	FÉDÉRATION EUROPÉENNE DE LA MANUTENTION Section IX SERIES LIFTING EQUIPMENT	**FEM** **9.222**
	Standards of the acceptance and availability of installations with storage/retrieval machines and other machinery	06.1989 (E)

Table of contents

Continued page 2 to 22

Available in English(E), German (D), French (F)

For references see end of Document

1 Symbols and Meaning

Symbol	Dimension	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.

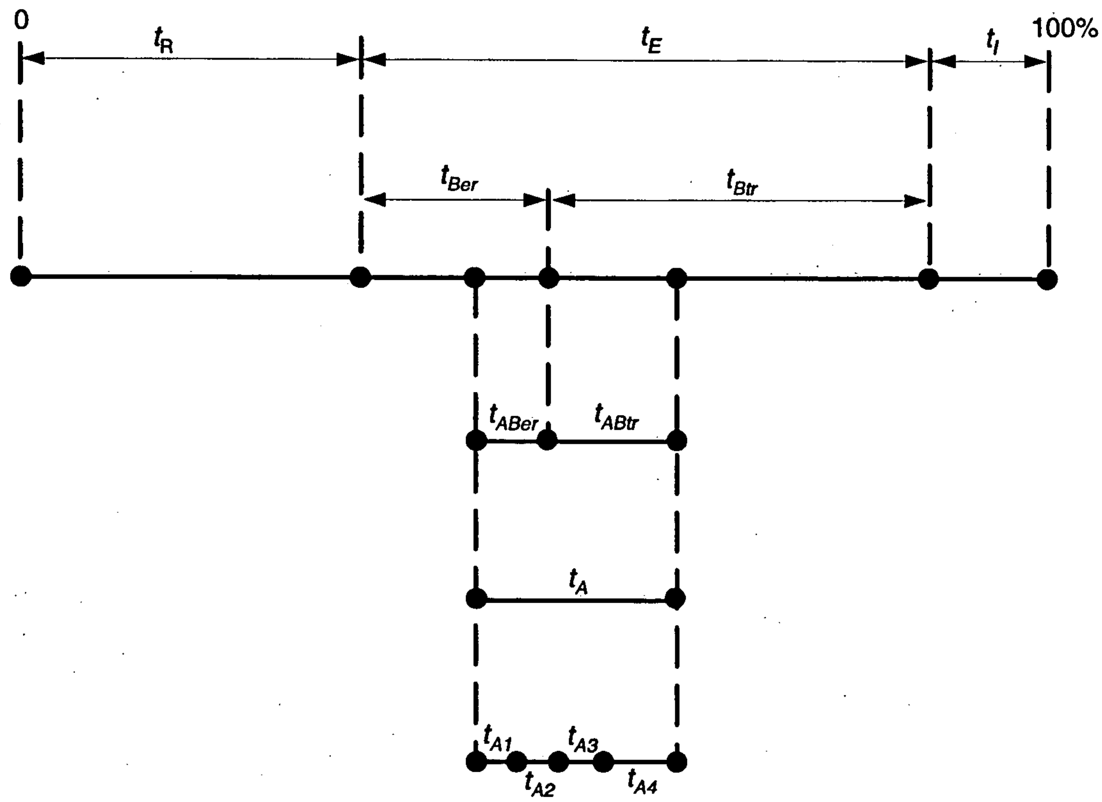

Figure 1: Possible time-proportions of an installation in the course of a day

3.4.3 Operating time (t_{Btr})
Operating time is when the installation is used under operating conditions.

3.4.4 Time in service ($t_E = t_{Ber} + t_{Btr}$)
Time in service time is the sum of the standby time and the operating time.

3.4.5 Downtime ($t_A = t_{A1} + t_{A2} + t_{A3} + t_{A4}$)
The period of time between the occurrence of a fault and the restoration of operational readiness. The down time is established with reference to FEM 9.221 „Performance Data of S/R Machines, Reliability, Availability". Downtime contains the following sub-periods:

t_{A1} = Period between the occurrence of the fault and start of the search for the fault by the responsible personnel

t_{A2} = Period needed to find the cause of the fault

t_{A3} = Period to prepare and organize correction of the fault, making ready etc.

t_{A4} = Period needed to clear the fault for operational readiness or until resumption of operations (the actual repair time). The operational readiness of the installation can be restored before the final completion of the repair. It should be noted here that the downtime can lie in both the standby time and in the operating time. Therefore the following applies:

$$t_A = t_{A\,Ber} + t_{A\,Btr}$$

$t_{A\,Ber}$ = Breakdown time during the standby time

$t_{A\,Btr}$ = Breakdown time during operating time

3.4.6 Maintenance time *(t_I)*
Time period during which the installation is maintained.

3.4.7 Influence of the Sub-periods
Different sub-periods can be used for calculating the availability.

As a rule downtime during the operating time has the effect of reducing the availability, particularly when the installation has no redundancy, stores, buffers etc. Downtime during the standby time does not have the effect of reducing the availability.

