Guideline „Fundamentals for the procurement and acceptance of machines and equipment in the confectionery industry“

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1. Purpose and scope

The investment into production equipment and the necessary calculation of the return on investment (ROI) requires in-depth information on performance, efficiency, availability, cleaning and implementation effort of the equipment planned. However, there is often no clear definition of terms and calculation methods. The consequences of this are that the contract partners may interpret the availability, efficiency and even the degree of quality of production equipment differently. This guideline shall contribute to the clarification of the terms, provide a calculation basis and also establish a basis for the discussion on quality parameters.

The recommendations and information in this guideline are based on state-of-the-art and experience gained with the practical handling of machines and equipment in the confectionery industry. This guideline is meant to be a reference and thus provides an overview only. It does not claim to be complete nor does it intend to interpret the existing legislation and regulations accurately. It must not replace the study of all relevant regulations, laws and directives. Added to that, the peculiarities of the respective products and their different application options need to be taken into consideration. This means that a number of other constellations are possible apart from the evaluations and procedures discussed in this guideline. This guideline shall only show solutions in an exemplary way that may serve as an orientation for day-to-day work.

2. Definition and application of the OEE

As the OEE (Overall Equipment Effectiveness) is gaining importance as a parameter, it is recommended here to use this key performance indicator for the commissioning and acceptance procedure for machines and equipment as well.

The OEE is a common key metric in the control of production lines and plants. For many production facilities, an increase in OEE has become a fixed part of the annual objectives. In order to secure the reproducibility of the OEE in the production process and to create a basis for defining its increase, this key figure must be taken into consideration in the procurement and acceptance of production lines.

The systematic integration of the OEE in the procurement process may aid in achieving successful commissioning and prevent disputes between the machine supplier and the equipment operator. In the first run, this process requires more effort, but it also contributes significantly to prevent losses in efficiency.

The OEE is a concept described by the Japan Institute of Plant Maintenance and used to quantify how well a manufacturing unit performs during its operating times or work shifts. The OEE of a manufacturing unit is defined as the product from the following three factors:

- Availability (A)
- Performance (P)
- Quality (Q)

$$OEE = A \cdot P \cdot Q$$

The value range is between 0 and 1 or 0% and 100%.

2.1. Availability

The availability is the ratio between down time and planned production time. Down time losses result from time needed for:

• **SETUP**
The equipment manufacturer demonstrates with suitable personnel that the setup times as defined in the requirement specifications can be met under the specified conditions (e.g. auxiliary equipment, form sets, etc).

• **CLEANING AND MAINTENANCE**
Cleaning is required for maintaining proper production conditions and for complying with hygienic requirements. The equipment manufacturer demonstrates with his own personnel or under their supervision the cleaning and maintenance work agreed upon within the agreed time. Agreements regarding cleaning cycles and cleaning effort shall be preliminarily defined.

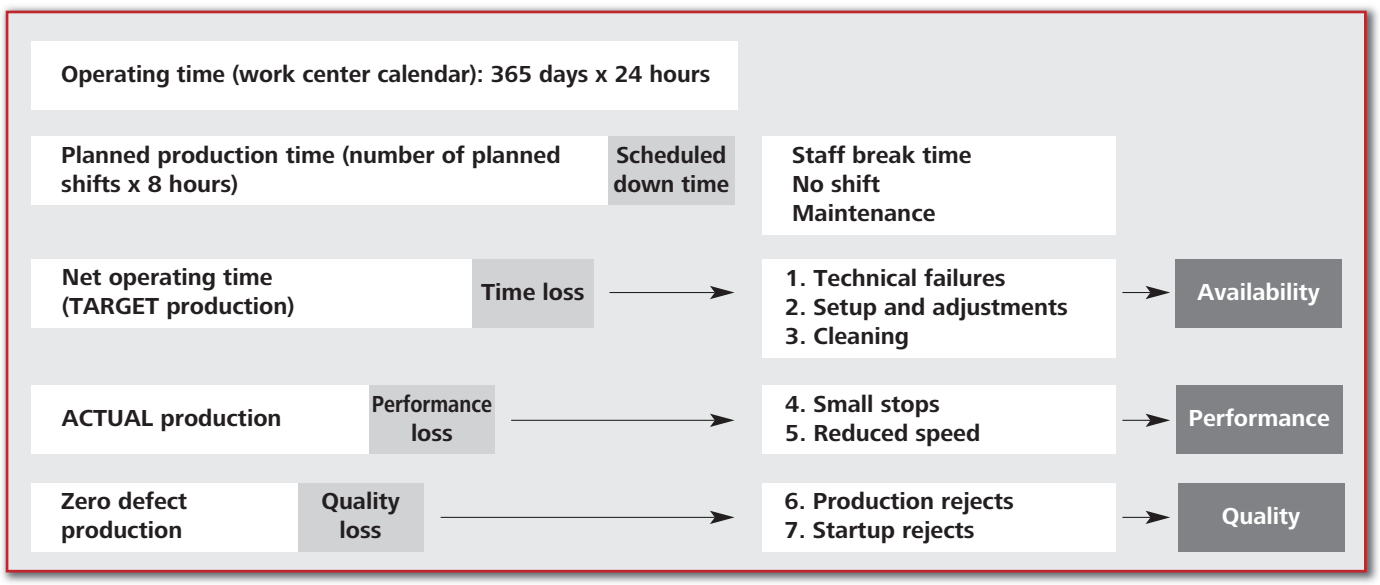
• **TECHNICAL FAILURES**
Equipment failures are defined as events that are caused by the equipment or are subject to a special contract agreement. This includes events originating in the upstream process, e.g. short-term line voltage deviations.

