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Standard Specifications for Data Acquisition Systems in Beverage Bottling Plants

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1 Introduction

These specifications were developed within the framework of the research project “Developing a Standard for Control by a General Business Data Capturing (PDA) system in Bottling Plants” by the Chair of Brewery Installations and Food Packaging Technology at the Technical University, Munich, Weihenstephan. The scientific research support programme of the German Breweries Association is hereby thanked for its support of this research project. Thanks also go to members of the working group of bottlers of the German Breweries Association as well as other practitioners from a large number of breweries and fountain plants, all of whom made possible these specifications through their sharing of information based on experience.

During September 2000, the specification was verified with representatives of the working group of bottlers of the German Breweries Association and the engineering firms KHS and KRONES.

Thanks to Siemens, München for translating this manual of good practice into English language.

1.1 Duties of PDA (Production Data Acquisition) Systems in Field of Bottling

PDA systems for bottling plants were first introduced about ten years ago with the aim of establishing the correctness and the universality of information flow as well as to enhance transparency of production and better to support decision making processes. It strove for an improvement of the business, enhancing productivity and economy, as well as securing the quality of the product. At the present stage of development, the following functions can be performed by an automatic PDA system [2,11]:

Producing Technical Information

- On-Line-Visualisation of quantities, times, measurements, and condition of installations,
- Evaluation of single aggregates and of total plant using key figures,
- Preventive maintenance.

Quality management

- Securing the quality of the product through avoiding mistakes and recognising causes of failures,
- Securing against third parties through fulfilment of duty of proof of product liability [10].

Documentation and Presentation of Information for the running of the business

- Archiving process data,
- Preparing and compressing data,
- Rational reporting systems,
- Automatic capturing of incoming and outgoing materials
- Providing key figures for technical control ,
    - Evaluation of bottling data against charges and shifts
    - Quantities for material required and product,
    - Times,
    - Specific performances and consumption.

1.2 Aim of this Specification

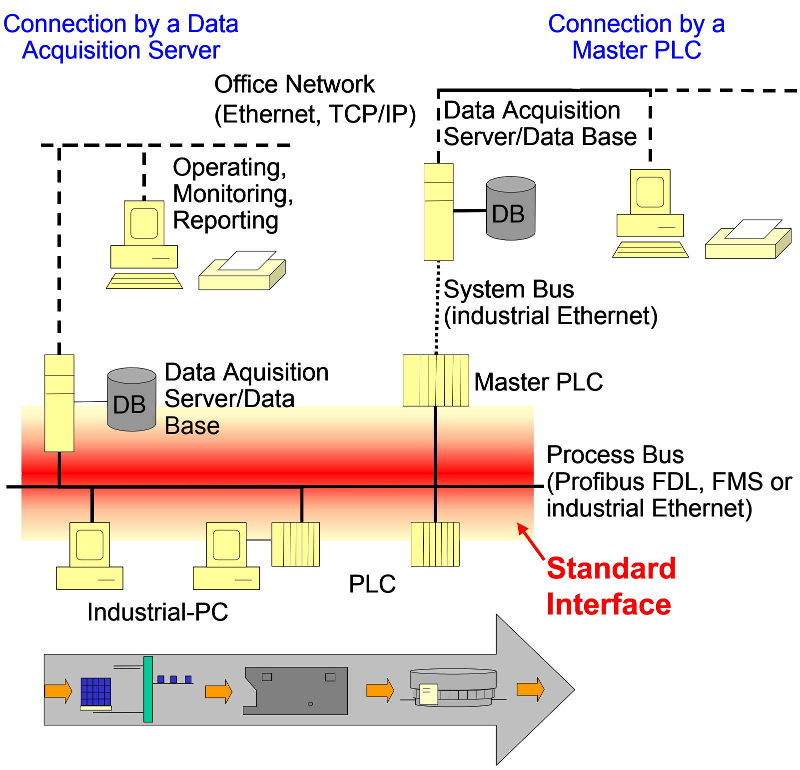
In the past, breweries often did not have the desired result when PDA systems were introduced in the bottling area. Usually, individual concerns had to apply special measures to solve problems, incurring great cost and work. These solutions often had excessive volumes of data. Compressing data was not always efficient, so that even today highly efficient computers are flooded with information and the maintenance of systems is made difficult. The lack of suitable evaluation mechanisms led to confusion and information of a poor quality. In addition, existing systems are often not integrated into the existing information network of the business. The bottling cellar constituted an information technical island in the brewery, which led to breakdown of media, duplication of data capturing, and the storing of redundant data. For these reasons, workers often did not accept the system and applied it only in a limited manner.

These problems must be counteracted by standardisation. The specification serves as the basis for introducing a standard in all branches that will make possible a slim, reasonably priced and effectively applicable general PDA system in bottling cellars. Instructions are given to indicate how a PDA system should be constructed in the bottling area, and what possibilities are given in the structuring of the architecture of the system. For the connection of individual machines, a standard interface is defined that will enable economic and simple data provision in different makes of bottling machines.

It is determined exactly what data must be incorporated by a PDA system in a bottling cellar to cover the basic needs for information in most breweries, and in what way the data has to be conveyed. The basic functions of data evaluation, which should be made available by every PDA system according to the present level of technology, are discussed. In conclusion, the construction of technical reports on bottling plants are discussed, and exemplars of reports are attached that could be employed as standardised ways of reporting.

2 Structural outline of the System

The information that may be captured by a PDA system is present as single bits or data words in the control fittings of the bottling machines and in the support fittings. Communication between the system and the controls is effected via the processing bus (refer illustration 1) [3, 7]



Picture 1: Structural Outline of PDA-Systems for bottling lines

The programmable logic controllers (PLC) of all machines must be supplied with communication network groups, and connected with a bus cable that is sufficiently insulated against electro-magnetic rays. Alternately, in larger systems, the connection may be made via main (head) controls. These bundle, as data concentrator, the information of a number of machine controllers, thus reducing the number of data telegrams that have to be worked through. If you have capturing media, these could be employed as buffer memory to avoid loss of data. However, additional costs for such main controls should be taken into consideration when the system is constructed. Recently, main controllers are often built directly into the PDA server as a plug in card.

Machines whose control do not function on PLC but through industrial PC or proprietor micro processor control, must also be prepared by a construction group to become suitable for the "bus" system, or must be extended by means of a small PLC in order to cope with the communication exercises. The method used to date of incorporating such machines (mostly, control machines) via a serial interface (e.g. RS 232) should be used only in exceptional cases. For the PDA server, the main control or an available machine control with free resources, specially programmed receiver software, must be developed for machines that are not "bus" adaptable. Within the near future, it will not be possible to set a standard for this form of communication.

By means of a network connection with the "World of Business" (usually via Ethernet-TCP/IP) the PDA server exchanges information with other business systems. In order to avoid insular solutions in bottling cellars, openness and integration possibilities are important criteria for consideration when a system is selected. Interfaces to production planning systems, laboratory information systems, maintenance software and material handling are very important factors for this. A general contact with programmes for technical controlling as well as with business planning and control systems (ERP systems) must be the aim for the future.

2.1 Data Transport ("Bus") System

As data transporting "bus" for data capturing in bottling plants, two standard systems are usually in place. If mainly Siemens controllers are connected, the "Profibus" is the cheapest alternative. With the introduction of the PC-technics in the bottling cellars, the industrial Ethernet is gaining in importance. The most important characteristics of both systems have been summarised in Chart 1.

The Profibus was standardised in Germany as a field "bus", and enables exchange of data of limited length of telegram. With minimal costs for Profibus technicians and with a high degree of robustness, the Profibus serves well for use in business data capturing, especially in smaller PDA systems for machines that have been equipped mainly with PLCs.

Table 1: Profibus and Ethernet [9]

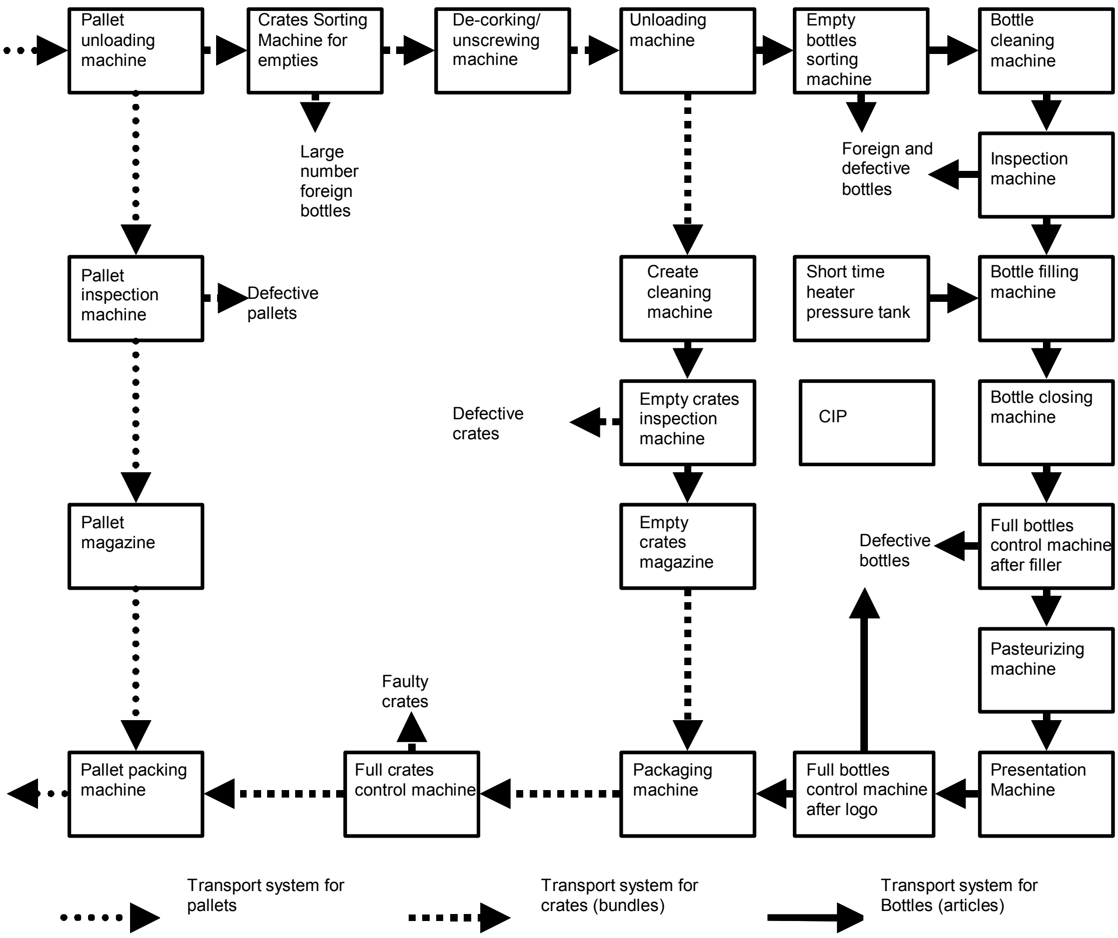
	Profibus	**Ethernet**
Standard	DIN 19 245 [16], EN 50 170	IEEE 802.3 [19]
Topology	electrical: line, star optical: line, star, ring wireless: point to point, point to multiple point	Line, tree, redundant ring, star
Behaviour in time	Deterministic	Not deterministic, adequate for PDA
Method of access	Hybrid method: Token Passing with built-in Master/Slave	CSMA/CD (Carrier Sensing multiple Access/Collision Detection)
Number of participants	Max. 127	Unlimited
Type. Length of Telegram	120 – 230 Byte (Siemens specification)	220 - 515 Byte (Siemens specification)
Max. Length of Telegram	246 Byte (DIN specification)	unlimited
Transfer media	Insulated two-wire lead, sunlight transmitter, (glass, PVC and plastic) Infra red	Tri- axial cable, industrial Twisted Pair and Twisted Pair lead Sunlight transformer: glass
Size of net	Electrical: 9,6 km optical 90 km	Electrical: 1,5 km Optical: 4,5 km
Transfer ratios	93,75 kBit/s, 187,5 kBit/s, 500 kBit/s , 1,500 mBit/s at PDA-Systems usually: 500 kBit/s	10 kBit/s 100 mBit/s (Fast Ethernet)

The service provided by the Profibus with access to the "bus" is called Fieldbus Data Link (FDL). Through direct access to the FDL services via the driver programme in the controls of single unit machines, exchange of data via the Profibus, with a high degree of transfer capacity, is possible.

The application service offered by Profibus, named Fieldbus Message Specification (FMS) presents a simpler application. In comparison with the direct access to FDL services, one must here expect effectiveness of the "bus" reduced by half. However, in using this system, one may do without driver programmes in the single unit machines, and it allows a simple cyclical call-up and sending of business data. The Profibus FMS is available, world wide, from Siemens under the title Sinec L2 – FMS. In the interest of dependable data transfer, the length of telegram, stipulated by Siemens as between 120 to 230 bytes and a transfer rate of 187,5 kBit/s (possibly also 500 kBit/s) should not be exceeded.

Because of the limited length of messages, the Profibus is cancelled for the transfer of large volumes of data as become available with the use of a main ('head") control acting as a data concentrator. For communication between the head control and the PDA server via the system bus, use is made of the system that has been adapted to processing technology, the Ethernet (industrial Ethernet) with the TCP/IP protocol (Transmission Control Protocol/Internet Protocol). It enables markedly higher data transmission rates than does the Profibus regarding unlimited length of messages, with 1.5 factor higher costs. The direct connection between single machine controls and the PDA server, via Ethernet, is also possible. Because of the growth of the PC-World and the growing importance of the Internet, costs of Ethernet components should reduce in future. Therefore, the industrial Ethernet should be the choice for connections in new bottling plants with a number of PC controls.

