TECHNICAL DELIVERY SPECIFICATION

I GENERAL INFORMATION

Status 07/2015

Preface

The ZF Technical Delivery Specification for Machines and Machine Systems described here supersedes all prior Technical Delivery Specifications of ZF Friedrichshafen AG that relate to this subject. It contains the essential technical instructions for the purchase and construction of machines/machine systems and is divided into the following categories:

I. General Information
II Technical Equipment Instructions
III Approved Lists for Components, Assemblies and Process Materials
IV Supplementary Information Specific to Location.

The instructions included in Chapters I through III apply to all ZF locations. These instructions may be augmented by instructions that apply only to one ZF location or Customer issuing the purchase order. The Technical Delivery Specification is also supplemented by the ZF Purchasing Terms and Conditions for Machines and Machine Systems, requirement specifications, and other agreements made between ZF Friedrichshafen AG and the Contractor. Please note that the Contractor must comply with all instructions and agreements as part of the purchase order.

This Technical Delivery Specification will be updated at irregular intervals to reflect the current state of the art. Therefore, the Contractor must request the latest version of ZF Friedrichshafen AG's Technical Delivery Specification from the Customer. Provided that no other agreement has been made, the version of the Technical Delivery Specification valid at the time when the order is confirmed will apply to the construction of the machine/machine system.

Amendments to the previous version are underlined and marked in blue in all documents.

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Modification Service

Status	Chapter / Page	Description of modification including name of the person responsible	Date
07/2015	Preface / 3	Deleted: "IV Division and/or" Deleted in paragraph 2: "division and/or"	
	1 / 10	Added in paragraph 1: worldwide Deleted: paragraphs 2, 3 and 4	
	2.2 / 10	Deleted: paragraphs 1, 2, 3, 6 Added, final chapter: "Furthermore, reference is expressly made to the terms and conditions contained in Chapters 14 (Nondisclosure) through 16 (General) of the current version of the ZF Purchasing Terms and Conditions for Machines and Machine Systems."	
	2.3 / 10	Modified, final paragraph: "The Contractor must notify the Customer immediately about any changes to the project schedule that threaten to delay or compromise the completion of the order. Such changes require a release."	
	2.4 / 11	Deleted: final paragraph	
	2.5 / 11	Added: "... of the Customer"	
	2.7 / 11	Expressions corrected, final paragraph: "... work equipment requiring inspection and facilities requiring monitoring ..."	
	5.2 / 14	Replaced "work" [safety] with "safety of machinery" Replaced "two copies" with "one copy" Added: "(see Annex 1)"	
	5.4, 5.5	Deleted	
	6.4 / 16	Deleted: paragraph 2	
	7.2 / 17	Paragraph 5 modified: replaced "is to receive" with "shall receive"	
	7.3 / 17	Deleted: paragraphs 2 and 3	
	7.4	Deleted	
	9.2 / 18	Modified: replaced "A test run" with "The ready-for-operation delivery"	
	10 / 19	Deleted, paragraph 1 in brackets: "program print-outs"	
	11.2 / 20	Shortened, paragraph 3 to: "The complete and updated technical documentation is available in the defined formats (see Annex 1) in accordance with TA08."	
	11.3 / 20	Deleted: paragraph 1	
	11.4 / 20	Deleted: paragraph 2	
	12.3 / 21	Deleted: final paragraph	
	12.5 / 22	Deleted: "in Chap. 3.4.1"	
	14.1 / 23	Deleted 2nd sentence Modified, final paragraph: replaced "is to" with "shall"	
	15 / 23	Changed chapter number from 14.4 to 15; all following chapters have received a higher number as a result; deleted in paragraph 1: "... contractually agreed properties such as short-term process capability, long-term process capability, or ..."	
	17.1 / 25	New: **"17.1 ZF ABC risk analysis for spare parts and wear parts lists**	

