AISM Association of Internationale de Signalisation Maritime IALA International Association of Marine Aids to Navigation and Lighthouse Authorities

IALA Guideline No. 1038

On

Ambient Light Levels at which Aids to Navigation Lights should switch on and off

Edition 1

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Table of Contents

1 Introduction

The most important aspect of a primary or secondary battery powered system design is the calculation of the daily energy load.[1] In order to conserve energy, AtoN lights which are only required during hours of darkness are switched off during daylight hours. For lighted aids to navigation that only operate at night, the switch-on / switch-off times can be regulated by either time switches or photo-sensitive devices that are calibrated to correspond to a nominated illuminance level.

In other applications, high power day time lights must be switched to lower intensity at night time in order to avoid glare, or lights may be switched on or intensity increased during periods of poor visibility in fog.

Time switch control switches the light on and off at preset times and requires a knowledge of the optimum switching time in morning and evening. In addition, the time switch must have a solar dial facility, so that the set times are automatically adjusted as seasons and length of day vary. Time switches cannot be used to switch the light on during periods of poor visibility.

Photosensitive devices do not suffer from these limitations. Since operation is dependent on ambient light level, photosensitive switches automatically adjust to varying seasons and weather conditions. They therefore provide the Mariner with the optimum AtoN service with minimum energy consumption

There are however conflicting requirements when using photosensitive daylight switches. If the selected ambient light level at which the light switches on is too high, the navigational light will be on for a long time. Energy resources will be wasted and the operational life of lanterns will be shortened. If the switching level is too low, the navigational light will not switch on until some time later and will be turned off earlier, thereby reducing the effectiveness of the navigation mark in its aid-to-navigation function and increasing the hazard to vessels and the risk of collision. In extreme cases bright moonlight may cause the light to switch off during the night if the switching level is set incorrectly. The problem of later switching on is that heavy overcast may cause the light to switch on during daylight. The problem of earlier switching ON is mainly a waste of energy resources.

1.1 Scope

This guideline has been developed to assist aids to navigation authorities when selecting and measuring the ambient light levels at which AtoN lights should switch on and off.

2 AMBIENT LIGHT LEVELS

The ambient light levels at which AtoN lights should switch on and off should be chosen so that the AtoN light switches on while the ambient light level is sufficiently high to allow safe navigation, while not switching on during overcast conditions when the AtoN is not necessary for safe navigation. A number of studies have been carried out to assist this determination.

[1] See Reference 4

2.1 Typical ambient light levels

Typical ambient light levels for different conditions are shown in Table 2.1.

Conditions	Ambient light levels (lux)
Sunlight Direct Illumination	$1\times10^5 \sim 1.3\times10^5$
Sunny Days in the Daytime	$1\times10^4 \sim 2\times10^4$
Cloudy Day	10^3
Wholly Cloudy Day	10^2
Civil Twilight Shadow	10
Dark Twilight Shadow	1
Full Moon	10^{-1}
The Moon at the First Quarter (or The Moon at the Third Quarter)	10^{-2}
Bright Sky Without Moon	10^{-3}
Cloudy Sky Without Moon	10^{-4}

Table 2.1 Typical ambient light levels

2.2 Timing of Astronomical Events

The astronomical events that define the transitions from day to night are shown in Table 2.2.[2]

Table 2.2 Timing of Astronomical Events.

Event	Condition	Typical Illumination Lux	Comment (Assuming the absence of moonlight, artificial lighting or adverse atmospheric conditions)
Sunset/Sunrise	Upper edge of the sun's disc is coincident with the horizon.	600	
Civil Twilight (beginning / ending)	Centre of the sun is at a depression angle of six (6) degrees below the horizon.	6	Illumination is sufficient for large objects to be seen but no detail is discernible. The brightest stars and planets can be seen For navigation at sea, the sea horizon is clearly defined.
Nautical Twilight (beginning / ending)	Centre of the sun is at a depression angle of twelve (12) degrees below the horizon.	0.06	It is dark for normal practical purposes. For navigation at sea, the sea horizon is not normally visible.
Astronomical Twilight (beginning / ending)	Centre of the sun is at a depression angle of eighteen (18) degrees below the horizon.	0.0006	Illumination due to scattered light from the sun is less than that from starlight and other natural light sources in the sky.

