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	Standards of the acceptance and availability of installations with storage/retrieval machines and other machinery	06.1989 (E)

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1 Symbols and Meaning

Symbol	Dimen-sion	Meaning
A	-	Availability
k_i	-	Weighting factor
$MTBF$	min	Mean time between failures
$MTTR$	min	Mean time to repair
n_f	-	Number of operations carried out incorrectly.
n_r	-	Number of correct or trouble-free operations
t_A	min	Downtime
t_{Ai}	min	Downtime of a single element i of a system
t_{A1}	min	Period between the occurrence of a fault and start of the search for the fault
t_{A2}	min	Period needed to find the cause of the fault
t_{A3}	min	Period to prepare and organize correction of the fault
t_{A4}	min	Period needed to clear the fault for operational readiness or until resumption of operations
$t_{A\,Ber}$	min	Downtime during the standby time
$t_{A\,Btr}$	min	Downtime during the operating time
t_{Ber}	min	Standby time
t_{Btr}	min	Total operating time
t_E	min	Total time in service
t_1	min	Maintenance time
t_R	min	Unattended time
φ	%	Reliability
η	%	Availability
η_{Btr}	%	Availability during the total operating time
η_E	%	Availability considering only the time in service
η_{Tot}	%	Total availability
η_n	%	Availability of an element

2 Scope

The following standard gives recommendations for the determination of the availability and for the commissioning, hand-over and testing of installations with storage/retrieval machines, material-handling facilities and other machinery and their controls.

3 Availability

3.1 Fault
A fault is the inadmissible deviation of a characteristic from a prescribed value.

3.2 Malfunction
A malfunction is the inadmissible impairment of a function.

In determining the reliability and availability, only those malfunctions are considered which actually impair the operation.

3.3 Reliability
The reliability φ of a discontinuously loaded element of a system is equal to the probability of that element carrying out its function under given boundary conditions correctly and without malfunctions. It is a measure of the functional safety of an installation.

The reliability is determined experimentally by the quotients

$$\varphi = \frac{n_r}{n_r + n_f} \qquad (1)$$

where

n_r = Number of correct or trouble-free operations

n_f = Number of operations carried out incorrectly

As systems consist of several elements, which are normally independent of each other, the appropriate model for determining the reliability and the availability must be formulated. When considering this the following applies :

— If, for a system to function, it is necessary that **every** element functions, it follows that the elements are arranged in series, ie if an element fails the functioning of the system is disrupted.

— If, for a system to function, it is adequate that only **one** of the elements functions, it follows that the elements are arranged in parallel, i.e. if an element fails the functioning of the system can be maintained due to redundancy (e.g. by-pass).

The function under observation must be tested with an adequate statistical frequency.

The deviations to be rated as faults or malfunctions are to be defined for the particular application.

In general the term „Reliability" makes no statement about the characteristics of a system in the case of a malfunction, but does give information about the susceptibility of a system to disruption.

3.4 Times

3.4.1 Unattended time (t_R)
Unattended time is when the installation is switched-off and is neither being maintained nor repaired.

3.4.2 Standby time (t_{Ber})
Standby time is when the installation is switched on but is not, however, performing its functions.