

# FATIGUE AND RISK INDEX CALCULATOR

Version 2.2

## USER GUIDANCE

Fatigue Index Calculator															
Company				Location				Assessor							
Shift ID				Date				<input checked="" type="checkbox"/> Display schedule				<input type="checkbox"/> Display charts			
Mode				Fatigue				Defaults				Res et Index			
				Calculate Index				© Crown Copyright 2005				Version 2.2			
												About			
Day	On Duty	Off Duty	Job type / breaks	Commuting Time	Duty Length	Rest Length	Average duty per day	Cumulative component	Duty timing component	Job type / Breaks component	Fatigue Index				
1	07:00	19:00	Default	Default	12h	Fully Rested	12h	0.1	0.8	3.4	4.3				
2	07:00	19:00	Default	Default	12h	12h	12h	1.8	0.8	3.4	5.9				
3	19:00	07:00	Default	Default	12h	1d	9h	1.9	17.4	23.8	42.4				
4	19:00	07:00	Default	Default	12h	12h	9h 36m	7.8	17.4	23.8	45.8				
9	07:00	19:00	Default	Default	12h	4d	6h 40m	0.5	0.8	3.4	4.7				
10	07:00	19:00	Default	Default	12h	12h	7h 12m	2.5	0.8	3.4	6.6				
11	19:00	07:00	Default	Default	12h	1d	7h	2.2	17.4	23.8	42.5				
12	19:00	07:00	Default	Default	12h	12h	7h 23m	8.2	17.4	23.8	46.0				
17	07:00	19:00	Default	Default	12h	4d	6h 21m	0.5	0.8	3.4	4.7				
18	07:00	19:00	Default	Default	12h	12h	6h 40m	2.5	0.8	3.4	6.6				
19	19:00	07:00	Default	Default	12h	1d	6h 36m	2.2	17.4	23.8	42.5				
20	19:00	07:00	Default	Default	12h	12h	6h 51m	8.2	17.4	23.8	46.1				
25	07:00	19:00	Default	Default	12h	4d	6h 14m	0.5	0.8	3.4	4.7				
26	07:00	19:00	Default	Default	12h	12h	6h 26m	2.5	0.8	3.4	6.6				
27	19:00	07:00	Default	Default	12h	1d	6h 26m	2.2	17.4	23.8	42.5				
28	19:00	07:00	Default	Default	12h	12h	6h 37m	8.2	17.4	23.8	46.1				
33	07:00	19:00	Default	Default	12h	4d	6h 11m	0.5	0.8	3.4	4.7				
34	07:00	19:00	Default	Default	12h	12h	6h 21m	2.5	0.8	3.4	6.6				
35	19:00	07:00	Default	Default	12h	1d	6h 20m	2.2	17.4	23.8	42.5				
36	19:00	07:00	Default	Default	12h	12h	6h 29m	8.2	17.4	23.8	46.1				
46	07:00	19:00	Default	Default	12h	9d	5h 29m	0.1	0.8	3.4	4.3				
47	07:00	19:00	Default	Default	12h	12h	5h 37m	1.3	0.8	3.4	5.4				
48	19:00	07:00	Default	Default	12h	1d	5h 36m	1.7	17.4	23.8	42.2				
49	19:00	07:00	Default	Default	12h	12h	5h 46m	7.4	17.4	23.8	45.6				
54	07:00	19:00	Default	Default	12h	4d	5h 33m	0.5	0.8	3.4	4.7				
55	07:00	19:00	Default	Default	12h	12h	5h 40m	2.5	0.8	3.4	6.6				
56	19:00	07:00	Default	Default	12h	1d	5h 41m	2.2	17.4	23.8	42.5				
57	19:00	07:00	Default	Default	12h	12h	5h 48m	8.2	17.4	23.8	46.0				
62	07:00	19:00	Default	Default	12h	4d	5h 37m	0.5	0.8	3.4	4.7				
63	07:00	19:00	Default	Default	12h	12h	5h 43m	2.5	0.8	3.4	6.6				
64	19:00	07:00	Default	Default	12h	1d	5h 43m	2.2	17.4	23.8	42.5				
65	19:00	07:00	Default	Default	12h	12h	5h 49m	8.2	17.4	23.8	46.1				
70	07:00	19:00	Default	Default	12h	4d	5h 39m	0.5	0.8	3.4	4.7				
71	07:00	19:00	Default	Default	12h	12h	5h 45m	2.5	0.8	3.4	6.6				
72	19:00	07:00	Default	Default	12h	1d	5h 45m	2.2	17.4	23.8	42.5				
73	19:00	07:00	Default	Default	12h	12h	5h 50m	8.2	17.4	23.8	46.1				

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## 2 BACKGROUND

The development of the Fatigue and Risk Index Calculator was undertaken by QinetiQ, in collaboration with Simon Folkard Associates Ltd, as part of a programme of research for the HSE. Details of work and data that were used in the development process are outlined in ‘The development of a fatigue/risk index for shiftworkers’ HSE Research Report 446 (2006) (available on HSE’s website in the ‘Research’ pages).

