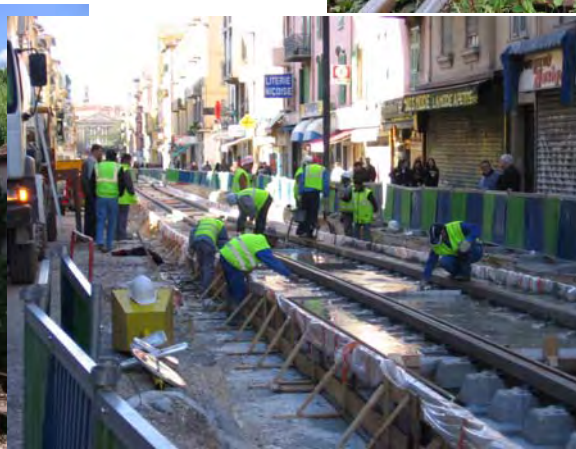


# **HSE's new Fatigue and Risk Index Calculator: A guide for new users.**

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HMRI, ORR

# HF Perspective



# What are 'human factors'?



Reducing error and influencing behaviour



- **The job**
  - task, workload, working environment, procedures, displays and controls
- **The individual**
  - competence, skills, personality, attitudes, risk perception
- **The organisation**
  - leadership, resources, work pattern, planning, communication, culture

# Human Factors Top 10 Issues

- Human factors in design
- Warnings and alarm handling
- Fatigue management
- Safety culture
- Non-compliance with rules or procedures
- Safety critical communications
- Responding to emergencies
- People resource (Workload, Staffing Levels, Change Management)
- Competence management
- Violence to staff, contractors

# Overview of talk

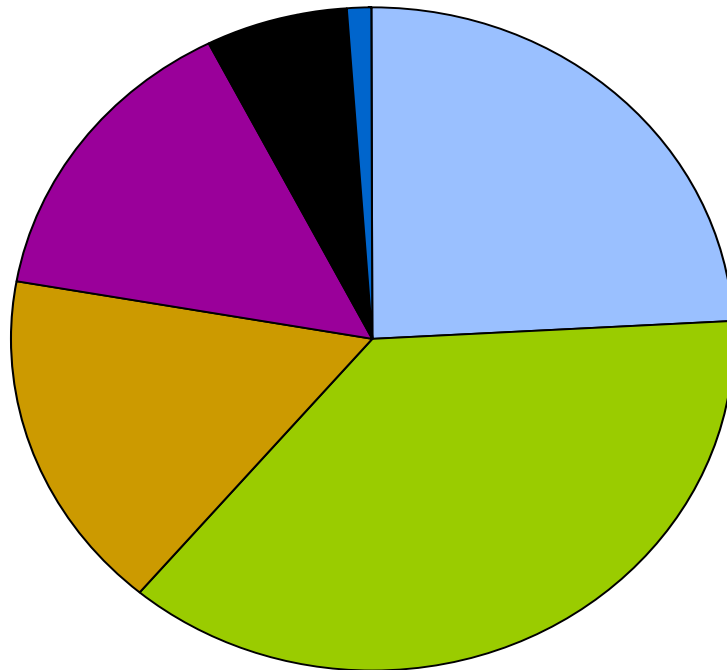
- PART 1 Context – fatigue management in safety critical workers and legal duties/changes
- PART 2 Background to the new FRI calculator
- The two indices: Fatigue and Risk
- The 3 components that make up the indices
- Entering data
- Interpreting the results
- Cautions for users of original FI

# PART 1 - CONTEXT

# What is fatigue?

- Perceived state of weariness caused by prolonged or excessive exertion
- Symptoms range from loss of alertness, slower reaction times, drowsiness, loss of patience
- Errors include absentminded slips, memory lapses, losing the picture, etc.

# CIRAS reports (n=95)



- Fatigue
- Rule violation
- Communications
- Knowledge
- Attention
- Skill
- Rule based error