		For all machines/machine systems, a risk analysis for spare parts and wear parts shall be conducted according to the provisions of ZF Friedrichshafen AG (Annex 4). To this end, all spare and wear parts installed in the machine/machine system shall be listed including their standard designation and sources of supply, and critical parts shall be identified based on the assessment of predefined criteria (sequence of failure, frequency of failure and identification). The filled-in template shall be part of the documentation."	
	18.1 / 26	Chapter added: **18.1 Service and maintenance concept** In the tender phase, the Contractor shall cooperate with the Customer to develop a service and maintenance concept.	
	18.3.4 / 27	Added, paragraph 4: "(also see TA07)"	
	19 / 28	Completely modified Energy Efficiency Chapter: In the quotation, the Contractor shall describe the status quo of the machine/machine system in terms of energy efficiency. The consumption values for regular operation, as well as for partial load operation and idle running shall be indicated. All energy efficiency measures that have been performed on the machine shall be listed and divided into the following categories: 1.) Measures involving the use of corresponding hardware (e. g. pumps, motors...) 2.) Measures involving shutdown strategies in partial load operation or during idle running (short-term standstill) 3.) Long-term shutdown (e. g. weekends) including automatic restart via the machine control unit. In particular, the automatic deactivation of power consumers during idle running, while guaranteeing a minimum (to-be-defined) run-up time for 5-minute (or longer) short-term standstills (to be agreed), and the automatic restart after long-term shutdowns shall be consistently implemented and demonstrated in accordance with quality requirements.	
	20 / 28	Modified, final paragraph: replaced "Current" with "Currently valid", "(see www.zf.com)" with http://www.zf.com/corporate/de/ company/purchasing_logistics/conditions_of_purchase/technical_supply_requirements/technical_supply_requirements.html All modifications: Helmut Bach, ZBST dept.	
01/2013	1-32	Current changes are marked in color (blue) and underlined, ZBOE4, Helmut Bach	2012-11-20
01/2011	1-32	Update, ZGM-B dept., Rita Gildemeier	2011-01-01
06/2009	1-33	Update, ZGM-B dept., Rita Gildemeier	2009-06-30
01/2008	1-32	Update, ZGM-B dept., Rita Gildemeier	2008-02-05
01/2005	3-28	Original	2005-01-01

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1 Scope of Application

The ZF Technical Delivery Specification for Machines and Machine Systems (hereinafter called "Technical Delivery Specification") described here is valid for all ZF plants worldwide.

The term "Contractor" refers to the supplier of the machine/machine systems, while the term "Customer" refers to ZF Friedrichshafen AG or the ZF location issuing the purchasing order.

2 General Requirements

2.1 Order of precedence

The relationship and order of precedence of this Technical Delivery Specification vis-à-vis other agreements between Customer and Contractor are governed by another authority, in the framework agreement generally, and/or in the minutes of negotiation.

In the event of contradictory statements within this Technical Delivery Specification, the provisions of Section II shall take precedence over those of Section I. The Contractor must notify the Customer about any contradictory statements within Sections I and II and cooperate on a solution.

2.2 Quotation

List the costs of any workpiece-specific scope separately.

The quotation must include information on all necessary media, connected loads, consumption values, dimensions and requirements for the installation site of the machine/machine systems. Submit a filled-out operating sheet (job card) for space and installation planning (based on Annex 3: Operating Sheet for Space and Installation Planning) when you submit your quotation.

Furthermore, reference is expressly made to the terms and conditions contained in Chapters 14 (Nondisclosure) through 16 (General) of the current version of the ZF Purchasing Terms and Conditions for Machines and Machine Systems.

2.3 Project schedule

When confirming the purchase order, the Contractor must send the Customer a detailed project schedule listing the Contractor's plans for completing the order. The Contractor must automatically update this project schedule at least every four weeks and then deliver it to the Customer.

The Contractor must notify the Customer immediately about any changes to the project schedule that threaten to delay or compromise the completion of the order. Such changes require a release.

2.4 Order processing

If the Contractor determines or is able to determine based on expert knowledge that he cannot, or only in a limited way for the intended purpose, properly perform the services agreed to, then the Contractor must notify the Customer about this immediately and cooperate on a solution.

2.5 Deviations

Any deviations from the Technical Delivery Specification require a written application with a sufficient technical explanation and are subject to the written approval of the Customer. Such deviations will only be valid for the order in question.

2.6 Overall machine function

If the existing machines/machine systems are expanded and/or modified, the Contractor shall also be responsible for the overall function of the machines/machine systems affected by the expansions and/or modifications, provided that no other agreement has been expressly made to the contrary.

Any modifications of the machine/machine system performed while work is being done on the order shall require the written consent of the Customer.

2.7 Equipment

The same equipment must be used within each machine/machine system. In other words, components and/or assemblies with the same function from different manufacturers may not be used.

Only components, assemblies, devices and process materials according to the Customer's approved lists may be used. They must be in their original condition and without any modifications whatsoever when installed. Unacceptable actions include the drilling of mounting holes, removing housing parts, modifying shaft ends and altering circuits.

The manufacturers' setup and installation instructions for devices and systems are binding.

The Customer must be informed of any work equipment requiring inspection and facilities requiring monitoring (components, assemblies and devices). They must be included in the Annex 2 Overview List. An agreement must be reached with the Customer on inspection periods (e. g. inspecting pressure reservoirs).

2.8 Subcontractors

The Contractor must ensure that all subcontractors also comply with the Technical Delivery Specification. The Contractor is responsible for arranging and coordinating this compliance.

2.9 Documentation of the Contractor

When there are constructions and workpiece-dependent equipment commissioned by the customer, the complete documentation (e. g. the construction drawings, assembly and individual part drawings with parts lists of the machine or machine systems, fixtures and tools) shall become the property of the Customer in copy-capable and/or electronic versions, and be made available without restrictions.

