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The incentive to bypass protective devices on machinery

1 Introduction

It is a well-known fact that protective devices on machinery are bypassed. The HVBG report entitled "Bypassing of protective devices on machinery" [1] was the first to deliver reliable statistics, data and facts on the phenomenon. It has now been shown that approximately 37% of all protective devices on metalworking machines are bypassed in this way. The machines concerned present a substantially increased risk of hazard and likelihood and severity of accidents. Fatal accidents are already known to have been caused by defeating with protective devices.

Ultimately, the bypassing of protective devices can be avoided only if machines are designed such that defeating offers no benefits, i.e. no incentive exists. By what means, however, can it be ascertained whether this (ideal) condition has been reached on a machine? This question is of particular relevance for:

- The designer of the machine (are the requirements of the Machinery Directive satisfied; can I apply a CE mark?)
- The purchaser of a machine (is the machine safe in use; is its purchase advisable?)
- The machine operator (can I satisfy the requirements of the safety regulations by means of this machine?)

An assessment matrix[1] is presented below with the aid of which the incentive to bypass protective devices on machinery can be evaluated. An Excel table is provided for use in practice.

2 Assessment matrix

If proof were needed, the HVBG Report has now shown clearly that the incentive to bypass protective devices is attributable to the resulting benefits during work on a machine. The results of the report reveal the following interrelationships:

1. Protective devices which do not hinder the working process are not generally defeated with, as no benefit exists from doing so.
2. Protective devices which hinder the working process provide an incitement to bypassing of them.
3. The probability of unsuitable protective devices being bypassed is directly proportional to the resulting benefit.

[1] DIN EN ISO 1088 A1:2007 [2] introduces the concept of reasonably anticipated bypassing. It recommends that measures be taken to reduce the scope for bypassing of interlocks used in conjunction with guards. The scale of the measures should be geared to the probability of the device being bypassed, and to the ensuing risk. The method presented here can be used to support quantification of this probability.

4. The benefits of protective devices being bypassed are dependent upon the operations to be performed on the machine concerned.

5. Machines are not necessarily restored to the original condition after defeating. In the worst case, a protective device that has been bypassed for occasional operations may therefore remain in this state permanently.

6. If certain tasks, such as setup operations, were not considered during design of a machine, bypassing of protective devices is unavoidable, as it would not otherwise be possible to operate the machine.

7. The CE mark does not necessarily mean that a machine need not or will not be defeated with.

The considerations stated here have been incorporated into the assessment matrix shown in figure 1. The essential principle here is for the benefits of a case of defeating to be identified, and the incentive to bypass (ITB) to be derived from them. For this purpose, the tasks arising in the life cycle of a machine are listed (left-hand column), together with the possible modes of operation and any limitations associated with them. The benefits of bypassing of protective devices identified in the HVGB Report are then summarized. The incentive to bypass for the task concerned is displayed at the end of each line.

Use of this method requires that all intended modes of operation and protective devices must be available. Each individual protective device is considered separately, and for each relevant task, a person familiar with operation of the machine is asked the following question:

"What would be the benefits of bypassing the protective device for work on the machine?"

Accordingly, defeating is defined as follows [1]:

Defeating is the rendering inoperative of protective devices with the result that a machine is used in a manner not intended by the designer or without the necessary safety measures.

Remarks:

1. The means by which the machine is defeated with are irrelevant.

2. All necessary manual operations must be considered.

Sections 2.1 to 2.4 must be considered in the table entries.