# Clapham Junction Accident 1987

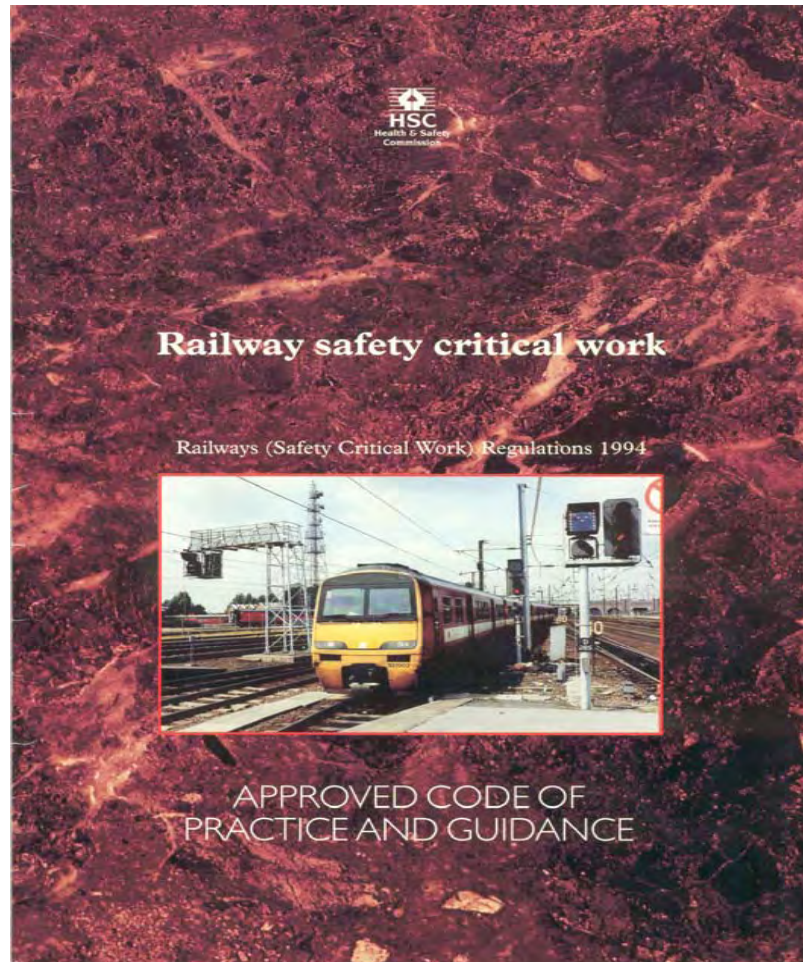


- Maintainer fatigue was one cause of error
- No system for monitoring hours or limiting excessive working
- Led to industry 'Hidden limits'
- What was 'operationally achievable' in 1980s
- Not based on science of sleep and fatigue

# GH/RT 4004 Appendix A

- Railway Group Standard
- Non mandatory limits, (so called Hidden Limits)
  - **No more than 12 hours per turn**
  - **No more than 72 hours per week**
  - **Minimum of 12 hours between shifts**
  - **No more than 13 turns in any 14 days**
- *It is important to realise that you can comply with these limits and still be very tired*
- *'Exceedances'*

# LEGAL CHANGES: Railway (Safety Critical Work) Regulations 1994 and ACoP repealed



# Railway (Safety Critical Work) Regulations

## Regulation 4 Hours of Work

- *‘Every employer shall ensure, so far as is reasonably practicable, that no employee of his undertakes any safety critical work for such number of hours as would be liable to cause him fatigue which would endanger safety;....’*
- ACOP – limits, risk assessment, breaks, when can exceed, monitoring

# Railway and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS)

## Fatigue (Regulation 25)

- Duty on controller of safety critical work to have **arrangements in place** to ensure, so far as is practicable, that safety critical worker doesn't work when **so fatigued** (or liable to become so fatigued) that could **significantly affect** his H&S or that of other persons on transport system
- Duty to review the arrangements when reason to doubt their effectiveness

# Change of approach

- From focus on 'number of hours' (in practice meant compliance with industry standard)
- To 'arrangements' ie management system for fatigue risks
- Recognition that fatigue influenced by hours, work patterns, working environment, nature of task, travelling time, social and domestic factors.
- Working Time Regs – provisions not sufficient to prevent person working when so fatigued that could endanger safety

# New guidance on 'Managing fatigue in safety critical work'

- To support regulation 25 of ROGS regulations – for rail industry
- Based on information from inspections on TOC/FOC companies
- What we know is good practice in UK rail sector
- Companies will need to review what they currently do against the guidance
- On ORR website – N.B. not the same as HSE shiftwork guidance!

# The 9 stages of a Fatigue Management System

- Identify safety critical workers
- Set standards and design working patterns
- Limit exceedances
- Consult with safety critical workers
- Record the arrangements

- Provide information to safety critical workers
- Monitor
- Take action when safety critical workers are fatigued
- Review the arrangements

# Designing shift patterns – good practice principles

- Minimise build up of fatigue – restrict no of consecutive nights/very early starts
- Plan adequate rest between shifts and blocks of shifts – allows fatigue to dissipate
- Plan work patterns to minimise sleep disturbance



# Managing shiftwork: Health and Safety Guidance (HSG 256)



Health and Safety  
Executive

## Managing shift work

Health and safety guidance



- The guidance aims to:
  - make employers aware of their duty under law,
  - improve understanding of the risks of shift work,
  - provide advice on risk assessment and key risk factors,
  - offer practical measures to help reduce the risks,
  - reduce fatigue, errors and accidents.

# PART 2 – FATIGUE INDEX

# Where found

- [www.hse.gov.uk](http://www.hse.gov.uk)
- Drop down menu “Tools”
- FRI will be within the list soon
- User Guide
- Excel Spreadsheet
- Research report  
[www.hse.gov.uk/research/rrhtm/301-400.htm#4](http://www.hse.gov.uk/research/rrhtm/301-400.htm#4)

# HSE's Fatigue Index tool

- Origins in 1999 produced by DERA in support of HSE guidance on Railway (Safety Critical Works) Regulations 1994
- A method for conducting a risk assessment of rotating shiftwork patterns
- To compare two patterns (eg during roster changes)
- To look at rosters to identify duties with higher potential for fatigue to arise

# Other uses of the HSE FI

- Post accident – to look to see if the work pattern may have contributed
- Selection of staff for overtime duties – who would be least fatigued
- NOTE that research report is freely available to all on HSE's website. HMRI developed spreadsheet and set out interpretation figures after research was completed.
- Widespread use of FI tool in rail industry. Some use in nuclear, chemical, police.