2.2 Model of Bottling Plant



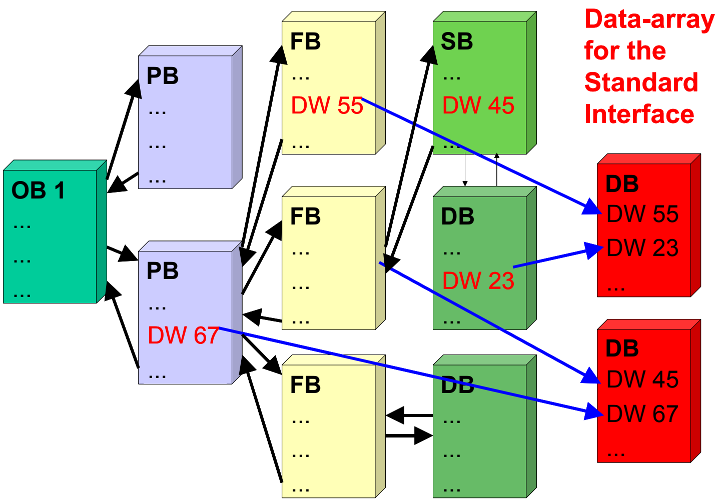
Picture 2: Model for a Multi-directional Bottling Plant

Picture 2 depicts a model of beverages bottling plant for returnable glass bottles. This type of plant was selected as the basis for standardisation. However, the directives may be changed easily in plants for plastic or one-way bottles.

Basically, all machines and the control of the transport of pallets, sheaves, and articles must be connected to the PDA system. That would enable an evaluation of all line movements and aggregates according to time consumption, disturbance susceptibility and need for maintenance. If one wants to connect only certain machines in new plants to the PDA system, the other machines must, nevertheless, be prepared according to the detailed prescriptions contained in chapter 3 of the specifications for the PDA connection. In this way, additional costs and problems regarding the control programme (e.g. changed times of cycles, exchange of CPU) will be avoided. The connection of the conveyers is imperative especially for evaluating the performance of the entire plant.

3 Supply and Transfer of Data

A vast amount of data and information is processed in bottling machines, of which a limited amount is of importance for the compilation through a PDA system. These data words are distributed in a programme scaffolding as illustrated in Picture 3. To create an interface for data acquisition, such point has to be transferred to an area reserved for PDA data, and constantly updated there. If connected in this way, the data can be exchanged via the processing bus with the PDA server.



Picture 3: Data transfer to the machine controller

The following specified instructions for the data points to be connected, their structure, coding, and transfer technology defines a standard interface for providing relevant PDA data by beverage bottling machines. It has been determined in detail which data is absolutely necessary for an effective evaluation of the bottling process. These data points are to be deposited structurally in the data fields determined for the PDA. It is prescribed in what formats they are to be coded. Defining content prescribed data fields or areas is of determinate importance for an interface standard. In spite of the type of controller used, the instructions must be feasible for all manufacturers of machines. Therefore, the details below are set out in such a way that they may be implemented irrespective of the control type or “bus’ system in use.

The instructions define an interface that will enable an effective evaluation of the bottling according to an in-depth study into the fundamental requirements of breweries. The interface is nevertheless flexibly structured and sufficient room has been made available to integrate smoothly extensions to project specific situations.

3.1 Data formats

PDA systems deliver information on the condition of machines, plants, failures or faults, capacity sizes, and quantities. In order to gain these different types of information from the machine controls data words of different sizes and varied characteristics must be devised. In this way, one differentiates different categories of information according to the data formats explained below.

Binary Coding

A single bit must be provided in the PDA interface for every possible piece of information. This must be placed on 1 when the specific type of function has been selected, a suitable programme is run, or if the respective condition (status) of machine is available. The following example relates to the last mentioned:

Bit = 1 ➔ means condition of machine is available
Bit = 0 ➔ means condition of machine is not available.

Working in this way requires little logical programming inside the controls, can therefore easily be realised by manufacturers of machines, and will hardly slow down the running of the programme. On the other hand, this type of coding allows for the simultaneous provision of a number of types of information.

Coding in Enumeration Mode (16-Bit Integer Data Word)

Besides the binary coding, information can be transferred as a 16 -Bit integer data word. Using an affiliated table, the PDA system can provide the user with the information stored in the number values. This form of coding always provides only specific information. Below is an excerpt from a classification table for notification of failures (faults).

Table 2: Example of a classification table

Numerical value of the integer data word for notification of failure	Meaning
...	...
...	...
45	Security circuit SOS – out
46	Security circuit main desk
47	Security circuit cycle kettle
49	Network guard
50	Motor contactor main drive
51	Motor contactor starter lines
52	Motor contactor exit lines
65	Motor contactor vacuum pump
66	Motor contactor HDE
...	...

Binary coding, or Coding in Numerical Mode?

Machine state*, operating mode, program* and operating state* of a machine can only occur as “exclusive or” combined according to the definition in the standard to hand, therefore an exact classification is necessary. This information can then be transferred as 16-bit integer data word. On the other hand, because, as a rule the information (or bits) in question is not huge, it seems that a co-ordinated binary transfer is a good alternative because it has the advantage of an easier programming within the controls. Careful attention must be given to the fact that, because of shunting errors in the SPS, a number of bits cannot be set simultaneously. The machine manufacturer must make the choice between the two systems.

Messages that could occur simultaneously (or-combined) and that should be transferred by the PDA system, must be binary coded. Machine specific messages* are binary coded for this reason.

For the transfer of failure notices, * pointers, * and programme processes* an integer number as 16-bit data word must be employed. Because failure and pointers may occur simultaneously, prioritising in the controls must be made in order to provide the PDA system with the information that is of interest to the user. In the case of failures only the initial notice* must be given. Further incremental notices need not be transferred. In the case of pointers, the new value notice* is of interest.

If failure notices as initial notices or pointers as new value notices are not feasible in the machine controls, or if the bottling concern is interested in having all notices placed in the controls, these notices must be binary coded and transferred as machine specific notices. In this case, a declaration of the type of notice* (failure or pointer) must be documented. An evaluation of a first value notice for failure notices and an evaluation of new value notice for pointers can then be made on the PDA system instead of on the controls of the machine.

16- or 32-Bit Integer Data Words for Parameters and Measurements

The available parameters and measurements in the machine controls must be put on as integer numbers in the size of 16 or 32 bits. This will allow the satisfactory correctness of all values that may occur in bottling cellars. Possible units and conversion factors for the correct decimal point must be worked into the documentation.

32-Bit Integrated Data Words for Counters

Counters serve the estimation of measurement and, in single instances, also time information. As time progresses, they can only increase in size. One differentiates principally between types of counters:

- Absolute Counters:

  The use of these counters makes provision for a “naught” setting at given times, for example at the start of a new charge. This is usually done by means of a “return” key on a machine, and allows for direct notification of the number on the display screen. For instance, in this way the absolute number of bottles filled during a specific run can be established.

- Running counters:

  Running counters are never reset to “naught”. The absolute value of a running counter is calculated by working out the difference between the start and end values within a specific period of time. When the counter has exceeded its maximum value, the counter is in over-run and starts again counting from naught. In this case, the end value of the specific period of time will be smaller than the start value. To establish the difference, the maximum value of the counter must be added in order to find the absolute counter.

  Experience has shown that setting the counter on naught manually leads to many mistakes being made. For this reason, only the running counter may be used for PDA systems. Running parallel with it, absolute counters may be used to take care of machine displays

  What must in any event be avoided is that a number of overruns in counters occur within a specified time, usually within a production charge. Because one has to do with large figures in the bottling process, figures must be coded twice on 32 bit. This would allow figures up to about $2 \times 10^{9.}$

3.2 Data Points

On the question of what data points should be built into the machines, research was undertaken to establish the basic needs of breweries and beverages industries. On the basis of existing norms, and in co-operation with machine manufacturers and distributors of PDA systems, a standard was worked out. The selected data points are being explained below in categories. They should be made available in all new bottling machines and transport facilities. If special requirements have to be met, additional data points could be added in the reserve section.

DIN norms have been applied in defining meanings.

Machine state

The machine state indicates whether the machine is in operation (Out: relevant Bit = 1, or is indicated by documented integer number). If this Bit is not set, the machine is in operation in one of the following ways:

Operating mode

The operating mode indicates the type and extent of interventions in a controls system through the operator or through messages from the driving mechanism (DIN 19 237). For machines in beverages bottling plants, the following types of operation modes occur and must be coded either in Bits or as integer numbers:

- **Automatic:**

  Operating mode in which the control works without intervention by the operator in a switched on controls run according to programme (DIN 19 237). In the context of this standard, what is meant here is that the machines of a bottling plant are usually integrated across the entire plant, and that their operation is regulated automatically.

- **Half-automatic:**

  Operating mode in which only part of the controls or the programme runs according to programme (DIN 19 237) without the intervention of the operator. In the context of this standard, what is meant is that the machines in a bottling plant are, as a rule, not integrated across the entire plant, and that starting the function of the machines is done by hand.

- **Hand (manual):**

  Operating mode in which the control mechanism, through manual intervention by the operator, works only in the event of locks (DIN 19 237). In the context of this standard, and in contrast to DIN, the following types of operation are included: to set up, set steps, and typing**.**

Programme (Programme building blocking of a control system)

The programme is a conclusive result of control instructions for a closed circuit application orientated function (DIN 19 237). In bottling machines Bits or documented integrity numbers must be provided for the machine operation with the following programme:

- **Production:**

  The machine is in the operational mode as per instructions by the manufacturer.

- **Start up/Full running capacity:**

  Although the machine is in the operational mode as per instruction by the manufacturer, it is actually in a start programme that is regulated by a particular requirement or by a period determined as a security factor or, in machines that capture grades, will secure full running capacity of the machine.

- **Run down/Running empty:**

  Although the machine is in the operational mode as per instruction by the manufacturer, it is in fact in a stop programme that will secure discontinuation according to a particular requirement or determined as a security measure or, in machines that capture grades, will guarantee the machine runs on empty.

- **Clean:**

  The machine operates in a cleaning function. This programme can have different steps that could be controlled independently one from the other, e.g. programme step "flooding" of the filling or locking machine, or programme step "disinfect head room" of the cleaning machine.

- **Change over:**

  The machine is in the change over programme in which automatic machine settings are changed dependent on parameters. *

- **Maintenance:**

  The machine is in a maintenance programme in which maintenance and care work is being done.

- **Break**:

  The machine is in an interval programme that will ensure a start of the operations after a regulated break.

If bottling machines have no programmes for cleaning, maintenance and break, information must be provided on the time statement auxiliary production time. Additional programmes, especially for the process technical periphery, must be added to machines as plant specific.

Operating states

During the running of the programme determined control course, a number of different operational conditions may occur in machines that have experienced failures. These may be selected, for every programme, from the following conditions that are clarified below, and may occur “exclusive or”: “ready," ”operational," “self caused failure", “operator intervention," “external failure," “starving," “blocking," “incomplete/build up in extension." The operational conditions must be coded as Bit, or documented as integer number.

- **Ready:**

  The machine is ready to execute its determined function; however, it is in an break condition and must be started by the operator (no starving/blocking condition).

- **Operational:**

  The machine is executing its determined function (DIN EN 292-1).

- **Self caused failure:**

  Failure that occurs in the machine itself that leads to a stopping of the machine (refer DIN 8782). In this operational condition the machine does not carry out its function as determined by a sensor system that the controls of the machine recognises because of an inadmissible deviation from the SHOUL BE condition (failure message*) and the machine stops. The inadmissible deviation is parameterised in the controls as self caused failure.

- **Operator intervention:**

  The machine does not carry out its function, not because of a sensor system in the controls, but because the operator picks up an inadmissible deviation from the SHOULD BE state and the machine stops so that the operator intervenes and opens a protection arrangement, presses the SOS-Out-Button or discontinues the operation of the machine manually.

- **External failure**

  Failure that is not attributable to the machine itself but that nevertheless leads to a machine stop (refer DIN 8782). In the operating state external failure, the machine does not carry out its designated function because of an inadmissible deviation from SHOULD BE state as recognised by a sensor system in the controls (machine stops). The inadmissible deviation is parameterised in the controls as external failure. The failure “starving”, “blocking”, and “incomplete/blocking in extension” are coded separately and are, therefore, not allocated as external failure. Other deficiencies or block situations are, however, determined as external failure.

- **Starving:**

  The machine does not carry out its designated function because the sensor system in controls picked up a deficiency in the current feeding into the machine (machine stops). In machines that have a number of starters, the condition starving refers to the main current, i.e. mains (box, bottle) that takes the current to the filler machine (central machine) or takes it from the filler machine. Starving is a external failure, but is built in separately because of the importance for visualisation and technical evaluation.

- **Blocking:**

  The machine does not carry out its designated function because the sensor system in controls picked up a blocking in the main electrical current of the machine (machine stops). In machines that have a number of starters, the condition starving refers to the main current, i.e. mains (box, bottle) that takes the current to the filler machine (central machine) or takes it from the filler machine. The blocking is a external failure, but is built in separately because of the importance of visualisation and technical evaluation.

- **Starving/blocking branch line:**

  The machine does not carry out its designated function because the sensor system in controls picked up a deficiency in the subsidiary current of the machine (machine stops). This condition can only occur in machines that have two systems to draw from or lead to machines (pre or post switched) in the bottling line (packaging and pallet machines). The subsidiary current refers to the mains (pallet, boxes) that are further removed from the filler machine (central machine). The blocking/Starving in the branch line is an external failure, but is built in separately because of the importance of visualisation and technical evaluation.