2.2. Performance

The performance is the actually achieved performance in relation to the performance agreed upon in the requirement specification for the respective product. This is based on the net operating time (= planned production time less down time). The performance is reduced by a reduced cycle time caused by personnel, organization, raw materials and product quality, quality of packaging materials or environmental conditions. From the contract partners' point of view, the deviations in raw materials and product quality agreed upon should be incorporated in the production process during acceptance of the equipment. Personnel, organization and stable environmental conditions are the sole responsibility of the equipment operator.

2.3. Quality

Quality is defined as the ratio between good pieces and the amount of raw material used. Quality loss can occur due to:
• Losses during startup, finish and flushing
• Rejects
• Process-related losses (e.g. by evaporation)
By defining in advance the quality criteria for good pieces, referred to in each recipe of the product portfolio, disagreements at a later time can be prevented.



OEE factors

Availability	$\frac{\text{available time (h)} - \text{down time (h)}}{\text{available time (h)}}$
Performance	$\frac{\text{actual quantity (t)}}{\text{target performance (t/h)} \cdot \text{actual time (h)}}$
Quality	$\frac{\text{actual quantity (t)} - \text{reject quantity (t)}}{\text{actual quantity (t)}}$

2.4. Definition and application of the OEE

Theoretically, the largest overall equipment effectiveness (OEE) can be achieved with

- operation at 100 % of the planned production time (see also A)
- production at 100% of the planned cycle time (see also P)
- production of 100% of all products in the defined quality (see also Q)

Any deviation from the 100% target is considered a loss. An early and precise analysis of loss factors may yield information on possible improvements of machines and equipment; these can be taken into consideration at the design stage. This analysis has to be performed specific for each product and each project. For example, setup times for equipment producing mono articles play a subordinate role while the setup losses for production lines processing a large variety of different products may be in the range between 10 and 40%. The degree of qualification and availability of operating personnel at the respective production facility equally affects the OEE.

2.5. Influence of machine supplier and equipment operator on the OEE

The OEE includes factors for which the machine supplier is responsible and factors that are in the responsibility of the equipment operator. For example, the machine supplier, in agreement with the equipment operator, has a joint responsibility for the qualification of the production staff for the specific equipment. With the amount of human resources made available and the qualification of the personnel, the equipment operator influences the degree of OEE that can be achieved.

Also, the chosen technical solutions significantly affect the technically required setup times, the availability and the life expectancy of the parts.

Optimum results can be achieved if all persons participating in the procurement and acceptance process cooperate. Decisive factors in this respect are integrative project management and binding specifications on requirements and functions.

Remark:
The OEE does not consider or assess manpower requirements. Therefore, human resources have to be explicitly laid down in the requirement specifications in terms of quantity and quality and differentiated by production process, setup and cleaning as well as scheduled maintenance of the equipment.

3. Project management

A basic requirement for a successful cooperation between equipment operators and machine suppliers is the creation of framework conditions which allow trustful cooperation.

Suitable project organization needs to be established as early as possible. Milestones to be applied for progress monitoring are also to be defined. Everybody who can contribute to achieving the intended objective needs to be involved. On the part of the operator, this includes, for example, development, technology, production, safety at work, maintenance, cleaning, procurement and quality management. The machine supplier also has to make available the expertise needed and involve sub-suppliers and service providers, if needed.

4. Requirements and functional specifications

(Source: DIN 69905 „Project Management, Project Management Systems")

It is appropriate to define all the requirements that a customer has on the delivery and performance of a supplier in a requirement specification document. The supplier will then compile a functional specification document in which he lays down precisely how he will comply with the requirements. Practice has shown that detailed functional specifications help to prevent failures, in particular, if the document is subdivided into a general and a project specific part.

In this context, all matters regarding intellectual property, joint development, experiments in a technical center and contractual definitions shall be specified as well.