# WARNING!!

- The HSE Fatigue Index (FI) and the new Fatigue and Risk Index (FRI) tools are **risk assessment methods**
- You should use them to **identify** where your most serious fatigue risks are
- You should then put **suitable and sufficient controls** in place, e.g.
  - Altering the work pattern to reduce the risk
  - Or, planning the work differently
  - Or, introducing additional supervision, checks, etc.

# Basis of the tools

- The FI and the new FRI are based on published scientific literature on fatigue, alertness, sleepiness, and occupational injuries. The new FRI has been updated to include literature from 1999-2005
- The tool was developed by Qinetiq and Professor Simon Folkard under contract to HSE
- The background report is available on HSE's website (RR446) 2006
- Excel spreadsheet tool on HSE website
- <http://www.hse.gov.uk/research/rrhtm/rr446.htm>
- Or type 'fatigue index' into the search

# The FRI

- Considers factors that are well known to affect fatigue and alertness including:
  - Nature of the task including workload
  - Time of day, shift start time
  - Length of shift
  - Number of consecutive shifts
  - Rest breaks within and between shifts
  - Direction and speed of rotation of duties

# The FRI

- Contains two indices
- **Fatigue Index** – built on knowledge of factors affecting fatigue and alertness
- **Risk Index** – based on a review of trends in risk related to shift work
- The two are similar in many aspects, but different in others eg time of day
- Users must consider both and **treat a high value on either index as needing action**

# The 3 components

- In the calculator you see
- **Cumulative** component – relates to fatigue associated with the way duties are put together to form a schedule
- **Duty timing** component – effects of start time, shift length and time of day
- **Job type/breaks** component – content of the shift eg activity undertaken and breaks