Machine specific messages

The PDA system should also make a note of a external failure*. These reasons for failure must be listed machine specific and, because a number of faults may occur simultaneously, they must be coded in Bit. Machine specific messages that are of importance to the visualisation exercises and/or the writing down for the PDA system must be treated in a similar manner. Because machine specific messages could vary according to type of machine, extensive documentation is important. A declaration of the type of message* (failure or pointer) is imperative.

A listing of machine specific messages appears in appendix B. Manufacturers of machines could of course include as machine specific messages, automatically, or custom specific, all messages structured into the control.

Examples of machine specific messages:

- Empty-bottles inspection machine: “Test bottle run requested”.

  The empty –bottles- inspection- machine requests test bottles in order to test its function.

- Empty-bottles inspection machine: “Test bottle run OK*

  The empty-bottles inspection machine had been provided with test bottles within the prescribed period, and all errors had been identified.

- Empty-bottles inspection machine: “Test bottle run not OK*

  The empty-bottles inspection machine had been provided with test bottles within the prescribed period, but not all errors had been identified.

- Empty-bottles inspection machine: “Test bottle run not carried out “.

  Despite request, no test bottles had been sent within the prescribed time.

- Bottle cleaning machine: “Suck out explosive gas”:
- Because a film had been spotted in the bottling run, the bottle-cleaning machine has activated the function to suck out the explosive gas.
- Bottle filler machine “too little CO2” :
  The sensor system of the controls of the filler machine has identified a CO2 deficiency. Bottle filler machine “not closed properly”:
- The sensor system of the controls of the filler machine has identified that it has not been closed properly.

Type of Message:

In these specifications, type of message refers to the category failure or pointer.

Notice of failure:

A notice of failure notifies the inadmissible deviation from the SHOULD BE condition (DIN 19235). In the context of this standard, it means that the control, because of a recognised inadmissible deviation, de-activates the machine

(machine stops). The notice of failure must be treated as a first priority message, and is coded as integer number in the enumeration mode.

First priority message means a process that selects from a number of messages that one whose condition had first changed since the last check (DIN 19 235). In these specifications, the concept is that, with a first priority message only the first message is produced and that following messages are suppressed for as long as the first message has not been dealt with.

Pointer

A pointer requires definite measures to be taken for execution (DIN 19 235). In the context of this standard, what is meant here is that the control has identified a deviation of the SHOULD BE condition from the SHOULD BE condition that has not yet caused a machine stop, but of which the operator is being informed. The most recent pointer must be incorporated into the PDA system in order that pointers may be carried out as new value messages and coded as integer figure in the enumeration modus.

New value message means a message exercise that selects from a number of messages that one whose condition had first changed since the last check (DIN 19 235). In these specifications it is meant that, in a new value message, only the most recent message is given, and that messages published earlier are suppressed as long as the most recent message appears.

Programme steps

The smallest functional unit of a programme of running control is called programme step (DIN 19 237). In order to secure the comprehensibility of the processes in a bottling cellar, one must, in addition to the programme, also provide the individual steps in an integer number in the enumeration mode.

Examples:

- Programme step “Head room disinfect."

  The cleaning machine is in the programme step of headroom disinfecting.

- Programme step “Overflow Filler Machine”

  The filler machine is in the programme step of overflow.

- Programme step “Overflow Closing Machine”:

  The closing machine is in the programme step of overflow.

Parameter

In these specifications, what is understood under parameter is the setting of a machine for the handling of specific types of beverages as well as packaging, aids to packaging or collective packaging. For every parameter, and integer number must be provided that can be allocated to the specific setting by means of a well -documented table (refer 3.1). A summary of necessary parameters for the machines in a bottling plant for multiple run glass bottles is attached in appendix B.

Measurement values

Sliding, staggered sizes of processes (temperatures, pressure etc.) and specific sizes of machines (e.g. Capacity) are summarised in the concept measurement values. For the display of measurement values, in most cases a simple data word with 16 Bit is sufficient. Measurement values for different bottling machines that are reasonably easy to compile have been listed in appendix B.

Counters:

Counters serve to compile information of numbers and sometimes also time information (e.g. hours of operations). As time goes by, they can only increase. Only running counters* (ref. 3.1) may be used. In all machines, the shift control maintenance intensive building sections must be recorded as counters. Further counters that must be recorded are listed in appendix B.

3.3 Partition of PDA Data Array

A memory area for saving all the relevant data words must be provided in all machines and transport controls to enable the realisation of a uniform PDA interface. Because different types of control and control programmes have been installed in bottling machines, it makes no sense be prescriptive regarding addresses and building block numbers. With the Simatic S7 an S5 controls of the firm Siemens, an unused data building block is to be used for the running of the programme. With Allen Bradley PLC's data files must be employed. In any event, in all instances, including all other SPS or PC based controls, an interrelated data field with the functionally structured contents as illustrated in 3.2 must be displayed and sufficiently documented. The sequence of Bytes and data words is left to the discretion of the manufacturer. The sequence displayed in table 3 is an example and may be used for testing completeness.

In our example, the first Bytes in the data field serve the Bit coding of the machine state, the programme, and the operating state. This information could also be displayed as three 16 Bit integer data words. A large enough number of bytes must be reserved for the binary coding of machine specific messages. The data words for the display of notices of failure, pointers, and programme step numbers have been given one after the other. These are followed by what is to be displayed as parameters, measurement values, and counters of machines. These areas are to be displayed in such a manner that they provide space for all data words that have to be displayed on the specific machine and also leave an unused reserve area of 50% of the size of the area used for later extensions.

With all display data the correct order of the individual Bits and Bytes inside the storage programmable controls and PC's must be heeded.

3.4 Data Points in Peripherial Processing Plants

For an inclusive evaluation of the bottling business, one should also connect to the PDA system a subsidiary bottling plant that has processing technical equipment. In these specifications these are understood to be plants that are connected to the bottling plant with the regulatory function. Here the following must be mentioned: short-term heating with/without support tank, CIP plant, and aseptic systems. For the PDA connection, the data analogue of bottling machines must be displayed in the processing plant. In addition, the settings of the ventilation must be included as a processing specific message in order to determine exactly previously concluded runs if required. A summary of special data points for processing technical plants is contained in appendix B.

3.5 Documentation of PDA-Interface

For the connection of PDA systems and the control of individual aggregates, an accurate documentation of the data words and their saved address displayed is unavoidable. This documentation should be prepared in the form of digital lists with standard programmes. When the system is put into use, the lists can directly be incorporated to create automatic parameters of the data points. In comparison to inserting parameters manually, this means definite savings in time and costs. Similar documentation tables must be attached to running instructions. Table calculation programmes (e.g. MS-Excel) prepared exemplars, with the aid of which the documentation may be prepared, are printed in appendix C.

Table 3: Data structure for the standard interface

		bit							
category	***DBB***	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
machine state, operating mode[1]	...	off	manual operation	semi-automatic operation	automatic operation				
program[1,2,3]	...	production	start up	run down	clean	change over	maintenance	break	
operating state[1,3]	...	ready	operating	equipment failure	operator intervention	external failure	starving	blocking	starving/ blocking branch line
machine specific messages[4]	...								
notice of failure[5]	... ...	16-bit integer-word for notices of failure							
pointer[6]	... ...	16-bit integer-word for pointer messages							
program step	... ...	16-bit integer-word for program steps							
parameters	... ...	16-bit integer-word for parameter 1							
	... ...	16-bit integer-word for parameter 2							
	... ...	…							
measured values	... ...	16- or 32-bit integer-word for measured value 1							
	... ...	16- or 32-bit integer-word for measured value 2							
	... ...	…							
counters[7]	... ...	16-bit low-word for counter 1							
	... ...	16-bit high-word for counter 1							
	... ...	16-bit low-word for counter 2							
	... ...	16-bit high-word for counter 2							
	... ...	...							

1 Instead of coding bit by bit also a 16-bit integer-word is applicable to code this information

2 If there is no program for cleaning, changes and maintenance service, an information for the time account „auxiliary production time“ (see Figure 2) has to be set up. Additional programs have to be specific for each machine.

3 In conjunction with the respective programs the operation states are necessary for the calculation of key figures and have to be applied XOR or for every machine.

4 This position is also suitable to apply all messages (notice of failure and pointer), that are provided by the controller Messages have to be declared with a message-type in general (notice of failure or pointer).

5 Notices of failure should be coded as a 16-bit with priorities ascending by time of occurence. If this cannot be realized by the machine supplier, bit by bit coding is necessary at the position for machine specific messages.

6 If all pointers are coded bit by bit, the 16-bit integer-word can be resigned.

7 For the calculation of operating figures the counters of the produced goods are indispensable.Data Points in Peripheral Processing Plants

3.6 Transmission and Storage of Business Data

Speed of Data Transmission via the Processing Bus

The information PDA data displayed in the defined data field is transferred as a data block in a telegram via the processing bus to a head -control or directly to the PDA server. For correct information of times, it is advisable that failures be picked up as soon as possible. Therefore, high rates of bus transfer should be striven for. The time distance between two telegrams should not exceed 1000 ms.

Storing collected data

In order to be able to evaluate data historically, it is important that data collected during the running of a bottling plant be stored. For this purpose, database systems are available that will archive business data structurally. However, because the capacity of data storage facilities are limited even today, and because large volumes of data require time to compute, business data that has been collected should not be stored unnecessarily often. For the operational condition of the machine, the operating mode, the programme that has been run, the operational condition, failures, and pointers, database storage should be implement only if changes occurred. Measuring and analogue values must be stored independent of their dynamics. For instance, it serves no purpose to document every second slowly changing temperatures in the cleaning machine. Counters should in any event be stored at the end of a specified time as well as at regular breaks (e.g. every 10 seconds) for better control of the production operation.

Databases

The state of technology, today, is relational databases (e.g. Oracle, MS-SQL server). A characteristic of the database systems is that data is saved in tabulation format. Every sentence of data consists of one or more columns, so-called attributes. Data can be distributed across a number of tables, and redundancies, i.e. storing data a number of times can be avoided. The result of this so-called normalisation is a very compact database with logical data structuring that can easily be administered and changed. An attribute is defined as a key in every data sentence as particular to that sentence. This is called a primary key in a minimal key. Via this key, data sentences of different spreadsheets may be brought into relation one with the other. In addition, using integrity rules, it may be ascertained automatically whether the correct data is being entered in the database. The integrity rules refer to guarding the value areas of data, the integrity of key areas, as well as the semantic correctness of data. In conclusion, data security is controlled by means of the display of so-called views in which every user or user group may view the data and individual authority to manipulate data is granted. This means, a problem-free multi-user system is possible. This is of particular importance in the production accountability because the possibility of establishing validity of the data capturing system is of great importance in this field. When the capturing capacity of the database of a PDA system is exceeded, a mechanism for the automatic archiving of data must be available.

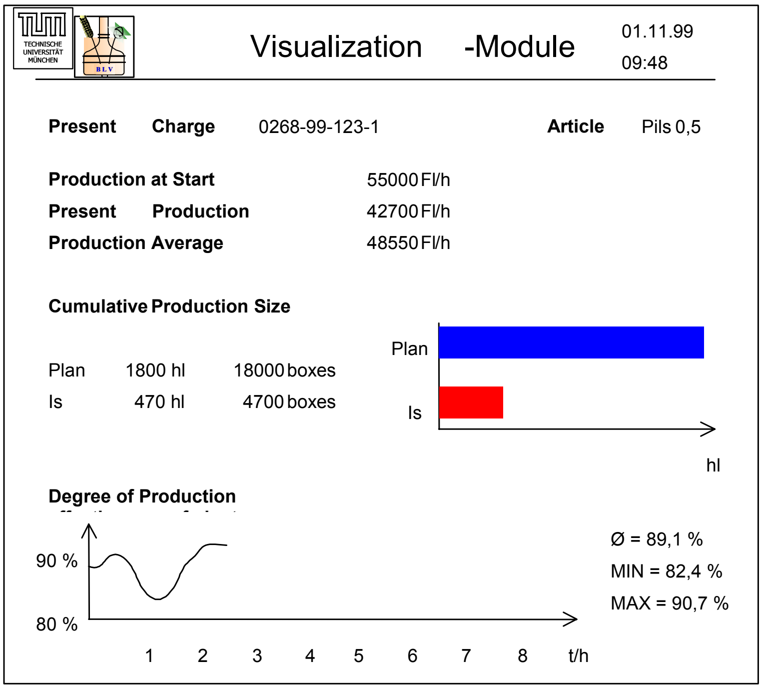
Access to the data is available with the aid of SQL (structured query language), a standardised database language for the construction and manipulation of relational databases that is defined in ISO 9075. Because of the established norm, this language is independent of the database system that has been used. It provides a simple and compact code by means of which any data may be retrieved. In future, it may also become possible to use database systems constructed by means of object orientated or multi-dimensional data models.

4 Functions of Data Evaluation

The possibility of graphic and quantitative evaluation of actually present data and historical data differs widely in what is available today and what could be used in PDA systems. In the light of differing requirements in individual bottling plants, it serves no purpose to define a detailed standard. However, because all businesses need certain basic functions, these are explained below. They should be relevant to all PDA systems with comparable functionality basePd on the standard. Specific adjustments and extensions should be made with ease.

4.1 Processing Visualisation

Visualisation systems can give the systems operator a quick view of the actual situation and of single aggregates of the entire plant. Data that have been visualised are viewed, for the greater part, without the operator at the terminal having to store in between. The aim and purpose of the visualisation is to present operating state of machines and plant, actual and cumulative data, measure values and data regarding failure and removal of failure. In this manner, the running and progress of the bottling process may be observed at any given moment.



