

Guide to

Determination of exposure limits, recovery times and relaxation times in work measurement

Committees responsible for this Draft for Development

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- British Gas plc
- Ergonomics Society
- HM Treasury
- Institute of Administrative Management
- Institute of Management Services
- Institute of Quality Assurance
- Loughborough University of Technology
- Methods — Time Measurement Association Ltd.
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This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature. This is because of the diversity of relaxation tables currently in use and of the sources of advice available to the Management Services practitioner. Adequate time is therefore needed for wide-ranging public comment.

This publication should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

A review of this Draft for Development will be carried out not later than two years after its publication. Notification of the start of the review period, with a request for the submission of comments from users of this Draft for Development, will be made in an announcement in the appropriate issue of *BSI News*.

According to the replies received, the responsible BSI committee will judge whether the Draft for Development can be converted into a British Standard or what other action should be taken.

Observations which it is felt should receive attention before the official call for comments will be welcomed.

These should be sent to the Secretary of the BSI Technical Committee QMS/31 at the BSI Head Office address as shown on the back cover.

Foreword

This Draft for Development has been prepared under the direction of the Quality, Management and Statistics Standards Policy Committee. It is published in order to provoke discussion on and research into ways of, and times for, recovering from work during the working day.

BSI Committee QMS/31, whose constitution is shown on the inside front cover of this Draft for Development, takes collective responsibility for its preparation under the authority of the Standards Board. The Committee wishes to acknowledge the personal contribution of Dr A L Minter who carried out the research and prepared the draft for this publication.

Guide

0 Introduction

In this Draft for Development, the background to relaxation times and recovery periods is reviewed, and the method is given for using work measurement data to determine the amount of relaxation time (RT) appropriate to the task and the recovery period (RP) suitable for the conditions or environment surrounding the task. The abbreviation RF (for relaxation factor) is used throughout, in place of the older term RA (for relaxation allowance) with its connotation of an arbitrarily awarded allowance. Where RA is mentioned, it is to refer to past applications and interpretations.

Appendix A describes the basis of the RF tables which are given in this Draft for Development. Appendix B describes the basis of the various regimes for exposure times and environmental conditions. Appendix C gives bench-mark examples for use in assessing work intensity. A bibliography is given in appendix D.

1 Scope

This Draft for Development gives guidance on determining relaxation times and recovery periods for human activities that have been measured by any of the work measurement techniques identified in BS 3138 and discussed in BS 3375 : Part 3.

NOTE. The titles of the publications referred to in this Draft for Development are listed on the inside back cover.

2 Definitions

For the purposes of this Draft for Development the definitions given in BS 3138 and BS 3375 : Part 3 apply, together with the following.

2.1 physical work

Activity in which parts of the body are used to change or move something (including the body itself). There is an expenditure of energy by the body which is measurable physiologically.

2.2 non-physical work

Activity in which the person carries out few or limited movements with parts of the body, which do not of themselves impose a physical load on the body. The principal purpose of the activity is the mental processing of information, with inputs by the senses and outputs by speech, or communication to a device through some means such as a keyboard, steering wheel, or an appropriate control mechanism. Such work can impose a mental load.

2.3 personal needs

The group of activities that are personal to an individual, which need to be undertaken from time to time to attend to personal hygiene, etc.

2.4 closure point

A point at which the work reaches a natural termination, either intermediate or final. It can be defined by the task itself, or set individually by the operator, e.g. the end of a batch of data being entered or the end of a stage of thinking something through.

2.5 relaxation factor (RF)

A factor, normally expressed as a percentage, which depends on the nature of the work done during the basic time and which is applied to the basic time in order to derive the relaxation time for that activity.

2.6 relaxation time (RT)

An addition to the basic time:

- (a) to afford relief from the physical and mental efforts of carrying out the work under specified conditions at standard performance;
- (b) to allow attention to personal needs.

NOTE. The additional time will depend upon the nature of the work and may be spent away from the work-place under management direction. Relief from fatigue may also take place during unoccupied time or recovery periods, so long as the duration of these periods are appropriate for relaxation.

2.7 recovery period (RP)

A withdrawal period to relieve stress caused by the work environment where adequate protection is impracticable. It should start when established threshold limits for the work are reached and should be spent away from the work-place. Recovery periods can be concurrent with relaxation time and unoccupied time, and other tasks can be undertaken during the withdrawal periods.

2.8 blanket RF

A value assigned for RF when it is inappropriate for any reason to apply the detailed procedures given in this Draft for Development.

2.9 CLO

A unit of insulation related to clothing. It is the insulation required to keep a seated person comfortable at an air temperature of 21 °C in an air movement of 1.0 m/s.