# Fatigue Index Calculator

**Company** QinetiQ  
**Location** Farnborough  
**Shift ID** 1234  
**Date** 30/11/05

**Assessor**

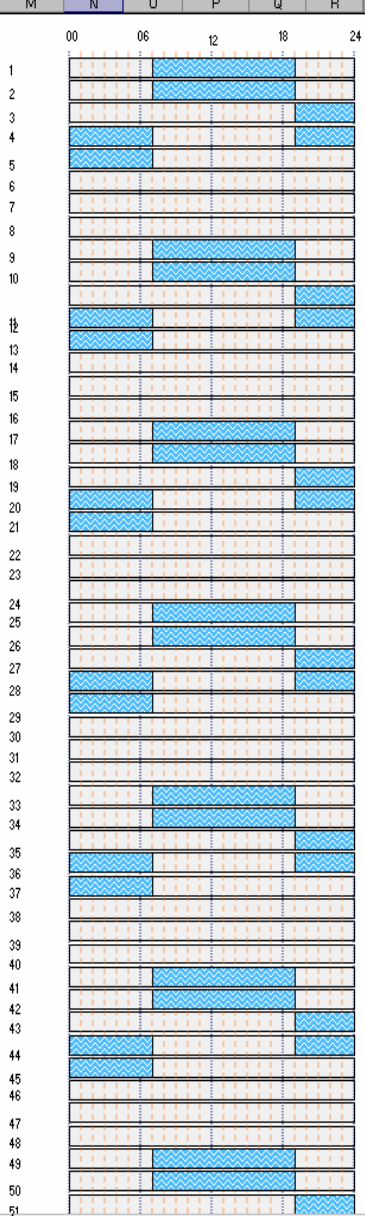
Display schedule  
 Display charts

**Mode** Fatigue | Defaults | Reset Index | Calculate Index

© QinetiQ PLC 2005  
Version 2.1

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	1.4	2.3
2	07:00	19:00	Default	Default	12h	12h	12h	1.8	0.8	1.4	4.0
3	19:00	07:00	Default	Default	12h	1d	9h	1.9	17.4	16.8	35.5
4	19:00	07:00	Default	Default	12h	12h	9h 36m	7.8	17.4	16.8	39.4
9	07:00	19:00	Default	Default	12h	4d	6h 40m	0.5	0.8	1.4	2.7
10	07:00	19:00	Default	Default	12h	12h	7h 12m	2.5	0.8	1.4	4.6
11	19:00	07:00	Default	Default	12h	1d	7h	2.2	17.4	16.8	35.7
12	19:00	07:00	Default	Default	12h	12h	7h 23m	8.2	17.4	16.8	39.6
17	07:00	19:00	Default	Default	12h	4d	6h 21m	0.5	0.8	1.4	2.7
18	07:00	19:00	Default	Default	12h	12h	6h 40m	2.5	0.8	1.4	4.7
19	19:00	07:00	Default	Default	12h	1d	6h 38m	2.2	17.4	16.8	35.7
20	19:00	07:00	Default	Default	12h	12h	6h 51m	8.2	17.4	16.8	39.6
25	07:00	19:00	Default	Default	12h	4d	6h 14m	0.5	0.8	1.4	2.7
26	07:00	19:00	Default	Default	12h	12h	6h 28m	2.5	0.8	1.4	4.7
27	19:00	07:00	Default	Default	12h	1d	6h 26m	2.2	17.4	16.8	35.7
28	19:00	07:00	Default	Default	12h	12h	6h 37m	8.2	17.4	16.8	39.6
33	07:00	19:00	Default	Default	12h	4d	6h 11m	0.5	0.8	1.4	2.7
34	07:00	19:00	Default	Default	12h	12h	6h 21m	2.5	0.8	1.4	4.7
35	19:00	07:00	Default	Default	12h	1d	6h 20m	2.2	17.4	16.8	35.7
36	19:00	07:00	Default	Default	12h	12h	6h 29m	8.2	17.4	16.8	39.6
41	07:00	19:00	Default	Default	12h	4d	6h 9m	0.5	0.8	1.4	2.7
42	07:00	19:00	Default	Default	12h	12h	6h 17m	2.5	0.8	1.4	4.7
43	19:00	07:00	Default	Default	12h	1d	6h 16m	2.2	17.4	16.8	35.7
44	19:00	07:00	Default	Default	12h	12h	6h 24m	8.2	17.4	16.8	39.6
49	07:00	19:00	Default	Default	12h	4d	6h 7m	0.5	0.8	1.4	2.7
50	07:00	19:00	Default	Default	12h	12h	6h 14m	2.5	0.8	1.4	4.7
51	19:00	07:00	Default	Default	12h	1d	6h 14m	2.2	17.4	16.8	35.7
52	19:00	07:00	Default	Default	12h	12h	6h 20m	8.2	17.4	16.8	39.6
57	07:00	19:00	Default	Default	12h	4d	6h 6m	0.5	0.8	1.4	2.7
58	07:00	19:00	Default	Default	12h	12h	6h 12m	2.5	0.8	1.4	4.7
59	19:00	07:00	Default	Default	12h	1d	6h 12m	2.2	17.4	16.8	35.7
60	19:00	07:00	Default	Default	12h	12h	6h 18m	8.2	17.4	16.8	39.6
65	07:00	19:00	Default	Default	12h	4d	6h 6m	0.5	0.8	1.4	2.7
66	07:00	19:00	Default	Default	12h	12h	6h 11m	2.5	0.8	1.4	4.7
67	19:00	07:00	Default	Default	12h	1d	6h 11m	2.2	17.4	16.8	35.7
68	19:00	07:00	Default	Default	12h	12h	6h 16m	8.2	17.4	16.8	39.6
73	07:00	19:00	Default	Default	12h	4d	6h 5m	0.5	0.8	1.4	2.7
74	07:00	19:00	Default	Default	12h	12h	6h 10m	2.5	0.8	1.4	4.7
75	19:00	07:00	Default	Default	12h	1d	6h 9m	2.2	17.4	16.8	35.7
76	19:00	07:00	Default	Default	12h	12h	6h 14m	8.2	17.4	16.8	39.6
81	07:00	19:00	Default	Default	12h	4d	6h 4m	0.5	0.8	1.4	2.7
82	07:00	19:00	Default	Default	12h	12h	6h 9m	2.5	0.8	1.4	4.7
83	19:00	07:00	Default	Default	12h	1d	6h 9m	2.2	17.4	16.8	35.7
84	19:00	07:00	Default	Default	12h	12h	6h 13m	8.2	17.4	16.8	39.6
89	07:00	19:00	Default	Default	12h	4d	6h 4m	0.5	0.8	1.4	2.7



# Default values: job type, workload, breaks, commuting time

Defaults

## Fatigue / Risk Assessment

**Commuting Time**  
What is the typical commuting time of employees to OR, from work (to the nearest 10 minutes):

About  hours  mins  
(Please specify the typical commuting time)

**Type of Job: Workload**  
The workload and/or work pace of the job is typically:

Extremely demanding, no spare capacity.

Moderately demanding, little spare capacity.

Moderately undemanding, some spare capacity.

Extremely undemanding, lots of spare capacity.

**Type of Job: Attention**  
The job typically requires continuous attention:

All or nearly all the time.

Most of the time.

Some of the time.

Rarely or nearly none of the time.

**Breaks**  
How frequently (to the nearest 15 mins) are rest breaks typically provided OR taken?

Every  hours  mins  
(please specify the typical interval between breaks)

What is the typical average length of these breaks (to the nearest 5 minutes) that are provided or taken?

hours  mins  
(please specify the average length of breaks)

What is typically the longest (to the nearest 15mins) period of continuous work before a break?


hours  mins  
(please specify the longest period between breaks)

What is typically the length of the break taken after this longest period of continuous work (to the nearest 5 minutes)?