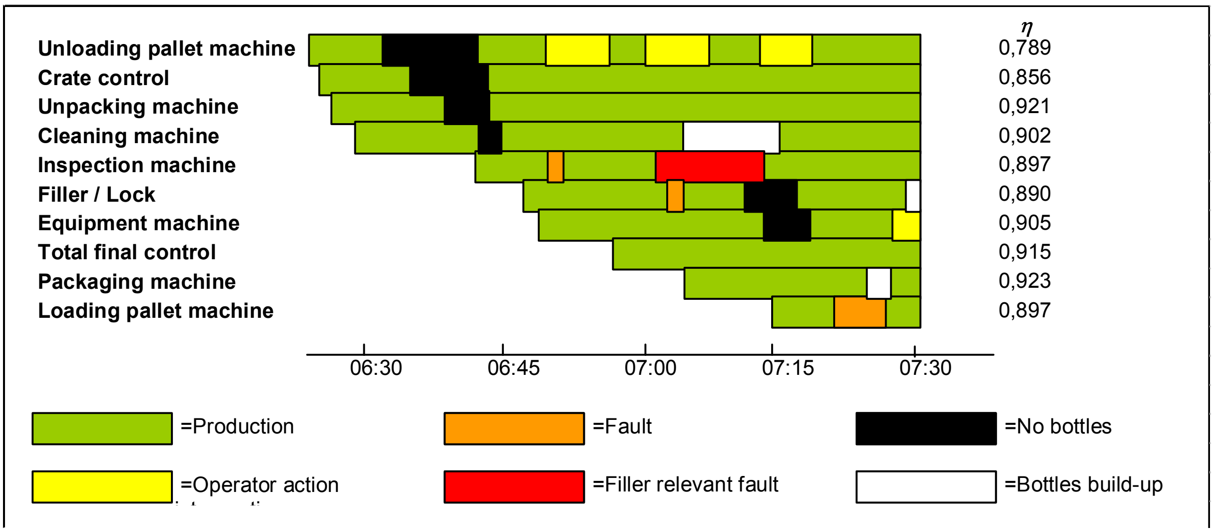
Picture 4: Visualisation of the most important Production Data

As a general view of the plant, a simple production line image (e.g. picture 2 on page 7) in which the operating state of individual machines and running units are represented in coloured animation serves the purpose. Using this total image, one could for instance by means of a machine (e.g. Mouse-click) retrieve details like counters or measuring values (top-down functionality). A similar visualisation module should also be available for the most important production data of every charge, as illustrated in picture 4 on this page.

4.2 Faults Analysis

Assessing Machines

In the past, a sorter of failures according to length of failure and frequency of failure proved effective [5]. If one represents these results graphically in a linear diagram, one can pick out the machine that is most susceptible to failures. Documentation of machines with average failures and average operational capacity should also be kept. That certain deterioration will set in as machines become older is a given, however, documentation provides an opportunity to place machines on hold or to effect maintenance services.



Picture 4: Faults Distribution on Gantt Chart

In addition, managers of plants are interested in the first instance in those faults that lead to a stoppage of the filler machine and that reduce the degree of production in the plant. Different ways of distribution of these faults are to be undertaken:

- If the filler machine stops without it having a fault, starving or blocking have caused such stoppage. By means of a reverse inspection of the fault situation along the filling line via the starving or blocking status of the preceding or following machine, the machine that has caused the stoppage can be identified. Because an emptied - bottles -buffer needs only very brief periods of stoppage of the previous machine to cause a filler stoppage, and because stocked buffers can, in contrast, withstand long periods of failure, the outcome of this method of searching the fault is often dependent on the way the machine had operated in the past. Therefore, the truly weak point in a production line is not always discovered in this way.
- A further method of investigation is based on a comparison between the length of the failure of a machine and a statistical threshold value. This time value must be established for every single machine and it points out as from what length of failure filler -stoppage results. If the threshold value is exceeded, the failure is most probably a fault relevant to the filler. This simple method provides very good results in constant stoppages and conveyor speeds [5]. For practical purposes, results in frequency regulated conveyor belts and machines in use today, average conveyor speeds must be used to work out threshold values.

In both instances, the distribution of faults (failures) may be supported by a graphic display of the operational machine states in the form of a Gantt chart as in illustration 5 above. Faults relative too the filler machine can be depicted in colour. By means of an analysis of blocking/ starving status in the other averages, the operator could test at breaks the automatic distribution of failures.

Assessing Buffers

The function of a buffer between two machines, A and B, before the filler machine is to pick up failures of machine A, and after the filler machine to pick up failures in machine B. If no buffer is available, every failure in machine A will lead to a weakness in machine B, and every failure in machine B will lead to a blocking in machine A. Define sizes as follows:

$T^{A}_{failure}$: Length of failure in observed period in machine A.
$T^{B}_{failure}$: Length of failure in observed period in machine B.
$T^{A}_{blocking}$: Status “Blocking” in machine A during observed period.
$T^{B}_{starving}$: Status “Starving” in machine B during observed period.

Define the effectiveness of the buffer η_{Buffer} between machines A and B:

- Before filler machine: $$\eta_{\text{bufferAB}} = \frac{T^{A}_{\text{failure}} - T^{B}_{\text{starving}}}{T^{A}_{\text{failure}}}$$

- After the filler machine: $$\eta_{\text{bufferBA}} = \frac{T^{B}_{\text{failure}} - T^{A}_{\text{blocking}}}{T^{B}_{\text{blocking}}}$$

The percentage of the maximum starving (bottles) or blocking is reproduced by the effectiveness of the buffer that has been established by the AB buffer. For instance, a buffer effectiveness of 80% means that, in the middle of a failure in machine A, 80% is absorbed by the buffer, and only 20% affects machine B. In other words, a failure of 1 min. in machine A will, on average, reflect 12 sec. failure in machine B [4].

The average degree of functionality can be established via the function of its blocking switch. This should also be documented because the buffer before the filler machine should be kept stocked that after the filler machine should be kept empty.

Repairs that will cause a long failure should be ignored during the buffer analysis because the buffer cannot absorb this.

4.3 Data Analysis with reference to Charge and Shifts

In context, one understands by "charge" the smallest homogeneous unit of a product. For instance, one understands the volume beer in a particular pressure tank that is filled in the same arrangement using the same equipment, in other words, a homogeneous complete unit of a particular article. In order to evaluate single bottling charges, the PDA system has to receive information concerning the actual charge in a plant. The problem is that changes of charges in a bottling line occur at different times and in different places. Because there are no simple sensors available for these sliding changes in charges, keeping up with it at every single machine is very labour intensive. As a rule, only manually operable equipment (e.g. a keyboard) that requires installation costs and the time of operators can be employed. For this reason, the division of a bottling plant is now limited to few charge areas in which, according to the logic of the PDA system, only packaging and beverages can be in a single charge at any one time. If no pasteurising is available, or if a number of different routes are taken for a single route packaging system, the following two charge areas should suffice for all practical purposes:

- Complete wet and dry parts of the pallet exercise up to and including the counting of the fully loaded entry (full crate control or full pallet machine).
- Area of the completed product after the full crate control or full pallet machine.

The description of the production charges should be taken over automatically by a production system. If, in the business, there is to date no software for this function, and if no such connection is to be made, The PDA must use a simple capturing mask for the production plan. Times for change over, maintenance and cleaning should also be planned in advance, so that the PDA system will be able to recognise these functions.

A signal to change the charge in the first charge area is generated by a change of product in the filler or a change of a pressure tank. Every single bottle must be stamped with a clear charge number in order to ensure the tracing of the charge for product liability. To date only manual manipulation of change of charge in the equipment machine can be carried out with any measurer of security. However, the PDA system should also take over this function in order to secure an automatic and unitary symbol of recognition.

Recognising change of charges at the full crate controls or at the full pallet machine is imperative in order to establish exact numbers that are stored in the goods stores. Here, too, a manually operated signal (e.g. keyboard) is necessary at the moment. One should, however, consider an automatic recognition, for instance by using a planned rearrangement gap (available in the production plan).

If the bottling plant runs on different shifts, starting and end times must be made available to the PDA system. Interfaces for automatic capturing of working shifts should be the aim, otherwise a change of shift must be captured manually. This would enable an evaluation of business operations regarding shift personnel.

In order to gather authoritative results from a large volume of collected data, such data should be made available with reference to differently selected references. Apart from the reference to production charges and shifts, data based on variables of time (weeks, months, …), definite articles or characteristics of articles should be able to be compressed. The possibility to compare on screen different evaluations (e.g. two charges or two periods of time of equal duration) is imperative if one wants to make authoritative statements.

The classical format of saved business data is the spreadsheet. In addition, functions of the BDE system should be able to produce graphically illustrative material. Both linear diagrams and trend charts (t-x-diagrams) are eminently suitable. Examples have been provided in picture 4 and appendix D.

4.4 Time Capturing and Identification numbers

Even without providing time and counters manually, the PDA system must be able to retrieve and display identification numbers relevant to the practice. Time concepts and identification numbers for evaluating bottling process are determined in DIN 8782, “Concepts for bottling plants and single aggregates” [17]. Accordingly, these must be derived from the specific programme and the relevant operating state of the machine. The correct retrieval and concept definitions are described below. Table 4 illustrates a summary of the time concepts according to DIN 8782.

Table 4: Time Concepts according to DIN 8782

<table>
<tr><td>effective runtime
production + operating</td><td>equipment failure period
production + equipment failure</td><td rowspan="2">external failure period
production + ready or external failure or starving or blocking</td><td rowspan="3">auxiliary production time
clean, change over, maintenance, break</td></tr>
<tr><td colspan="2">general runtime</td></tr>
<tr><td colspan="3">operation time
production</td></tr>
<tr><td colspan="4">working time</td></tr>
</table>

Time concepts for individual machines in a bottling line and retrieving these from the operating state and programmes

- effective runtime

  Sum total of the period of time during which the aggregate works without failure. For automatic determination the time must be documented in a time statement in which the aggregate runs in the programme Production, * Production start-up, * or Production run down* and is in the operation state operation.*

- equipment failure period

  Sum total of the period of time in which the single aggregate has to be switched off because of failures in the aggregate itself (self caused failure time). To establish the time automatically, the sum total of the times must be calculated during which the aggregate works in the programme Production, * Production start-up, * or Production run down* and the operational state equipment failure* or operator intervention*.

  Not all equipment-failures can be picked up automatically from the sensor system of the aggregate. If the operator has to take action, this serves the purpose, in most cases, of removing a failure that had been picked up by the plant server as equipment- failure of a machine. That is why these times have to be added to equipment-failure times that can be established automatically.

  The failure time of an aggregate caused by a machine, serves as the basis for calculating the degree of operation of the machine. Adjusting machines to smaller capacities has not to be taken into account.

- external failure period

Sum total of the times during which the single aggregate must be switched off because of failures that cannot be relayed to the aggregate itself. To establish the time automatically, the sum total of the times must be calculated during which the aggregate works in the programme Production, * Production start-up, * or Production run down* and the operating state is on ready, * external failure, * starving* and blocking, * or if blocking/starving shows in the ancillary current, a simpler way to calculate the machine external failure time is to calculate the difference between the operation time* and the general runtime* of the aggregate.

In total the machine external failure time is of little importance in evaluating bottling machines. It is advisable to keep note of the separate times and frequency for starving at entry* blocking and starving/blocking in ancillary current because these times enables one to evaluate the basic concept of the total plant.

- general runtime of a single aggregate:

  Sum total of the effective runtime and equipment failure period of the single aggregate.

Time Concepts for a Bottling line

- Effective runtime of the bottling line:

  Sum total of the times during which the machine is operational without any failures. For the automatic calculation of the identification number (or code), the effective runtime of the aggregate-filling machine must be taken as the effective runtime of the entire plant.

- Equipment failure period related to the bottling line itself:

  Sum total of the periods of time during which the filling machine, because of equipment-failures or plant related failures in one or more aggregates relevant to the bottling line must be switched off.

- External failure period of the bottling line:

  Sum total of the periods of time during which the filling machine must be stopped because of failures not related to the plant.

- General runtime of the bottling line:

  Sum total of the effective runtime plus the equipment failure times related to the bottling line itself.

At the moment, the PDA system cannot differentiate absolutely between plant related and outside failures without additional details by the operator. Algorithms that still have some uncertainties for the allocation of types of failures in individual aggregates are described in 4.2. Within the context of these specifications, these must, however, be used in connection with narrow and low-cost PDA systems and not to establish automatic times and codes. Failure period* and operation time* of a bottling line can be established automatically.

- Failure period of the bottling line:

  Sum total of the times during which the filling machine must be stopped because of failures related to the bottling line as well as eternal failures. This equates with the sum total of the times in which the filling machine should execute its allocated function, i.e. the programme's Production, * Production start-up, * or Production run down* have been selected but the operating state operating* is not available. The failure period of the bottling line can also be established as the difference between operation time and effective runtime of a bottling line.

General Time Concepts:

- Operating Time:

  Sum total of the effective runtime plus the failure periods. This is equal to the times during which an aggregate should carry out its designated function, in which the programme Production, * Production start-up, * or Production run down* have been selected. The operation time of the bottling line is equal to the operation time of the filling machine.

- Working time:

Working time is the sum total of the operation time plus auxiliary production times. It reflects the total time during which the operators of a plant are present and are being paid for. Paid breaks are included as auxiliary production time.

Auxiliary production times are work times during which no productions operations of the bottling line can or should take place. For purposes of evaluating economic operations, change over time relative to a specific charge, and maintenance and care times that are distributed among a number of charges should be differentiated.

- Change over time:

  Time to set-up or to change the entire bottling line or single aggregates to the desired type of beverage, equipment, packaging or the container. The automatic reading of the change over times can be made, with suitable bottling aggregates, via the sum total of the times during which the programme change over* has been selected.