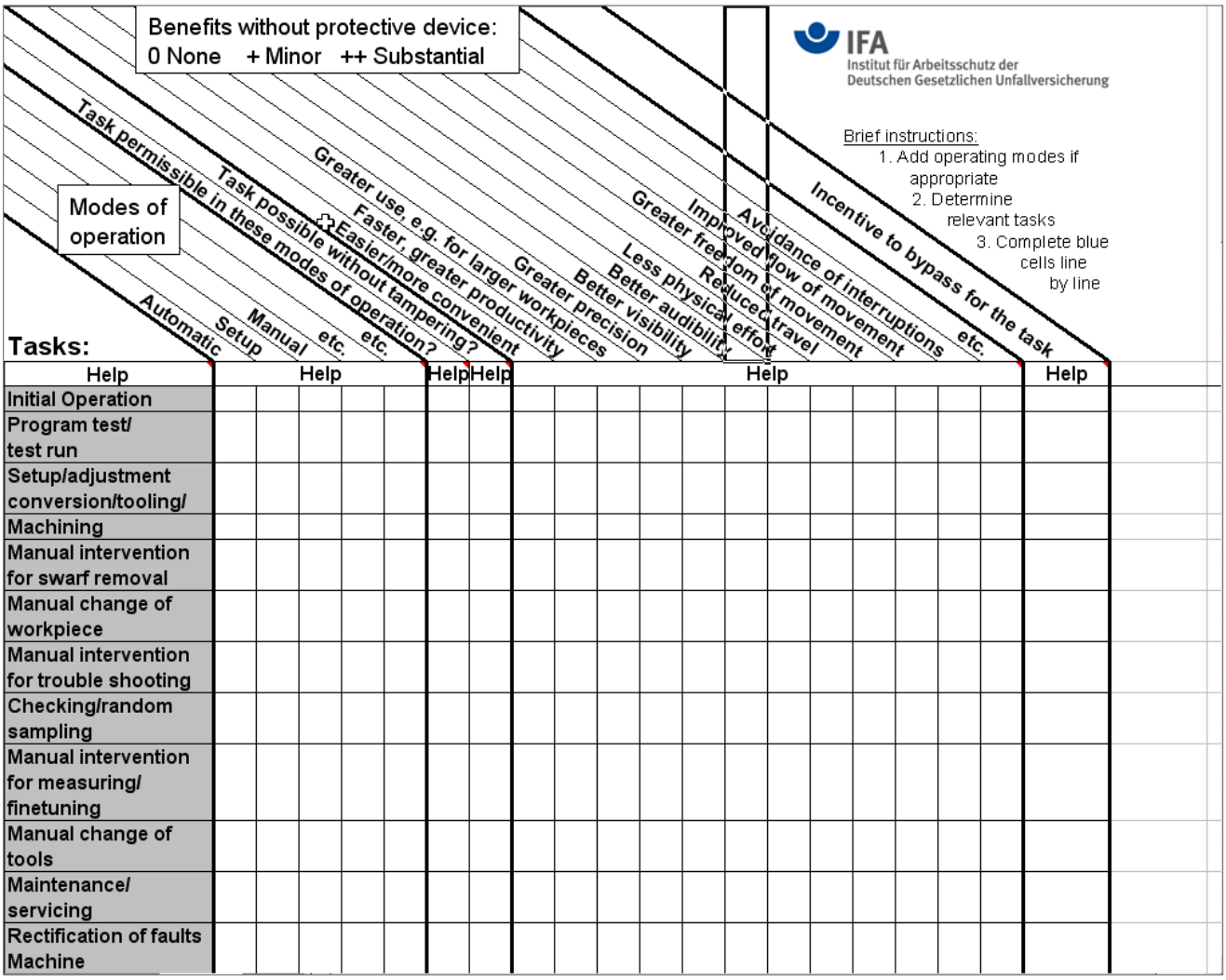

Figure 1: Example assessment of the incentive to bypass a protective device

2.1 Is the mode of operation permissible?

The majority of machines feature several modes of operation. If a task is carried out in a mode of operation other than that intended, this also represents a case of defeating. This may in particular occur on machines featuring a "process observation" mode: this is a mode of operation in which, for reasons relating to the process, very few safety measures are possible. Owing to the associated greater hazards, this mode of operation is permissible only under tightly restricted conditions [4], observance of which is however assured only by organizational measures within the plant. Should a task not be intended in this mode of operation, an instance of defeating clearly exists, and no need remains to determine the incentive to bypass a protective device.

2.2 Can the task be performed without defeating?

"No" in this instance means that the task concerned cannot be performed at all unless the protective device is bypassed. Here too, there is no further need to assess incentives for bypassing of a protective device.