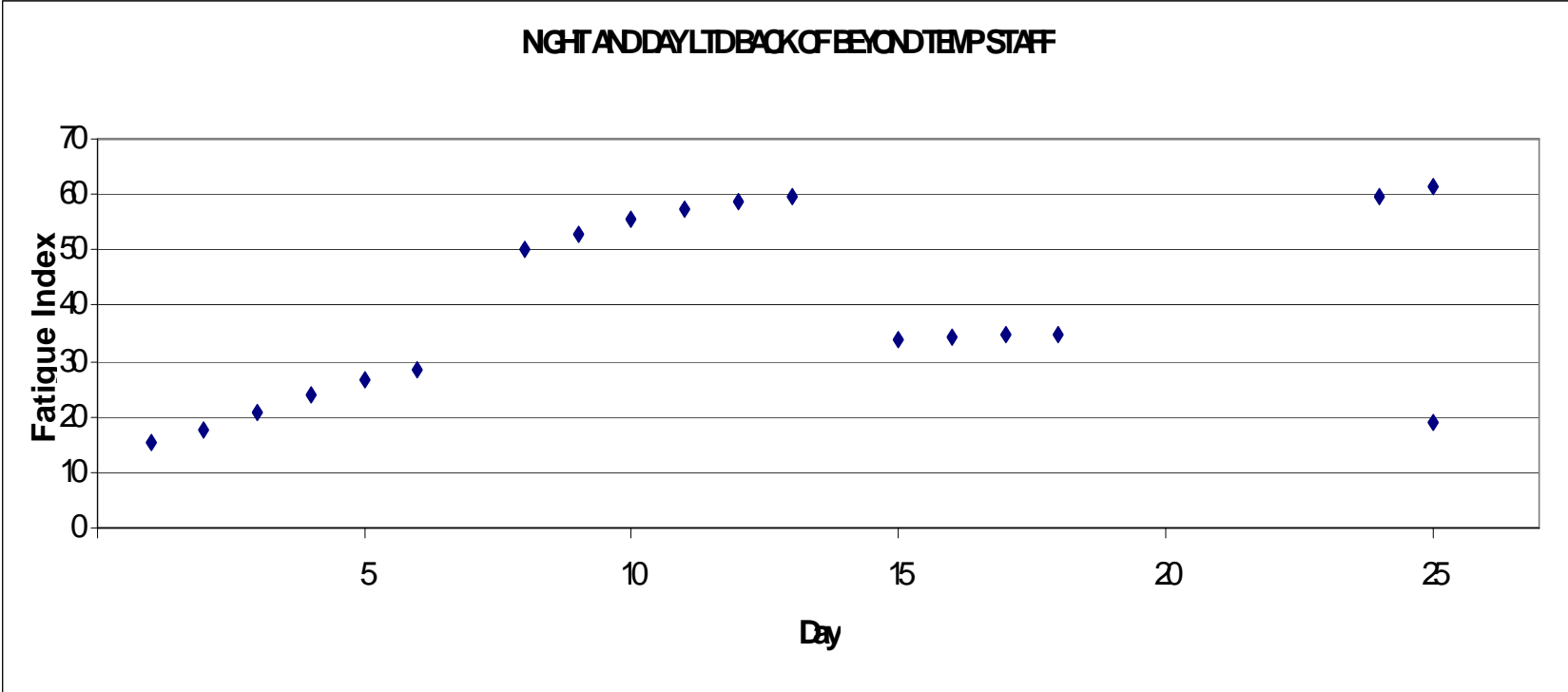
hours  mins  
(please specify the length of the break following the longest period between breaks)

**NB Please note that the answers you provide above will be set as the 'default' for the entire work schedule, but that you can alter the value(s) for any given duty if appropriate.**

