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| IALA TUTORIAL |

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FOR Leading Lines DESIGN SPREADSHEET



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Revisions to this document are to be noted in the table prior to the issue of a revised document.

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# Introduction

The 'Leading Line Design Programme' is a Microsoft Excel® Spreadsheet to design the geometric and photometric features of a leading line. It requires an input of several parameters. The spreadsheet gives several output parameters which are automatically assessed and when the design is not correct, problem codes are generated. The aim is to vary the input parameters in that way that no problem code occurs and the final design is suitable according to practical conditions.

The spreadsheet follows the IALA Guideline on Design of Leading Lines. Although the spreadsheet may be used with little knowledge, it is recommended that the user is familiar with the principles given in the guideline.

# Licence and Warranty

*IALA should say something about the licence and warranty. This can be done with the subsequent statement (proposal: MIT licence)*

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# System Requirement

The spreadsheet was developed with Microsoft Excel® from Microsoft Office® Professional Plus 2016 and should run on all newer versions of Excel.

# Design Steps

The design steps are shown in Figure 1.

The procedure starts with a preliminary assessment of the position of front and rear light. It is based on the length and width of the channel. If the positions of the leading marks are already determined by geographical or other limitations preliminary assessment can be omitted.

After the preliminary calculation the main calculation process starts with the input of all relevant parameters. The procedure itself is an iteration.

The spreadsheet immediately gives an output and an assessment via 'problem codes'. Based on output and the problem codes the user changes the input parameters step-by-step with the aim that no problem code occurs. When this is the case the user gets the required geometric (distances, heights and dimensions of the daymarks) and photometric (luminous intensities) parameters.

In any case the layout has to be assessed for practical considerations, which are listed in the guideline (see Guideline Chapter 7.5 and 8.).



1. Design Steps

Any of the leading line parameters can be entered and modified in any order, but when first starting out it is recommended that the input data be entered in the order outlined below. The input cells are shaded and outlined with a box. An Initial Channel Layout Worksheet is included in the workbook to recommend a ‘very good’ leading line design (Cross-Track Factor 15 - 20%) in the event that the locations of the front and rear structures are not initially known. To use this preliminary design tool, click on the ‘Initial Input’ worksheet tab and enter the data indicated below. All input cells require data unless otherwise indicated.

# Initial Input (SHEET A)

Enter the following cells.

|  |  |  |
| --- | --- | --- |
| 1. Leading Line Name | The name is copied to all other sheets automatically and is used to identify the leading line. | OPTIONAL |
| 2. Channel Length (C) | Length in metres | REQUIRED |
| 3. Channel Width (W) | Width in metres | REQUIRED |

Recommended distance between front light (FL) and the rear light (RL) towers (), and recommended distance from FL to Near End of the Channel () are computed and displayed on the Initial Channel Layout. These values are also shown on the ‘Leading Line’ worksheet adjacent to the data entry.

# Leading Line (SHEET B)

## INPUT

The input cells are shaded and numbered with prefix **#** (#1, #2, ...) according to the IALA guideline.

| **Input Number** | **Parameter** | **Explanation** | **Comment** |
| --- | --- | --- | --- |
| #1 | Use of daytime lights | N (night) / D (day) as pull down menu | DEFAULT is 'N' |
| #2 | Length of channel | Length in metres | REQUIRED |
| #3 | Width of channel | Width in metres | REQUIRED |
| #4 | Mean range of tide | MRT in metres | REQUIRED |
| #5 | Background lighting | None, minor, considerable as pull down menu | DEFAULT is ‘considerable’ |
| #6 A,  #6 B,  #6 C | Height of eye | Three heights of eye of the observer can be entered. It is assumed that the input includes the minimum and maximum relevant heights. | At least one entry is REQUIRED. |
| #7 | Minimum visibility | Minimum visibility in nautical miles (M), typically the value which occurs 90% of time | REQUIRED |
| #8 | Design visibility | Recommended value is 10 M, but it may be changed. | REQUIRED  DEFAULT is '10 M' |
| #9 | Maximum visibility | Recommended value is 20 M, but it may be changed. | REQUIRED  DEFAULT is '20 M' |
| #10 | Distance | Distance between front and rear light in metres | REQUIRED |
| #11 | Distance M | Distance between front light and near end of channel in metres | REQUIRED |
| #12 | Safe height above water | Safe eight considering waves and vandals, in metres | DEFAULT is '0' (zero) |
| #13 | Use of daymarks | Y (yes) / N (no) as pull down menu | DEFAULT is 'N' |
| #14 Obs#1 | Distance of obstruction #1 | Distance from obstruction to near end of channel in metres | OPTIONAL |
| #15  Obs#1 | Height of obstruction #1 | Height of obstruction above MHW | OPTIONAL |
| #14 Obs#2 | Distance of obstruction #2 | Distance from obstruction to near end of channel in metres | OPTIONAL |
| #15  Obs#2 | Height of obstruction #2 | Height of obstruction above MHW | OPTIONAL |
| #16 | Selected daymark length, front light | Length in metres | Input is ignored when daymarks are not used (#13). |
| #17 | Selected daymark length, rear light | Length in metres | Input is ignored when daymarks are not used (#13). |
| #18 | Selected luminous intensity, front light | Value in candela | REQUIRED |
| #19 | Selected luminous intensity, rear light | Value in candela | REQUIRED |
| #20 | Selected front light height | Height of lantern above MHW | REQUIRED |
| #21 | Selected rear light height | Height of lantern above MHW | REQUIRED |
| #22 | Calculation method for recommended intensity | * Factor 10 (2001, old guideline) * Factor 2 * Simplified method | DEFAULT is Factor '10' (2001, old guideline) |
| #23 | Calculation method for daymark length | * US Coast Guard method (2001, old guideline) * 3' - rule (Guideline on daymarks) * 6' - rule (Guideline on daymarks) | DEFAULT is 'US Coast Guard method' (2001, old guideline) |
|  | Daymark width? |  |  |

