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Guideline for marking and verification of special characteristics – No.: 381

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1 PURPOSE AND SCOPE

The determination of inspection and special characteristics and their tolerances is one of the essential prerequisites to secure the product and process quality. This guideline describes the uniform marking of inspection and special characteristics and defines which verification requirements apply for them. It is valid within the Domel group as well as for Domel suppliers. This guideline fully replaces previous document number 381. Issue date: December 1st, 2020.

Note: The determination of tolerances is not part of this guideline.

2 NORMATIVE REFERENCE

The integration of inspection and special characteristics in the drawing shall be executed according to function-, production- and inspection-related aspects. Herein, external requirements by bodies (for instance VDA, VDE, AIAG, ...), public authorities and customers as well as Domel-internal requirements must be considered and may have to be agreed with the customer and possibly with the supplier. This guideline applies to Domel group and shall also be applied by all service providers/suppliers assigned by Domel.

The following references apply to the current issue of each document, unless otherwise agreed:

- **SIST EN ISO 286-1** Specifikacija geometrijskih veličin izdelka - Tolerančni sistem ISO za dolžinske mere - 1. del: Osnova za tolerance, odstopanja in ujeme (ISO 286-1:2010) (Geometrical product specification (GPS) - ISO code system for tolerances on linear sizes - Part 1: Basis of tolerances, deviations and fits)
- **DIN 406-10** Engineering drawing practice; Dimensioning; Concepts and general principles (DIN 406, part 10:1992)
- **DIN 406-11** Engineering drawing practice; Dimensioning; Principles of application (DIN 406, part 11:1992)
- **SIST EN ISO 1101** Specifikacija geometrijskih veličin izdelka (GPS) - Toleriranje geometrijskih veličin - Tolerance oblike, orientacije, položaja in opleta (ISO 1101:2017) (Geometrical Product Specifications (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out)
- **VDA brand 1** Documented Information and Retention
- **VDA manual** Product creation - A process description covering special characteristics (SC)
- **General Quality Agreement (GQA)** for suppliers (internal Domel document)

All mentioned documents are available on Domel servers.

3 DEFINITION OF TERMS

3.1 SPECIAL CHARACTERISTICS

Special characteristics are characteristics, which may have an effect on the safety, the compliance with legal provisions, homologation (for instance VDE, CE, CCC, UL, CSE, ...), the performance or the further processing of the product (4F – **F**it, **F**orm, **F**unction, **p**er**F**ormance) or whose nonfulfillment might lead to severe economic damage. Herein, the state-of-the-art of science and technology shall always be considered. Special characteristics are defined as such externally (legislation, authorities, customers) or on the basis of internal expertise and standards.

Special characteristics must be assured and/or monitored, so that compliance with the requirements is always ensured. They may relate to the product or to the process. They must be unambiguous and verifiable either on the product or in the process.

Special characteristics must be marked without exception in all technically relevant documents of the product and process documentation and run like a common thread through product development and production all the way from the customer requirements to the product manufactured under series conditions.

According to their importance for the product, special characteristics are divided into the categories:

- P/S – Special characteristics related to safety
- P/L – Special characteristics related to legal and regulatory requirements
- P/F – Special characteristics related to functions and requirements.

The **critical** characteristics and so-called characteristics requiring **mandatory record-keeping documentation** are the special characteristics related to safety (P/S) and special characteristics related to legal (P/L) and regulatory requirements described in the chapters 3.1.1 and 3.1.2. Records about special characteristics shall be archived according to the requirements specified in VDA volume 1. **ATTENTION! Critical characteristics were previously marked as »K« or »A characteristic«, this instruction defines them as P/S and P/L as stated below.**

3.1.1 SPECIAL CHARACTERISTICS RELATED TO SAFETY (P/S)

A characteristic is to be classified as special characteristics related to safety, whenever safety aspects (safety requirements, product safety, safety-relevant consequences) are concerned. The non-compliance of the characteristics may cause an immediate risk to life and limb and is foreseeable. An example of such characteristic on Domel products is high voltage insulation strength (previous designation in Domel documentation was “A documentation” or marked as K – critical characteristic).