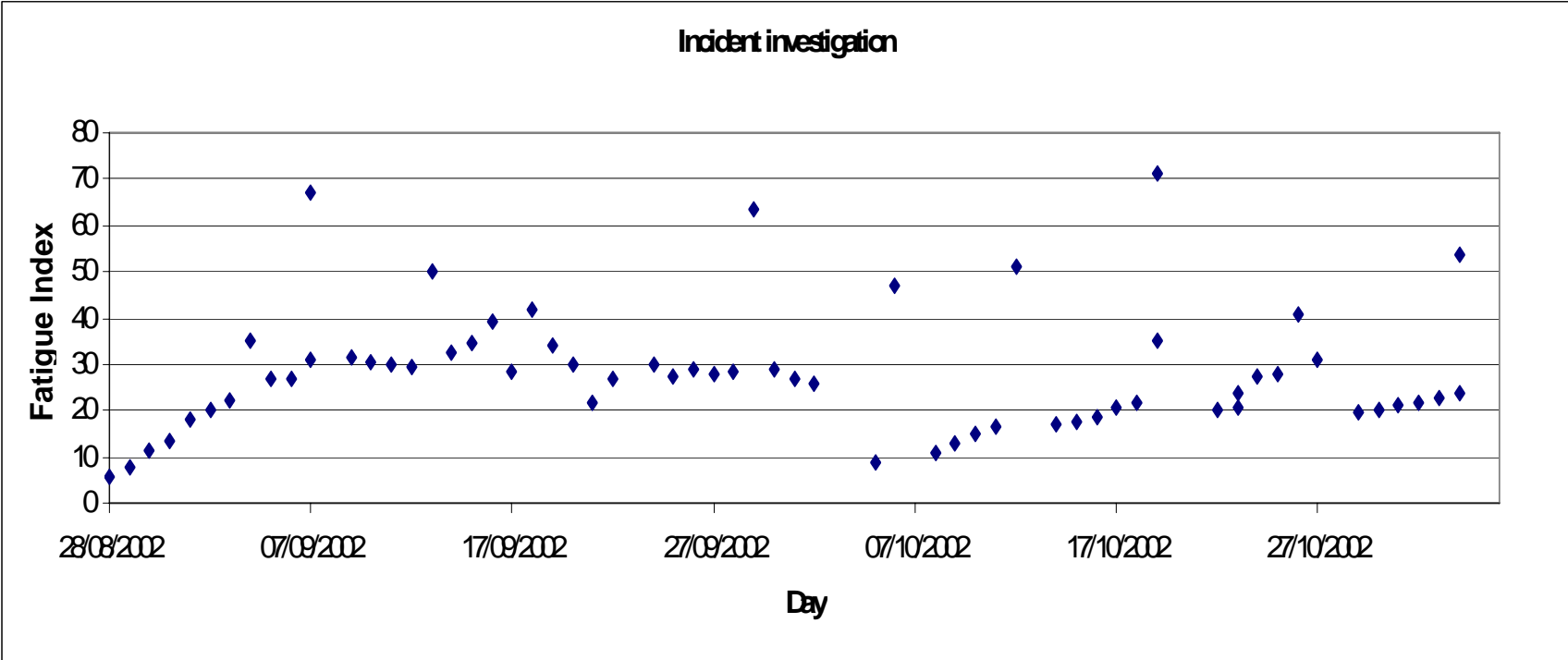
OK CANCEL



# Output charts



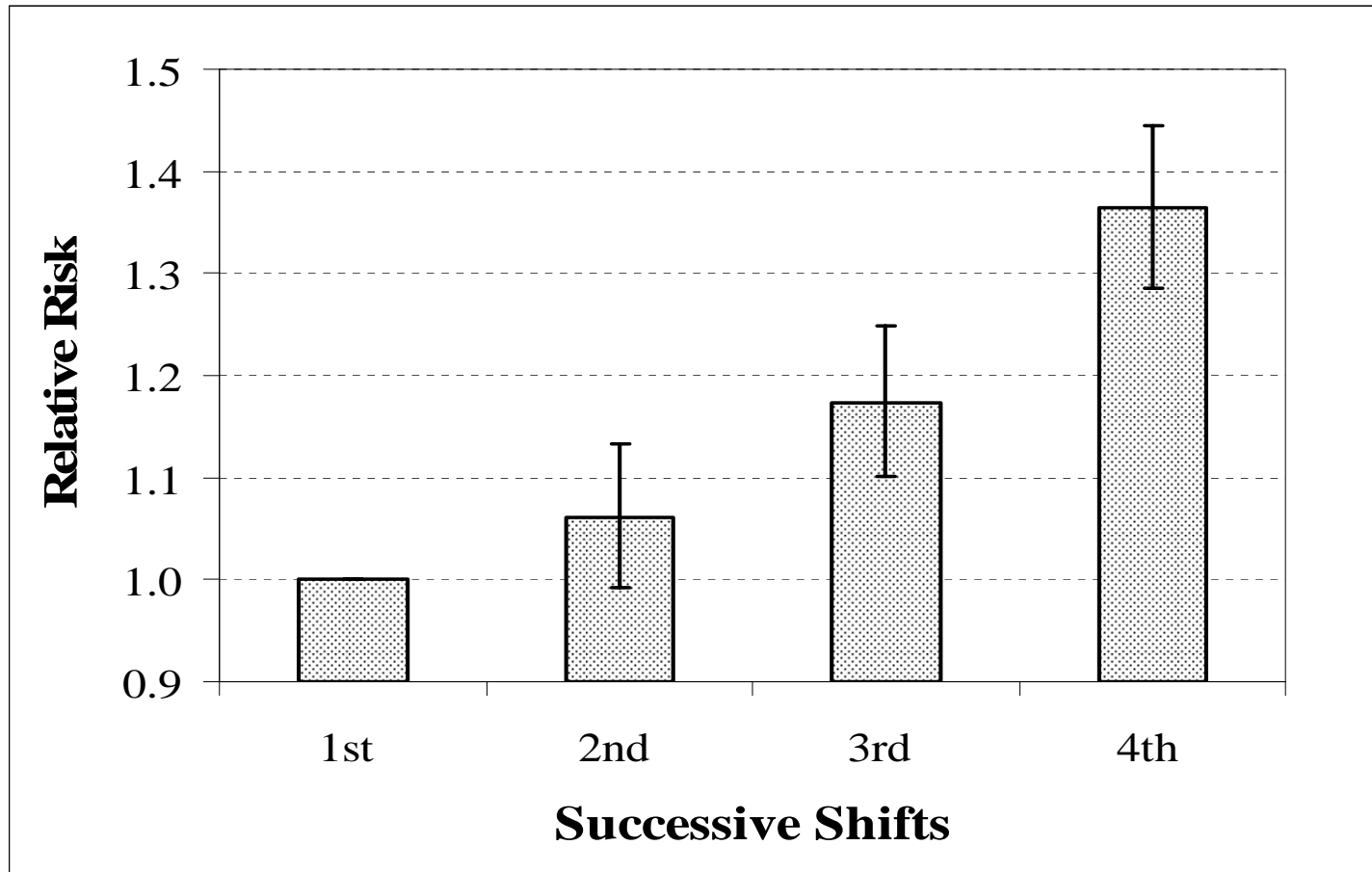
# Incident investigation - output



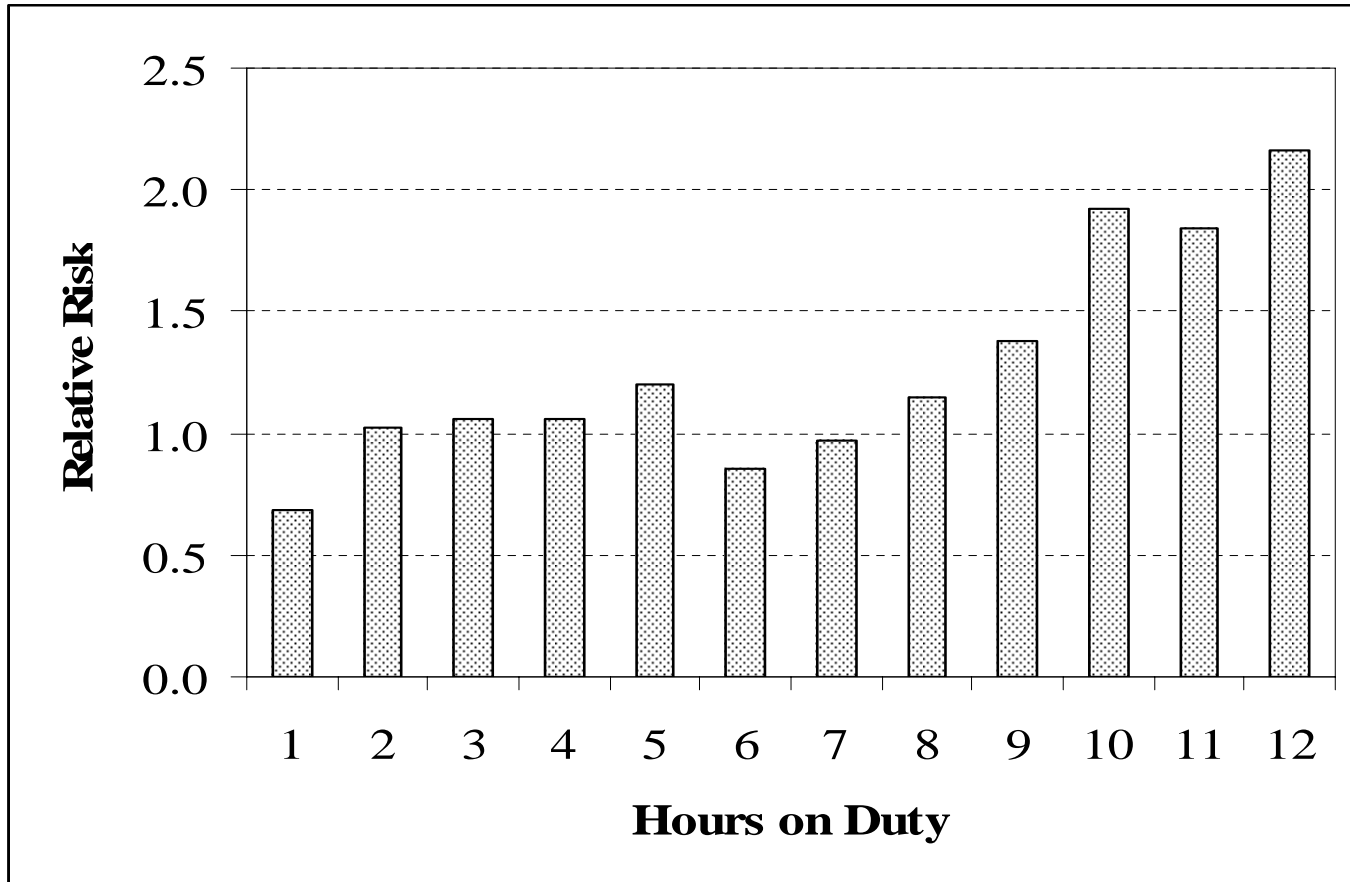
# Interpreting the results

- Fatigue Index output – relates to the probability of high levels of sleepiness.
  - Value between 0 and 100
  - (Initial indication is PEAK high value for day shifts around 30 to 35 – this may change)
  - (Initial indication of PEAK high level for night shifts around 40 to 45 – again this may change)
  - DO NOT USE PREVIOUS VALUES OF 25 AND 30 WHICH APPLY ONLY TO ORIGINAL FI TOOL
  - Look at overall profile of fatigue scores not average over the whole schedule