## OUTPUT

The output cells are numbered with prefix **%** (%1, %2, ...) according to the IALA guideline. The cell content is green.

| **Output Number** | **Parameter** | **Explanation** |
| --- | --- | --- |
| %1 | Recommended daymark length, front light | Value in metres |
| %2 | Recommended daymark width, front light | Value in metres |
| %3 | Recommended daymark length, rear light | Value in metres |
| %4 | Recommended daymark width, rear light | Value in metres |
| %5 | Minimum luminous intensity, front light | Value in candelas |
| %6 | Minimum luminous intensity, rear light | Value in candela |
| %7 | Recommended luminous intensity, front light | Value in candela |
| %8 | Recommended luminous intensity, rear light | Value in candela |
| %9 | Maximum luminous intensity, front light | Value in candela |
| %10 | Maximum luminous intensity, rear light | Value in candela |
| %11 | Recommended intensity ratio, rear versus front light |  |
| %12 | Intensity ratio of selected intensities |  |
| %13 | Recommended height of front light above MHW |  |
| %14 | Recommended height of rear light above MHW |  |
| %15 | Illuminance values from **front** light, **minimum** visibility | values all inside the channel |
| %16 | Illuminance values from **front** light, **design** visibility | values all inside the channel |
| %17 | Illuminance values from **front** light, **maximum** visibility | values all inside the channel |
| %18 | Illuminance values from **rear** light, **minimum** visibility | values all inside the channel |
| %19 | Illuminance values from **rear** light, **design** visibility | values all inside the channel |
| %20 | Illuminance values from **rear** light, **maximum** visibility | values all inside the channel |
| %21 | Minimum elevation angle for different observer heights | values all inside the channel |
| %22 | Cross-Track factor for different observer heights | values all inside the channel |

## PROBLEM CODES

The output cells are numbered with prefix **§** (§1, §2, ...) according to the IALA guideline. The cell content is red. The problem codes are checked all inside the channel for all observer heights.

### Basic Problem Codes

| **Output Number** | **Parameter** | **Red Problem Code** |
| --- | --- | --- |
| §1 | Blur test | **1** |
| §2 | Cross-Track factor too big | **2** |
| §3 | Front light not bright enough | **3** |
| §4 | Rear light not bright enough | **4** |
| §5 | Front light causes glare | **5** |
| §6 | Rear light causes glare | **6** |
| §7 | Front light daymark too small | **7** |
| §8 | Rear light daymark too small | **8** |
| §9 | Rear light below front light | **9** |
| §10 | Front light below safe height above water | **10** |
| §11 | Front light below horizon | **11** |
| §12 Obs#1 | Obstruction #1 blocks front light | **12** |
| §12 Obs#2 | Obstruction #2 blocks front light | **13** |
| §13 Obs#1 | Obstruction #1 blocks rear light | **14** |
| §13 Obs#2 | Obstruction #2 blocks rear light | **15** |

### Daymark Problem Codes

| **Output Number** | **Parameter** | **Blue Problem Code** |
| --- | --- | --- |
| §14 | Portion of front light daymark below horizon | **1** |
| §15 | Front light daymark below safe height above water | **2** |
| §16 | Front light obscures part of rear daymark at far end of channel | **3** |
| §17 | Front light obscures half of rear light day mark at near end of channel | **4** |
| §18 | Obstruction #1 obscures front light daymark | **5** |
| §19 | Obstruction #1 obscures rear light daymark | **6** |
| §20 | Obstruction #2 obscures front light daymark | **7** |
| §21 | Obstruction #2 obscures rear light daymark | **8** |