If intolerable downtime t_{A1} - t_{A4} arises due to lack of readiness or qualification of the personnel, it can be deducted proportionately.

3.5 Availability
In theory availability is described as the probability of finding a system at a given time in an operable condition.

In practice the availability is the measure of the useful operating/ service time of an installation and thus also dependant on how quickly a fault, on average, can be cleared. The availability is calculated as

$$\eta_{Btr} = \frac{t_{Btr} - t_{ABtr}}{t_{Btr}} \qquad (2)$$

on condition that breakdowns during the standby time do not effectively impair the operation or

$$\eta_E = \frac{t_E - t_A}{t_E} \qquad (3)$$

on condition that portions of downtime during the standby time should also count as reducing the availability where

η_{Btr} = Availability during the total operating time
η_E = Availability considering only the service time
t_{Btr} = Total operating time
t_E = Total service time
t_{ABtr} = Portion of the downtime which falls within the operating time
t_A = Total downtime

As the systems consist of several system elements, the appropriate availability model must be formulated:

- If, for a system to function, it is necessary that every element functions, it follows that the elements are arranged in series:

$$\eta_{Ges} = \eta_1 \cdot \eta_2 \cdot \eta_3 \cdot \ldots\ldots\ldots\ldots \eta_n \qquad (4)$$

- If, for a system to function, it is adequate that one of the elements functions, it follows that the elements are arranged in parallel:

$$\eta_{Ges} = 1 - [(1-\eta_1) \cdot (1-\eta_2) \cdot \ldots\ldots\ldots \cdot (1-\eta_n)] \qquad (5)$$

In reality these formulas are strongly idealised partly because:

- The elements can have not only the conditions „functional“ or „failed“ but also „diminished performance“,
- Normally the elements are not independent of each other but are linked together eg. by a control system,
- Downtimes of different elements can coincide.

It is recommended that the following adaptation of the formula (3) is used in practice:

$$\eta_E = \frac{t_E - \sum_{i=1}^{n} k_i \cdot t_{Ai}}{t_E} \qquad (6)$$

where:

t_E = Total service time
t_{Ai} = Total downtime of the system element *i*
k_i = Weighting factor of the system element *i* which represents the influence of the disruption of this element on the total function. For a series arrangement of the elements k_i = 1. For a parallel arrangement of the elements this becomes $1 \geq k_i > 0$. For *n* identical parts of the system this becomes $k_i = 1/n$

3.6 Methods of achieving a high reliability
From the relationship:

$$\eta_E = \frac{t_E - t_A}{t_E} = 1 - \frac{t_A}{t_E} \qquad (7)$$

it can be deduced that to achieve a high availability there are principally two approaches:

- keep the breakdown time t_A low.
- keep the value of t_E high in comparison to t_A, i.e. to achieve a low downtime rate which corresponds to a high reliability.

These facts are represented in Fig. 3 with a list of methods.

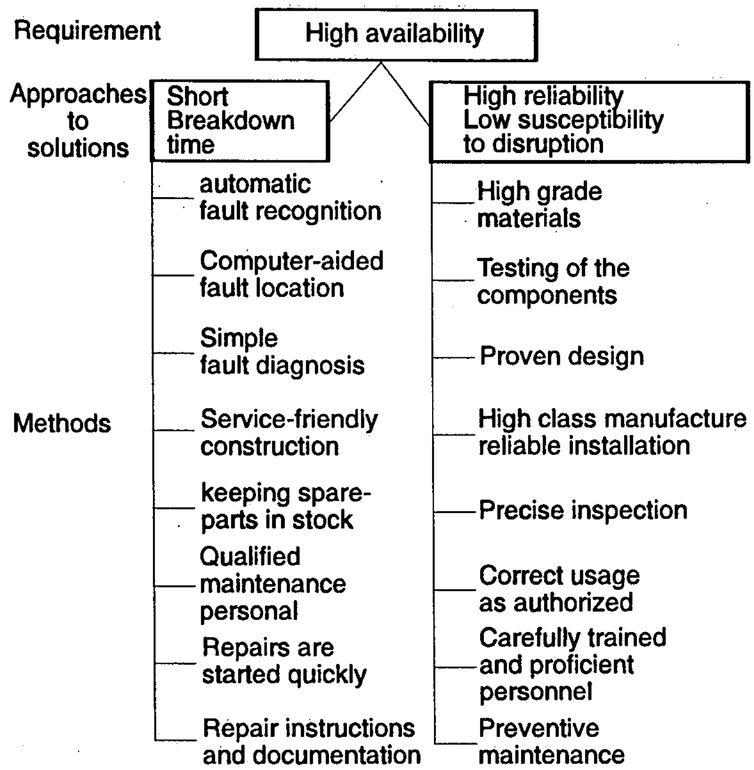

Fig. 3. Approaches to achieving a high level of availability

NOTE The formulae for the availability η contain portions of time which can be measured experimentally during a certain observation period. The formulae can thus be used as measurement instructions. In some cases the availability is not regarded as a measurement instruction but as a property of the system.