2.10 Customer's drawings

The Customer must safely destroy all received drawings, including copies and other duplications, within a reasonable amount of time.

Furthermore, reference is expressly made to the terms and conditions contained in Chapters 14 and 15 of the ZF Purchasing Terms and Conditions for Machines and Machine Systems.

2.11 Nondisclosure

This Technical Delivery Specification or excerpts thereof may only be passed on to third parties with the Customer's written consent.

Exhibits of the machines/machine systems intended for the Customer and the publication of photos, drawings, technology data, etc., shall require the written consent of the Customer.

Furthermore, reference is expressly made to the terms and conditions contained in Chapters 14 and 15 of the ZF Purchasing Terms and Conditions for Machines and Machine Systems.

3 Normative References

Although the Technical Delivery Specification may not indicate those aspects in detail, the Contractor is fully liable for ensuring that all requirements relating to the performance rendered by the Contractor – beyond the scope of the aforementioned Technical Delivery Specification – that are derived from regulations (e. g. EU directives, regulations and other applicable legislation) as well as standards and generally accepted rules of technology are adhered to (in the following called “directives, standards and rules”).

To the extent that the present Technical Delivery Specification refers to directives, standards and rules of technology, the Contractor has to independently verify whether these are relevant for the service rendered and whether there are other directives, standards and rules that the Contractor must observe. In cases of doubt, the Contractor must contact the Customer immediately.

Moreover, the Contractor will immediately inform the Customer if – thanks to his expertise in the matter concerned - the Contractor has gained knowledge or realized that the performance/service to be rendered for the Customer can only be used to a limited degree or not at all for the intended purpose.

4 Definitions

The definitions listed constitute supplementary information to DIN EN 60204-1, VDA-LVE, DIN EN ISO 12100 and VDI 2856.

4.1 Error list

The error list describes the sources, types and possible combinations of errors.

4.2 Operating modes

The Contractor must implement a secure automatic and initial setup operation in the machine/machine systems.

4.2.1 Automatic

During automatic operation, the production process of the machine/machine system runs automatically regardless of whether the loading takes place manually or with automation.

The following operating sub-modes are possible:

- Semi-automatic (automatic without loading automation):

  The machine/system runs with manual feeding and/or removal of parts.
- Fully automatic (automatic with loading automation):

  The machine/machine system runs with automatic feeding and/or removal of parts.
- Home position return:

  When this function is selected, the machine/machine system automatically moves to a defined position (home position).

4.2.2 Setup

In the setup operation, every function must be individually selectable in compliance with the safety rules (e. g. reduced speed and/or power, enabling button, two-hand operation, safety light grid). The setup operation shall be coordinated with the Customer.

4.3 Partial steps within the operating modes

4.3.1 Manual mode

Each individually defined program step is executed with a start signal. All safety devices are active.

4.3.2 Running empty

All parts within the machine/machine system or magazine are fully processed when the corresponding selection has been made in fully automatic operation. The feed inlet for processing additional parts is blocked.

4.3.3 Stopping at cycle end

When processing of the part is finished, the machine/machine system stops, e. g. in home position.

5 Design Approval / Release

5.1 Supplied drawings

In terms of correctness, completeness and feasibility in accordance with the contractual agreement, the Contractor must inspect drawings provided by the Customer for each order. If the Contractor has gained knowledge or realized - thanks to his expertise in the matter concerned - any related discrepancies and the necessary changes to address them, then the Contractor must notify the Customer about this immediately and cooperate with the Customer on a solution. Changes approved by the Customer must be incorporated.

5.2 Inspection and endorsements

Provided that no other agreement has been made to the contrary, one copy each of the function plan, the general and final drawings of the machine/machine system, the documentation for electrical engineering, mechanics, hydraulics, pneumatics, lubricating technology, cooling lubricating technology, as well as safety of machinery, environmental protection and fire protection must be delivered to the Customer for inspection. Enough time must be allowed so that changes made with the Customer's endorsement can also take place without delaying the manufacture of the machine/machine system (see Annex 1).

The endorsement does not affect the Contractor's contractual obligations.

As a rule, allow the Customer a period of at least two weeks for an inspection.

The Customer will provide the Contractor with the design approval / release once the inspection and any design discussions have been completed. The Contractor is responsible for arranging the schedule for this.

5.3 Discussion with suppliers about components and assemblies

Within four weeks following the design approval / release, the Contractor must contact the suppliers in the approved lists and those specified in the location-specific supplementary information as well as any other suppliers of components, assemblies, devices and process ma-

terials that are involved in producing the machine/machine system as needed in order to allow enough time to coordinate plans and to prevent delivery bottlenecks. The Contractor must automatically enter and update in the project schedule any scheduled discussions/meetings.