## Problems and Fixes

Below are some suggestions on resolving problems with leading line designs, with possible constraints and costs. Common problem codes are grouped together.

| **Code** | **Problem** | **Possible Fix** | **Constraint / Cost** |
| --- | --- | --- | --- |
| **1** | Lights will blur | * Raise RL * Reduce intensities * Lower FL * Decrease C | |  | | --- | | * Extra cost * Decreased sensitivity * Lights harder to acquire and align? * Closer to water and vandals? * May not meet user requirements. | |
| **2** | Cross-Track Factor too big | * Increase R * Increase FL height or decrease RL height (decrease elevation difference) | * May need real estate * Extra cost * May need to increase RL height * Lights may blur |
| **or 4** | FL or RL not bright enough in minimum visibility | * Increase intensities * Decrease M | * May cause glare or blur * Extra cost |
| **5 or 6** | FL or RL exceeds glare limit in maximum visibility | * Reduce intensities * Increase M | * Lights harder to acquire and use * May need real estate * Extra cost |
| **7 or 8** | FL or RL daymark too small in minimum visibility | * Increase daymark size * Use daytime lights | * Extra cost * Extra initial equipment cost |
| **9** | RL appears lower than FL | * Lower FL and daymark * Raise RL * Decrease R | * Lights / daymark closer to water * Extra cost * Decreased sensitivity |
| **10** | FL below safe height above water | * Raise FL * Use smaller daymark | * May cause blur → raise RL * May not be adequate |
| **11** | FL below horizon | * Raise FL * Decrease M | * May cause blur → raise RL * May cause glare * Harder to balance illumination ratios |
| **12 or 14** | Obstruction #1 or #2 blocks front light | * Remove obstruction | * May not be legal / possible |
|  | * Raise FL | * May cause blur * Need to raise RL |
|  | * Decrease M | * May cause glare * Harder to balance illumination ratios → move RL forward too |
| **13 or 15** | Obstruction #1 or #2 blocks rear light | * Remove obstruction | * May not be legal / possible |
|  | * Raise RL | * Decreased sensitivity * Extra cost |
|  | * Decrease R * Decrease M and R Unchanged | * Decreased sensitivities |
| **1** | Portion of FL daymark below horizon | |  | | --- | | * Raise FL daymark * Decrease M * Use daytime lights | | * Extra cost due to larger tower * May need to raise rear daymark * May cause glare * Harder to balance illumination ratios * Extra initial equipment cost. |
| **2** | FL daymark below Safe Height Above Water. | * Raise FL daymark * Use daytime lights | * Extra cost due to larger tower * May need to raise rear daymark * Extra initial equipment cost |
| **3** | FL daymark obscures part of RL daymark | * Lower FL daymark * Raise RL daymark * Use daytime lights | * Closer to water and vandals? * Decreased sensitivity * Extra cost * Decreased sensitivity * Extra initial equipment cost |
| **4** | FL daymark obstructs more than half of RL daymark | * Lower FL daymark * Raise RL daymark * Use daytime lights | * Closer to water * Decreased sensitivity * Extra cost * Decreased sensitivities * Extra initial equipment cost. |
| **5 or 7** | Obstruction #1 or #2 blocks front daymark | * Remove obstruction | * May not be legal / possible |
|  | * Raise front daymark | * May cause blur * Extra cost * Need to raise rear daymark |
|  | * Decrease M | * May cause glare * Harder to balance illumination ratios |
| **6 or 8** | Obstruction #1 or #2 blocks rear daymark | * Remove obstruction | * May not be legal / possible |
|  | * Raise RL | * Decreased sensitivity * Extra cost due to larger tower |
|  | * Decrease R | * Decreased sensitivities |

# Leading Line DAY (SHEET C)

In this sheet the all the values of sheet B are found as a copy and there is no need to input them again. Sheet C is to determine the luminous intensity for a daytime light only.

For the evaluation it is only necessary to put in the selected luminous intensity of front and rear light.

All computations are the same as described for nighttime leading line worksheet B, with the required illuminance set to .

# FINAL DESIGN LAYOUT (SHEET D)

No additional calculations are made on this final spreadsheet (click on worksheet tab ‘Final Design Layout’). This sheet provides a conveniently summarized presentation of all the leading line’s prominent configuration and design attributes on a single worksheet suitable for printing and filing in project records.