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1. PURPOSE

This Technical Specification sets out the minimum manufacturing inspection requirements to purchase orders for steelwork equipment, pipes, flanges and fittings for PETROBRAS.

This requirement are complementary to I-ET-0000.00-0000-972-1AL-001 -Quality of Materials General Requirements. This Complementary Requirement shall prevail in case of disagree.

2. SCOPE

This requirements apply to the families of steelwork equipment, pipes, flanges and fittings listed on the Petronect website or when referred in the purchase order:

- Pressure vessels, process reactor, process tower (including its components and internals) etc.
- Tube and Shell heat exchanger (including components e.g.: tubular beam, tube sheet), plate type heat exchanger, air cooler, air preheater for furnaces and boilers etc.
- Boilers, furnaces and industrial burners;
- Storage tanks and spherical gas storage tanks;
- Pipes for pipeline transportation systems and tubes of thermal exchange;
- Piping accessories: forged and tubular fittings (e.g. flanges, curves, reductions, nipples etc.);
- Flow Metering Systems, Injection Systems and City Gates etc.

3. REFERENCES

- I-ET-0000.00-0000-972-1AL-001 - Quality of Materials General Requirements
- ABNT NBR 16278 – Manufacturing Inspection – Qualification and Certification of Personnel for the Oil and Gas Sector


Documents applicable to the project are not limited to the ones listed in the Complementary Requirement other documents listed in the contract shall be attended.

In case of disagree between the complementary quality requirements and contractual documents, the supplier shall notify PETROBRAS, and shall prevail contractual specifications.

4. DEFINITIONS

The definitions adopted in this document are present in I-ET-0000.00-0000-972-1AL-001 and ABNT NBR 16278.

During elaboration of Inspection and Test Plan (ITP), the acronyms defined in I-ET-0000.00-0000-972-1AL-001 shall be use.

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5. EQUIPMENT CATEGORIZATION

The following equipment are considered under special requirements service using H₂, H₂S, lethal, toxic, clad, with heat treatment of stress relief, control of fracture toughness etc.

The equipment shall be classify according to the project standard of the other contractual documents.

The categorization and classification of the equipment according to the contractual documentation shall be included in the ITP and other relevant documentation.


6. INSPECTION PLANNING

Planning guidelines and standardized definitions are describe in the Quality of Materials General Requirement.

6.1 Hold Point

The steps listed below are considered the minimum follow-up to be carried out by manufacturing inspection responsible, referred to as hold points, and shall be detailed in the ITP, when applicable:

- a) qualification of welding procedures;
- b) receiving inspection of raw material;
- c) clearance to start the welding, according to item 9.2;
- d) clearance of NDT procedure for the respective examination;
- e) production tests;
- f) beginning of heat treatment;
- g) dimensional examination of equipment (internally and externally);
- h) internal and external visual examination;
- i) clearance for execution of the hydrostatic test, after **g** and **h**, records verification of inspections and tests in the ITP;
- j) hydrostatic test;
- k) painting inspection (visual examination, thickness measurement and adhesion);
- l) check spare parts and internal parts that shall be assembled in the field before shipment (when applicable);
- m) final inspection, verification of the equipment identification and of all inspection records foreseen in the ITP, including reports of non-conformities issued during the entire manufacturing, assembly and testing process;
- n) verification of the manufacture technical documentation book (data book). The Release Notice (CLM) shall be issued only after the approval of the data book;
- o) check equipment packing for shipment (when applicable).

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Other inspection and testing activities required in the contractual documentation shall be included in the ITP. The participation of manufacturing inspection responsible shall be defined when the ITP is analyzed and approved.

7. INSPECTION AND TEST PLAN - ITP

The supplier shall prepare an ITP contained in its Quality Plan, following the standard ISO 9001, I-ET-0000.00-0000-972-1AL-001 and this Complementary Quality Requirement. The ITP shall ensure the compatibility of the equipment supplied with the project, specifications, procedures and contractual documentation.

A ITP shall be prepared for each equipment to be supplied, which shall include the classification of the equipment according to the project and the contractual documentation.

The ITP shall meet the same requirements and acceptance criteria set out in the contractual documentation even for components and parts manufactured in sub-suppliers.

8. ACCOMPLISHMENT OF MANUFACTURING INSPECTION

The documents listed in this section are subject to verification and clearance by manufacturing inspection responsible in the beginning of the process or at the PMM.


8.1 Clearance to start manufacturing

The inspection and testing plan shall be approved by manufacturing inspection responsible in order to begin production;

8.2 Clearance to start welding

The following items shall be submitted to manufacturing inspection responsible, for verification, before the beginning of welding, when applicable and specified in contract:

- a) certification of welding inspectors;
- b) submit welding consumables storage and handling procedure approved by welding inspector;
- c) WPS, PQR and welding plans approved by welding inspector and cleared by manufacturing inspection responsible. The NDT shall be in accordance with the ITP;
- d) qualification of welders and / or welding operators;
- e) welding consumables quality certificates;
- f) welders and / or welding operators performance control criteria. Welders and welding operators with a repair index (every two weeks) higher than the one settled are considered unqualified, they shall be submit to training and requalified;
- g) qualification of the repair procedure by welding inspector, including how to remove the defect, perform the repair, the types and extent of non-destructive testing to be perform;


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- h) procedure for the removal of temporary welds, including the method of certification to be used, and subsequent inspection.