6 Test Run at the Contractor's Site

6.1 General requirements

The machine/machine system test run always takes place according to the contractual agreements or the Customer's specific test run terms and conditions at the Contractor's plant.

The machine/machine system test run at the Contractor's plant does not represent the Customer's final acceptance.

6.2 Preparation

The Contractor must coordinate the contents and date of the test run with the Customer. The Contractor must also contact the Customer again shortly before the test date to confirm the completion of the machine/machine system for the test run.

At least eight days before the test run, the Customer shall receive verification of successful processing trials of test workpieces (e. g. in the form of measurement reports).

If the Customer provides the Contractor with checklists for the test run, the Contractor must fill them in and return these to the Customer at the latest eight days before the test run.

If necessary, a technical department of the Customer shall visit the Contractor's plant to check for compliance with technical equipment instructions and approved lists before the planned test run. In this context, responsibility for coordinating deadlines lies with the Contractor.

6.3 Implementation

The Contractor's test run shall be conducted in the presence of Customer representatives.

A joint test run report shall be created at the end of the test run confirming its success, possibly with reserved rights concerning any stated defects (list of defects), or documenting its failure – likewise with a statement of detected defects (list of defects).

A test run must be accompanied by operating instructions and a declaration of conformity as well as all necessary pre-operation inspections and the corresponding test certificates and technical documents, including data carriers, and these are handed over to the Customer's project manager.

6.4 Defects

The Contractor must correct any defects detected during the test run by the time the machine/machine system is delivered to the Customer.

Furthermore, reference is expressly made to the terms and conditions contained in Chapters 10 and 11 of the ZF Purchasing Terms and Conditions for Machines and Machine Systems.

6.5 Delivery release

Delivery release / approval is a part of the test run at the Contractor's plant.

A successful test run at the Contractor's plant is a prerequisite for delivery release. The Customer shall give its delivery release to the Contractor by issuing a written confirmation in the test run report.

Once delivery release has been granted, the Contractor is to coordinate with the Customer about the delivery date for the machine/machine system and the date when the Contractor's technicians will begin their setup and assembly work.

7 Installation and Assembly

7.1 General requirements

The machine/machine system shall always be set up and assembled at the Customer's installation site according to the contractual agreements or the Customer's specific setup and assembly terms and conditions. Furthermore, reference is expressly made to the terms and conditions contained in Chapters 5 through 8 of the ZF Purchasing Terms and Conditions for Machines and Machine Systems.

Vibration-isolated setup is mandatory. This means that vibrations impacting surrounding areas must be minimized and that at least the requirements of DIN 4150 Part 2 are to be observed. The Contractor must provide the Customer with the necessary information regarding this process.

The Contractor must offer or supply the setup elements in accordance with the approved list.

If possible, the machine/machine system is to be set up without being fastened, i.e. no anchoring or doweling.

If it is not possible to set up the machine/machine system without fastening it, then the Contractor must coordinate with the Customer to determine the type of anchoring to be used for the machine/machine system. Suitably sturdy dowels and anchors are to be used.

7.2 Preparation

The Contractor must coordinate the contents and date of the setup and assembly work with the Customer.

The Contractor shall provide the Customer with basic requirements for the setup site, e. g. stiffness, large recess clearances, precision, information on vibration damping, anchoring, stress points, settling tolerances and other basic requirements that the Customer must follow.

The Contractor must become familiar with the local conditions of the setup site in advance. This shall take place at appointed times with the help of the Customer and involve, for example, the possibility of installation, the energy supply, as well as the arrangement and setup of assemblies like switch cabinets, coolant and lubricant systems and hydraulic units.

The Contractor must submit any relevant, detailed documents such as setup plans with connection data, execution drawings, assembly plans, updated operating sheet for space and installation planning, scheduling and staff allocation plans to the Customer for approval in good time and no later than 12 weeks before the start of setup work at the Customer's setup site. For the purpose of preliminary planning, the Customer shall receive a preliminary version at least four weeks after the order has been placed.

Before setup begins, the Contractor shall examine all pertinent foundations, connections, anchoring elements, recess clearances and pegs to make sure that the reference axes are correct. The date for this inspection is to be coordinated with the Customer.

If any machine/machine system is filled with material hazardous to water such as hydraulic fluids, lubricants, cooling lubricants, etc., the Contractor must prove its technical qualifications to the Customer in accordance with § 19 l of the Federal Water Act before setup work is to begin.

Before assembly, the Contractor must inspect any safety equipment and protective coatings at the setup site used to collect fluids that are hazardous to water. Defective areas may be closed in only after repairs have been completed. The Contractor must coordinate this with the Customer in each instance.

If hazardous materials and/or work substances are used or processed during the assembly of the machine/machine system, then the Contractor must provide the Customer with the name, type, quantity and storage location before assembly begins. The Contractor is responsible for the transport of such substances to and at the machine/machine system setup site.