4.1. Requirements and functional specifications – general part

The following is an example on how the general part could be structured:

General
- Scope
- Project manager/project team
- Non-disclosure agreement
- Validity of legal regulations, standards, guidelines, rules, state-of-the-art, etc.
- Food legislation requirements/compliance of materials used
- Technical specification of equipment parts (in-house standard)
- Obligation of the supplier to offer and deliver only according to the requirement specification document. Any deviation from the specified requirements must be approved
- Customer's duty to provide information

Safety regulations
- General
- Environmental protection and disposal

Terms of delivery and payment

Passage of risk
- Selection of Incoterms
- Regulation on the transfer of responsibility upon commissioning

Hygiene

Documentation, identification, technical documents
- CE sign, declaration of compliance, nameplate
- Operating Manual
- Risk assessment

Warranty and acceptance terms

Service and maintenance, availability of spare parts

Annexes

4.2. Requirements and functional specifications – project-specific part

4.2.1. Definition of project requirements

All product and process specific requirements must be clarified and communicated as early as possible. In particular, it should start with the definition:

- What must the production plant (or individual units or parts) be able to do?
- What can be retrofitted later?
- Statements on product and performance
- Statements on surroundings and available space
- Statements on supply engineering
- Statements on personnel (manning, qualification, training requirements)
- Statements on maintenance requirements

4.2.2. Product description and manufacturing technology

- Presentation of products/product ideas to the equipment manufacturer. This includes the disclosure and documentation of manufacturing stages and/or product or raw material specific characteristics – as far as known
- Definition of MUST-HAVE features of the equipment (e.g. dark chocolate coating)
- Definition of SHOULD-HAVE features (e.g. milk-containing coating to be implemented in the future)
- Definition of CAN-HAVE features – as far as already known (e.g. optional decoration of the products in the future)
- Explanation of the equipment manufacturers on how the MUST-HAVE and SHOULD-HAVE features will be implemented and on all other options the equipment might offer
- Presentation of the possible production technology by the equipment manufacturer, in the ideal case by using the customer's original raw materials
- In the case of deviations regarding the fulfillment of the defined product idea, joint developments or adaptations of the product specifications are to be conducted
- Precise definition of all measurable and significant process and quality parameters and tolerances
- Description of all quality criteria that cannot be measured by instruments, e.g. sensory, haptic or visual properties
- Selection and storage of reference samples defined and accepted by both parties, if feasible and reasonable

Remark:
If the known technologies are not suited to producing the defined product idea, a development contract will be useful.

4.2.3. Equipment performance indicators

- Information of the equipment manufacturer on the parameters throughput, number of cycles, manpower needed, etc. (kg/h, cycles per time)
- Agreement on the OEE parameters availability, performance and quality.

4.2.4. Interfaces

- Interfaces with upstream and downstream machines and processes
- Connection agreement for software, production control and management information systems

4.2.5. Tolerances and reproducibility

Product tolerances must always be disclosed and defined in a binding manner. For forming and moulding equipment, the uniformity and reproducibility of the products produced on such equipment is of great importance. Therefore, it is important that the tolerances to be expected are clarified and defined in a binding manner as early as possible.

4.2.6. Setup and changeover times

Setup processes are becoming more and more important. The development and optimization of a changeover matrix can be of assistance in this context. From this matrix, the required constructional measures and improvements can be derived in order to minimize setup effort and setup time.

4.2.7. Maintenance-friendly design

With regard to OEE, in particular, the following issues need to be considered:

- Minimization of maintenance work (inspection, service)
- Favorable design for easy maintenance work (see also Guideline "Maintenance within the life cycle of machines and equipment in the confectionery industry", in the German language only)

4.2.8. Hygienic design

Easy cleaning should be achieved by hygienic design. Good accessibility, prevention of dead spaces, correct material selection, suitable cleaning concepts, etc. are to be taken into consideration. It is recommended to observe DIN EN 1672-2 "Food processing machinery – Part 2: Hygiene requirements" as well as the relevant EHEDG guidelines.

5. Acceptance of equipment

The acceptance procedure of equipment should involve several stages:

- Pre-acceptance at the supplier (FAT = Factory Acceptance Test)
- Test run at the customer
- Product-depending partial acceptance
- Rectification and optimization
- Final acceptance under production conditions (SAT = Site Acceptance Test)
- Delivery to the customer

For the individual acceptance stages, checklists with all the relevant test criteria and flow charts should be compiled in advance. For successful equipment acceptance, special emphasis is given to the early coordination of the acceptance process with all parties concerned.
For the commissioning phase, in particular, the product portfolio, the time required, the handling of reject products, the support during shift operation and the reaction to unexpected failures are to be defined.
Since the acceptance process may take quite some time, it may be that a marketable product is possibly produced on equipment that has not finally been accepted. In this case, it is necessary to define the manufacturing capacity of the equipment and to regulate the passage of risks. The existence of complete documentation is the basis for final acceptance. In EU countries, translation into the national language of the equipment operator has to be provided according to CE conformity.

Recommendation:
OEE – improvement as a continuous task
Within the commissioning scope of new production equipment, it is defined and documented that performance and quality criteria agreed upon have been achieved. From experience it is known that several optimization cycles are required for OEE improvements. Therefore, it is beneficial to define the contractual cooperation between machine supplier and equipment operator for the longer term. For example, annual meetings for improving the OEE could be established as a fixed part of the cooperation. Methods such as Six Sigma, TPM and similar could be helpful with this.

6. References

DIN EN 16722 “Food Processing Machinery - Part 2: Hygiene requirements”

DIN 69905 “Project Management, Project Management Systems”

Guideline “Maintenance within the life cycle of machines and equipment in the confectionery industry” Working Group „Machines and Equipment in the Confectionery Industry”, March 2007 (in the German language only)

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