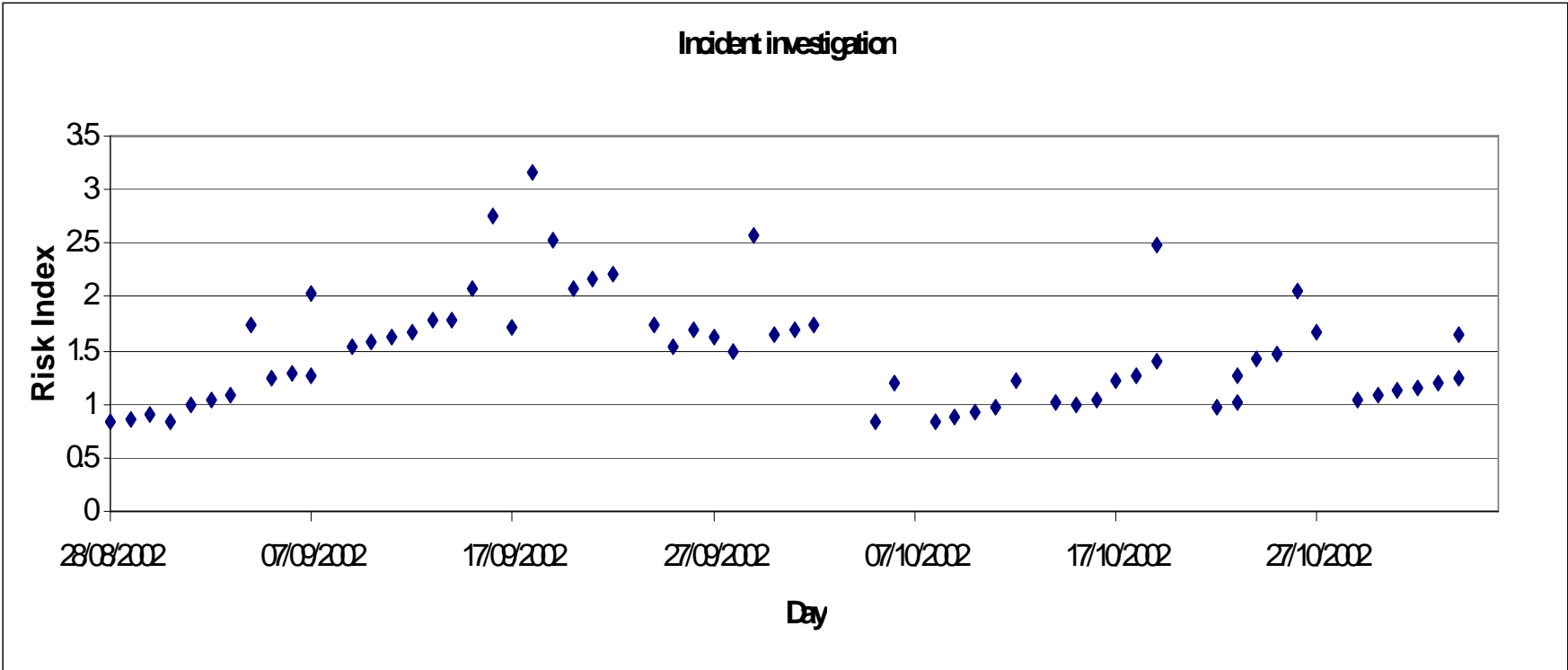
# Example of a relative risk trend – successive night shifts



# Trend for hours on duty



# Risk index for same incident



# Interpretation: Risk Index

- Output is in terms of the relative risk of an incident occurring
- Calibrated – value of 1.0 is average risk of incident for DDNNRRRR schedule on 12 hour shifts
- Users set own interpretation threshold
- Data is mostly based on occupational injuries

## **Cautions for users of current FI (1999)**

- Do not compare across the new and old tools
- You need to re-enter data into the new tool if you want to compare
- There is no equivalent to the Risk Index in the original FI
- Do not use the original interpretation values of 25 and 30 for the new index
- Please read the user instructions and refer to the research report before using the index

# Cautions

- The tool is not advised for work involving very long series of night shifts such as are worked offshore
- It can be used for split shifts and on call work
- See the research report for advice on using the tool for permanent night workers
- The value given is an average for the whole duty not hour by hour
- The FRI is very sensitive to job types/breaks – think carefully and document your assumptions

# Remember

- The FRI can only be calculated using the tool – manual calculation is not possible.
- Excel spreadsheet is available for all to use
- Do not try to change the underlying equations!!
- Do not try to ‘micromanage’ the output!!
- Use the tool within a fatigue management system
- Advice is available from HMRI in ORR for rail sector, HSL for other sectors.

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