The Contractor must contact the Customer again shortly before the delivery date to confirm the completion of the machine/machine system for delivery.

7.3 Implementation

Before and during the setup and assembly work, the Customer's safety coordinator and the Contractor must review the schedules and technical safety issues in terms of the provisions of the employers' liability insurance association (DGUV).

8 Initial Operation / Startup

The machine's/machine system's startup shall always take place at the Customer's installation site according to the contractual agreements or the Customer's specific startup terms and conditions.

The Contractor is responsible for providing the programming and service devices, tools, resources, measurement and test equipment and hoisting devices needed to start up, program and service the machine/machine system.

During startup, the Contractor is to list all setting parameters. This list is one of the requirements for final acceptance and must include the official date.

The Contractor must notify the Customer as soon as the startup has been completed.

9 Ready-for-Operation Delivery

9.1 General requirements

The machine/machine system shall always be delivered ready-for-operation at the Customer's setup site according to the contractual agreements or the Customer's specific terms and conditions for ready-for-operation delivery.

Ready-for-operation delivery does not represent final acceptance.

9.2 Prerequisites

All defects previously detected in the machine/machine system are corrected in coordination with the Customer.

The machine/machine system must pass the Customer's technical-safety inspection before ready-for-operation delivery can take place.

The Customer's operators are successfully oriented/instructed and trained according to the terms and conditions listed in Chapter 15.

The ready-for-operation delivery must be accompanied by operating instructions and a declaration of conformity as well as all necessary pre-operation inspections and the corresponding test certificates and technical documents, including data carriers, and these are handed over to the Customer's project manager.

9.3 Implementation

Ready-for-operation delivery shall be performed in the presence of both Customer and Contractor representatives.

A joint report shall be created at the end of the ready-for-operation delivery confirming a successful ready-for-operation delivery, possibly with reserved rights concerning any stated de-

fects (list of defects), or rejecting the ready-for-operation delivery — likewise with a statement of detected defects (list of defects).

9.4 Defects

The Contractor must coordinate with the Customer to schedule any corrections of defects discovered during the ready-for-operation delivery process.

If ready-for-operation delivery needs to be repeated and the Customer is not at fault, then the Contractor shall pay the Customer's expenses incurred while repeating the ready-for-operation delivery.

Furthermore, reference is expressly made to the terms and conditions contained in Chapters 9 through 11 of the ZF Purchasing Terms and Conditions for Machines and Machine Systems.

10 Test Run at the Customer's Site

The test run of the machine/machine system at the Customer's site is generally performed under the Customer's volume production operating conditions. During the test run, the latest version of software and hardware documentation (e. g. technical documents, on-site data carriers, etc.) must always be available to the operator.

If the Contractor needs to modify the PLC program after ready-for-operation delivery, then the data carrier containing the program valid at that time is to be picked up beforehand from the Customer's responsible maintenance department. After the modification of the PLC program has been completed, the data carrier containing the changed and updated program must be returned to the responsible maintenance department.

11 Acceptance

11.1 General requirements

Final acceptance of the machine/machine system shall always take place at the Customer's installation site according to the contractual agreements or the Customer's specific final acceptance terms and conditions. Furthermore, reference is expressly made to the mandatory terms and conditions contained in Chapter 9 of the ZF Purchasing Terms and Conditions for Machines and Machine Systems.

11.2 Prerequisites

All conditions of the machine/machine system agreed to between the partners (requirement specification, negotiation protocol, etc.), especially the agreed upon technical values (quality, cycle time, setup time, technical availability ≥ 98%, short-term process capability $c_{mk} \geq 1.67$, long-term process capability $c_{pk} \geq 1.33$, geometric measurements, etc.), are mandatory.

All defects previously detected in the machine/machine system are corrected. The Contractor must notify the Customer once the defects have been corrected.

The complete and updated technical documentation is available in the defined formats (see Annex 1) in accordance with TA08. See Annex I

The Customer's operators and maintenance personnel are successfully oriented/instructed and trained according to the terms and conditions listed in Chapter 16.

11.3 Implementation

The approved tools, clamping devices, jigs and fixtures are to be used during final acceptance. Any changes shall require written confirmation. During the final acceptance process, the reference workpieces described in the requirement specification shall be machined.

The same fastening and clamping spots are to be used for holding the workpieces that are to be machined as those that the Customer will use for the machine/machine system during volume production.

The machine/machine system must be warmed up at the start of and during final acceptance.

Workstation or emissions measurements are to be performed by an independent, licensed institution in coordination with the Customer as part of final acceptance. The Customer shall determine the conditions under which a measurement can be omitted. The Contractor shall bear the costs of these measurements.