[2] The timing of astronomical events can also be applied to calculations (computer programs) for sizing solar power supplies.

2.3 Effect of sun elevation on ambient light level

Table 2.3 shows the effect of sun elevation on ambient light level in clear weather.

Table 2.3 Effect of suns elevation on ambient light level in fine weather.

Elevation of the Sun □°)	Ambient light level (lux)	Remarks
—18°	6.51×10^{-4} lx	Astronomical twilight (beginning/ending)
—12°	8.31×10^{-3} lx	Nautical twilight (beginning/ending)
—6°	3.4	Civil twilight (beginning/ending)
—5°	10.8	
—0.8°	453	
—0.25°	600	Sunrise/ Sunset (Upper edge of the sun' disc is coincident with the horizon)
0°	732	
5°	4760	
10°	1.09×10^{4} lx	
15°	1.86×10^{4} lx	
20°	2.73×10^{4} lx	
25°	3.67×10^{4} lx	
30°	4.70×10^{4} lx	
40°	6.67×10^{4} lx	
50°	8.50×10^{4} lx	
60°	10.2×10^{4} lx	
70°	11.3×10^{4} lx	
80°	12.0×10^{4} lx	
90°	12.4×10^{4} lx	

2.4 Orientation of daylight switch

Tests carried out in China in 2004[3] indicate that measured ambient light levels are significantly affected by the orientation of the measuring instrument. This means that the orientation of a daylight switch for AtoN light control must be chosen carefully.

At any given moment, ambient light level may be measured towards the sun horizontally, away from the sun horizontally, or towards zenith. These three values vary with time and weather conditions. Table 2.4 and Table 2.5 show measured values of ambient light level for different weather conditions. Generally speaking, the tested Ambient light level towards zenith comes closest to the ambient light level on the ground at that time.

[3] See reference 2.

Table 2.4 Effect of measuring instrument orientation on measured light level
(overcast weather, 38 degrees north latitude and 118 degrees east longitude)

	Ambient light level for different orientations (lux)			**Time difference for ambient light level of different orientations to reach the same value of ambient light**					
Time UTC 14 Feb	I Towards the sunrise	II Towards zenith	III Away from the sunrise	III is later than I (minute)		I is later than II (minute)		III is later than II (minute)	
6:56	50	83	48						
6:57	57	90	48	1	48				48
6:58	67	116	50	2	50				50
6:59	80	133	61	2	61	3	80		61
7:00	90	149	72	2	72	3	90		72
7:01	106	170	79	2	79	3	106	6	79
7:02	120	191	84	3	84	4~5	120	6	84
7:03	127	215	90	3	90	4~5	127	6	90
7:04	142	242	107	3	107	4~5	142	7	107
7:05	160	275	112	4	112	4~5	160	7	112
7:06	181	311	122	3	122	4~5	181	7~8	122
7:07	202	347	144	3	144	4~5	202	7	144
7:08	238	378	180	2	180	4~5	238	7	180
7:09	259	421	219	2	219	4~5	259	6	219
7:10	273	476	238	2	238	4~5	273	6	238
7:11	310	532	249	3	249	4~5	310	7	249
7:12	338	591	274	2	274	5	338	7	274
7:13	371	651	315	1	335	5	371	7	335
7:14	438	736	347	2	347	4~5	438	7	347
7:15	483	821	386	2	386	5~6	483	7	386
7:16	528	925	417	2	417	5~6	528	8	417
7:17	589	1000	486	2	486	5	589	7	486
7:18	702	1090	465	3	465	4~5	702	8	465
7:19	770	1148	531	3	531	4~5	770	8	531
7:20	830	1216	622	3	622	5	830	7	622

Table 2.5 Effect of measuring instrument orientation on measured light level
(fine weather, 38 degrees north latitude and 118 degrees east longitude)