3.1.2 SPECIAL CHARACTERISTICS RELATED TO LEGAL REQUIREMENTS (P/L)

Special characteristics related to legal and regulatory requirements refer to specifications valid at the time of the introduction of the product to the market. These may be legally or approval-relevant - e.g., homologation (VDE, CE, CCC, UL, CSE, ...).

3.1.3 SPECIAL CHARACTERISTICS RELATED TO FUNCTIONS AND OTHER REQUIREMENTS (P/F)

These special characteristics refer to:

- Ability to assemble (**Fit**)
- Important functional requirements (**Form, Function, perFormance**)
- Appearance.
- The quality of the subsequent work processes.
- Severe economic damage to customer and/or supplier.

3.2 INSPECTION CHARACTERISTICS (K/K)

Inspection characteristics serve primarily to control production processes. They can be defined as mandatory Inspection characteristics towards the production areas based on experience and process know-how. The definition will be done using the respective marking in the drawing (see paragraph 4.1). These Inspection characteristics shall be included into the Control Plan and shall be marked there accordingly, too. **Several possible examples below, the simplest Domel example is a turning diameter of shaft, important for further grinding operation, but not present on the final shaft drawing.**

Proofs/test records for Inspection characteristics are to be archived for minimum of 3 (THREE) years after creation of the document (following VDA Band 1 “Documented Information and Retention”).

3.3 SOME EXAMPLES FOR TYPES OF CHARACTERISTICS, WHICH MAY BE MARKED AS INSPECTION OR SPECIAL CHARACTERISTICS:

- Overload protection elements or circuitry or function.
- All geometry-related dimensions.
- Function-relevant information, such as water-tightness, performance, torque, noise etc.
- Information on decorative, visual properties.
- Information on surface properties (roughness, porosity, ...).
- Shape and positional tolerances.
- Information on heat treatment and material.
- Information on tothing, threading etc.
- Surface treatment information.
- Information on welding.
- Information on workpiece edges.
- Specifications relating to flammability/combustibility of materials.
- Heat resistance, impact resistance, flexural strength of materials.
- Characteristics related to the process, e.g., pull/push/shear forces, starting power.

3.4 FURTHER DEFINITIONS OR TERMS RELATING TO DIMENSIONS AND CHARACTERISTICS

Further definitions of terms relating to dimensions, tolerances and fits as well as their marking are given in SIST EN ISO 286-1, SIST EN ISO 1101 and DIN 406-10 which are available on internal network of the company.

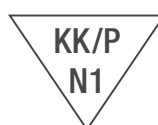
Variable characteristics are measured and their characteristic values are indicated as numerical values plus unit (e.g. 0.5 mm, 10 V).

Attributive characteristics may be described with words (e.g., OK/NOK, flammability rating: minimal hazard/slight hazard/moderate hazard/serious hazard/severe hazard, assessment of the visual quality by means of school marks: 5 = excellent, ..., 1 = very poor).

4 MARKING OF INSPECTION AND SPECIAL CHARACTERISTICS IN TECHNICAL PRODUCT/PROCESS DOCUMENTATION

4.1 INSPECTION CHARACTERISTICS

Marking of Inspection characteristics in a drawing is done with an upside-down triangle with text KK/P (Inspection characteristic for Production/Process).



Inspection Characteristics shall be included into the Control Plan and marked there accordingly as well. In the Control Plan the Inspection characteristics can be marked with the same sequence of characters "KK/P" in the classification column. In other text documentation Inspection can be marked with text following the Characteristic definition, for instance: dimension $50,5 \pm 0,1$ KK/P N1. Marking of Inspection characteristics in further documents is not required.

4.2 MARKING ACCORDING TO CUSTOMER REQUIREMENTS (IN DOMEL)

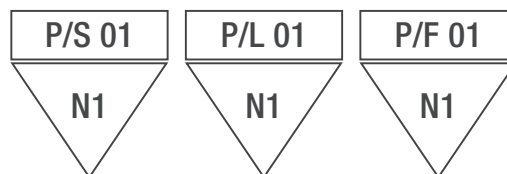
Special characteristics shall be marked in the entire product and process documentation according to paragraph 4.3 of this document. The assignment of additional equivalent customer symbols to Domel documentation is also possible up to the agreed extent (mainly when we use customer's drawings).