NOTE. This amounts to an ordinary suit, shirt, underwear, etc. One CLO is equivalent to 0.18 °C/kcal per h per m² of body surface.

2.10 tog

A unit of thermal resistance widely used in the field of textiles and clothing.

NOTE. One tog is equivalent to 0.1 m² · K/W.

3 General

3.1 Background

There are a very large number of RA tables in existence. An effect of the diversity of tables is that there can be very wide differences between observers in deriving RA for a given task.

Most RA tables are based on the Bedaux concept of adding a percentage to the basic time for an element to allow for relaxation and recovery. None of the published tables have been accepted officially, either nationally or internationally, although specific industry groupings may have accepted a particular table for internal use. The International Labour Office (ILO) book on work study [4] gives tables specifically as examples; this does not constitute acceptance or authorization in any way.

Attempts have been made to find alternative ways of determining the addition to the basic time, including the following:

- (a) Barth and Merrick, who had an empirical approach which led to a family of curves linking element duration and percentage allowance [1];
- (b) Kerkhoven, who linked the standard time to the minimum possible time for the work [2], [3];
- (c) using energy levels (REFA and others);
- (d) various kinds of points assessment systems (ILO, [4]).

Most of these are not widely used in ordinary work study practice in the UK. The basis of guidance given in this Draft for Development is that developed by Spitzer and Hettinger in Germany [5], and is supported by ISO 8996.

3.2 Constraints on the applicability of this Draft for Development

The relaxation factor (RF) derived from the recommendations in this Draft for Development can be inappropriate for very heavy work. Standard times should not be set for work practices that are unsafe, or where circumstances in any way contravene the Health and Safety at Work etc. Act 1974 or related legislation. If such circumstances exist, then it is wrong to modify RF% or RT values to compensate. If use of this Draft for Development leads to a smaller standard time than that already existing for work in substandard conditions, then this suggests that the conditions need to be improved before the new standard time can be applied.

4 Determination of relaxation and recovery times and exposure limits

4.1 Method of determination

It is always assumed, when applying a standard time, that the operator is a qualified worker (see BS 3138), with the necessary physical attributes and the required intelligence and education, skill and knowledge to carry out the work in hand to satisfactory standards of safety and quality. If this is not wholly true, then the standard time as derived by use of this Draft for Development may be inappropriate.

When determining relaxation times and recovery periods, no distinction can be made between male and female persons. A person of either sex, with the necessary attributes, can be a qualified worker for the task under consideration. Furthermore, the Equal Pay legislation requires that male and female workers receive the same pay for work that is broadly similar; to have different RF% for the same work for male and female persons would be contrary to this legislation.

The calculation of relaxation time and recovery period takes place after the work has been measured by a suitable work measurement technique. This will have produced a basic time (see BS 3138) for the work, element by element; with the coarser measurement techniques, the time may be for the work cycle as a whole.

The result obtained by following the procedure described in clause 4, is a RF% to be added to the basic time with, where appropriate, guidance as to suitable work regimes for dealing with special types of work or environmental conditions.

Figure 1 gives a flow chart which shows the sequence of steps to be taken. Begin at the point marked START and follow the procedure through the various decision branches to the end. The chart contains a number of conditional jumps which are observed at the appropriate time.

The procedure for dealing with physical work is described in 4.2, while 4.3 describes how to deal with non-physical work and 4.4 describes how to deal with the environment. The application of the results is described in 4.5, with guidance about the local use of the values obtained from following the flow chart (see figure 1), or by applying a blanket RF% (see 4.2.12).