The calculator contains two separate indices, one which relates to fatigue (Fatigue Index) and one that relates to risk (Risk Index). While the two indices are similar in many respects they diverge in others. The main differences are due to the different time of day effect: the peak in risk occurs close to midnight, whereas the peak in fatigue tends to occur some five hours later, in the early morning. Therefore, when assessing a pattern of work it is important to review both the Fatigue and Risk indices.

In the spreadsheet, both the risk and the fatigue indices are expressed in terms of three individual components:

1. A cumulative component. This relates to the way in which individual duty periods or shifts are put together to form a complete schedule. The cumulative component associated with a particular shift depends on the pattern of work immediately preceding that shift.
2. A component associated with duty timing, i.e. the effect of start time, shift length and the time of day throughout the shift.
3. A job type / breaks component. This relates to the content of the shift, in terms of the activity being undertaken and the provision of breaks during the shift.

Before using the Fatigue and Risk Index Calculator for the first time, it is recommended that users read the research report associated with the development of the Index and in particular, Section 2: Development of a new Fatigue Index (HSE RR446 (2006)).

### 3 DOWNLOADING AND SAVING THE SPREADSHEET

The Excel spreadsheet is available for downloading on HSE’s website. On the ‘Home’ page look in the drop down menu under ‘Tools’. Having downloaded the spreadsheet, save and use this version as a template for future assessments.

### 4 ENTERING DATA

The spreadsheet uses a number of macros to calculate the Fatigue and Risk Indices. On starting the program, a security warning will appear indicating that macros are present in the spreadsheet. Select **Enable Macros**. (Please note that you will need to check that the security setting on your computer for Excel is set to ‘medium’ so that you can enable macros to be used.)

#### 4.1 SETTING DEFAULT VALUES

On opening the spreadsheet for the first time a default window will appear (Figure 1).

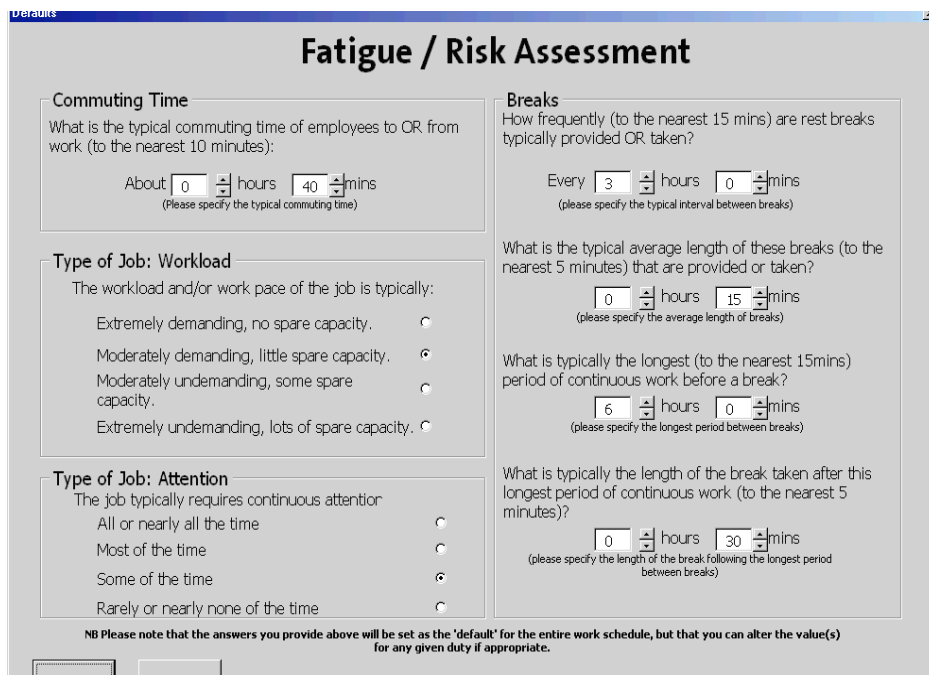


Figure 1: Default window

Before a Risk or Fatigue Assessment can be made, the appropriate values for the defaults should be entered, as these will be used as the defaults for all duties entered in the spreadsheet.

When you have chosen your default settings, select **OK**. The default settings that have used will be listed in the ‘Summary’ worksheet.