Figure 2 shows clearly that the mean value of $t_E - t_A$ and of t_A correspond to the usual terms in the English speaking world of *MTBF* and *MTTR*

The availability as a system property is defined there as A (availability)

$$A = \frac{MTBF}{MTBF + MTTR}$$

where *MTBF* = Mean Time Between Failures
MTTR = Mean Time To Repair

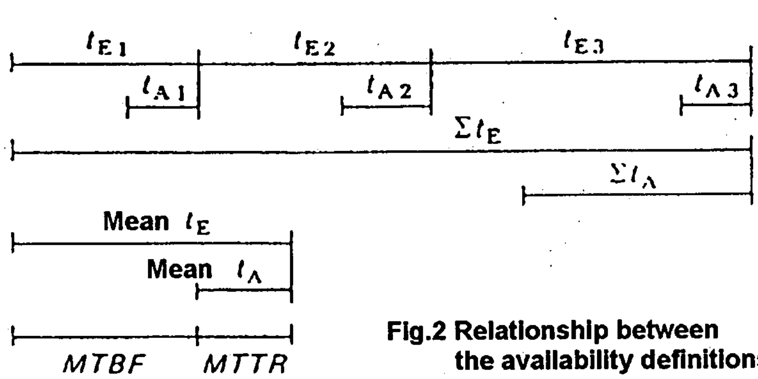

Fig.2 Relationship between the availability definitions

4 Acceptance Testing

The customer and the contractor have to reach an agreement before the contract is signed on which regulations are to complied with (customer's as well as statutary regulations and recommendations) and which inspections are to be carried out.

The inspections and the hand-overs can be carried out in several intermediate steps described below. Some of these can be omitted or combined.

4.1 Preliminary inspections
When required the following contract conditions regarding inspections can be agreed before delivery commences:

- Inspection of the approval drawings of the individual parts of the system
- Inspection of sub-assemblies or components which will not be accessible later
- Arrangement of the controls
- Factory inspections

4.2 Intermediate inspections
Among other things the following intermediate inspections can be agreed for checking the progress of the project:

- Completion of phases
- Completeness of deliveries
- Deliveries free from damage
- Completed installation, commissioning
- Computer link to the system
- Interfaces (for example: building tolerances, software and hardware interfaces etc.)
- Comparison between delivery and specification

In the case of export contracts intermediate inspections will be arranged.

4.3 Partial hand-overs
Partial hand-overs can take place for provisional use or to support the work of third parties. In doing so the risks involved in this use pass to the user. In this case the question of the warranty is to be agreed.

4.4 Official inspections
The customer arranges for the official inspections after the contractor has indicated to him his readiness for them. The contractor is to assist in this inspection and afterwards is responsible for the rectification of outstanding work over which he has control.

4.5 Acceptance of the installation
The installation is ready for acceptance as soon as it is in a condition to fulfill the functions agreed in the contract. In this connection it is not required to demonstrate the full performance capability.

The acceptance of the installation takes place in the presence of the customer and the contractor.

Insofar as it has not previously been shown the acceptance of the total installation covers:

- Completeness of the delivery
- Adherence to the promised characteristics
- Agreed situation at the interfaces

- Compliance with statutory regulations
- Hand-over of the documentation

A report is to be drawn up concerning the acceptance.

Outstanding work which has no essential influence on the overall function are not grounds for refusal of acceptance.

The warranty commences with the acceptance.

Exclusions and reservations must be in writing. Outstanding work current at the time of acceptance is to be set down in writing. Outstanding work which becomes evident or occurs later come under the warranty obligations of the contractor.

If the customer is unwilling to take over the installation a description of the situation is to be recorded by mutual agreement. Further acceptance conditions shall be negotiated.

After the acceptance has taken place the responsibility for the use and risk passes to the customer. In particular the customer is responsible for seeing that the maintenance and service work is carried out in accordance with the contractors guidelines. The customer is responsible for the holding of spare parts.

Adherence to the safety regulations and obtaining licences to operate is a matter for the customer. The contractor has only a limited influence on the inspection by the authorities, therefore a delayed inspection by these authorities shall not delay the hand-over.

If the customer uses the installation before the acceptance the transfer of risk to the customer takes place at the latest from the moment it is used, the warranty period beginning at the same time.

4.6 Proof of agreed characteristics
Depending on the type of installation and the operating philosophy, functional -, performance - or availability-tests can be agreed before, during or after the acceptance.