- Maintenance and care time:

  Period of time necessary to maintain the operating state of the different aggregates of the entire bottling line. The automatic reading of the maintenance and care times can be made, with suitable bottling aggregates, via the sum total of the times during which the programme maintenance* or cleaning* has been selected.

- Break time:

  Periods of paid operational breaks. The automatic reading of the break time can be made, in suitable bottling lines, via the times during which the programme break* has been selected.

Key figures of single aggregates of the bottling line.

- Nominal output of a machine $Q_{n\,E}$:

  Nominal output is the production per time unit for which the aggregate was calculated and designed. According to the nature of the single aggregate, it depends on beverage container, packaging, equipment and type of beverage. This means that one machine may have different nominal outputs.

- Setting output $Q_{est\,E}$:
  Operational speed of the machine. It reflects the theoretical production per time unit that is possible if the machine operates at the set running speed, uninterrupted operation and total capacity. The maximum setting output of the machine must be equal to at least its nominal output.

- Effective output $Q_{eff\,E}$:

  Partial number produced during the general runtime in average per time unit of the aggregate in uninterrupted status.*

In order to identify weak spots in a bottling conveyor system and in order to direct maintenance staff effectively, machines should be evaluated after a equipment-failure has occurred. A key figure for this is the efficiency of the machine.

- Efficiency of an aggregate η_E:

  This is the relationship between effective output and setting output. The difference 1-η_E indicates the loss of production versus the setting output. This value is equal to the portion of eqipment failure time (machine related failure time) and the general runtime of the aggregate. The efficiency of a machine can be calculated automatically from the effective runtime and the proportion of machine caused failures. Only if the machine runs with constant production can the calculation also be made via the relationship between effective output and setting output.

$$\eta_E = \frac{\text{effektive runtime}}{\text{general runtime}} \left(= \frac{Q_{eff\,E}}{Q_{estE}} \right) = \frac{\text{effective runtime}}{\text{effective runtime} + \text{equipment failure period}}$$

Key figures of the bottling line

- Nominal output of the bottling line $Q_{n\,A}$:

  Production per time unit for which the bottling line had been constructed. It is indicated per time unit for a type of beverage and a beverage container according to type, size, stopper and fittings. This means that a particular bottling line may have different nominal outputs. The nominal output of the bottling line equates with filling machine(s) operational in the plant. A prerequisite for this is that all other aggregates of the bottling line have at least the same nominal output as that of the filling machine or the filling machine of the specific beverage container or beverages.

$$Q_{n\,A} = \frac{\text{number of units}}{\text{time unit}}$$

- Effective output of the bottling line $Q_{eff\,A}$ (refer DIN 8782):

  Number of units produced during the general runtime of the bottling line as an average per time unit.

$$Q_{eff\,A} = \frac{\text{number of units}}{\text{general runtime}}$$

Because the general runtime of the bottling line cannot be determined exactly (refer time concepts for a bottling line), the automatically determined effective output $Q^{\#}_{eff\,A}$ is introduced here. This is sufficient for the evaluation of the bottling line in practice.

- Effective output of the bottling line $Q^{\#}_{eff\,A}$ (determined automatically):

  Number of units produced during the operational time of the bottling line on average per time unit.

$$Q^{\#}_{eff\,A} = \frac{\text{number of units}}{\text{operation time}}$$

- Average production of the bottling $Q_{m\,A}$ (refer DIN 8782):
  Number of units produced during the working time in the bottling line on average per time unit.

$$Q_{m\,A} = \frac{\text{number of units}}{\text{working time}}$$

An important key figure for the evaluation of a bottling line according to DIN 8782 is the supply rate λ_A that also forms the basis of bottling line sales.

- Supply rate of a bottling line λ_A (refer DIN 8782):
  Relationship between effective output and nominal output of the bottling line.

$$\lambda_A = \frac{\text{effective output}}{\text{nao min al output}} = \frac{Q_{eff\,A}}{Q_{n\,A}} = \frac{\frac{\text{filled quantity}}{\text{general runtime}}}{\text{no min al output}}$$

An application of $Q^{\#}_{eff\,A}$ results as automatically determined by a PDA system in a supply rate of $\lambda^{\#}_{A}$ of a bottling line:

$$\lambda^{\#}_{A} = \frac{\text{effective output}^{\#}}{\text{nao min al output}} = \frac{Q^{\#}_{eff\,A}}{Q_{n\,A}} = \frac{\frac{\text{filled quantity}}{\text{operation time}}}{\text{no min al output}}$$

Of greatest importance in practice is the degree of exploitation of a plant that can give information via the number of filled bottles on the total working time.

- Degree of exploitation of a bottling line: φ_A (refer DIN 8782):

Relation between the average production and the nominal output of the bottling line:

$$\varphi_{\mathrm{A}} = \frac{\text{average output}}{\text{nominal output}} = \frac{Q_{\mathrm{m\,A}}}{Q_{\mathrm{n\,A}}}$$

General keys:

- The code "Man-hours per hl“ σ_{hl} is handy for the evaluation of work productivity.

$$\varphi_{\mathrm{A}} = \frac{\sum_{i=1}^{n} \text{working time}_{\mathrm{n\,shift}}}{\mathrm{hl}_{\mathrm{shift}}}$$

The number of staff in the area of bottling is n, and hl refers to the quantity filled during the shift.

Further codes are needed to identify the use of ancillary and business materials, like for instance:

- Heating quantity per bottle
- H_2O cold per bottle
- CO_2 per bottle
- Fading (loss) per hl

Preventive Maintenance

A PDA system provides the basic data for a tool for preventive maintenance. On the basis of standards established in these specifications the necessary data in the PDA system can be incorporated and be read as a tool for maintenance by means of access to the database.

One has to differentiate between preventive maintenance based on counters, which implies historical operations experience, or instructions by the manufacturer of the machine, as well as maintenance related to loss of effectiveness in machines or buffer functionality in the bottling line [1]. In the first instance:

- Runtimes of all machines and
- Interplays of the machine in parts prone to wear and tear

must be determined. From this information, the maintenance tool works out the times during which maintenance work should be done, administers the maintenance staff, and communicates with the materials business, so that spare parts may be available on time, and generates concrete maintenance orders for the entire plant.

Deviations in the functionality of machines or buffers are determined by means of an analysis of failures, for example:

- Deviations in the degree of functionality of machine from a particular window, or
- Deviations in the degree of functionality of buffers.

This, often sliding, drop in functionality of machines should generate maintenance orders that effectively fall between an immediate correction of a fault and a long-term maintenance plan. The maintenance system should, as soon as resources are available, exchange maintenance measures so that effective counter-measures may be taken quickly. The function of machines also reveals quality data that is handled by the laboratory information and management system. Here, too, deviations from “should be” values must be treated in the same manner.

5 Technical Reporting for Bottling

Technical reports serve the purpose of informing the decision-makers in different departments and hierarchies in a business concern. The need for information depends on the work that has to be done and varies strongly among the different levels. For this reason, individual reports must be prepared for everyone responsible for every process. With the aid of these reports, the person will be able to perform the functions of planning, directing, control and documentation. Instructions on how to compile technical reports follow below. At the end of this chapter, examples of reports are given that could serve as a basis of creating a standardised system of reporting for the evaluation of bottling.

5.1 Need for Information in the Bottling Business

Appendix A illustrates the need for information as established by means of investigation in a large number of businesses for a rational technical bottling reportage. This cannot be covered solely by an automatic PDA in a bottling conveyor. Some information is already available on systems in other departments or in a production planning system and could be taken over from these systems. For a while, one will have to rely on manual capturing of data.

According to the business management level model (refer picture 6) the functions in a business are divided in a hierarchical system, and work could be delegated and done top-down [12]. It becomes more and more concrete the more it has entered the lower ranks of the hierarchy. There is a vertical flow of information between the various levels, as well as horizontal information flow within the levels, for instance between separate sections. The most important duties of individual levels are summarised below [7]:

Business management level:

- Strategic (long-term) Planning,
- Logistical duties,
- Business auditing

Production management level:

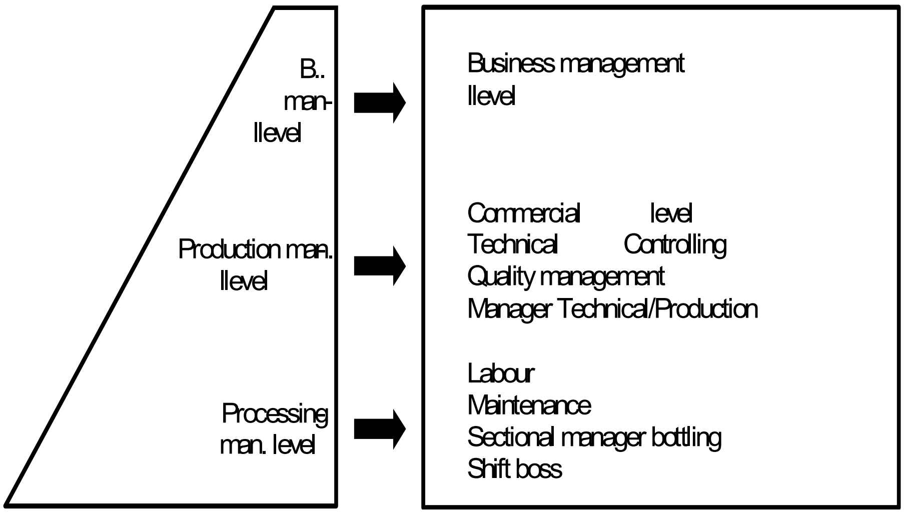
- Logistics of production,
- Planning of production,
- Plant and Staff arrangements,
- Business management duties,
- Tracking flow of production,
- Guarantee quality.

Process management level:

- Evaluation of processing and product qualities,
- Handling failures (faults).

The business management level is the level that sets aims and goals for the business. It needs reports form all areas of the business in order to work out the strategic aims. The production management level executes in broad outline these strategic planning instructions by the business management level. These plans are put into concrete practice, and are co-ordinated and monitored, at the processing management level.

There must be a constant exchange of information in order to construct such a division of duties and to make these a reality. The reporting function must also orientate itself to this. It provides the instrument that makes possible a structured exchange of information in the business and it is, therefore, of cardinal importance to the business. For this reason, the different reports sent must make it possible for the different instructions to be carried out. A rough division of the aims of reports can be made in line with the time aspect. For instance, daily reports reflect mainly the documentation of production processes, the short-term management of production and bottling processes and control of bottled quantities. Monthly reports serve the purpose of monitoring “should be/is” deviations as well as the foundations for planning in the technical sphere. Lon-term reports (monthly or annual reports) have little operative function. They have a controlling function and serve strategic planning. The distribution of information plays a very important role in a business for controlling as an aim orientated co-ordination of planning, care of information, administration and control. The report system is an important instrument for controlling.

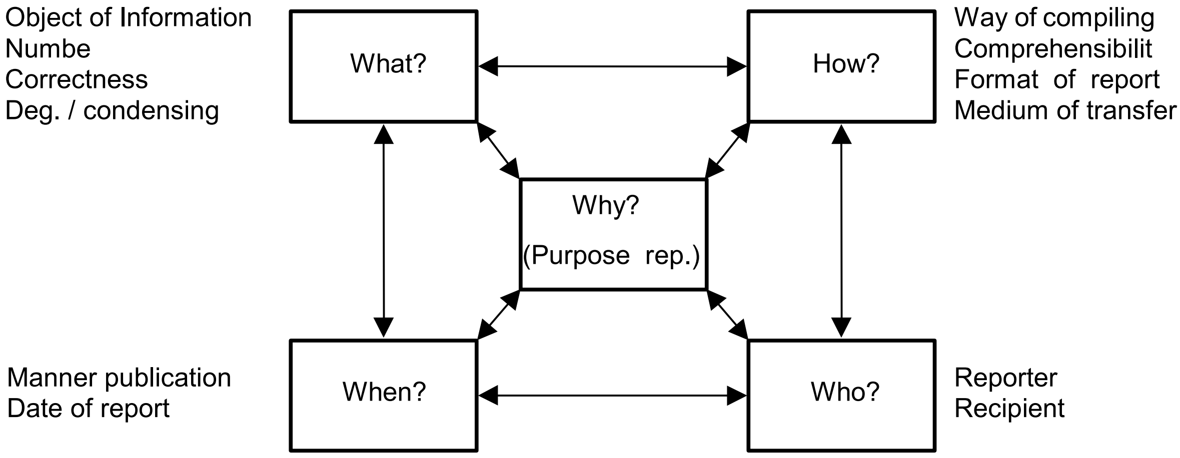


Picture 6: Recipients of reports in bottling plants

Picture 6 indicates the recipients of reports at the various levels of a bottling plant. Their need for information is different not only with regard to the extensiveness of the data, but also in the quality, topicality, and in the degree of condensing. The decisive factor is what the dominant purpose of the report is at the relevant level. The basic principle is that the volume of information decreases as one moves up in the hierarchy, and that the degree of condensing increases as one moves up. This is related to the across-area-reporting examination at higher levels of an organisation. Because information from all reports and sections of the business come together here, separate pieces of information must be more compact in order to keep the mass of data comprehensible.

5.2 Compiling Reports

The way in which a report is compiled can influence directly how, and especially to what extent, information is absorbed. A person responsible for a process, at whatever level of a business, can and will only make use of the data made available to him when these have been presented in a useful format. The possible ways in which reports may be compiled are, therefore, illustrated below.



