# Performance Influencing Factors (PIFs)

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## 1. Introduction to PIFs

Performance Influencing Factors, or PIFs, are factors that combine with basic human error tendencies to create error-likely situations. In general terms PIFs can be described as those factors which determine the likelihood of error or effective human performance. It should be noted that PIFs are not automatically associated with human error. PIFs such as quality of procedures, level of time stress, and effectiveness of training, will vary on a continuum from the best practicable (e.g., an ideally designed training program based on a proper training needs analysis) to worst possible (corresponding to no training program at all). When PIFs relevant to a particular situation are optimal then performance will also be optimal and error likelihood will be minimised.

A comprehensive list of PIFs can be used as an audit tool, to identify problem areas that will give rise to increased error potential. PIFs may also be used in the process of incident investigation. Any investigation that seeks to establish the underlying causes of major or minor accidents will benefit from a systematic evaluation framework. The PIF concept is also applicable during the process of design. Design guidelines to maximise usability and minimise the potential for error can be based upon comprehensive descriptions of PIFs which determine the most effective presentation of information in control rooms, or the characteristics of usable and clear operating instructions.

## 2. Selection of PIFs

Some PIFs such as ‘illumination’ or ‘fatigue’ are generic and will influence performance in most industries. Other PIFs are more likely to be important in specific industries. For example, the effect on performance of ‘personal protective equipment’ is unlikely to be as much of a consideration in aviation as it might be in the process industries. For this reason it is difficult to produce an exhaustive list of PIFs that could be used as an audit tool in any given situation. It is recommended, therefore, that the advice of an experienced human reliability or human factors specialist is sought when deciding which PIFs should be covered in a specific situation. The specialist can then consult with task experts (such as process controllers) and decide upon an appropriate, comprehensive list of PIFs for the task under consideration.

## 3. Rating PIFs

For some applications (e.g. human reliability analysis) PIFs need to be rated on a numerical scale. Again this procedure will involve consultation between human factors specialists and task experts, the former providing rating scales and the latter supplying ratings based upon these scales. In these cases, values such as those shown in the left hand column of Table 1 can be generated by comparing the situation being evaluated with the descriptions in the second, third and subsequent columns which represent other PIFs relevant to the situation being assessed. These represent the worst, average and best conditions that are likely to occur and correspond to ratings of 1, 5 and 9 on the numerical scale in the left hand column of Table 1. Obviously, it is possible to interpolate between these values for situations that are intermediate between the descriptions provided.

Unlike the hardware component in a system, human performance is much more variable and difficult to predict. The same combination of input conditions will produce similar effects on hardware. This is not the case for humans who will process inputs in the light of their intentions and biases in a unique manner.

| PIF Evaluation Scale (Qualitative and Quantitative) | Procedures | Physical Work Environment |
|---|---|---|
| **WORST** 1 | • No written procedures, or standard way of performing tasks<br>• Not integrated with training | • High levels of noise<br>• Poor lighting<br>• High or very low temperatures and high humidity or wind chill factors |
| **AVERAGE** 5 | • Written procedures available, but not always used<br>• Standardized method for performing task | • Moderate noise levels<br>• Temperature and humidity range |
| **BEST** 9 | • Detailed procedures and checklists available<br>• Procedures developed using task analysis<br>• Integrated with training | • Noise levels at ideal levels<br>• Lighting design based on analysis of task requirements<br>• Temperature and humidity at ideal levels |

**Table1: Examples of PIF Scales**

Some PIF scales require further deconstruction before a confident value can be assigned for the situation under consideration. For example, both a human factors professional and task expert may agree that fatigue is an important PIF. Before being able to rate the PIF, however, they need to decide what constitutes 'fatigue' and devise scales for these constituent parts. The values assigned for these parts can then be aggregated and averaged to provide a composite value for fatigue. This example is developed on the following page.