At the request of the contractor the customer will make available in the necessary quantities for all phases of the test and hand-over:

- Qualified inspection, works and operating staff
- Transport units
- Means of transport (Reach trucks, trailors etc.)

4.6.1 Function test
In this test the functions of the installation are demonstrated. In doing so criteria such as performance and availability are not taken into consideration.

Errors and faults over which the contractor has no control are to be recorded, such as :

- Voltage interruption
- Voltage fluctuations
- Inadmissible ambient temperature
- Unsuitable loading aids
- Unstable loads
- Operating errors
- Escape of liquids, granulates, loose paper, protruding foil or parts of the load

- High air pollution (dust)
- Inadequate air conditioning for computer installations
- Interference with the installation by the customer

Faults or malfunctions which do not impair the operational readiness of the installation are not taken into consideration. Different functional areas in larger installations are often separated from each other by buffers. Faults in sub areas do not, therefore, necessarily have an effect throughout the entire installation.

4.6.2 Performance test
A performance test presupposes that a clearly measurable performance specification is defined in the contract.

The performance of the installation is composed of the performances of the individual elements. The performance can be demonstrated separately for the individual elements of material handling and storage equipment and for the entire installation.

For the demonstration of the performance of the individual elements of material handling equipment the existing recommendations can be used e.g. FEM 9.851 "Performance data of S/R Machines - Cycle Times". These recommendations can also be applied in whole or in part to narrow aisle stacker trucks.

The performance of the entire installation is only then demonstrated if the responsibility for it rests with the contractor. The test procedure is to be clearly established between the customer and the contractor.

In doing so the problems which arise when several lines of conveyors are operated at the same time are to be taken into consideration such as, for example, the build-up of accumulations, response times of the higher-order computer. The customer has to fulfill the boundary conditions necessary for the performance test in good time, above all providing the necessary unit loads as well as personnel and machinery for placing the unit loads onto the conveyor system.

4.6.3 Availability test
The availability of the installation should be specified, at the latest, before signing the contract with the customer. The availability model for the installation must be defined. It includes:

- Structure or linkage of the individual elements of the system
- Weighting distribution of the individual elements of the system
- Distribution of the goods in the storage aisles
- Buffering in the individual areas
- Redundancy
- Test procedure

The duration of the fault rectification is dependant on human factors, which are to be considered.

If, in certain cases, an analysis is required of the faults which occur, then the analysis time is not added to the downtime.

In the case of complex installations the time of the availability testing must be agreed between the customer and the contractor.