4.3 DOMEL MARKING

For clear identification, special characteristics are also marked with inverted triangle with added rectangle on the top (to emphasize the importance of the characteristic) and the following letters in all relevant documents (following to VDA recommendations):

- P/S – Special characteristics related to safety
- P/L – Special characteristics related to legal and regulatory requirements
- P/F – Special characteristics related to functions and requirements.

The following symbols are to be used to help finding special characteristics on a drawing (examples):



The symbol must contain the following information:

- Category of special characteristic (e.g., P/S)
- Consecutive numbering of the characteristics (e.g., 01). Each category and each drawing requires independent numbering.
- Inspection level (e.g., N1, in case of special agreement with customer we use marking NS with explanation near the head of the drawing).

To find the Special characteristics more easily in free text documents (e.g., work instructions, test instructions), it is recommended to highlight these characters in bold and/or in square brackets, for instance

[dimension 10,00 ± 0,01 P/F 01 N2].

4.3.1 TOTAL NUMBER OF INSPECTION AND SPECIAL CHARACTERISTICS ON THE DRAWING

The total number of inspection and special characteristics and the reference to this guideline shall be indicated on the drawing as follows:

Inspection and special characteristics according to guideline No.: 381:

Total count of inspection and special characteristics = ...

KK/P – Inspection characteristic ' = ...

P/S - Special characteristics related to safety = ...

P/L - Special characteristics related to legal and regulatory requirements = ...

P/F - Special characteristics related to functions and requirements = ...

Special characteristics that are omitted, added or changed for any reason during the life of the drawing are to be indicated on the drawing by means of a change index (see OP 29).

A marking which has been assigned once in a drawing (e.g., P/F 02) must not be used again if the respective special characteristic is omitted.

4.4 VERIFICATION REQUIREMENTS

Fundamentally, every dimension and characteristic given in a drawing shall be observed by all parts.

4.4.1 VERIFICATION REQUIREMENTS FOR INSPECTION AND SPECIAL CHARACTERISTICS

For each inspection and special characteristic, the inspection level is indicated on the drawing (see symbols in paragraph 4.1 and 4.3). The inspection levels and the related minimum requirements are described in paragraph 4.4.2. Details relating to the inspections (extent and frequency of random sampling, reaction plan, requalification tests) are agreed between the supplier and the customer (Domel can play both roles in the process) and stated in the Control Plan (pre-series and series). Testing according to the Control Plan is to be executed and documented by the manufacturer throughout the entire series production. The results shall be made available on request.

As special characteristics (as well as inspection characteristics) play an essential role in ensuring product and process quality, it shall be ensured by means of initial qualification and continuous process monitoring that the requirements relating to special characteristics are always fulfilled on all manufactured parts/devices. The inspection level will be determined with respect to technical reasons.

4.4.2 DEFINITION OF INSPECTION LEVELS

Proof of machine and process capability values is performed according to OP 34 – Determination of capability and reliability of machinery and processes.

Procedure for external suppliers is described in General Quality Agreement (GQA) signed by supplier(s).

INSPECTION LEVEL N1

Variable characteristics (a):

- 1) Proof of short-term-/machine capability C_{mk} for ISIR/PSW.
Calculation basis ≥ 50 pcs per tool/nest.
- 2) Proof of preliminary process capability P_{pk} .
Calculation basis ≥ 125 pcs e.g. collected in 25 shifts at 5 pcs each
- 3) Proof of long-term process capability C_{pk} or P_{pk} respectively with instable processes.
Calculation basis: production period ≥ 20 days and ≥ 250 pcs (e.g. 2 x 5 parts per shift in 2-shift production: 400 parts after 20 production days; or 1 x 5 per shift in 1-shift production: 250 parts after 50 production days).
- 4) The collection of the random¹ samples for preliminary and long-term process capability shall be accompanied by a process control chart (SPC control charts). It shall be maintained over the entire production period. The test frequency shall be selected to ensure a sensible statistical process control suitable for the production process. Random sampling size ≥ 5 pcs is recommended².