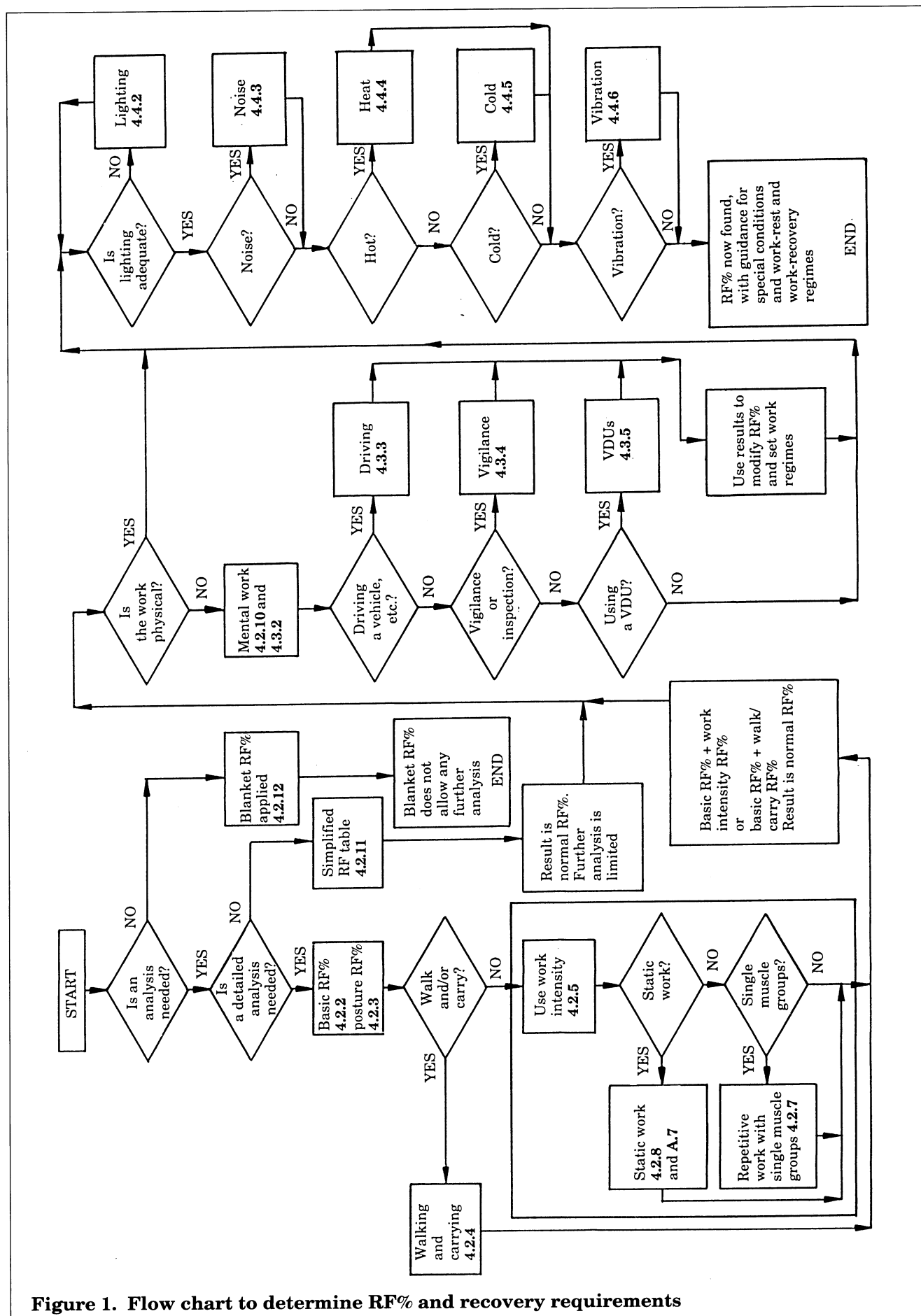


Figure 1. Flow chart to determine RF% and recovery requirements

4.2 Relaxation times for physical activities

4.2.1 Outlines of procedure

All activities have some physical content, even if the person is sitting doing nothing except looking at something. Unoccupied time that is enforced by the work process or team balance should be awarded the appropriate RF%. Apply the tables as indicated. At the end, calculate the total RF% as follows:

total RF% =

$$\text{basic RF\%} + \text{posture RF\%} + \begin{matrix} \text{walking RF\%} \\ \text{or} \\ \text{work intensity RF\%} \end{matrix}$$

Guidance on a simplified table for RF% for physical activities is given in 4.2.11.

4.2.2 Basic relaxation time

This applies to every activity. Every person needs to change activities and attend to personal requirements from time to time. In addition, the standard time should recognize that it needs to carry its share of the physiological cost of the person's actual living existence. Basic relaxation time includes provision for personal needs. The basic relaxation factor corresponding with basic relaxation time is 8.6 %.

The derivation of this value is given in A.3 and A.4.

4.2.3 Posture

Posture applies to every element or group of elements as given in table 1.

Table 1. Posture RF%	
Posture	RF%
Sitting	0.5
Standing	1.4
Kneeling	1.7
Squatting	1.7
Bent over	2.3
Lying	1.2

Only one posture can be selected for any given element, i.e. that used for at least 85 % of the element. If there are major changes in posture during an element, then the element should be subdivided to recognize the different postures.

Where the posture adopted during the element is not adequately represented by the six categories given in table 1, then special circumstances exist. These are dealt with by multiplying the posture RF% value (incremented, where appropriate, with an adjustment for protective clothing, see 4.2.6) by the appropriate factor given in table 2.

Table 2. Adjustment factors for posture RF%

Circumstance	Factor
Restricted movements	1.25
Unbalanced/unstable posture or movements	1.1
Arms high or above head/shoulders	1.2

Where more than one factor applies in a given element or situation, then multiply the factors together to obtain the total increment.