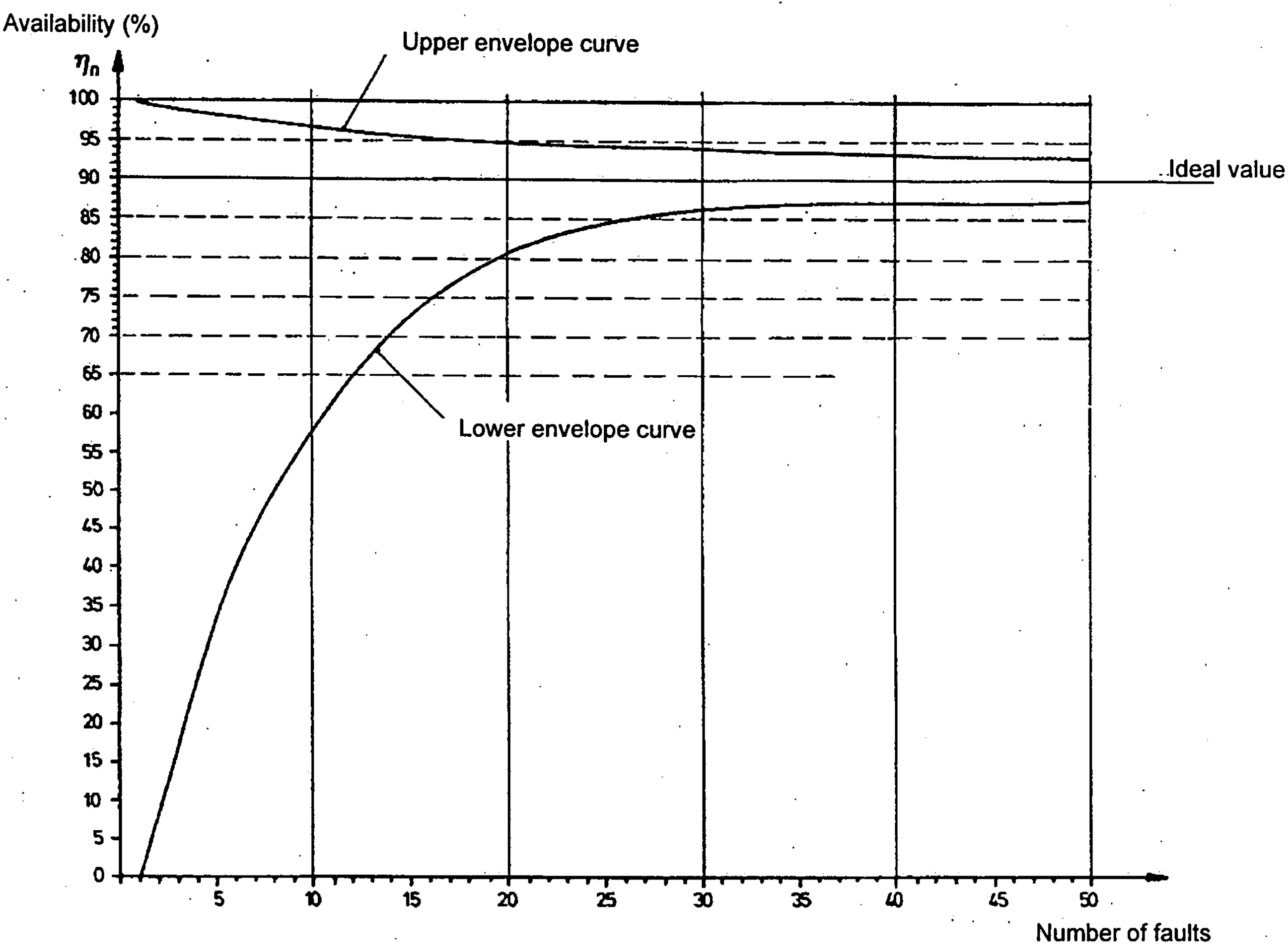

Figure 4: Accuracy of the determination of an availability

A high availability is not generally achieved until after a sufficiently long period of running-in operations. If, after the first test, an installation does not fulfill the agreed values, the contractor is to be allowed, after a period of time in which to effect improvements, further testing opportunities. During the acceptance test the availability is considered reduced only if the faults in the functioning of the installation really impair the operation ; for example an automatic repeat of a positioning operation after a fault, without manual intervention, is not to be taken into consideration.

The accuracy with which the availability of an element of a system can be demonstrated increases with the duration of the observation.

Figure 4 serves as an example for the quantitative envelope curves which are to be expected for an availability of 90 % of an individual element. The values determined in the practical test can lie in the area between the envelope curves.

One can see that approximation to the underlying availability of 90% for the element does not come into effect until there are a large number of faults.

Because of the significance of this behaviour the observation time should be laid down when the contract is agreed.

4.7 Outstanding work after acceptance

The contractor has to rectify the outstanding work within the shortest possible time. The contractor and the customer have to reach an agreement about the chronological sequence of the completion of outstanding work. The contractor has to show the customer that the outstanding work has been completed.

5 Operational phase

5.1 Running-in operations

After the hand-over of the installation to the customer the practical phase of ramping-up begins. The duration is set appropriate to the complexity of the installation. The objective of these operations is to stabilize the system technology, to give the staff the opportunity to operate the installation safely and to recognize and rectify external disruptive influences at the interfaces.

In this phase it must be possible for the operator to use the installation as agreed, sacrifices in performance and reduced availability may, though, occur.

5.2 Measurement phase

After completion of the running-in operations and after rectification of the faults which have arisen during them, it is useful to make the analysis of the availability

5.3 Checking point

The contractor must confirm to the customer, in good time before the end of the warranty period, that listed outstanding work has been completed and that all outstanding contract conditions have been complied with.

6 Contract procedure scheme

The contract process chart (Figure 5) describes with an example the essential steps in the processing and handling of a contract up to the end of the warranty period.