## 4. An Example: Fatigue

Figure 1 illustrates how the PIF 'fatigue' can be considered to comprise of three component PIFs. The human factors specialist can produce scales for each of these components based upon current literature, the task expert can then use these scales to rate the situation in question.

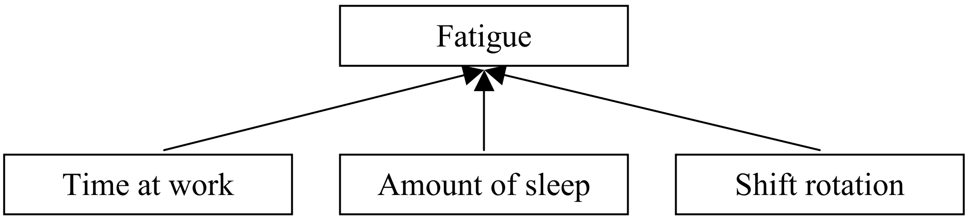


**Figure 1 Components of fatigue**

## 4.1 Time at work

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Research involving control room operators and the difference between 8 and 12 hour shift schedules, showed that after seven month's adaptation to new 12 hour schedules there is a decrement in tests of performance and alertness attributable to the extra 4 hours of work per day. There were also reductions in sleep and disruption of other personal activity during 12 hour work days. There have, however, only been a few direct evaluations of the effects of long workdays on individual functioning. Those that do exist have provided some suggestions of accumulated fatigue across a number of long workdays. The overall conclusion is nevertheless that substantive further work is needed to clarify the performance effects of long workdays. Below twelve hours the evidence is even less clear, and the extent to which fatigue occurs will depend on the adequacy of rest breaks, the nature of the work and the working environment.

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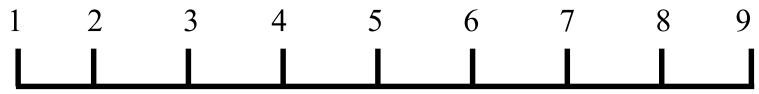



Workers work shifts of twelve hours or longer, with few breaks and are unhappy with their working environment

Workers work regular shifts of eight hours or less, have regular breaks and are happy in their work environment

## 4.2 Amount of sleep

The daily rest between shifts needs to be adequate to enable shift workers to return to work fully rested. An adult typically needs about seven to eight hours of sleep each night. Rest days are valuable in allowing people to 'recharge their batteries' and to maintain their work performance. The planning of rest days needs to take account of their frequency and the length of 'recovery time' available after blocks of shifts. Shift workers, especially night workers, benefit from regular recovery periods of at least 48 hours. This is because shortened or interrupted sleep over a period of time can result in their spending part of the day sleeping.

The effects of acute sleep deprivation where subjects are deprived of sleep over successive days have been studied extensively. Research findings have demonstrated clear decrements in psychological performance and resulting behavioural impairments. In particular, tasks of 30 minutes or more in duration, low in novelty, interest, or incentive or high in complexity have been shown to deteriorate in a situation of prolonged work duty and no sleep. Memory has also been found to be affected in people who are required to stay awake. However, such effects are reversed with only 1 to 2 nights of recovery sleep even in the longest deprivation studies.

The limit of tolerance for prolonged spells of reduced sleep seems to be around 4-5 hours of sleep per day. This seems to represent an obligatory quota. Providing this quota can mostly be reclaimed or retained, it is possible for psychological performance and daytime tiredness to be maintained at normal or near normal levels. However, this depends on subjects maintaining a regular sleep schedule

1 2 3 4 5 6 7 8 9

| | |
|---|---|
| Operators receive less than five hours sleep and have no opportunities to reclaim lost sleep during the week | Operators have at least eight hours sleep per night with regular and frequent rest days |

## 4.3 Shift rotation

The main concerns about the effects of shift rotation involve the disruption of 'circadian rhythms'. The term circadian rhythm refers to variations in certain physiological variables, e.g. body temperature, over the twenty-four hour cycle. Individuals who are 'day adjusted', i.e. who are active and asleep during the normal periods of day and night, have body temperatures and alertness levels that climb steadily from about 6am until just prior to midnight, whereupon both fall rapidly through the night.. When individuals work on continuous night shifts for a protracted period, the circadian cycle gradually changes so that the peaks of body temperature and alertness tend to occur at night when the worker is active.