Measures must be taken to ensure that the value measured during acceptance permanently and reliably stays below the current threshold value for hazardous materials and air pollution (e. g. work station limit value in accordance with Hazardous Substances Ordinance, TA Luft (Technical Instructions on Air Quality Control), TA Lärm (Technical Instruction on Noise Abatement)).

A joint final acceptance report shall be created upon completion of the final acceptance process confirming final acceptance, with reserved rights concerning any stated defects (list of defects), or withholding final acceptance — likewise with a statement of detected defects (list of defects).

11.4 Defects

The Contractor must coordinate with the Customer to schedule any corrections of defects discovered during the final acceptance process.

If a final acceptance process needs to be repeated and the Customer is not at fault, then the Contractor shall pay the Customer's expenses incurred while repeating the final acceptance process.

The Customer may withhold a reasonable sum from the remaining portion of the total price until all defects are corrected or until final acceptance has been granted.

12 Short-Term Process Capability (Machining Capability)

12.1 General requirements

The machine/machine systems must be capable of short-term process capability (machine capability) with the respective required properties for workpieces listed in the requirement specification in accordance with the applicable inspection and/or procedural instructions valid for the respective division with a c_{mk} value ≥ 1.67 or in accordance with other agreements.

The short-term process capability (machine capability) shall be guaranteed by the Contractor until the end of the warranty period.

12.2 Verification

The Contractor must prove the short-term process capability (machine capability) for the first time during the test run at the Contractor's plant. This is an essential part of the final acceptance criteria and is a requirement for final acceptance to be granted and the warranty period to end. In this case, the Contractor must satisfy the machine or system-specific requirements, respectively.

12.3 Defects

If the Contractor is not able to verify short-term process capability (machine capability) during the test run at the Contractor or during the acceptance process, the provisions specified in Chapter 6.4 or in Chapter 11.4 apply respectively.

If the short-term process capability (machine capability) of the machine/machine system fails during the warranty period and the Customer is not to blame, then the Contractor must correct this problem within a period determined by the Customer.

If the short-term process capability is not achieved after a reasonable period, then this shall be considered abnormal. To address this issue and to solve any outstanding problems, negotiations shall be taken up by both partners. The same shall also apply to serious damage during the warranty period.

12.4 Extension of the warranty period

If the short-term process capability (machine capability) is not realized during the last month of the warranty period and the Customer is not to blame, then the warranty period shall be extended automatically by one month, respectively, until short-term process capability (machine capability) is achieved.

12.5 Measuring equipment capability

The measuring and test equipment must be capable of measuring/testing the workpieces with a c_{gk} value > 1.0 with the required properties listed in the requirement specification or the accuracy required by the Customer vis-à-vis standard parts.

Furthermore, the rules specified in Chapters 12.2 to 12.4 apply respectively.

13 Long-Term Process Capability

13.1 General requirements

The machine/machine systems must be capable of long-term process capability with the respective required properties for workpieces listed in the requirement specification in accordance with the applicable inspection and/or procedural instructions valid for the respective division with a c_{pk} value ≥ 1.33 or in accordance with other agreements.

The long-term process capability shall be guaranteed by the Contractor until the end of the warranty period.

13.2 Verification

The long-term process capability is an essential part of the final acceptance criteria and shall be determined by the Customer for the first time following the ready-for-operation delivery of the machine/machine system, but no later than 6 months after ready-for-operation delivery. In this case the Contractor must satisfy the machine or system-specific requirements, respectively.

13.3 Defects

If the Contractor cannot provide verification for long-term process capability during the test run at the Customer, the acceptance implementation process is delayed until the time of the successful defect correction; the provisions specified in Chapter 11.2 apply respectively.

If the long-term process capability of the machine/machine system fails during the warranty period and the Customer is not to blame, then the Contractor must correct this problem within a period determined by the Customer.

If the long-term process capability is not achieved after a reasonable period, then this shall be considered abnormal. To address this issue and to solve any outstanding problems, negotiations shall be taken up by both partners. The same shall also apply to serious damage during the warranty period.

Furthermore, reference is expressly made to the terms and conditions contained in Chapters 10 and 11 of the ZF Purchasing Terms and Conditions for Machines and Machine Systems.

13.4 Extension of the warranty period

If the long-term process capability is not realized during the last month of the warranty period and the Customer is not to blame, then the warranty period shall be extended automatically by one month, respectively, until long-term process capability is achieved.

14 Technical Availability

14.1 General requirements

The machine/machine system must provide the technical availability (≥ 98%) required by the Customer.

Moreover, the machine/machine system shall provide a uniformly high degree of availability over its entire service life.

14.2 Verification

The technical availability and the downtime for the machine/machine system are determined using VDI 3423 as a basis. The technical availability and downtime are calculated in each case as the average of the last three months at the time of consideration. The evaluation itself shall take place each month.

14.3 Defects

If the technical availability of the machine/machine system fails during the warranty period and the Customer is not to blame, then the Contractor must correct this problem within a period determined by the Customer.