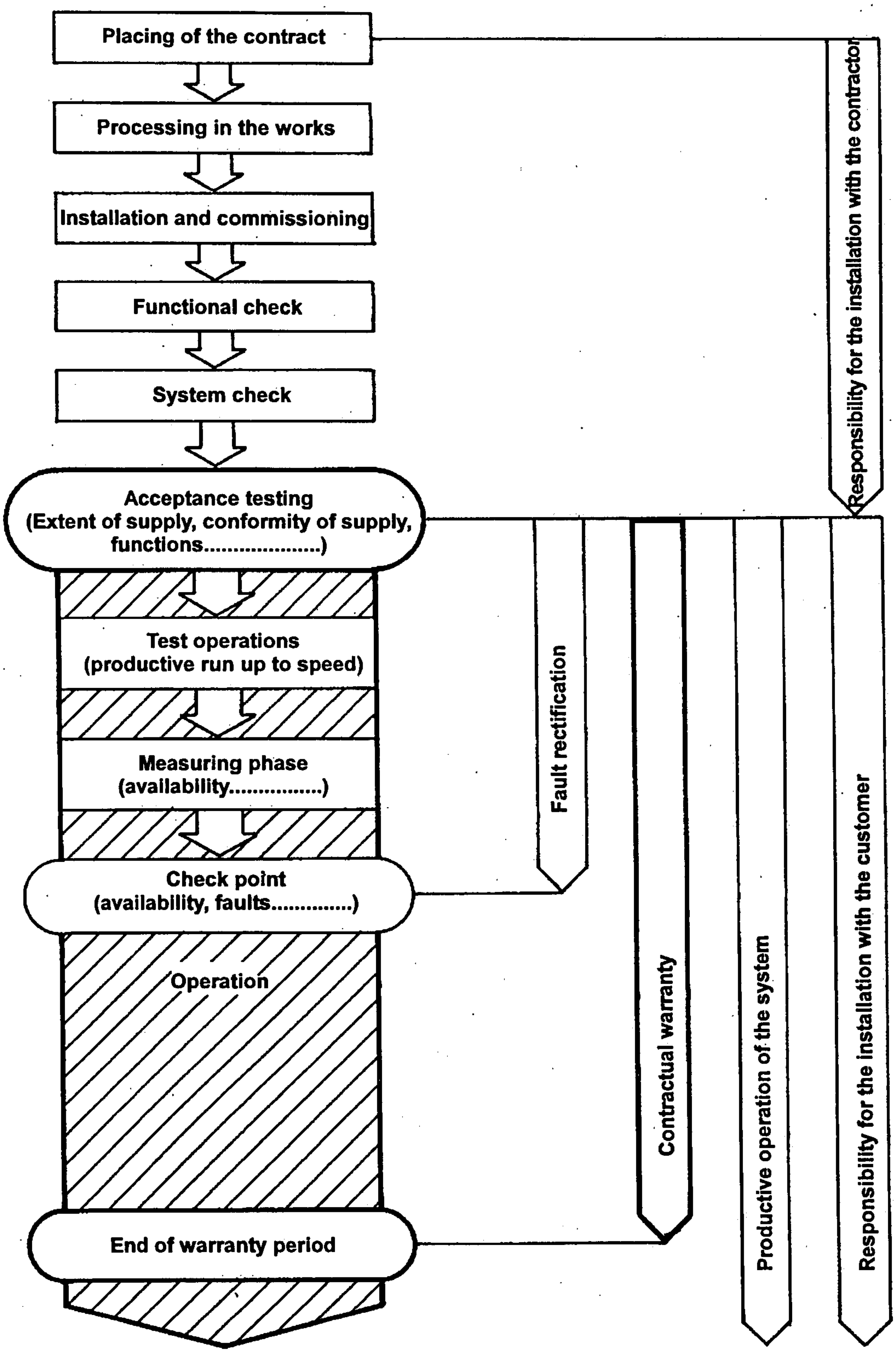

Figure 5: Contract procedure scheme

7 Examples for determining availability

7.1 High bay warehouse (HBW)

Installation considered
The installation includes 3 S/R machines and stationary material handling equipment in the front zone of the warehouse. It is not possible to run the warehouse without the stationary materials handling equipment being operative.

Definitions
The breakdown time of one of the 3 S/R machines is multiplied by the weighting factor k_i = 1/3. The breakdown of the stationary material-handling equipment counts as a total breakdown of the system; k_i = 1

The availability is calculated according to formula (6)

$$\eta_E = \frac{t_E - \sum_{i=1}^{4} k_i \cdot t_{Ai}}{t_E}$$

t_E = Time in service (affected with faults) here two days, e.g. two-shift working, t_E = 32 h.

t_{Ai} = The breakdown time for the part i of the installation

k_i = Weighting factor of the element i of the installation; it characterizes the share of that part in the total functioning of the installation.

Record of measurements for Time in service t_E = 32 h

Part of the installation i	Weighting factor k_i	Measured downtime h	Due to customer h	Due to faults h	$k_i \cdot t_{Ai}$ h
1: S/RM 1	1/3	1	0.4	0.6	0.2
2: S/RM 2	1/3	0.6	-	0.6	0.2
3: S/RM 3	1/3	0.3	-	0.3	0.1
4: Front zone	1	0.5	0.2	0.3	0.3

$$\sum_{i=1}^{4} t_{Ai} \cdot k_i = 0.8$$

Calculation

$$\eta_E = \frac{32h - 0.8h}{32h} = 0.975 = 97.5\%$$

To compare the availability of the partial system „3 S/R machines“ (i = 1....3)

$$\eta_E = \frac{32h - 0.5h}{32h} = 0.984 = 98.4\%$$

7.2 Computer controlled warehouse system

The installation consists of the following sub-systems:

- 1 Warehouse management system (WMS)
- 6 Automatic S/R machines (S/RM)
- 1 Transport installation for storage (TIS)
- 1 Transport installation for retrieval (TIR)
- 1 Automatic Guided Vehicle system with 6 vehicles which connects to the transport installation for retrieval (AGV).