	Ambient light level of different orientations lx			**Time difference for ambient light level of different orientations to reach the same value of ambient light**					
time 9 Feb UTC	I Towards the sunset	II Towards zenith	III Away from the sunset	III is earlier than I (minute)		I is earlier than II (minute)		III is earlier than II (minute)	
17:30	680	660	418	5	418	<1	680	5	418
17:31	650	630	380	5	380	<1	650	4	380
17:32	590	574	340	5	340	<1	590	4	340
17:33	530	516	318	4	318	<1	530	4	318
17:34	470	457	280	4	280	<1	470	4	280
17:35	410	401	250	4	250	<1	410	4	250
17:36	370	355	228	4	228	<1	370	4	228
17:37	310	314	210	3	210	<1	310	3	210
17:38	265	284	185	3	185	<1	265	3	185
17:39	232	245	150	3	150	<1	232	3	150
17:40	206	215	125	4	125	<1	206	4	125
17:41	188	189	110	4	110	<1	188	4	110
17:42	160	168	98	3	98	<1	160	3	98
17:43	143	140	79	3	79	<1	143	3	79
17:44	123	122	68	3	68	<1	123	3	68
17:45	101	103	58	3	58	<1	101	3	58
17:46	78	82	43	3	43	<1	78	3	43
17:47	69	68	36	3	36	<1	69	3	36
17:48	55	56	28	3	28	<1	55	3	28
17:49	45	45	22	4	22	<1	45	4	22
17:50	35	36	19			<1	36		
17:51	28	29	17			<1	29		
17:52	26	26	16			<1	26		
17:54	25	22	14						
17:55		18							
17:56		14							
17:57		11							
17:58		8							
17:59		6							
18:00		4							
18:01		2							
18:02		1							
18:03		0							

In Table 2.4 (overcast), at any given time, Ambient light level away from the sunrise is 80% of that towards the sunrise and Ambient light level towards the sunrise is 60% of that towards zenith. The time difference is 1 to 3 minutes to reach the same Ambient light level when measuring towards the sun and away from the sun (III is later than I). The time difference is 6 to 7 minutes when measuring away from the sun and towards zenith.

In Table 2.5 (fine weather), at any given time, the Ambient light level measured away from the sun is 60% of that measured towards the sun. The Ambient light level towards the sunset is roughly the same as that towards zenith. There is a time difference of 3-5 minutes to reach the same ambient light level towards the sun and away from the sun.

In clear conditions, a large bright moon directly in front of the daylight switch may be sufficiently bright to cause the AtoN light to be switched off if the switching level is set too low. Increasing the switching threshold overcomes this problem.

In many applications, pointing the daylight switch away from the noontime sun (north in northern hemisphere) provides satisfactory performance. For floating aids to navigation, pointing the daylight switch vertically at zenith often provides a compromise, although it is found that fitting the daylight switch within the lantern lens provides satisfactory performance on buoys in many applications.

2.5 Effect of latitude

The higher the latitude, the longer the time difference to reach the same ambient light level at various orientations.

Consider the civil twilight for in Table 2.6 (horizontal altitude of the sun –6 degrees ~ 0 degree). The time difference between Civil Twilight and Sunrise is the shortest near the equator at about 21 minutes all the year. At 40 degrees this increases to 30 minutes all year around. High latitudes regions change fast with variations of seasons and longitudes.

Table 2.6 Period between Twilight Civil and Sunrise (elevation of the sun from—6°~ 0°)

	2001-06-21 midsummer			**2001-09-22 the autumnal equinox**			**2001-12-21 midwinter**		
Lat.	Twilight Civil	Sunrise	period	Twilight Civil	Sunrise	period	Twilight Civil	Sunrise	period
°	h m	h m	m	h m	h m		h m	h m	m
N70°				0442	0540	58			
N66°				04 54	05 43	49	0854	1035	101
N64°		01 31		04 58	05 43	45	0834	0952	78
N60°	00 49	02 36	107	05 05	05 44	39	0805	0902	57
N50°	03 06	03 51	45	05 15	05 46	31	0718	0756	38
N40°	03 59	04 31	32	05 21	05 47	26	0648	0718	30
N30°	04 32	04 59	27	05 23	05 48	25	0626	0652	26
N20°	04 57	05 21	24	05 27	05 49	22	0607	0630	23
N10°	05 18	05 40	22	05 28	05 49	21	0550	0612	22
0°	05 36	05 58	22	05 28	05 49	21	0532	0554	22
S10°	05 53	06 16	23	05 28	05 50	22	0514	0537	23
S20°	06 10	06 34	24	05 27	05 50	23	0454	0518	24
S30°	06 29	06 55	26	05 24	05 50	26	0429	0456	27
S40°	06 52	07 22	30	05 21	05 49	28	0355	0428	33
S50°	07 21	08 00	39	05 15	05 49	34	0303	0347	44
S56°	07 46	08 33	47	05 09	05 48	39	0207	0309	62

the sun continuously above horizon
the sun continuously below horizon
the sun continuously twilight

2.6 Meteorological effects

The effect of cloud on ambient light levels is considered in section 2.2.