2.3 Benefits gained by bypassing of the protective device

For the purpose of the questions posed here, the protective device is assumed not to exist. The resulting benefits to the user of the machine are assessed as follows:

0	No benefits
+	Minor benefits
++	Significant benefits

2.4 Incentive to bypass (ITB)

The entries are assessed individually for each task. The incentive to bypass (ITB) protective devices is presented by the introduction of a corresponding concept. This in turn is divided into three levels:

ITB=	**When …**
Low	No "+" or "++" entries have been made for a task
Present	At least one "+" or "++" entry has been made for a task
High	The task is performed in an impermissible mode of operation, or The task cannot be performed without bypassing of the protective device

ITB = low describes a machine on which the protective device clearly does not impair the working process, and on which bypassing would not therefore yield any benefit. No need for action exists. Should the machine nevertheless be defeated with, the reason is not therefore flaws in the design of the machine.

ITB = present indicates that the protective device hinders the working process, and that bypassing it would yield benefits. Whether defeating would actually occur cannot be determined from the existing assessment matrix alone; other factors would require consideration, such as the psychological stress to which different individuals are exposed, and the corporate culture. How high is the psychological barrier to defeating? Is defeating tolerated/encouraged in the plant, or is it generally opposed? The ITB can therefore indicate only that the tasks have been identified for which an incentive to bypass exists, and that further clarification is required.

ITB = high indicates a machine which cannot be operated at all unless defeated with. Improvements are necessary – the machine is unsafe.

Weighting or averaging of the incentive to defeat across the tasks relevant to the machine is not permissible, since a machine which is defeated with for particular manual operations is not necessarily restored to its original condition afterwards, and this case would not necessarily be evident from a summary. The only means by which the incentive to bypass a protective device can be described comprehensively are therefore by use of the least favourable value for a task.

3 Corrective measures

The phase in a machine's life cycle determines the measures which can or must be taken in order to reduce the incentive to bypass. The following will be considered:

- Design phase
- Purchase of a machine
- Operation of a machine

3.1 Measures at the design phase

The results from the assessment of the incentive to bypass provide indications of any weak points. If ITB = high, the essential health and safety requirements of the Machinery Directive have not been satisfied; CE marking is therefore not allowed. ITB = present however also indicates a need for improvements. The operating and safety concept should perhaps be reviewed; the ergonomic design may be unsatisfactory, or unsuitable protective devices may have been selected. In cases where the operator must reach into the danger zone at frequent intervals, for instance, a light curtain may be more suitable than a protective door.

In certain situations, a machine must be operated with the protective devices disabled, for example during setup. The use of suitable safety components, such as drive controls with safely limited speed, enables the necessary modes of operation to be achieved with safe technology. Selected examples can be found in the HVBG Report.

If electromechanical position switches or proximity switches are employed for safety functions, the psychological barrier to defeating can be raised by the use of dedicated coded products, shrouded fitting and/or non-removable fitting of actuators. For further information, see BG Information Nos. 575 and 670.

3.2 Measures taken at purchase of machines

At the time of purchase, a decision is taken to use a machine for a period of perhaps 20 or 30 years. Whereas for the manufacturer of the machine, the process is largely completed with commissioning and acceptance at the customer's premises, the operator of the machine still faces the long-term task of providing his employees with safe workplaces. This is by definition not possible on a machine that has been defeated with. The hope that this objective can be attained merely by the purchase of a machine bearing the CE mark is unfortunately not always fulfilled, as the HVBG Report shows: 50% of the machines defeated in the study bore the CE mark.

The incentive to bypass **must** be assessed, with consultation of the future operating personnel, before any machine is purchased. Where the ITB = high or "present", a solution must be found in conjunction with a safety professional and the manufacturer of the machine. If appropriate, the machine should not be purchased.

3.3 Measures to be taken by the operator of the machine

If the machine is already in use, the reasons for (anticipated) defeating must be identified in conjunction with the safety professional. A design solution may be possible, or modifications to the use or operating process of the machine. If none of these measures are possible, organizational measures are still better than nothing. Whatever the solution, the subject must be raised openly in

order for it to be made clear that defeating with the machine will not be tolerated in the plant, and that proper measures should instead be sought. Support can be expected from the responsible BG (institution for statutory accident insurance and prevention) or the BG expert committee responsible for the machine.

4 Bibliography

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