Conditions S/R machine

For putting goods into the warehouse the principle of cross-section storage applies, that is, the number of articles is considerably less than the number of compartments. With this arrangement each article can be available in several aisles. The WMS decides on the allocation of article to the aisle.

Under these conditions every breakdown of a sub-system goes into the calculation of the availability only as the percentage with which the part has a share in the overall function. In the case of 6 S/R machines for example each S/R machine with 1/6.

Conditions TIS / TIR

If storage and retrieval operations are carried out in the same ratio and at the same time (normal operation in a high bay warehouse) then if the input conveyor fails the function is only reduced by 50%. If the last element of a transport chain breaks down (for example if the last aisle of a high bay warehouse can no longer be operated) then the breakdown goes with 1/6 of 50% into the availability of the entire installation.

Conditions AGV

If all 6 vehicles are required to produce the necessary throughput the breakdown of one AGV goes into the calculation as 1/6. If the required throughput is achieved due to available reserves despite the breakdown of a vehicle, then the breakdown time is omitted from the evaluation.

Conditions WMS

If the WMS breaks down then in general only emergency functions are possible. e g. single fast withdrawals using the subordinate control system. The breakdown of the WMS goes into the availability calculation at 100%

Example:

Operating time :	8 hours = 480 minute
Computer breakdown:	3 min
Fault S/RM 1:	12 min.
Fault S/RM 3:	8 min.
Fault S/RM 6:	2 x 5 min. = 10 min.
Data concentrator S/RM breakdown:	8 min.

Transport installation

3 Faults:

1. The input conveyor could not serve the aisles 5 and 6 during a period of 30 min.
2. The entire input system did not function for a period of 12 min. (Problems with the pallet checking device).
3. The control of the output conveyor was disrupted for 10 min. i.e. no withdrawals were possible.

Conveyor controls breakdown: 6 min.

AGV system

Breakdown of one vehicle 30 min.

Evaluation:

Fault	Downtime	Influence		$k_i \cdot t_{Ai}$
	t_{Ai} min	Description of breakdown	Factor k_i	min
Computer breakdown	3	Installation at a standstill	1.0	3.0
S/RM 1	12	1 aisle from 6	1/6	2.0
S/RM 3	8	1 aisle from 6	1/6	1.3
S/RM 6	10	1 aisle from 6	1/6	1.7
Concentrator S/RM	8	all aisles	1.0	8.0
TIS	12	Entire input system	0.5	6.0
TIS aisles 5 & 6	30	Input system 2 aisles 1/2 x	2/6	5.0
TIR control device	10	entire retrieval system	1/2	5.0
Conveyor control	6	All conveyors	1.0	6.0
1 AGV	30	Redundant	0.0	-
		(or 1 of 6)	1/6	5.0
Sum	129	Sum		38.0 (43.0)

With the formula (6) the availability of the installation can be calculated

$$\eta_e = \frac{t_E - \sum k_{ki} \cdot t_{Ai}}{t_E} = \frac{480 - 38}{480} = 92.1\%$$

or 91.0 % respectively if the AGV cannot be reckoned as redundant.

This example shows the calculation procedure. In order to achieve an adequate statistical accuracy of the availability the observation time must be increased. Compare section 4.6.3.

7.3 Installation with S/R machines, Assembly and test stands

Problems with the calculation of the availability and the effects of buffers and interconnections are explained using the example with the two variants A and B.

System configuration

An S/R machine serves two assembly lines, two test stands for the parts are arranged on each of the assembly lines.

Two further assembly lines follow before the removal of the parts takes place in common for both lines.

When laying out the system the performance of all parts of the installation was designed for the maximum without regard to the losses due to availability. This resulted in parallel tracks. There was no overdimensioning. The parallel tracks do not therefore represent any redundancy. The splitting only has the function of dividing the throughput and does not increase redundancy.

The availability of the individual elements is:

		η Btr %	t_{Ai} hrs	k_i	
S/R machine	η Btr SRM	97	3	1.0	Whether the availability of the individual elements was estimated or measured against comparable elements is irrelevant to this example:
Assembly line I	η Btr Ass. I	95	5	½	
Test stand	η Btr Test	90	10	¼	
Assembly line II	η Btr Ass. II	95	5	½	