The ambient light level in fog conditions is variable, ranging from very bright in shallow sea fog conditions to quite dark in heavy fog conditions. However, the danger to safe navigation due to restricted visibility is much the same for all fog conditions. Snow conditions also frequently give rise to restricted visibility with relatively high ambient light levels. It is therefore difficult to use photosensitive switches effectively to detect poor visibility conditions.

3 LOCAL ENVIRONMENTAL FACTORS

Local conditions can have a significant impact on the ambient light level and the light level at which a light should switch.

3.1 Bright artificial light

In harbours and confined waters where there is background lighting, consideration should be given to the possible need for AtoN lights to switch on earlier than the background lights. Typical switch on levels for streetlights is 200 lux.

3.2 River lights

In rivers where multiple lights are used to mark a channel, it is desirable, and sometimes necessary, to ensure that all lights switch on and off at the same time. Where there are dark riverbanks on part of the channel, it may be found that the lights in this part of the channel switch on and off earlier and later than those in more open section of the channel.

3.3 Passing traffic

In narrow channels, the shadow cast by passing large ships may affect the ambient light level in the vicinity of the light.

3.4 Hydrograph and meteorology

Local hydrographical or meteorological conditions may give rise to frequent fog, snow, ice or shadow conditions that affect the local ambient light levels. The effects of these are discussed in section 2.6.

4 SENSORS

4.1 Human perception of light

The unit of illuminance, the lux (lumen/$m^{2)}$, is a photometric one and is therefore based on the spectral response of the human eye in bright light (photopic response $V(\lambda)$).

Photometric devices such as luxmeters are corrected, usually by the use of filters, to this photopic response. However, photoreceptors (PDR's and PD's) used in light level switching usually are not corrected to $V(\lambda)$. Therefore, there will be errors between the levels recorded or switched by the two devices when illuminated by light sources of different spectral distribution.

If true lux level switching is desired, it would be necessary to employ photopic correction in the photoreceptor. However, most devices currently in service worldwide would fall outside any such specification.

One exception to this is photoreceptors employing selenium. Such devices have a spectral response close to $V(\lambda)$. Unfortunately, they suffer from degradation with age and use, just like real eyes.

It should also be considered that the safe limit of contrast for the human eye is recognised as 5%. This is the basis for the nominal range chart in IALA 1966. However, visibility will also affect the contrast. Visibility may also affect the ambient light level and this, to some extent, may be self-adjusting.

4.2 Spectral response

Ideally, the spectral response of the light detector carrying out the switching should be corrected to the human eye response (CIE V lambda). If such devices were corrected to V(λ), the calibrating light source would not need to be daylight because the luxmeter and the switching device would have a similar spectral response.

Unfortunately, devices currently in use are usually not corrected, and this causes problems with their calibration. Using a standard light source (such as illuminant A) for calibrating switching devices requires a correction to be carried out. The information required for such a correction are:

1. Spectral response of standard lamp (this changes when the lamp voltage is reduced to simulate falling light levels)
2. Spectral response of measuring instrument (luxmeter)
3. Spectral response of switching device
4. CIE V(λ)

There is a CIE formula that gives a correction factor from the above spectral data.

Irrespective of the type of sensor used, it is essential that the sensor should not have any significant sensitivity outside the spectrum of the human eye response, so that the sensor does not respond to radiation to which the human eye is not sensitive.

However, in practice spectral correction using test lamps is difficult and expensive.

Figure 4.1 shows the spectral distribution for visible light during daytime and at sunrise and sunset.