Research on circadian rhythms has generally indicated that performance on mental tasks broadly follows the same pattern of variations as body temperature and alertness. However, other work suggests that in fact this is only the case for mental tasks requiring little information processing capacity. For more complex 'cognitive' tasks where working memory is more important, variations in performance are in the opposite phase to body temperature, i.e. best performance, occurs when the body temperature is low, i.e. at night.

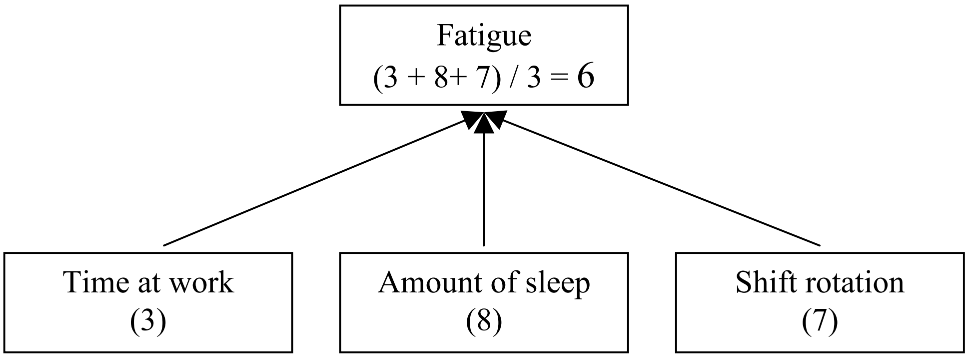
1 2 3 4 5 6 7 8 9

| | |
|---|---|
| Worker frequently change shift, start earlier than previous shifts and undertake shifts of longer than 12 hours | Workers do the same shift all the time and work shifts of 8 hours or less |

With regard to the scheduling of shift work, the general recommendation (putting aside social and lifestyle considerations) is that shifts should allow workers to either remain day or night adjusted. This is because it is the constant readjustment of circadian cycles which appears to produce the most acute feelings of fatigue and disorientation.
This implies that permanent night or day shifts will be the most effective (In a union environment, where seniority provisions could lead to inexperienced operators being concentrated on the afternoon or evening shifts, there could be an off-setting problem of fixed shifts to rotating shifts). Failing this, shifts should be operated over a sufficiently short cycle that they allow the operating team to remain day adjusted. However, it must be emphasised that determining optimal shift work regimes is a highly complex and controversial area of research.

## 4.5 Rating and combining the component PIFs

Using these scales the task expert decides that the amount of sleep that the workers




achieve and the shift rotation schedules are fairly close to the best case scenarios describes in the scales. The task expert did feel, however, that workers often work considerable hours in a day. As a consequence this PIF has received a lower rating, one closer to the worst case scenario. The diagram above illustrates how these values can be combined to give a value for fatigue.

This PIF value can then be used hierarchically, in conjunction with other PIFs (for example, 'boredom') to obtain a value for higher level PIFs such as 'alertness'. PIFs can be identified retrospectively during incident analysis or used as a proactive tool for assessing the current work situations, with a view to reducing the likelihood of human error.

It may be suggested that PIF analysis is somewhat subjective. The strength of the method, however, is that it provides a framework for assessing the impact of human factors on the work environment and the error likely situation. Whilst it could never be claimed that the ratings assigned to PIFs are completely accurate, the involvement of task experts means that the relative importance and potential or actual impact of human factors can be documented in a structured manner. This documentation facilitates the evaluation of a present mode of work and the cost benefit analysis of potential improvements to a work system.