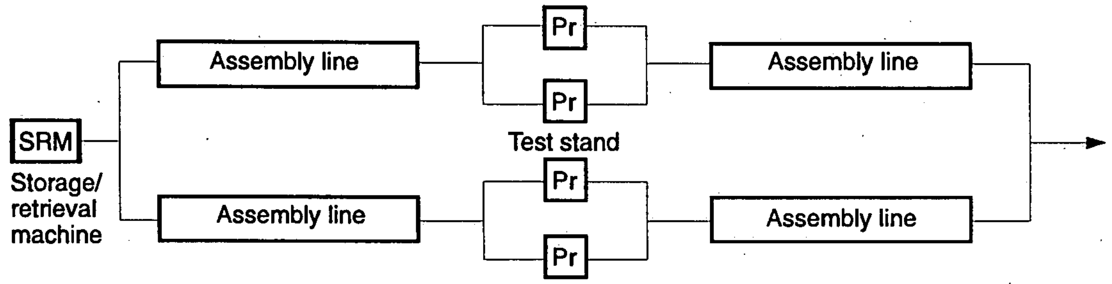

Figure 6: Variant A

Variant A, Calculation to formula (5)
As the installation has parallel paths for reasons of splitting the throughput (and not for reasons of increasing the redundancy) the formula for the series arrangement applies

$$\eta_{Tot} = \eta_1 \cdot \eta_2 \cdot \eta_3 \cdot \ldots\ldots\ldots\ldots \eta_n$$

$$\eta_{Tot} = \eta_{Btr\ SRM} \cdot \eta_{Btr\ AssI} \cdot \eta_{Btr\ Test} \cdot \eta_{Btr\ AssII}$$

$$\eta_{Btr\ Tot} = 0.97 \cdot 0.95 \cdot 0.90 \cdot 0.95 = 78.8\%$$

Variant A, Calculation to formula (7)

$$\eta_E \frac{t_E - \sum_{i=1}^{n} k_{ki} \cdot t_{Ai}}{t_E}$$

t_E = Observed time in service (affected with faults) (here 100 h).

t_{Ai} = The breakdown time for the part of the installation (in h)

$$\sum_{i=1}^{n} k_i \cdot t_{Ai} = 1 \cdot 3 + 2(1/2 \cdot 5) + 4(1/4 \cdot 10) + 2(1/2 \cdot 5) \qquad = 3 + 5 + 10 + 5 = 23$$

$$\eta_E = \frac{100 - 23}{100} = 77\%$$

Variant A, Simulation
The simulated value for the total availability (with a user-specific simulation model) amounts to

$$\eta_{Btr.Tot.} = 82.9\ \%$$

This value is slightly higher than the values from formulae (5) and (7). The cause is that in the formulae no consideration is given to the fact that the breakdown times of individual elements can coincide and that the time which is affected with faults is shorter with reference to the installation.

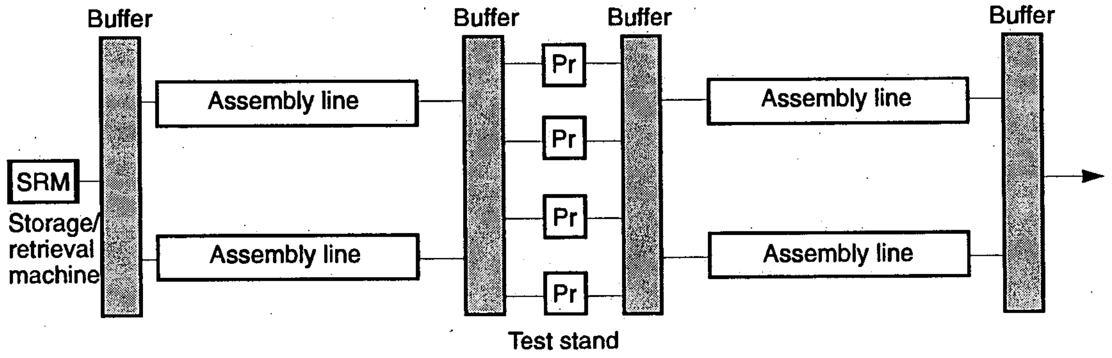

Figure 7: Variant B

Variant B
Provides three buffers with cross-distribution facilities. The buffers were dimensioned such that the capacity comes to twice that of the parts which are conveyed through the installation in 4.5 min. (80 % of all the downtimes are in this selected case smaller)

Variant B simulation
An empirical determination of the availability from existing installations which consist of intermeshed networks with buffers is very difficult as the effects of faults on other areas, and thus also on the filling levels of the buffers, must be observed at the same time.

There is no known analytical procedure for determining the availability of planned installations which consist of intermeshed networks with buffers.

A determination of the availability of such installations is possible by means of simulation if realistic estimated values on the availability of the individual elements are to hand.

The simulated value for the total availability (with a user-specific simulation model) amounts to

$$\eta_{Btr.Tot.} = 89.6\%$$

The maximum possible value of 90 % (this is the minimum value of the individual elements, in this case the value of the test stands) is barely reached. A value over 90 % would also not be possible even with further buffers.

In the calculation of complex installations a precise check should be made on which formula it is possible to work with.

In the case of intermeshed installations with buffers it is recommended that a simulation be carried out in the planning phase, before the final commitment to the layout. In doing so the effects of intermeshings, buffers and redundancies can be determined and compared with the appropriate costs.

References

Prepared by the Committee "Storage/retrieval-machines and stacker cranes" of Section IX of the Fédération Européenne de la Manutention (FEM)

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