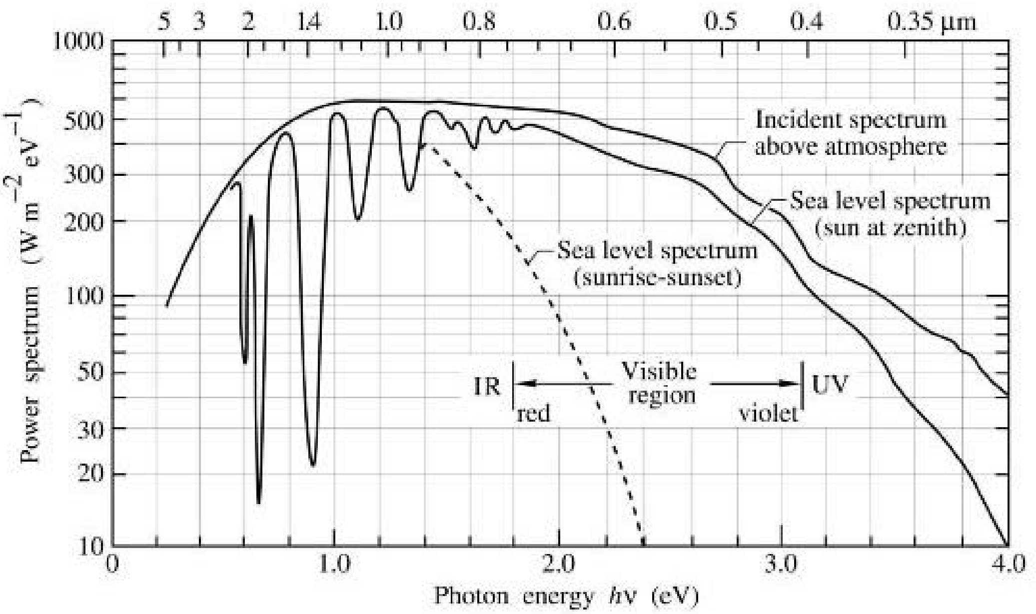

Figure 4.1 Power spectrum of solar radiation versus photon energy and wavelength for different conditions (adopted from Jackson, 1975).

4.3 Light dependent resistor (LDR)

The most common daylight switch sensor is the light dependent resistor (LDR), as they are cheap and simple to use. The resistance of the LDR varies with illumination, with LDR resistance decreasing as illuminance increases. This change in resistance is used to trigger the switching action.

In case of LDR, we can typically choose between 520, 540, 560, 570, 620 and 630 nanometers of peak sensitivity wavelength. Manufacturers state that these sensors are non-polar resistive elements with spectral response characteristics close to the human eye but do not supply the spectral response curve. The manufacture's resistance values for adjustment are measured for tungsten filament lamps operating at a colour temperature of 2856 K , then some changes are necessary for the adjustment of daylight levels but it's important to know the spectrum of light in sunset or sunrise is near to this lamp (see figure 4.1). The accuracy between 100 and 10 lux depending of the model is about 85% or 90%

4.4 Semiconductor photodiode

Some photovoltaic applications use the output of the solar array as a daylight sensor. The output from one solar panel is connected to a comparator where voltage is compared with an adjustable reference voltage. The change in solar cell voltage is used to trigger switching action.

When using this technique, the spectral response of the solar array should be considered. The spectral response of Silicon solar array is good in blues or near ultraviolet zones but is no good in the red zone. In case of GaAs arrays, the spectral response is better in the red zone of the spectrum.

5 RECOMMENDED SWITCHING LEVELS

The selection of the ambient light at which AtoN lights switch on or off must meet the following criteria:

- the navigational requirements must be met, i.e. the navigation light must be switched on when the light is required as an AtoN,
- where multiple lights are used as AtoN's such as to form a channel using buoys, all lights should switch on and off almost simultaneously to avoid gaps in the channel mark at lighting up and light off time,
- switching levels should not be set too high, to avoid excessive daily energy consumption.
- however, where there is conflict between energy consumption and provision of the AtoN function, priority should be given to the AtoN function.
- the recommended switching levels should be based on the basic characteristics of human perception. Ideally, the AtoN should switch on at an ambient light level when the AtoN becomes unusable as a daymark.

5.1 Hysteresis in switching levels

In order to ensure that the on and off switching levels are clearly defined, it is necessary to ensure adequate hysteresis between the on and off levels.