Picture 7: Characteristics of compiling a report

Picture 7 shows the characteristics and compiling of reports. The focal point is the purpose of the report. The purpose of the report determines on what activities and objects the report must be compiled. This depends on the defined need for information of the particular recipient. In order to compile the report effectively, these characteristics must be combined correctly one with the other. In doing so, all characteristics must be orientated to the purpose of the report. Because there is a very close connection between the purpose of the report and the recipient, the characteristics naturally also take into consideration the needs of the recipient.

It is important to compile the reports in such a way that the recipient will be able to take in the information without any problem. The clearer a report has been structured, the easier the information can be absorbed and the faster, more securely and correctly can it be understood. Comprehensibility of reports may be enhanced in the following manner:

- Split general and detail information.
- Hi-light important matters.

There are various ways in which this may be accomplished. Your aim is to define optical and structural elements that will be perceived by the recipient as belonging together. One may list:

- Similarity (e.g. same font, colours, size of writing).
- Closeness (e.g. by means of different distances)
- Enclosed (e.g. by means of boxing in or dividing lines).
- Experience (familiar structures are identified first)

Apart from the comprehensive structuring of a report, the selection of comprehensive details to report is also important. This implies that comprehensible graphs should be introduced and that the typescript should be clearly legible. Take into consideration the following:

- Proportional spacing is more legible than typewriter print.
- Half-bold typeface is more legible than bold or very thin print.
- Words in upper casing are more difficult to read than words in lower casing
- The letter size should be at least 10, and even in exceptional cases should not be smaller than 8.
- Cursive and negative writing is more difficult to read than is upright and positive writing.

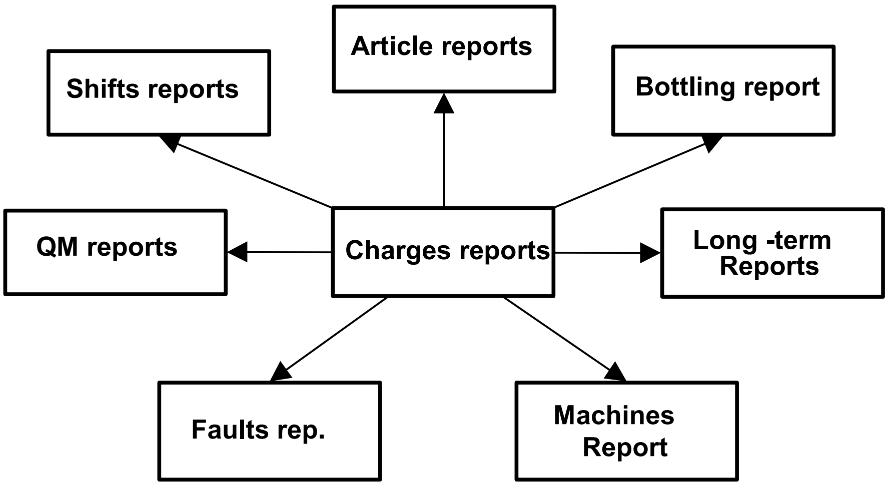
The rules for compiling reports do not refer only to report/s for a section. They should be applied uniformly across the entire business. Reports should formally be structured the same way so that the content of different reports can be absorbed and understood quickly.

The reports below must be considered as suggestions, and should be adjusted to fit in with the reporting practice in the plant.

The concepts used in reports must also be uniform and clear. At all costs one must avoid using concepts having more than one meaning and that may be interpreted differently by different persons responsible for the processes in the business. Transfer of information should be without errors. For these reasons, the development of a catalogue setting out meanings of concepts is an important element in the development of a system of writing reports. In this catalogue all concepts used in reports have been clearly defined. (Refer data points under 3.2 and code numbers under 4.4).

5.3 Examples of Reports

Technology provides a number of possibilities for presenting commercial data in reports. The main software in use is HTML Tools or standard tabular calculation like MS-Excel. HTML (Hyper Text Mark up Language) has the advantage of almost unlimited possibilities of structuring. To the left of other reports and operational instructions can be realised with little effort, and multi media may even be integrated. The only software required is Browser Software. However, the actual compiling of the reports requires quite a bit of work, and the reports are thus inflexible. In most instances, a specialist is required to look after the reportage. Therefore solutions based on tabular calculation programmes are usually preferred. Such reports are easy to prepare and are fairly flexible. If necessary, the recipient could make changes to the report by himself. In addition, the data made available in a tabular calculation can easily be incorporated in other calculations. For these reasons, all exemplars of reports in appendix D have been compiled in MS-Excel.



Picture 8: Reporting on the basis of charge relative data

An important requirement by business from the reporting system is Top-Down-Functionality. This implies that from a report on a higher business level on defined points of relevance (for example, on the number of the charge) readings may be made from lower level reports in order to enable a detailed view of the business, The number of reports should be limited. That is the only way to have an overall view and to work effectively. Nevertheless, all relevant information must reach the recipient. Below, reports are given that aim at meeting the requirements of all persons responsible in the processes. In compiling these reports, attention was paid to the requirement of brief, comprehensible reporting. No one report is longer than a DIN A4 page. All the reports enable the evaluation of the report over a variable time period. This leads to greater flexibility and opportunities to draw comparisons. Copies of the reports appear at the end of the chapter.

Charge Reports and Shift Reports

Charge reports and shift reports are the most detailed and the most extensive reports in the bottling business. The charge report gives the detailed data of the filling process of a charge. All other reports compress the charge data and refer to the "Focal point of bottling reports" (refer picture 8). A charge report must have identification data, processing data and product data. The charge is identified by its code and the date in the heading of the report, as well as by the original article, pressure tank and bottling plant. Processing and product data are limited to the data that are absolutely necessary for the evaluation of a charge. Naturally, actual filling quantity as compared to planned quantity must be established and documented. Establishing the data occurs from a reading of various counters in order that variables can be determined. Deviations from planned quantities are indicated –as in all other reports as well – by means of green imaging to represent positive deviations, and red imaging to represent negative deviations. In a brewery, the charge related data must be established for the control of beer relevant quantities of bottling, because beer control is based on the original wort. This remains constant in the charge.

Apart from the code figures of the entire plant and a “hit list” of filler relevant failures, the consumption data is of interest. Especially the code quantity per bottle is of importance if, within the framework of costing, an article relevant costing result has to be carried out. Here, negative deviations in the consumption figures are imaged in green – different to the standard norm.

Because all the other reports are based on the charge report, the quality data must be documented here. Apart from data on the product, the status of the main lye in the cleaning machine must absolutely be given. As actual laboratory results, only the microbiological data as well as the data of the chemical-technical analysis of the pressure tank can be used, as results from the bottling area are available only a number of days after the bottling of the charge. These details may be entered afterwards in the report. The behaviour of the inspection machine is documented in greater detail in the shift report unless every charge is filled separately in product specific units. In this instance the reason for exclusion from the charge report must be documented. The section manager bottling is the recipient of this report.

A shift report comes before a charge report. It is distributed to the following recipients:

- Sectional manager bottling,
- Shift boss.

The shift boss must receive this report because he is directly involved in the process of bottling. He can, for instance, best interpret the auxiliary production times and he knows the reasons for possible delays. He can influence directly the staff on his shift and can, thus, work towards an improvement of working conditions. The shift report summarises the separate charges of the particular shift. To this is added detailed evaluation of additional times and failures. The way in which the discharge of the inspection machine functions is also documented in detail. This secures the Top-Down-Functionality so that the combination via the charge number of the report of the specific charge with all detailed information may be called up.

Documentation of personnel data in the exemplar is limited to the minimum. Personnel time evaluation may possibly be extended to include names and job descriptions. However, according to article 87 of the (German) Labour Relations Act such a measure must be done in consultation with a labour representative committee that has a voice according to the paragraph in the constitution.

For a general evaluation, information regarding the number of workers and the actual working times during which they worked will suffice. This is transported directly from the personnel management system. However, the name of the shift boss must definitely appear in the shift report because he is the person responsible for the processing.

Article Report and Bottling Report

The article report should give the technical manager an overall view of the production of a specific article during a randomly selected period of time. The following recipients should receive this report:

- Section manager bottling,
- Manager technical/production.

This report presents a quick overall view of the quantity filled of a specific article as well as important code figures. Deviations between planned and actual quantities filled are easily picked up. The manager technical/production, who is also responsible for the overall planning of the production in the bottling area can, by using this report, be in control of his plans and can, if necessary, make adjustments. If this report is compiled regularly, for instance on a monthly basis, it could serve as the basis of planning in this area. If small deviations occur, the manager bottling must change his finer planning in order to reach targets. He will also be interested in the resume of the code figures that provide information on the way the staff performs and on the bottling plant. The Top-Down-Functionality is also secured in this report via the charge number as link to the relevant charge report.

When the article reports are condensed further, the filling report results. In this report is documented all quantities of bottling products within a randomly selected period of time. There should be a possibility to determine different sorting criteria. For instance, sorting should be done not only according to quantity, but also according to article or according to deviations in comparison to the same time the previous year.

Through the cumulative quantities, development of bottled quantities in the actual calendar or business year can be compared to the previous year. Not only is this possible for every type of beer, but also for all types of beverages. A graphic presentation will more clearly indicate comparisons with the previous year; trends are more easily discerned and are more prominently presented than in a table. The following persons are recipients of the bottling report:

- Business Management,
- Manager technical/production
- Financial manager

Because of the exposition of the cumulative quantities, the bottling report can also be used as an annual report.

Machine Report and Failures Reports

Reports on machines and on failures are absolutely essential for the search of problems in individual machines and in the entire bottling plant. They document the way the plant works and list all failures that occurred.

The machine report concerns itself with an individual machine and is compiled separately for each aggregate. It documents in detail the functioning of the particular machine plus working and failures times. Failures are compiled in a "hit list" in order better to identify the failure in the machine and in its surroundings. Machine reports are also used for maintenance purposes. For this reason, the last inspection and lubrication are documented by date. This data is available in the database of the PDA system and can, therefore, continually be compared to instruction data.

Dates of inspections and lubrication can, therefore, be indicated as absolute time records in the report. The picture of the degree of functionality of the machine can also be an indicator of its status. Therefore, the degree of functionality is represented as a curve. If a slipping trend is noticeable over a period of time, measures to implement preventive maintenance may be considered. Recipients of the machine report are:

- Section manager maintenance
- Section manager bottling,
- Manager technical/production

Although machine reports and failures reports are similar in content, the recipients are different. Because of the documentation of maintenance periods, machine reports have an influence on the planning of production and are, therefore, a strategic component. Because failure reports have a purely operative aim and are not strategically planned, they are mainly of importance at the process management level. Therefore, failure reports must be sent to:

- Sectional manager, bottling,
- Sectional manager maintenance.

Failure reports have the purpose of identifying and analysing failures that have occurred in the bottling plant, to find ways and means to avoid these failures on a long-term basis and thus to improve the bottling production. Different ways of approach may be used to achieve this aim.

Tracing the failures is very important; therefore a separate report is compiled that integrates the tools for failures analysis as discussed under 4.2. A further way of handling the failures is to draw up a “hit list” of failures. Such a hit list enables one to discover the most prominent weaknesses in a bottling plant. The list should be able to be sorted not only according to the cumulative time of failures, but also to the locality of the failure. In this way, for instance, failures in all transports could be evaluated at a glance.

Quality Reports

Because the quality of products in the area of food processing is of the utmost importance, most businesses have highly developed security controls in this area. The norm listing DIN ISO 9000ff has contributed much to this. Measures for securing product quality must also be documented. For this purpose there are special QM reports. Quality control management receives these reports.

The CIP report documents all CIP processes in the bottling plant. It is not compiled merely to document whether the cleaning has been done or not, but it also documents data concerning all cleaning materials and disinfectants that have been used and carries the signature of the person responsible for the cleaning. In this way, hygiene in the sections of the plant that come into contact with the product can be safeguarded. One could, perhaps add to this laboratory data, for instance data on microbiology of the final rinsing water.

A further necessary quality report is that of the inspector of test bottles. In this report, reasons for failures are documented to enable one to recognise weak spots.

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Appendices

Appendix A: Requisite Data for Technical Reporting

	Automatic caturing by BDC system	Manual capturing or transporting from Other systems
Original data		
Time	X	
Article		X
Beer type		X
Charge code		X
Previous charge Pressure tan		X
Bottling plant		X
Quantity data		
Inserted product quantity (hl)	X	
Entry storage area (crates/pallets)	X	
Performance of individual machine	X	
Actual production of machines	X	
Setting production of machines	X	
Quality data		
O2-content of produ	X	
CO2-content of produ	X	
Bottl. pressu	X	
Bottl.temperatur	X	
Broken bottles	X	
Half-filled bottles	X	
Overflowing bottles	X	
Bottles not closed	X	
Ventilator statistic filling m.	X	
Temperature Lye/Cl. mat.	X	
Conductance lye/cl	X	
Discharge bottle inspection	X	
Discharge crates full crates control	X	
Discharge crates empty crates control	X	
Discharge pallets	X	
Temperature,time kept,PE if Pasteurizer or KZE	X	
CIP-measures	X	
Lab. data Microbiology		X
Lab. data CTA		X
Consumption dat		
Sheaves	X	
Equipment	X	
Fresh water	X	
Corks/bottle tops	X	
Warming/hot water	X	
CO2		X
electri		X
grease		X
Air press.		X
Machine data		
Operation	X	
Switching	X	
Maintenanc		X
Personnel data		
Name Shift boss		X
Work time		X
Faults da.		
Length fault	X	
Cause of fault		X
Fault location	X	
Time data		
Work time	X	
Prep.	X	
Mainten.	X	
Prep.tim	X	
Cleaning times	X	
Cleaning time	X	
Operat time	X	
IMaintenance		X

Appendix B: Standardised Data Points to link up.

Table5: Standardised data points to link up for bottling machines and transports.