## 4.2 CHANGING DEFAULT VALUES

To change the default settings, go to the 'Schedule' worksheet, select the **Default** button near the top of the screen and change the appropriate value. Select **OK**.

To change the settings for an individual duty, make a right click with the mouse in the appropriate cell. The 'Fatigue/Risk Assessment' window will be displayed. The user can then change the values as required. Select **OK**. Once data have been changed from the default values this will be indicated by the word **Individual** appearing in the relevant cell.

## 4.3 INPUTTING DATA

The user can enter and alter data in cells with a white or blue background i.e. the columns entitled 'day', 'on duty', 'off duty', 'job type/breaks and 'commuting time'. These five title cells contain a comment box which will pop up when the user places the mouse in the appropriate cell.

Those cells which have a grey background should not be altered directly by the user. They are provided for information to indicate how the various components contribute to the Fatigue Index and to provide details about the duty periods themselves e.g. duty length, rest length.

Information can be entered in the Company, Location, Shift ID, Date and Assessor cells. This information will also be displayed in the 'Summary' and 'Charts' worksheets.

### 4.3.1 Day

Information about the duty day can be input as day number e.g. 1, 2, 3

**OR**

in date format. When entering data in date format, the input can be completed as ddmmyy or ddmmyyyy or dd/mm/yy or dd/mm/yyyy.

N.B. It is not possible to use a mixture of day number and date formats.

### 4.3.2 On duty and off duty

On duty and off duty refer to the duty start and end times of the shifts. Data can be entered with or without a colon. For example, acceptable formats are **0800** or **08:00**. When entering times, it is necessary to use the 24-hour clock.

If more than one duty period is undertaken per day, then each period should be entered on a separate row. A Fatigue or Risk Index will be calculated for each period.

### 4.3.3 Job type/Breaks

The input to the job type/breaks component is automatically generated from the default information. Unless the user chooses to change this information, the score will be the same for each duty.

To change the default value for an individual duty, make a right mouse click in the appropriate cell of the Job type/breaks column, highlighted in blue. A 'Fatigue/Risk Assessment for a duty' window will be displayed which will allow the user to change the settings. Once the appropriate values have been set, select **OK**. The **Default** flag will change to **Individual**.

To change the individual settings back to the default settings, make a right mouse click over the cells displaying **Individual**. A 'Fatigue/Risk Assessment for a duty' window will be displayed which will allow the user to select the **Change to default** option.

#### **4.3.4 Commuting time (or travelling time)**

Commuting time (or travelling time) is the time taken to travel to **OR** from work each day and is automatically populated once the default information has been entered.

To change the commuting time for an individual duty, make a right mouse click on the appropriate cell of the 'Commuting Time' column, highlighted in blue. A 'Commuting Time' window will appear which will allow the user to change the value. Changes to the default setting are indicated by **Individual**.

To change the individual settings back to the default settings, make a right mouse click over the cells displaying **Individual**. A 'Commuting Time' window will be displayed which will allow the user to select the **Change to default** option.

#### **4.3.5 Deleting data**

Deleting data from either spreadsheet is a permanent action, which it is not possible to undo.

To clear all entries relating to day, on duty and off duty times, select the **Reset Index** button. This will delete all data from the spreadsheet.

To delete individual duty periods from the spreadsheet, ensure that the appropriate row/s is/are selected, and then using a right mouse click select **Delete**. It will then be necessary to select the **Calculate Index** button to re-calculate the Index.

Alternatively, select the data to be deleted, select **Edit** from the menu bar followed by **Delete**. Select **Calculate Index** button to re-calculate the Index.

#### **4.3.6 Inserting data**

To insert a new duty day within an existing schedule, type the day number or date in the first blank row. Once the on duty and off duty cells have been populated select Calculate Index and the data will automatically be reordered chronologically.

#### **4.3.7 Importing data**

Data can be copied and pasted into the spreadsheet. However, it must be in the same format and sequence as the Fatigue Index calculator spreadsheet.

Before importing data, it is recommended that all existing data are removed from the spreadsheet by selecting the **Reset Index** button.

N.B. When importing data from the previous version of the Fatigue Index (where 'R' or 'r' was used to indicate a rest day), select and copy the day, on duty and off duty information. Close down the old version of the Fatigue Index and paste the data into the new version of the Fatigue Index (failing to close the old version of the Index will slow down the import process). The new version of the Index will automatically replace cells containing 'R' with blank cells. Select **Calculate Index** and the program will prompt you to check the default settings. Once the default values have been set, select **OK**. Then select **Calculate Index**. All blank rows will be removed automatically from the data set.

#### **4.3.8 Calculating the Indices**

Once all the duty data has been entered, select the **Calculate Index** button. The components contributing to the index and the final index will be displayed.