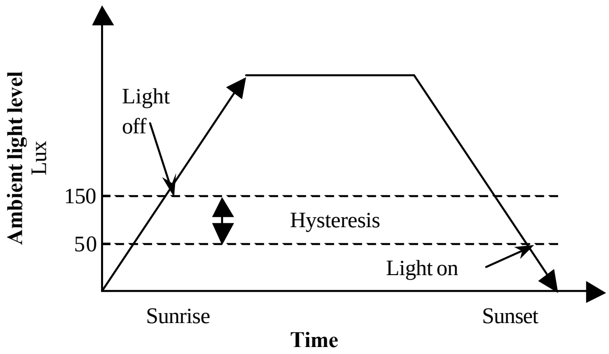

Figure 5.1 Hyteresis in AtoN light switching

In figure 5.1, a difference of 100 lux between the light off level as ambient light level increases and light on level as ambient light decreases ensures that the light does not switch on and off at the switching threshold point. Typical hysteresis of 50 to 100 lux provides satisfactory performance. It is also possible to include a time delay of a few minutes in the hysteresis system to limit the bandwidth of the switching element.

5.2 IALA survey of switching levels used by Members

In 2003, IALA carried out a survey through questionnaire on Ambient Light Levels at which AtoN lights should be switched on and off. A total of 8 responses where received, from Finland, France, Germany, Sweden, Denmark, Holland, England and Hong Kong. The responses are summarised in Annex 1.

The following observations were made:

1. Most of the respondents have established formal policies defining the ambient light level at which their AtoN's turn on and off.
2. One respondent (Germany) has no ambient light sensors at their lighthouses, but controls ON and OFF switching on the basis of the time of sunset – 1 hour and sunrise + 1 hour at a reference location. This method seems to discard any effects from varying meteorological conditions.
3. The ON switching level for *lighthouses* varies in the range 20-100 lux.
4. The ON switching level for *buoys* varies in the range 15-200 lux.
5. The OFF switching level for *lighthouses* varies in the range 40-200 lux.
6. The OFF switching level for *buoys* varies in the range 40-200 lux.
7. According to one respondent it is important to ensure that a system of AtoNs turn ON and OFF at approximately the same time, in particular on leading lines where lights preferably should switch simultaneously.
8. Most of the respondents have a switching time delay (hysteresis) to avoid switching oscillation but the switching delay time varies in the range 15-600 seconds.
9. In many cases the switching level can be adjusted, both in the workshop and in the field.

10. Both light dependent resistor (LDR) and semiconductor photodiode type sensors are used.
11. At lighthouses, most respondents face the sensors away from the sun.
12. During manufacturing process, switching levels may or may not have been tested against ambient light.
13. In many cases lighthouse switching levels are tested during commissioning and in some cases monitored afterwards.
14. Buoy lanterns are mostly not tested during commissioning, but in some cases monitored afterwards.
15. The switching level adjustments may either be done by flasher programming or by mechanical means including adjustable optical filters.

5.3 Ambient light switching levels

A useful guide to the ambient light levels at which AtoN lights should switch on and off is as follows:

- Switch on at 50 – 100 lux.
- Switch off at 150 – 200 lux.
- hysteresis of 50-100 lux
- if hysteresis has time delay, typical value of 0.5 to 8 minutes.

6 TESTING

Because of the difference in spectral characteristics between artificial light and sunlight, it is difficult to devise effective workshop methods of setting up daylight switches using artificial light. Standards such as D65, D55 and D75 simulate daylight at different times of the day but are expensive.

The spectral characteristics of the light source used for the measurement is important.

One method of illuminating a daylight switch for test purposes is a simple incandescent filament lamp such as a household lamp with a well known spectral distribution (colour temperature). The illumination from the lamp is varied by adjusting the distance from the lamp to the measuring location.

A common method of setting up lighthouse lights is to use a luxmeter to measure the ambient light level and adjust the daylight switch circuitry to switch on the light when the required ambient light level is reached.