Aggregate	Machine specific notices	Parameter	Reading	Count val.
Pallet unloading machine		Type pallet	Setting production	Pallets total
		Type crate		Crates total
		Type bottle		
		Storage sit.		
Crate- Sorting machine For empties	Build-up sorted crates	Crate type	Setting production	Crates total
		Shape of bottle		Good bottles
				Rejection cause
				Wrong bottles
				Bottles too high
				Bottles too low
				Colour of bottle
				Compart.emp
				Foreign object
				Wrong crate colour
				Wrong crate logo
				Crate defective
				Etc.
Bottle de-corking Or unscrewing machine			Setting production	
Unpacking machine			Setting Production	Total crates
Empty bottles Sorting machine	Build-up diversion	Shape of bottle	Setting production	Total bottles
				Sorted bottles as
				Height of bottle
				Shape of bottle
				Colour of bottle
				Closed bottles
Bottle cleaning machine		Shape of bottle	Setting production	Use of clean water
			Temperature Hot water	Hot water consumption
			Conductance main lye	Steam used
			Temperature main lye	Cleaning material used
			Concentration Main lye	Additives used
			Temperature lye spray	
			concentration Lye spray	
			Spay pressure in Separate zones	
			Temperature Hot water	
			Redox potential Hot water	

Ta

Aggregate	Machine-specific notices	Parameter	Readings	Countvalue
Empty bottles inspection-Machine	Build-up diversion	Shape of bottle	Setting production	Total bottles
				Total good bottles
				Discharge bottles Containers
				Discharge bottles Reverse belt
				Faulty bottles cause
				Opening
				Bottom
				Lye IR
				Lye HF
				sides
				Scuffing
				Foreign bodies
				Colour of bottle
				Shape
				Etc.
Bottle filling machine	Lack of product	Beer type	Setting production	Total bottles
	Deficient air	Pressure tank	Bottl. pressur	Broken bottles
	CO2-deficiency	Shape of bottle	Bottling temp.	Product quantity
			O2 in Product	CO2 consumption
			CO2 in Product	
			Temperature Flood water	
			Extract Product	
			Temperature HDE	
			PressureHDE	
			pH-Value of Products	
			Conductance of Product	
Bottle closing machine	Lack of stoppers		Setting production	Total bottles
Full bottles control machine After filler	Build-up diversion	Shape of bottle Type	Setting production	Total bottles Total wastage
		Beer type		Wastage acc.to::
				half filled
				Over filled
				Stopper
				Metal in the bottle
				Etc..
				Bottl.ventilation
Pasteurizing machine			Setting production	Cold water used
			Temperature per	Hot water used
			Past. zone Support speed	Steam used
			PE	Additives used
Bottle presentattion machine	No labels	Dating code	Setting production	Total bottles
	No glue		Glue temperature	Labels
	Fault in			
	Date stamp			

Aggregate	Machine specific notices	Parameter	Readings	Numbers
Full bottles control machine After labeling	Build-up diversion	Shape of bottle	Setting production	Total bottles
		Type		Total wastage
				Wastage caused
				Half filled
				Over filled
				Label faulty, (belly, breast, back," staniol", ribbon)
				stopper
				Date stamp
				Etc.
Packaging machine	No crates		Setting production	Total crates
Full crates Control machine	Build-up discharged Crates	Crate type		Total crates
				Bad crates because
				Bottles missing
				Bottles too tall
				etc.
Pallet loading machine	No pallets	Pallet type	Setting production	Total pallets
		Crate type		Partial pallets only
		Shape of bottle		Total crates
		Storage		Total filled crates
				Total empty crates
Bottle transporters Buffer and no pressure brought together	Lubricant dosage In/out		Speed or Frequency of FU's	Water consumption
				Chain lubricant used
Crate cleaning machine			Setting production	Water consumption
			Temperature	
			Spray	
Empty crates inspection machine		Crate type	Setting production	Total crates
				Good crates
				Bad crates because:
				Colour
				Broken handle
				etc.
Crates magazine			Degree of filling	
Pallet-Inspection machine				Total pallets
				Defective pallets
				Good pallets
Pallet transport Pallet magazine			Degree of filling	

Table6: Data Points for Technical Processing Plants

Aggregate	Machine specific notices	Process specific notices	Readings	Numbers
Short term heater Buffer tank		Ventilator settings	Pressur	Quantity of flow of Product
			Temperature	Hot water consumption
			Volume flow Product	Steam consumption
			PE	
			conducta	
CIP		Ventilator setting	Conductance revers	Consumption Cleaning material
			Temperature reverse	
			Volume flow Cleaning material	
CAF		Ventilator settings	Sterilization temperature	Sterile air used
			Excesspress.sterileroom	

Appendix C: Forms for Documentation

Table7: Documentation form for Bit coded Conditions and Messages

Bit coded Conditions and Messages

machine:

Data block No.:

Area	DBB		Bit or Mumber	Meaning (Bit = 1)	Comment
machine state		exlisiv or		out	
operating mode				hand	
				semi-automatic	
				automatic	
programme		exlisiv or		production	
				start up	
				run down	
				clean	
				change over	
				maintenance	
				break	
operating state		exlisiv or		ready	
				operating	
				equipment failure	
				operator intervention	
				external failure	
				starving	
				blocking	
				starving/blocking branch line	
machine specific messages		or			

Table8: Form for Documentation of Notices of failure

Interference messages (First value message listing mode)	
Machine:	
Data block No.:	
16 Bit Data word for Fault message on DBB 4 and 5	
Numbers	**Meaning**
0	No fault message

Table9: Form for documentation of Pointers

Directive Messages(new value message in listing mode)	
Machine:	
Data building block No.:	
16 Bit Data word for directive messages on DBB 6 and 7	
Number	**Meaning**
0	No directive message

Table10: Form for Documentation of Programme steps

Program Steps	
Machine:	
Data building block No.:	
16 Bit Data Word for Program steps on DBB 8 and 9	
Numbers	**Meaning**

Table11: Form for Documentation of Parameters

Parameters (16 Bit Data Words)		
Machine:		
Data building block No.:		
Parameter number	**DBB**	**Meaning**
1	0	
	1	
2	2	
	3	
3	4	
	5	
4	6	
	7	
5	8	
	9	
6	10	
	11	
7	12	
	13	
8	14	
	15	
9	16	
	17	
10	18	
	19	
11	20	
	21	
12	22	
	23	
13	24	
	25	
14	26	
	27	
15	28	
	29	

Table12: Form for Documentation of Measuring Values

<table>
<tr><th colspan="5">Measure Values(16 Bit Data Words)</th></tr>
<tr><th colspan="5">Machine:</th></tr>
<tr><th colspan="5">Data building block No.:</th></tr>
<tr><th>Meas.value number</th><th>DBB</th><th>Meaning</th><th>Unit</th><th>Conversion factor</th></tr>
<tr><td rowspan="2">1</td><td>0</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>1</td></tr>
<tr><td rowspan="2">2</td><td>2</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>3</td></tr>
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<tr><td rowspan="2">8</td><td>14</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>15</td></tr>
<tr><td rowspan="2">9</td><td>16</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>17</td></tr>
<tr><td rowspan="2">10</td><td>18</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>19</td></tr>
<tr><td rowspan="2">11</td><td>20</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>21</td></tr>
<tr><td rowspan="2">12</td><td>22</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>23</td></tr>
<tr><td rowspan="2">13</td><td>24</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>25</td></tr>
<tr><td rowspan="2">14</td><td>26</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>27</td></tr>
<tr><td rowspan="2">15</td><td>28</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">,</td></tr>
<tr><td>29</td></tr>
<tr><td rowspan="2">...</td><td>...</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>...</td></tr>
</table>

Table13: Form for the documentation of Counters

Counters(32 Bit double words)				
Machine:				
Data building block No.:				
Countval.-number	**DW**	**DBB**	**Meaning**	**Overrun at**
1	Low	0		
		1		
	High	2		
		3		
2	Low	4		
		5		
	High	6		
		7		
3	Low	8		
		9		
	High	10		
		11		
4	Low	12		
		13		
	High	14		
		15		
5	Low	16		
		17		
	High	18		
		19		
6	Low	20		
		21		
	High	22		
		23		
7	Low	24		
		25		
	High	26		
		27		
...	...	...		
		...		
	...	...		
		...		

Appendix D: Exemplars of Reports

TECHNISCHE UNIVERSITÄT MÜNCHEN · BLV

Charge Report

09.10.1999 16:29

Charge-Code: 0224-99-123-2

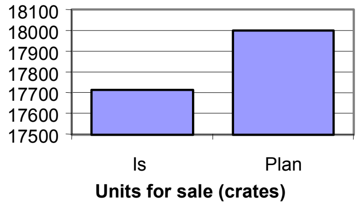
Date: 01.09.99

Original data

					Is	Plan
Art.-No.:	123	**Press.tank:**	14	**Start:**	07:15	07:00
Article:	Pils 0,5l	**Bottl.Plant:**	2	**End:**	13:35	13:30
				Work time	06:20	06:30

Quantiti es

	Is	Plan	Deviation	
hl	1785,5	1800	-14,5	-0,81%
Bottles	354687	360000	-5313	-1,48%
Crates	17713	18000	-287	-1,59%
Pallets	354,2	360	-5,8	-1,61%



Decrease 0,79%

Beercontr 1771 hl

Codenumbe rs

Degr.deliv ery Plant : 89,60% **Degree exploitation Plant:** 86,50%

Filler relevant Faults

Length (min)		**Frequency (number)**	
Aggregat e	**Length**	**Aggregat e**	**Frequency**
Pallprod.con.	23	Filler mach.	9
Filler mach.	18	Packer	5
Packer	12	Pallet packer	3
EtiMa	5	EtiMa	2
Unpacker	3	Unpacker	1

Consumptiondata

	Is	Plan	Deviation		Quant./Bottles	Unit
Sheaves	356040	360000	-3960	-1,10%	1,00000	Bottles
H2O cold	720	720	0	0,00%	0,00202	hl
CO2	1,895	1,9	-0,005	-0,26%	0,00001	kg
KK	354458	360000	-5542	-1,54%	0,99556	KK

Quality data

	Middle	Min	Max	Unit
O2 bef.Filler	0,24	0,09	0,31	mg/l
CO2-Content	5,41	4,98	5,53	g/l
Temp. Lye Cl. Mat.	82,9	78,1	85	°C
Conduct Lye/Cl. Mat.	210	180	225	mS
Bottling temper.	3,1	2,9	3,4	°C

Lab. results DT 14 no microbiological findings

Chem.-technical Analysis OK

Wastage ratio inspection machine 0,17% equals 612 bottles

Broken bottles	98
Overfilled bottles	456
Bottles not closed	187

TECHNISCHE UNIVERSITÄT MÜNCHEN

BLV

Shift Report

09.10.1999 16:29

Early Shift

Date: 31.08.99

Original data

		Start	07:00	**Shft Boss**	Maier
Bottl. line	2	**End**	16:00	**Staff**	5,0
		Breaks	01:00	**Staff Time**	2380 min

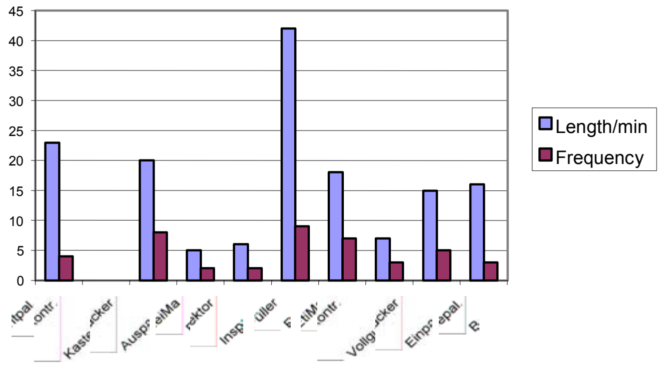
Charges

	1	2	3	Total
Charge Nos.	0217-99-123-2	0218-99-246-2	0221-99-127-2	
Article No	123	246	127	
Article	Pils 0,5	Hopfenhell 0,5	Pils 0,33	
Filled hl	945,5	238,7	456,3	1640,5
Filled Bottles	189100	47740	138264	375104
Filled Crates	9455	2387	5761	17603
Start	00:30	-	-	00:30
Runout	-	-	01:00	01:00
Prep. time	-	-	00:30	00:30
Other parallel time	00:02	00:18	00:05	00:25
Total parallel time	00:32	00:18	01:35	02:25

Code numbers

Supply rate Plant	88,50%	**Setting Production**	60000
Exploitation degree Plant	86,70%	**Average Production**	53120

Interruptions

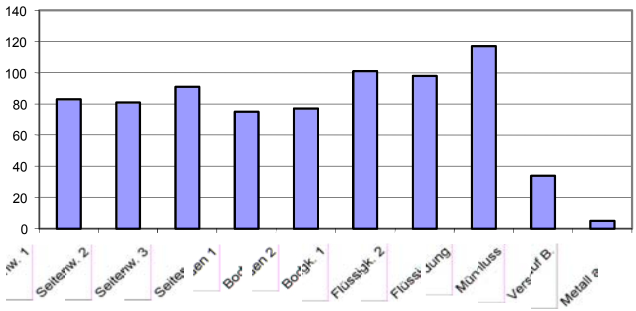


	Length/min	Frequency
End pal.	23	4
Crates contr.	0	0
Unloader	20	8
Clea/M	5	2
Inspector	6	2
Fillingmachi	42	9
EtiMa	18	7
Full gds cntr.	7	3
Packer	15	5
Palletin	16	3

Inspection machine

Rejection hard 502 Bottles

Rejection soft 260 Bottles



reason	Number
Bottle side 1	83
Bottle side 2	81
Bottle side 3	91
Bottom 1	75
Bottom 2	77
Liquid 1	101
Liquid 2	98
Opening	117
Stopper	34
Metal on bottom	5

TECHNISCHE UNIVERSITÄT MÜNCHEN

BLV

Article Report

09.10.99 **16:29**

from: 04.09.99 **to: 08.09.99**

Article No 123 **Article** Pils 0,5

Summary

		Filled hl			Filltime	
Charge Nos.	**Date**	**Is**	**Plan**	**Deviation**	**eff. (h)**	**Degree effec.**
0225-99-123-2	04.09.99	1762	1800	-38	8,1	89,6
0226-99-123-2	05.09.99	945,5	950	-4,5	4,2	88,5
0228-99-123-1	06.09.99	258,6	260	-1,4	1,1	90,5
0232-99-123-1	07.09.99	1200	1200	0	5	89,8
0235-99-123-2	08.09.99	1250	1200	50	5,1	89,4
Total		**5416,1**	**5410**	**6,1**	**10826,1**	

Bottling Rep.