4.2.4 Walking and carrying

4.2.4.1 Table 3 is used only for walking. Any element in which there are a few steps mixed with other activities should be treated as described in 4.2.5, or the element should be subdivided further, so that the walking and non-walking parts can be treated separately. Use the speed of walking which is considered to be 100BS (see BS 3138) for the particular circumstances. (This may not necessarily be 4 mile/h; this speed may be hazardous in certain locations.) Obtain the RF% and add to this any percentage for gradient, stairs and carrying as detailed in 4.2.4.2. Do not use table 3 together with the adjustments for work intensity described in 4.2.5.

Table 3. Walking RF%

Speed (mile/h)	1	1.5	2	3	4	5
RF%	1.2	2.2	3.2	5.8	9.6	16.4
Speed (km/h)	1	2	3	4	5	6
RF%	0.6	1.6	2.9	4.2	6.1	8.5

4.2.4.2 For movement with or against gravity, the walking RF% (see 4.2.4.1) is to be adjusted according to one of the following:

- (a) uphill: add 0.2 per degree rise;
- (b) downhill: deduct 0.1 per degree fall;
- (c) upstairs: add 1.8 per metre up;
- (d) downstairs: add 0.5 per metre down.

A further adjustment to the RF% is applied for load carrying. In this case the RF% is incremented with the appropriate value from table 4 (see also A.5).

Table 4. Increments to walking RF% for load carrying

Load (kg)	0 to 10	11 to 15	16 to 20	21 to 30	30 to 50
RF% increment per kg	0.3	0.6	0.7	0.8	1.0

4.2.5 Work intensity (muscle loading)

Table 5 is a general table, suitable for most activities. Use the bench-mark activities in appendix C to select the most appropriate cell of the table, and do not over-assess the activities. For mental work, refer to 4.2.10. Obtain the RF% value from table 5.

Table 5. Work intensity RF%

Body used	Intensity of activity			
	Light	Medium	Heavy	Very heavy
Hand	0.5	1.4	2.3	3.2
One arm	1.4	2.8	4.3	5.7
Two arms	3.4	4.8	6.3	7.7
Whole body	6.3	9.7	14.3	20.0

Guidelines for the use of table 5 are as follows.

(a) Body used:

- (1) hand: the element requires the use of hands only; there is little or no arm movement; the range of movement is up to 15 cm;
- (2) arm: there is arm movement during the element; one arm only is principally used; the other hand and arm are not moved very much, these being used as holding devices rather than moving devices; the range of movement is up to 45 cm;
- (3) two arms: two arms are required to execute the element; the range of movement is up to 45 cm;
- (4) whole body: the whole body is used or moved to greater or lesser extent during the element; related arm and leg work is included.

(b) Intensity of activity. The intensities of the activity are described by the columns in table 5. Recourse can only be had to a subjective assessment using the terms light, medium, heavy and very heavy. As a guide:

- (1) light work: there is little load on any of the muscles used during the element, either overall or on average. The desired effect can be obtained by easy use of the hand muscles with little assistance from the rest of the body;

(2) medium work: the muscle loading is moderate. Hands need to be assisted by muscles in the arms;

(3) heavy work: there is fairly heavy loading of the main muscles used. Hands or feet need to be assisted by upper-arm and upper-leg muscles, with some help from trunk movement;

(4) very heavy work: there is very heavy loading of the muscles used. Considerable forces are being applied by the hands/arms/feet during the element. The largest muscles available are being heavily loaded.

As an aid to assessment of an actual activity, reference should be made to appendix C for examples of activities in the different categories. It is easy to assess wrongly the level of an activity, and care should be taken to avoid this error.

4.2.6 Protective clothing

Where protective clothing is used, the elemental times will reflect the effect this may have on the time taken to carry out the element. Donning and removing such clothing should be measured separately, attracting its own RF%. Adjustments of RF% for protective clothing are as follows:

- (a) for each kilograms weight of protective clothing additional to normal clothes, add 0.3 to the posture RF% and increase the RF% obtained for work intensity by 0.02 times the latter RF% value;
- (b) if restrictive headgear is used, e.g. hood, mask, vision-limiting goggles, increase the work intensity RF% by 0.10 times its value.

Where the effect of wearing protective clothing is greater than can be covered by these recommendations, a specialized investigation would be appropriate and would override these recommendations (see also A.6).

4.2.7 Repetitive work with single muscle groups

This occurs where:

- (a) a motion pattern applies a load to a specific group of muscles;
- (b) there is no way in which these muscles can be assisted by other parts of the body;
- (c) the motion pattern is repeated at short intervals.