Remark 1-4: For processes with very small production volumes (e.g., annual requirement produced in < 5 shifts) or for special processes (e.g., production of parts in a 50+ cavity tool), special agreements can be made between manufacturer and customer (Domel can play both roles in the process).

If short-term capability, preliminary capability or long-term process capability cannot be proven, 100% testing of the characteristic is required. In case of destructive tests or very complex tests, a suitable random sampling test including control chart monitoring may be executed instead. The actual reaction plan shall be defined in the Control Plan.

¹ Random sampling means sampling of random pieces in pre-defined fixed time intervals.

² Project team can define different sample size in the Control plan.

Variable characteristics in processes with present systematic variation sources (b):

SPC by definition is suitable only for processes where all sources of systematic variation were eliminated, and only random sources of variation are influencing the process output. We are aware of several processes where we cannot eliminate systematic source of variation, but we recognized them, and we are controlling them. So, characteristics from such processes e.g.:

- grinded diameters of shafts (wear of grind wheels).
 - dimensions on punched parts and stacks (wear of cutting blades and matrices),
- cannot be approved and controlled with SPC methodology, the variation between “in a moment” produced consecutive parts is minimal, so the use of Xbar-R control charts is of no added value as well. Such characteristics have well known “saw-tooth” shape of time plotted values, therefore I-MR (individual values and moving range) control charts gives us the most information about the process. For example, sampling of 1 piece every 2 hours and the definition of safety limits. When the process (characteristic) value reaches the safety limit, process shall be stopped and readjusted (leveling of grinding wheels, sharpening of punch tool).

Documentation (Domel internally, Excel, Minitab reports):

Remark: 1a), 2a), 3a) initial:

- Capability indices, distribution, mode of calculation.
- Actual value, mean value, standard deviation.

Remark: 4a) and 4b) permanent:

- SPC-charts:
 - Xbar-R (a)
 - I-MR (b)

Attributive characteristics:

100% testing shall be performed throughout the entire production period. The documentation/proof of 100% testing (measured variables as well as attributive characteristics) will be determined project-specifically.

Inspection level N2

1) Proof of short-term/machine capability (C_{mk}) for ISIR/PSW

Calculation basis ≥ 50 pcs per tool/nest

2) Regular random (see ¹ above) sampling for actual values (frequency depends on the potential changes in the process, such as material batch changes etc.) with random sample size of ≥ 5 pcs per tool/nest (see ² above). For these characteristics, it is not necessary to keep a control card. .

Documentation (Domel-internal: Excel, Minitab reports):

Remark 1) Initial:

- Capability indices, distribution, mode of calculation
- Actual value, mean value, standard deviation

Remark 2) Permanent:

- Actual values.

Inspection level N3

1) Proof for ISIR/PSW: Actual values lie within the specification.

Sample size ≥ 5 pcs per tool/nest (see ² above)

2) Regular random (see ¹ above) sampling for actual values (frequency depends on the potential changes in the process, such as material batch changes, tool wear depending on the number of shots etc.) with sample size ≥ 5 pcs per tool/nest (see ² above). For these characteristics, it is not necessary to keep a control chart³.

³ SKL records are not control charts. Control charts are defined in the SPC manual which is available on the company intranet.

Documentation:

Re. 1) Initial:

- Actual values

Re. 2) Permanent:

- Actual values

Inspection level N4

The verification requirements of inspection level N4 correspond to those of N3, but they are used for attributive characteristics or measured variables which will be tested with a gauge during production.

- 1) Proof for ISIR/PSW: Actual values lie within the specification. For attributive characteristics a clear OK/NOK result is sufficient. Sample size ≥ 5 pcs per tool/nest (see ² above).
- 2) Regular random (see ¹ above) sampling with an attributive test, e.g. OK/NOK gauge (frequency depends on the potential changes in the process, such as material batch changes, tool wear depending on the number of shots etc.) with sample size ≥ 5 pcs per tool/nest (see ² above).