Any 'Rest Length' of less than 12 hours will be highlighted in bold. Any 'Duty Length' of greater than 12 hours will also be highlighted in bold.

If duty data are amended or deleted, information derived from these figures (i.e. data in grey cells) will be deleted. Reselect the **Calculate Index** button to populate these cells.

#### **4.4 SWITCHING BETWEEN FATIGUE AND RISK INDEX**

To switch between the Fatigue Index and Risk Index, select the button located next to Mode. This can be found towards the top of the schedule worksheet.

### **5 INTERPRETING THE OUTPUT**

#### **5.1 SCHEDULE WORKSHEET**

The output columns are shaded grey. The first two of these present the derived values for duty and rest length. The next column, under the heading 'Average duty per day', presents the cumulative average duty per day at that point in the schedule. This calculation is based on whole days up until midnight at the end of the day on which that particular duty ends. However, it does not include a contribution from any subsequent duties.

Subsequent columns provide details for either the Fatigue or Risk Index, depending on which mode has been selected. These columns comprise:

1. the cumulative component;
2. the duty timing component;
3. the job type/breaks component.

The final column is the Index itself (either risk or fatigue), which is calculated from the preceding three columns. Note that it is not a simple sum of the previous three columns.

Selecting **Display Schedule** followed by **Calculate Index** will display a graphical representation of the schedule alongside the spreadsheet. This can be copied and pasted into other documents e.g. Word or Powerpoint documents. When importing the schedule display into Microsoft Office applications use the **Copy** function. In the new application select **Edit** followed by **Paste Special** and paste the object as a **Picture (Enhanced Metafile)**.

Selecting **Display Charts** followed by **Calculate Index** displays graphically the values of the index as a function of day number (top chart) and duty number (bottom chart). These can be found on the 'Charts' worksheet.

The Risk Index provides output in terms of the relative risk of an accident/incident occurring. A value of 1.0 corresponds to the average risk on a DDNNRRRRR schedule with 12-hour shifts, assuming typical values for the job type / breaks factor.

The output from the Fatigue Index is related to the probability of high levels of sleepiness. It is expressed as a value between 0 and 100. A value of 20.7 corresponds to the average from the DDNNRRRRR pattern, assuming typical values for the job type / breaks factor.

### **5.1.1 Thresholds**

Thresholds have not been included in version 2.2 of the Fatigue and Risk Index calculator.

## **5.2 SUMMARY WORKSHEET**

The worksheet called 'Summary' provides an overview of the data relating to the schedule e.g. number of duty days, number of days off. The data used to populate the summary are dependent on the mode that is selected (i.e. risk or fatigue).

To ensure that any changes made to the **Schedule** or the **Default** settings are incorporated into the summary worksheet, select **Calculate Index** before viewing the Summary worksheet.

## **5.3 CHARTS WORKSHEET**

The 'Charts' worksheet displays graphically the values of the index as a function of day number (top chart) and duty number (bottom chart). Data displayed are dependent on the mode that is selected (i.e. risk or fatigue).

To populate the charts worksheet, select **Display Charts** and then select **Calculate Index**. The charts will be displayed in the charts worksheet.

The charts can be copied and pasted into other documents e.g. Word or Powerpoint. When importing the graphics into Microsoft Office applications use the copy function. In the new application, select **Edit**, followed by **Paste Special** function and paste the object as a **Picture (Enhanced Metafile)**.

## 6 CAUTIONS FOR USERS

HSE considers that the Fatigue and Risk Index tool is a risk assessment method for use with rotating shift patterns. Split shifts and on call working may be assessed with the tool. It is not appropriate for work patterns which only involve day working. Nor is it advised for use with shift patterns which are worked offshore. If you wish to use the method to evaluate permanent night working then please consult the research report first.

You are advised to use the tool to identify where your most serious fatigue risks are likely to be. You should then put into place suitable and sufficient controls for these risks, for example, by altering the work pattern to reduce the risk, by planning the work differently, or by introducing additional rest breaks, supervision, etc. You may also need to consider any individual differences for example in travelling time or sleep patterns as the tool is based on average data. The Fatigue and Risk Index tool is most effective when used together with other arrangements for managing the risks from mental fatigue.

The tool can be used to compare different work patterns (e.g. when planning changes to shiftwork) or to look within a work pattern to identify those duties with a higher potential for fatigue to arise. Previous versions of the tool have been used after incidents to see whether fatigue due to shiftwork may have been a causal or contributing factor. The tool may also be helpful in selecting staff for overtime duties.

Further advice on using the tool is available. If you work within the rail sector then contact human factors specialists in HM Railway Inspectorate in the Office of Rail Regulation. Otherwise please contact HSE or HSL.