness of the observers

## Effect of length of flashes with proportionally longer eclipses between groups

As can be seen from Figure 10 light with shorter periods are perceived as better than “scaled up” versions of them where the same problems occur as in 7.4 (too long flashes and too long eclipses between them) which makes it difficult to wait for the next flash and to perceive a group as a group.

Figure 10. Effect of length of flashes and proportionally longer eclipse between groups in group flashing lights to spatial awareness of the observers

## Other observations

Due to lots of background lights and illuminated objects as reference points, once the light to be observed was located along with its nearest objects, it was actually difficult to lose it again.

The observers agreed that the length of eclipse that should be considered too long depends on navigational situation – density and speed of traffic, amount of other navigation lights and background lighting. The eclipse that is too long for an area with heavy traffic and background lighting may be acceptable on a dark open sea.

It was noted that with lots of flashes in a group it was sometimes possible to make observations during one group and long eclipse didn’t seem to be so problematic, i.e. longer duration of a group could somewhat compensate longer eclipse.

It was also noted by an observer that other adjacent flashing lights distracted the attention during long eclipses.

An observer with maritime background sent additional comments after the trial. He said that in practice when navigating, a light is usually observed only once, not for multiple periods. The light is identified and the flash pattern memorized by the first period. Another reason for not counting the flashes multiple times is that other lights and things take/need attention as well, especially in areas with dense traffic.

# Conclusions and Recommendations

Due to large number of possible combinations the selection of characters made for this viewing trial may not be representative enough to be basis for an international recommendation. The same may apply to the small number of observers and to the observing conditions.

As the transition between “bad” and “good” light is smooth and it depends on other factors like number and length of flashes as well, **there is no clear justification for selecting a single number as a limit for recommended length of eclipse** between groups in a group flashing light.

What is considered **too long depends largely on navigational situation** – traffic speed and density, amount of other navigational lights and background lighting.

It may be possible to set a limit for **absolute maximum length of eclipse** in a group flashing light that would apply to situation on a dark and empty open sea. Based on experiences from this trial, in this case the number could probably be larger than 8 seconds. However that would not be appropriate upper limit for an eclipse in a restricted area with dense traffic. And still the final impression would also depend on what is “beside the eclipse” in the period.

Based on the results of the trial it is recommended to investigate if limits to lengths of eclipses could be based on a **ratio of light and darkness** in a period.

# A. Observation Sheet

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Very bad | Bad | Acceptable | Good | Very good |
|  |  | 1 | 2 | 3 | 4 | 5 |
|  | **1**+1+**1**+3 =6 |  |  |  |  |  |
|  | **1**+1+**1**+4 =7 |  |  |  |  |  |
|  | **1**+1+**1**+5 =8 |  |  |  |  |  |
|  | **1**+1+**1**+6 =9 |  |  |  |  |  |
|  | **1**+1+**1**+7 =10 |  |  |  |  |  |
|  | **1**+1+**1**+8 =11 |  |  |  |  |  |
|  | **1**+1+**1**+9 =12 |  |  |  |  |  |
|  | **1**+1+**1**+10 =13 |  |  |  |  |  |
|  | **1**+1+**1**+11 =14 |  |  |  |  |  |
|  | **1**+1+**1**+12 =15 |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Very bad | Bad | Acceptable | Good | Very good |
|  |  | 1 | 2 | 3 | 4 | 5 |
|  | **1**+10 |  |  |  |  |  |
|  | **1**+1+**1**+10 |  |  |  |  |  |
|  | **1**+1+**1**+1+**1**+10 |  |  |  |  |  |
|  | **1**+1+**1**+1+**1**+1+**1**+10 |  |  |  |  |  |
|  | **1**+1+**1**+1+**1**+1+**1**+1+**1**+10 |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  | **1**+3 =4 |  |  |  |  |  |
|  | **1**+1+**1**+6 =9 |  |  |  |  |  |
|  | **1**+1+**1**+1+**1**+9 =14 |  |  |  |  |  |
|  | **1**+1+**1**+1+**1**+1+**1**+12 =19 |  |  |  |  |  |
|  | **1**+1+**1**+1+**1**+1+**1**+1+**1**+15 =24 |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Very bad | Bad | Acceptable | Good | Very good |
|  |  | 1 | 2 | 3 | 4 | 5 |
|  | **0,5**+0,5+**0,5**+8 =9,5 |  |  |  |  |  |
|  | **1**+1+**1**+8 =11 |  |  |  |  |  |
|  | **2**+2+**2**+8 =14 |  |  |  |  |  |
|  | **3**+3+**3**+8 =17 |  |  |  |  |  |
|  | **4**+4+**4**+8 =20 |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  | **0,5**+0,5+**0,5**+1,5 =3 |  |  |  |  |  |
|  | **1**+1+**1**+3 =6 |  |  |  |  |  |
|  | **2**+2+**2**+6 =12 |  |  |  |  |  |
|  | **3**+3+**3**+9 =18 |  |  |  |  |  |
|  | **4**+4+**4**+12 =24 |  |  |  |  |  |

# B. Scores of the Observed Characters



1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Leave open if uncertain [↑](#footnote-ref-2)