If the technical availability is not achieved after a reasonable period, then this shall be considered abnormal. To address this issue and to solve any outstanding problems, negotiations shall be taken up by both partners. The same shall also apply to serious damage during the warranty period.

Furthermore, reference is expressly made to the terms and conditions contained in Chapters 10 and 11 of the ZF Purchasing Terms and Conditions for Machines and Machine Systems.

15 Extension of the Warranty Period

If the technical availability is less than expected during the last month of the warranty period and the Customer is not to blame, then the warranty period shall be extended automatically by one month, respectively, until the agreed technical availability is provided.

16 Orientation/Introduction and Training of Operators and Maintenance Staff

16.1 General requirements

The Contractor is to document the successful instruction and training of the Customer's operators and maintenance personnel (scope, name of participants and signatures of instructor and participants). Multiple-shift operation of the machine/machine system is to be taken into account and performed for the respective shifts.

If the Customer's operators and maintenance personnel are insufficiently trained or are not trained on time due to the Contractor's negligence, then the Contractor must ensure the availability of the machine/machine system with his own personnel and at no cost to the Customer until the necessary training level is achieved.

16.2 Instructions

The instruction/training of the Customer's operators and maintenance personnel is included in the scope of delivery for the machine/machine system. The Contractor must coordinate the location, date and duration of the introduction with the Customer.

The instruction/training for the operators and maintenance personnel is to be performed separately.

The following mandatory topics must be dealt with comprehensively during the instruction/training:

- Overall machine/machine system function
- Automation concept
- Hardware setup
- Installation concept
- Operating and message concept (e. g. status messages and error reports)
- Software structure
- Modules for units (unit module, connecting module)
- Setup of data coupling (e. g. data exchange between machine control und coordinating control)
- Explanation of the option for changing the parameters and texts (incl. the execution of practical examples)
- Troubleshooting and error tracking using documentation, e. g. with the help of a programming device
- Safety and protective equipment
- Remaining risks to the machine/machine system.

16.3 Training

The Contractor is to submit a quotation coordinated with the Customer concerning the scope and cost of sufficient system training in hardware and software (e. g. for function and overview of the machine/machine system, CNC control, PLC control, drives, measuring systems and/or measuring equipment, hardware and software of the machine/machine system).

16.4 Introductory and training material

For the introduction or system training, materials from the documentation are to be prepared and made available to each introduction and training participant (such as programmed instruction, operating instructions, device descriptions, programming instructions, special course material, diagnostic aids, startup manual, safety instructions).

17 Provision of Spare Parts

The Contractor must ensure that the Customer can obtain spare parts for built-in components in the machine/machine system within 24 hours on weekdays. This also applies to any subcontractors.

The Contractor must make spare parts available to the Customer within 24 hours on weekdays for at least 15 years, beginning with the date of final acceptance (start of the warranty period) for the delivery item. Thereafter, the Contractor must at least keep drawings available so that the Customer can manufacture the item in-house. This also applies to any wearing parts.

If the Contractor, regardless of culpability, is not able or for some reason might not be able to meet the obligations of Paragraphs 1 and 2, either for the long term or short term, then he must inform the Customer immediately and collaborate on the appropriate corrective measures.

If special parts are used, the Contractor shall allow the Customer to order spare parts directly from the manufacturer.

17.1 ZF ABC risk analysis for spare parts and wear parts lists

For all machines/machine systems, a risk analysis for spare parts and wear parts shall be conducted according to the provisions of ZF Friedrichshafen AG (Annex 4).
To this end, all spare and wear parts installed in the machine/machine system shall be listed including their standard designation and sources of supply, and critical parts shall be identified based on the assessment of predefined criteria (sequence of failure, frequency of failure and identification).
The filled-in template shall be part of the documentation.

18 Efficient Maintenance and Machine Management (TPM)

18.1 Service and maintenance concept

In the tender phase, the Contractor shall cooperate with the Customer to develop a service and maintenance concept.

18.2 General requirements

The maintenance cost for the machine/machine system is to be kept as low as possible. The Contractor must indicate this in the quotation both in terms of time and money, assuming a runtime of 5,000 h. This amount is a criterion for the evaluation of the machine/machine system and may become part of the contract.

Non-productive and dead times for the machine/machine system must be kept to a minimum. This applies especially to setup processes. The Contractor must explain in writing which measures they have taken or planned, so that the machine/machine system can be quickly and safely reset within the setup time required by the Customer. Setup or resetting should not require any tools if at all possible.

18.3 Contents

18.3.1 Simple cleaning (TPM Stage 1)

The machine/machine system operators and/or the production personnel must be able to clean the machine/machine system easily.

An appropriate cleaning schedule must be provided to the machine/machine system operator.