Documentation:

Re. 1) Initial:

- Actual values (measured variables) or test result OK/NOK (attributive characteristics)

Re. 2) Permanent:

- Test result OK/NOK

Inspection level NS

(Poseben nadzor. Velikost vzorca in nadzor določena za posameznega kupca oz. projekt).

- 1) Proof for ISIR/PSW: Actual values lie within the specification. For attributive characteristics a clear OK/NOK result is sufficient. Sample size ≥ 5 pcs (see ² above).

Inspection level NS is applied for all special characteristics which change very slowly, if at all, and which do therefore not require series-accompanying monitoring. A different random sample size can be defined, it shall be agreed with customer. NS characteristics shall be tested 1x per year (requalification) unless agreed otherwise.

Documentation: Actual values (measured variables) or OK/NOK test result (attributive characteristics).

Table 1: Inspection levels overview

	Inspection level	N1	N2	N3	N4	NS
Initial	Proof	1) Short-term/machine capability, C_{mk} . 2) Preliminary process capability, P_{pk} . 3) Long-term process capability C_{pk} or P_{pk} for unstable processes.	Short-term/machine capability, C_{mk} .	Actual values lie within the specification.	Actual values lie within the specification or clear OK/NOK result (for attributive characteristics).	Actual values lie within the specification or clear OK/NOK result (for attributive characteristics).
	Extent of sampling	1) ≥ 50 pcs per tool/nest 2) ≥ 125 pcs e.g. collected in 25 shifts, 5 pcs each 3) Production period ≥ 20 days and ≥ 250 pcs.	≥ 50 pcs per tool/nest.	≥ 5 pcs per tool/nest (see ² above).	≥ 5 pcs per tool/nest (see ² above).	≥ 5 pcs per tool/nest (see ² above).
	Documentation	Capability index, distribution, mode of calculation, actual values, mean value, standard deviation.	Capability index, distribution, mode of calculation, actual values, mean value, standard deviation.	Actual values.	Actual values.	Capability index, distribution, mode of calculation, actual values, mean value, standard deviation.
Permanent	Proof	Keeping of a process control chart (SPC) (Xbar-R, I-MR, ...).	Regular random (see ¹ above) sampling for actual values.	Regular random (see ¹ above) sampling for actual values.	Regular random (see ¹ above) sampling with an attributive test.	Annual testing unless otherwise specified.
	Extent of sampling	≥ 5 pcs (see ² above).	≥ 5 pcs per tool/nest (see ² above).	≥ 5 pcs per tool/nest (see ² above).	≥ 5 pcs per tool/nest (see ² above).	≥ 5 pcs (see ² above).
	Documentation	Process control chart (SPC).	Actual values.	Actual values.	Test result OK/NOK.	Test result OK/NOK.
Remark	Additional instructions	100% testing is required if one of the capabilities cannot be proven. For attributive characteristics, 100% testing is required				A different sample size may be defined, but requires agreement with customer.

4.4.3 ADDITIONAL REQUALIFICATION⁴ REQUIREMENTS FOR SUPPLIERS

Characteristics with inspection level N1 are part of the requalification testing having to be executed 1x per year, unless specified otherwise. A requirement is the proof of the long-term process capability (C_{pk}), according to paragraph 4.3.2, inspection level N1, item 3. The proof can be provided from the latest data from the series-accompanying tests. There is no need for separate additional measuring. Characteristics with inspection level N2 are part of the requalification testing having to be executed 1x per year, unless specified otherwise. The proof can be provided from the latest data from the series-accompanying tests. Characteristics with inspection levels N3, N4 and NS are part of the requalification testing having to be executed 1x per year, unless specified otherwise. A requirement is the repeated proof, according to paragraph 4.3.2, of inspection level N3, N4, or NS, item 1, proof for EMPB/ISIR/PSW.

⁴ Some customers use the terms “yearly layout check” or “layout inspection” instead of requalification.