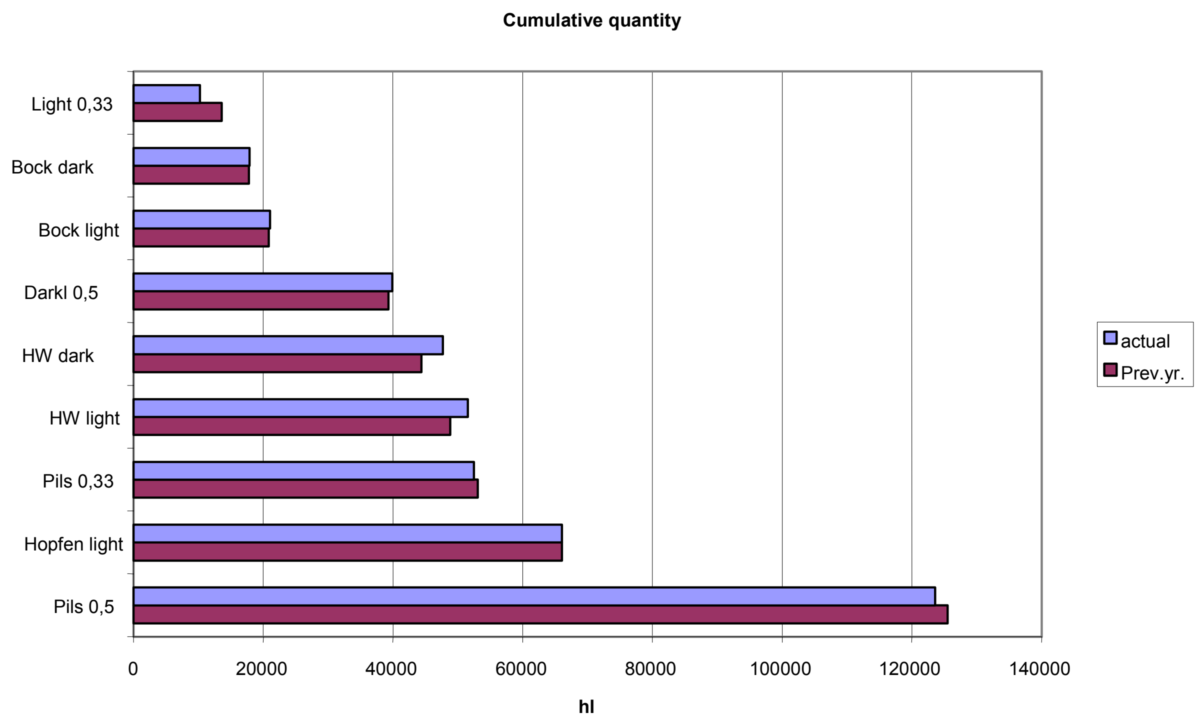
09.10.99 16:29

From: 04.09.99 **to: 08.09.99**

Sorted acc. to Quantity

Summary

		Filled hl			Cumulative from 01.01 to today		
Art. No.	**Article**	**Actual**	**Prev. yr.**	**Deviation**	**Actual**	**Prev. yr.**	**Deviation**
123	Pils 0,5	5416,1	5458,6	-42,5	123568,2	125468,9	-1900,7
246	Hopfen light	3877,3	3880,4	-3,1	65987,3	65988,0	-0,7
127	Pils 0,33	3001,3	3125,2	-123,9	52456,2	53069,9	-613,7
560	HW light	2987,9	2651,0	336,9	51500,0	48799,2	2700,8
580	HW dark	2450,6	2231,7	218,9	47650,2	44365,9	3284,3
341	Dark 0,5	1750,6	1710,2	40,4	39845,2	39254,6	590,6
756	Bock light	965,4	952,9	12,5	21003,6	20857,4	146,2
774	Bock darkl	897,5	901,2	-3,7	17890,5	17796,3	94,2
995	Light 0,33	450,3	503,2	-52,9	10254,3	13564,8	-3310,5
Total		**21797,0**	**21414,4**	**382,6**	**430155,5**	**429165,0**	**990,5**



TECHNISCHE UNIVERSITÄT MÜNCHEN

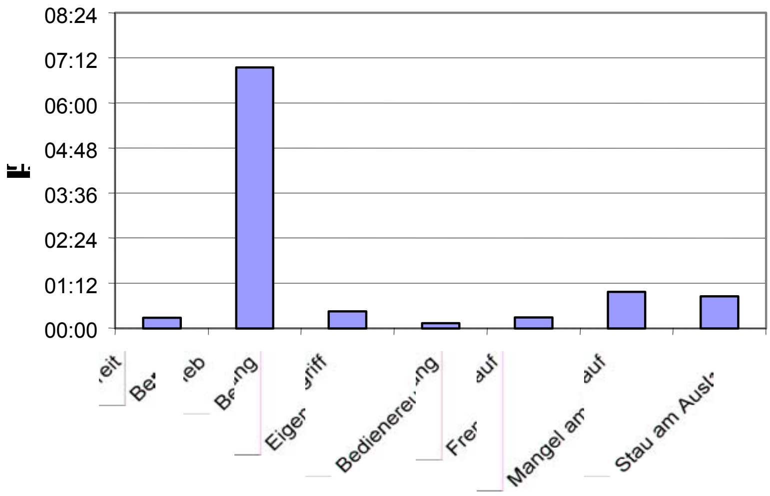
Machine Report

09.10.1999 16:29

From: 04.09.99 **to: 08.09.99**

Aggregate Filling machine 2

Operational Time



	Duration (/h)
Ready	00:16
Operatio	06:57
Self-fault	00:27
Operator action	00:08
Outside fault	00:17
Deficient/Entry	00:58
Build-up rundown	00:51

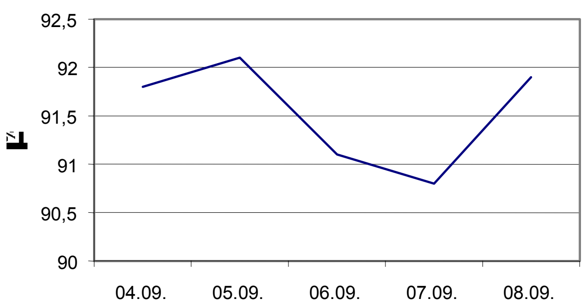
Störungshitliste

sortiert nach Dauer (min)		sortiert nach Häufigkeit	
Flaschenbruch	36	Flaschenbruch	18
Druckluftmangel	8	Allgem. elektr. Störung	8
Ventildefekt	6	Allgem. mech. Störung	5
Allgem. elektr. Störung	5	Druckluftmangel	3
Allgem. mech. Störung	2	Produktmangel	3
Produktmangel	1	Ventildefekt	1

Summe Fremdstörungen (min): 9
Summe Eigenstörungen (min): 49

Kennzahlen

Wirkungsgrad Durchschnitt:	91,54%
Wirkungsgrad Vorgabe:	92,00%
Wirkungsgrad Abweichung:	-0,46%
Einstellausbringung 0,5 NRW	55000
Durchschnittsausbr. 0,5 NRW	37850
Einstellausbringung 0,33 Vichy	60000
Durchschnittsausbr. 0,33 Vichy	41558



Wartungsdaten

Betriebszeit im Zeitraum	06:57		
Gesamt seit letzter Inspektion	187:32	**Letzte Inspektion**	05.07.1999
Gesamt seit letzter Abschmierung	52:28	**Letzte Abschmierung**	25.08.1999

Inspektion fällig am 05.11.1999
Abschmierung fällig am 11.10.1999

TECHNISCHE UNIVERSITÄT MÜNCHEN

Störungshitliste

09.10.99 16:29

Störbericht

vom: 04.09.99 **bis: 04.09.99**

Abfüllanl. 2
Uhrzeit 10:45

Sortiert nach Dauer

Störungen

Ort	**Ursache**	**Dauer (min)**
Entpalettiermaschine	Defekte Palette	15
drucklose Zusammenführung 3	Lichtschranke belegt	11
Füllmaschine	Defektes Ventil	10
Auspackmaschine	Elektr. Störung	8
Ausstattungsmaschine	Etikettenmangel	7
Reinigungsmaschine	Überlastkupplung	5
Füllmaschine	Produktmangel	5
Inspektionsmaschine	Dauerausscheidung	3
Verschließer	Druckluftmangel	2
Einpackmaschine	Greiferkopf aufgesetzt	1

TECHNISCHE UNIVERSITÄT MÜNCHEN

BLV

Störungsrückverfolgung

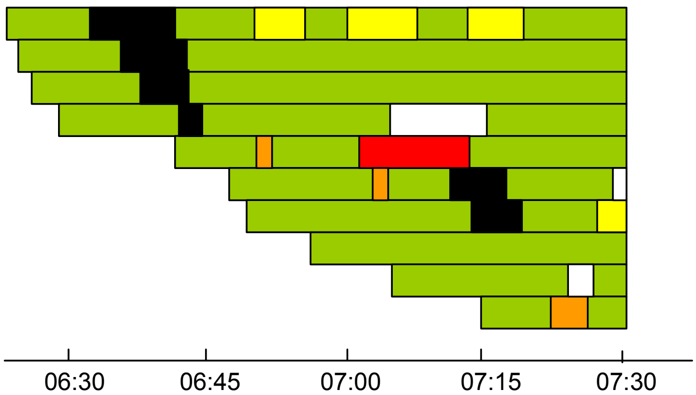
09.10.99 16:29

Störbericht

vom: 04.09.99 **bis: 04.09.99**

Abfüllanl. 2
Uhrzeit 07:30

Rückverfolgung



	Eta
Entpalettiermaschine	0,789
Kastenkontrolle	0,856
Auspackmaschine	0,921
Reinigungsmaschine	0,902
Inspektionsmaschine	0,897
Füller/Verschließer	0,890
Ausstattungsmaschine	0,905
Vollgutkontrolle	0,915
Einpackmaschine	0,923
Bepalettiermaschine	0,897

=Produktion =Störung =Flaschenmangel

=Bedienereingriff =füllerrelevante Störung =Flaschenstau

füllerrelevante Störungen

	Anteil	Dauer (min)
Entpalettiermaschine	0,00%	0,0
Kastenkontrolle	0,00%	0,0
Auspackmaschine	0,00%	0,0
Reinigungsmaschine	0,00%	0,0
Inspektionsmaschine	68,50%	7,5
Füller/Verschließer	15,40%	1,7
Ausstattungsmaschine	16,10%	1,8
Vollgutkontrolle	0,00%	0,0
Einpackmaschine	0,00%	0,0
Bepalettiermaschine	0,00%	0,0

TECHNISCHE UNIVERSITÄT MÜNCHEN

BLV

Inspektor-Testflaschenbericht

09.10.99 16:29

QM-Bericht

vom: 04.09.99 bis: 04.09.99

Details siehe Ausdruck an der Inspektionsmaschine

Inspektionsmaschine

Testläufe		Testflaschen	Erkannt	Störungsursache
04.09.99	06:28	10	10	
04.09.99	07:10	10	10	
04.09.99	07:55	10	10	
04.09.99	08:38	10	9	elektr. Störung Mündungskamera
04.09.99	08:43	10	10	
04.09.99	09:15	10	10	
04.09.99	10:45	10	10	
04.09.99	11:37	10	10	
04.09.99	12:08	10	10	
04.09.99	13:10	10	10	
04.09.99	13:55	10	10	

TECHNISCHE UNIVERSITÄT MÜNCHEN

BLV

CIP-Bericht

09.10.99 **16:29**

QM-Bericht

vom: 04.09.99 **bis: 08.09.99**

Bereich Flaschenkeller **Detail** Füllmaschine
Vorgang Reinigung und Desinfektion

Puffertank
KZE
Produktleitungen

CIP-Protokolle

	04.09.99 15:00	05.09.99 14:45	06.09.99 00:02	07.09.99 14:25	08.09.99 10:30
Lauge Leitwert (mS)	95	95	90	94	93
Lauge Zeit (min)	32	30	31	30	31
Spülen Leitwert (mS)	0,2	0,2	0,2	0,3	0,2
Säure Leitwert (mS)	53	55	55	53	54
Säure Zeit (min)	29	31	30	28	30
Spülen Leitwert (mS)	0,2	0,2	0,2	0,3	0,3
Steri. Temperatur °C	92	90	91	90	90
Steri. Zeit (min)	25	30	28	28	30

Lauge Leitwert (mS)
Lauge Zeit (min)
Spülen Leitwert (mS)
Säure Leitwert (mS)
Säure Zeit (min)
Spülen Leitwert (mS)
Steri. Temperatur °C
Steri. Zeit (min)