Facings and covers shall preferably have smooth surfaces. Dirt-collecting corners, chip-trapping cavities and horizontal surfaces (interior angle < 90°) are to be avoided.

If dirt cannot be prevented, then suitable containers must be provided to collect it. These must be easy to empty without having to shut down the machine/machine system.

The ingress/distribution of soiling and particles is to be avoided.

When using fluids (cooling lubricant, hydraulic fluid, etc.), the seal integrity of all systems is especially important, in other words, the machine/machine system must not leak.

18.3.2 Implement known improvements / optimizations (TPM Stage 2)

In a joint meeting before design approval / release is given, the weaknesses identified by the Customer and Contractor must be presented and solutions must be developed to prevent and/or eliminate them. All optimizations and improvements must be scheduled and imple-

mented for the machine/machine system that will be built. The Contractor is responsible for coordinating this.

If machines/machine systems that are identical or similar in construction are to be delivered, then the updated standard as agreed between the Contractor and the Customer must be complied with. Moreover, all improvements identified by the Customer and Contractor must be taken into account and implemented in the machine/machine system to be built as agreed with the Customer.

If advances relating to possible improvements occur while the machine/machine system is being built, then these improvements must be taken into account and implemented — after consultation with the Customer.

18.3.3 Low inspection and maintenance costs (TPM Stage 3 and 4)

The machine/machine system must be low-maintenance, more specifically:

- Inspection intervals > 1 week
- Maintenance intervals > 1 year.

Any necessary inspection and maintenance points (e. g. oil level gage glasses, pressure gages, grease nipples, etc.) must be easily accessible and visible on the machine/machine system. The proper fill level or setting value must be marked in each case (min/max) or color-coded.

It must be possible to perform necessary inspections during machine/machine system operation.

All components of the machine/machine system that are not wear-free must

- be equipped with a central lube system or permanent lubrication,
- be capable of being re-adjusted or re-tightened,
- be exchangeable quickly and without special tools.

The necessary maintenance and inspection work must be clearly described in a maintenance schedule for each machine/machine system.

18.3.4 Ease and speed of repairs (TPM Stage 5 and up)

The diagnosis must be clear and comprehensive enough that the operator can independently detect and correct, if necessary, any malfunctions in the machine/machine system.

It should be possible for the machine/machine system operator to make simple repairs. This means that all components must be accessible and that sufficient installation and removal space is to be incorporated. To this end, all protective equipment must continuously remain in operation.

It must be as easy as possible to replace components and assemblies. Plugs are to be used in the connections.

If maintenance must be performed on machines, there must be safe platforms and/or signaling systems (also see TA07).

Components and assemblies are to be connected and protected in such a way that they are not damaged by such events as being stepped on, falling parts, chips and machine/machine system malfunction.

If identical machines/machine systems are to be delivered, all modified components and assemblies must be compatible. Components and control elements (sensors, actuators, plug-in connectors, wires, etc.) must be marked on the machine/machine system clearly and permanently. The function must be indicated on the basis of comprehensible plain text.

19 Energy Efficiency

In the quotation, the Contractor shall describe the status quo of the machine/machine system in terms of energy efficiency. The consumption values for regular operation, as well as for partial load operation and idle running shall be indicated. All energy efficiency measures that have been performed on the machine shall be listed and divided into the following categories:
1.) Measures involving the use of corresponding hardware (e. g. pumps, motors...)
2.) Measures involving shutdown strategies in partial load operation or during idle running (short-term standstill)
3.) Long-term shutdown (e. g. weekends) including automatic restart via the machine control unit.

In particular, the automatic deactivation of power consumers during idle running, while guaranteeing a minimum (to-be-defined) run-up time for 5-minute (or longer) short-term standstills (to be agreed), and the automatic restart after long-term shutdowns shall be consistently implemented and demonstrated in accordance with quality requirements.

20 Other Applicable Documents

Standard	Designation
DIN EN 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
VDA-LVE	German Association of the Automotive Industry - Delivery specifications for the electrical equipment of machines, machine systems and equipment
DIN EN ISO 12100	Safety of machinery - Basic concepts, general principles for design
VDI 2856	Standardized specification for inquiries and offers on machine tools
DIN 4150 Part 2	Vibrations in buildings - Part 2: Effects on persons in buildings
§ 19 WHG	Federal Water Act
German regulation on "AGW gem. GefStoffV"	Work station limit values in accordance with the Hazardous Substances Ordinance
TA Luft	Technical Instructions on Air Quality Control

TA Lärm	Technical Instruction on Noise Abatement
VDI 3423	Technical availability of machines and systems - Terms, definitions, determination of time periods and calculation

Currently valid ZF Purchasing Terms and Conditions for Machines and Machine Systems (see http://www.zf.com/corporate/de/company/purchasing_logistics/conditions_of_purchase/technical_supply_requirements/technical_supply_requirements.html)

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