7 REFERENCES

1. IALA, *IALA Aids to Navigation Guide (Navguide) 4th Edition, Section 3.4.4 Timing of Astronomical Events*, IALA Aids to Navigation Guide (Navguide) 4th Edition
2. IALA Engineering Environment and Preservation of Historic Lighthouses Committee, *EEP4 Input Comment on Ambient Light level at which the Lights should switch on and off,* Maritime Safety Administration of Peoples Republic of China, 2004.
3. IALA Engineering Environment and Preservation of Historic Lighthouses Committee, *IALA EEP3 Input Summary of Responses to IALA Ambient Light Level Questionnaire,* Royal Danish Administration of Navigation and Hydrography, 6 September 2003
4. IALA *Guidelines on a standard Method for Defining and Calculating the Load Profile of Aids to Navigation*, December 1999.

ANNEX 1 - Summary of Responses to Ambient Light Level Questionnaire 2003

	Question	Comments (Lighthouse)	Comments (Buoy)
1	Does your organisation have standards/policy for switching of light levels of AtoN's?	NO = 1, YES = 4 "ON switching level is set" "We depend upon lantern suppliers standard for their equipment and is normally one hour before dark and one hour after dawn" "There are no switching sensors in lighthouses"	NO = 1, YES = 5 "ON switching level is set" "as supplied by lantern manufacturer" "We depend upon lantern suppliers standard for their equipment and is normally one hour before dark and one hour after dawn"
2	ON switching level (lux)?	20, 50, 100, 100, 50-100 "Depends on the sunset. Light switches ON one hour before sunset in the city of Cuxhaven."	15, 20, 50-00, 100, 100, 100, 200
3	OFF switching level (lux)?	40, 100, close to 100, 150, 200 "Depends on the sunset. Light switches ON one hour before sunset in the city of Cuxhaven."	40, 60, 100, 100-150, 150, 200, 200
4	Acceptable tolerance levels?	+30 and -0, ON 10-40 and OFF 10-60, Varies from 70-350 "Switching levels are field adjusted according to amount of trees and other obstructions around AtoN to have AtoN switch on and off times approximately equal between AtoN's. Adjustment is especially important and difficult on leading lines because lights should switch on and off simultaneously."	±20 10% ON 10-40 and OFF 10-60 Varies from 70-350 Not defined
5	Is there a switching time delay?	NO = 2 YES = 4	NO = 2 YES = 6
6.1	Switching delay time?	60, 15-60, 15-240, 600 seconds	15-60, 15-240, 30, 60, 60, 600 seconds
6.2	Can the switching level be adjusted?	NO = 2 YES = 4	NO = 1 YES = 5 "Only in some lanterns"
7	What is the adjustment range of switching level	2 lux 10-1000 lux ±50%	2 lux 15-60 lux, 10-1000 lux ±50%
8	Can the switching level adjustment be factory or field set?	YES = 2 "Factory and field" "Field set" "Factory setting is usually 100 lux"	YES = 2 "Factory and field" "Field set", "Field" "Factory setting is usually 100 lux" "Only factory/workshop set"
9	What type of light switching sensor is used?	LDR = 3 "Cadmium Sulphate Photocell" "Photodiode" "Photoconductive cell"	LDR = 3 "Cadium Sulphate Photocell" "Photodiode", "Photoconductive cell" "Phototransistor BP 103/4
10	Which direction does the sensor face (vertical, facing the sun or away from the sun)?	"Facing North", "Vertical facing North" "Vertical away from the sun" "Away from the sun" "To the most open direction and away from the forest" "Fitted in base of a light tube which collects light all around (360 degrees)"	"Typically horizontal" "Vertical, sensor is facing the sun"
11.1	Are switching levels tested against ambient light levels during manufacture?	YES = 2 NO = 3	YES = 3 NO = 2
11.2	Are switching levels tested against ambient light during commissioning (user)?	YES = 3 NO = 2 "On and Off times are monitored after commissioning"	YES = 1 NO = 4 "On and Off times are monitored after commissioning"
11.3	Please provide details of switching level adjustment procedures.	"With old flashers adjustment is made by rotation optical filter. With new programmable flashers adjustment can be made either by filter or programming" "Mechanical Adjustment" "to cover switching resistor" "Resistor value"	"DIP Switch setting according to manual" "Programmable flasher" "LMT lux measurements lamp + daylight. "to cover switching resistor"