 Input paper: [[1]](#footnote-1) ENG2-9.3

Formerly ENG1-11.2.9

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

**□** ARM • ENG **□** PAP **□** Input

**□** ENAV **□** VTS • Information

Agenda item [[2]](#footnote-2) 9.4

Technical Domain / Task Number 2 Marine Signalling

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Trials and Implementation of the Fixed and Flashing Rhythmic Character on Estonian AtoN

# Summary

This paper provides a short overview of latest visibility tests and implementation examples of the fixed and flashing rhythmic character (FFl) on AtoN lights in Estonia. After a successful and widely commended visibility test on the Sõrve lighthouse (omnidirectional light signal, 15M range) in December 2013, another sequence of tests was performed in February 2014 in order to obtain understanding of the benefit of FFl when implemented on leading lights. The Sõrve lighthouse has been successfully converted to FFl with several others waiting in the queue. A leading line at Pärnu bay is at the final stage of formal FFl implementation. The outcome of testing will also be reported in a technical article to be published in a future issue of the IALA Bulletin. The paper also outlines certain technical issues related to conversion of existing LED lights to FFl operation.

## Purpose of the document

This document is submitted to the IALA ENG Committee in order to share the good practices of implementing the fixed and flashing rhythmic character on AtoN lights.

## Related documents

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# Background

Benefits of the fixed and flashing mode of operation of an AtoN light have been known already for centuries; it is accepted by IALA, listed in [1], Table 1, class 9. In accordance with that recommendation, duration of a flash should be equal to or shorter than 1 second, while the low luminous intensity fixed light signal is provided during a time at least three times of the flash (d ≥ 3 I). Use of FFl with a relatively long duration of the low intensity light signal phase is reasonable; it would not be substantiated in case of short eclipses - a mariner would not lose a track of an AtoN signal during a short eclipse, while from the other hand, the eye would not adapt quickly enough to make use of the low intensity signal of short duration between flashes of higher luminous intensity in excess of an order of magnitude. The key benefit of FFl implementation from the operational aspect is ability to use shorter flash phase and a longer low light signal during an eclipse without compromising navigation safety. Recent conversion of major lighthouses from rotating optics to LED lights that no longer provide the “halo” effect during an eclipse can be made much more acceptable to the mariners, even seamless, by replacing the former atmospheric effects of the rotating beam by introducing a low light eclipse of an FFl rhythmic character.

Nevertheless, FFl characters have not been widely used, with the exception of Japan Coast Guard - most likely due to difficulties of implementation using a single light source. Namely, IHO ([2]) permits portrayal of an AtoN light as FFl only in case when the FFl signal is produced by a single light unit, not by separate sources for the fixed and flashing signal components, with the obvious purpose of avoiding confusion in case of failure of one of the sources providing separate light signals.

FFl was demonstrated at the EEP Committee meeting 19 ([3]) with opportunities for both indoor and outdoor observations; it raised interest and was considered worthy of further investigations for wider endorsement by the Committee. This paper is intended to share the most recent experiences and findings in the line of implementing FFl on AtoN lights in Estonia.

# Discussion

## Implementation of FFl on the Sõrve Lighthouse (Estonia)

The Estonian Maritime Administration completed conversion of the first major lighthouse on the Baltic Sea to the FFl character “FFl W 15s” (0.5+14.5=15 s) with publication in the List of Lights on March 01, 2014. The Sõrve lighthouse with a 15M nominal range was fitted with an omnidirectional LED light of new generation supporting FFl already in 2013, with both the fixed and flashing light signal components provided by a single physical lantern. It was furnished with two external FFl adapters which were inserted into the regular flasher control signal path of the dual (redundant) lantern system. Published range of the fixed light signal is 9M.

The decision to implement FFl on the Sõrve lighthouse was preceded by a series of viewing tests conducted in December 2013 with involvement of several professional mariners. The white fixed and flashing navigational light signal practically without any background lighting was observed from several distances up to 10 nautical miles at several luminous intensity levels of the fixed signal component. While even 1% of the luminous intensity in flash (34 kcd) enabled tracking of the lighthouse signal during the former eclipse from the 10M distance, it was considered to be insufficient in order to introduce comfortable peripheral tracking. Although difference between the 2% and 3% fixed intensities was not significant from 10 nautical miles, it was decided to recommend a 3% level (~1kcd) that was not degrading the conspicuity of the flashing signal from shorter distances while providing sufficient headroom for visibility from longer distances in adverse weather conditions. Higher fixed intensity levels up to 10% of peak were tried but at the higher end the fixed component started to degrade the conspicuity of the rather short flash noticeably.

The agreement about significant improvement of the situational awareness of a navigator due to the use of FFl was unanimous and has been re-confirmed by actual use since implementation. Comprehensive analysis of other lights will be done during 2015 to identify lights that could be improved by introducing FFl.

## Visibility tests of FFl on Pärnu leading lines

Another set of tests to study the benefits of and find optimum parameters for implementation of FFl on leading lights was performed in February 2014 on two leading lines at the Pärnu river estuary: the Pärnu Approach leading line, and the Silla leading line. Background lighting situation was completely different from the Sõrve lighthouse, close to the “minor” level.

### Silla leading line

The Silla leading line was operated at “Iso R 3s” (front, 2M range) / “Iso R 6s” (rear, 2M range). After trying several fixed level combinations it became evident that in such case it must be relatively higher than in case of missing background lighting. Luminous intensities in the range of 3% to 5% level of intensity in flash (2500 cd) implemented on both lights were found to improve the ability to track the leading lights at all times. An important finding was the dual nature of alignment introduced by the fixed and flashing rhythmic character: **while at the far end of the useful segment a mariner would primarily use the flash phase for navigating, at the near end where the lights may become blurry in flash at excellent visibility conditions, the low intensity fixed signal provides a clean sight for precise navigation**.

It was decided to implement FFl on both leading lights of the Silla leading line at 3% of intensity in flash in slightly non-standard way as “**fixed and isophase**”, reducing the night time luminous intensity of both lights to 50% of the initial intensity in flash, and changing the earlier character of the front light as follows: “F.Iso R 2s” front / “F.Iso R 6s” rear. When the 3% fixed light intensity level will be deemed insufficient by the mariners during the initial period starting in week 46/2014, it would be increased to 5%.

### The Pärnu Approach leading line

### The Pärnu Approach leading line was operated at “Q R” (front, 10M range) / “Iso R 6s” (rear, 11M range), with both lights at the luminous intensity of 100 kcd in flash. After trying several fixed level combinations it became obvious that in such case implementing FFl on the front light has only marginal effect due to high intensity of the light signal in flash and insufficient time for the eye to adapt to the low level intensity during the eclipse (0.5s). Implementation of luminous intensities in the range of 3% to 5% level of intensity in flash was found to be beneficial for the rear light. Validity of the existing IALA recommendation of the minimum duration for the fixed low intensity light signal component to exceed sub-second range was re-confirmed.

### As a result of above tests, it was decided to reduce the night time luminous intensity of both lights to 50% of initial intensity, to leave the front light character “Q R” as it was, and to implement FFl at 3% of intensity in flash only on the rear light using a rhythmic character “F.Iso R 6 s” (3s flash + 3s fixed) with the fixed / flashing signal ranges of 8M / 11M. When the 3% fixed light intensity level will be deemed insufficient by the mariners during the initial period starting in week 46/2014, it would be increased to 5%.

### A note was made about the need for recommendations concerning atmospheric transmissivity (meteorological visibility) dependent control of luminous intensity of leading lights in the widely varying environmental conditions where lights are kept at excessive intensity just in order to provide a reasonable range in adverse weather conditions.

## Implementation of FFl using LED AtoN lights

Three paths may be considered for implementing FFl on an AtoN:

1. Replacing all components to establish a completely new AtoN signal light system;
2. Replacing an external control module (flasher) of existing LED based AtoN light with an FFl-capable product;
3. Introducing an external FFl adapter module into the flashing control signal path; it would inject additional pulse width modulation (PWM) signal of selected duty cycle into the control circuitry of existing AtoN light during the eclipses detected in the control signal of the existing flasher to produce a low intensity fixed light signal of necessary luminous intensity.

Modern light emitting diode (LED) based AtoN lights are expected to provide ratio of the lowest and highest luminous intensity signals of up to 1:10,000 by complex application of analog and digital control methods for LED currents. This is expected to be sufficient for provision of day and night operation using FFl in single product.

While the alternatives B and C are more cost effective in comparison to A, they require detailed review of the technical capabilities of the existing systems in order to avoid problems. LED based AtoN lights are considered to be very well fitted for implementation of fixed and flashing rhythmic characters, but implementing FFl on an existing LED light may not always be successful:

* Control circuits may not be compatible with higher frequency / low duty cycle PWM signal that is the only way of introducing FFl without making changes in the existing light source circuitry; such signal may interfere with lantern’s own internal signals, results being unpredictable (up to component failures);
* Power driver circuitry of LEDs may not be fast enough to follow the quick control signals, even when supported by the control circuitry.

Prior to making a decision to use alternatives B or C for converting an existing AtoN light system to FFl, it is highly recommended to achieve a thorough understanding of the possible side effects of subjecting the existing lantern to the more complex FFl control signal. Consulting the supplier of the existing equipment may be the only way to guarantee trouble free conversion.

# References

1. IALA Recommendation E-110 for the Rhythmic Characters of Lights on Aids to Navigation. Edition 3, June 2012.
2. IHO UNIVERSAL HYDROGRAPHIC DATA MODEL. Special Publication No. 101. Electronic Navigational Chart Product Specification. Appendix A. Data Classification and Encoding Guide. Working Version – February 2013
3. Time to Revisit the Fixed and Flashing (F.Fl.) Rhythmic Character? Presentation at IALA EEP19 by Aivar Usk (Cybernetica AS) – October 2012

# Action requested of the Committee

The Committee is requested to:

1. Evaluate the benefits of the fixed and flashing rhythmic characters for improving the safety of navigation and provide more extensive guidelines and recommendations for the users in relevant IALA publications in the process of updating the publications.

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