8.3 Inspection and test activities

Documents subject to verification by manufacturing inspection responsible before the activity, when applicable and specified in the contract:

- a) certification of NDT inspectors;
- b) certification of paint inspectors;
- c) certification of dimensional control inspectors;
- d) qualification and adequacy of the inspection procedure by non-destructive testing by level 3 inspector in the respective technique;
- e) qualification and adequacy of the painting procedure by a painting level 2 inspector;
- f) dimensional control procedure qualified by dimensional control inspector;
- g) procedure of identification, transfer and control of traceability of materials;
- h) Nonconformity Report (NCR) control procedure. The NRCs shall be submitted to manufacturing inspection responsible containing the opinion of the manufacturer on the corrective actions to be taken, before their execution and, subsequently, the closing thereof;
- i) drawings cleared for manufacturing;
- j) PMI procedure;
- k) reaming procedure;
- l) forming procedure (e.g. straightening, tube bending, calendaring, stamping etc.)
- m) seal test procedure (leak-tightness);
- n) examination procedure for delta ferrite content;
- o) internal and / or external coating application procedure;
- p) report model for dimensional examination, indicating dimensions and their tolerances;
- q) stress relief heat treatment execution procedure;
- r) hydrostatic test procedure (including drainage, cleaning and drying after the test);
- s) functional testing procedure;
- t) procedure for pickling, passivation and inertization;
- u) refractory and thermal insulation installation procedure;
- v) calibration certificates of instruments to be used for inspection and factory testing through standards traced to the Brazilian calibration network or similar when the equipment is manufactured abroad;
- w) packing, shipping, transport and storage procedure;
- x) indication of the devices / equipment, including the required accuracy, for obtaining quality, checking critical dimensions, performance and acceptance tests;
- y) forging procedure for fittings.

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8.4 Tests

Test procedure shall be prepared according to project rules and contractual complementary requirements (RM, ET, FD etc.) and shall include the following information when required in the contractual documentation. Objective, applicable standards, personnel qualification, test description, acceptance criteria, conditions for execution (area, devices and ancillary equipment, safety etc.), test fluid, chloride content (for materials subject to corrosion by chlorides), use of corrosion inhibitors (if applicable), filter conditions and suitability, lighting, resolution and calibration of gauges, transducers, displays, dampers and software.

The Supplier shall have the means to ensure the visualization of all pressurized interfaces where leakage may occur during the tests.

The equipment included in the NR-13 shall be subject to the Hydrostatic Test (TH) at the end of the manufacturing, with proof by means of an expert opinion signed by a Qualified Professional (PH – “Profissional Habilitado”) and have the test pressure value marked on its nameplate.

For the purposes of NR-13, a Qualified Professional (PH) is considered to have legal competence to perform the occupation of engineer in activities related to construction, operation and maintenance follow-up, inspection and supervision of boiler inspection, pressure vessels and pipelines in accordance with the professional regulations in force in Brazil.

It is the responsibility of the manufacturer to assign the Qualified Professional (PH) and issue the hydrostatic test report, to be included in the equipment records as required by NR-13.

8.5 Dimensional

Supplier engineering department shall record the dimensions considered critical based on the project criteria and contractual documents.


The manufacturing inspection responsible shall witness dimensional examination of standard dimensions and interfaces. Dimensional examination of shape and position shall be recorded.

Dimensions reworked due to non-conformities shall be present for follow-up by manufacturing inspection responsible.

9 RECORDS AND CERTIFICATION

9.1 Traceability

Supplier shall identify and track all components defined as critical in ITP. They shall also consider the premises set out in the Quality of Materials General Requirements and in this Complementary Requirements.

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9.2 Quality Records

The following quality records (including sub-contractors), where applicable, shall be submitted for verification by manufacturing inspection responsible:


- a) certificates of raw materials and components;
- b) materials and equipment receiving inspection report, it shall attend a methodology of traceability of the parts with their certificates;
- c) non-destructive testing reports foreseen in ITP and Welding Plan;
- d) reports of non-conformities containing the respective analysis of the manufacturer, corrections, corrective actions, preventive actions and evidence of PETROBRAS acceptance when there is a change in the project;
- e) technical consultations;
- f) dimensional examination reports;
- g) destructive tests reports;
- h) certificates of welding consumables;
- i) stress relief heat treatment records;
- j) hydrostatic, pneumatic and leak-tightness test report;
- k) reports of coating application inspections, detailing the surface preparation, each layer applied, as well as results regarding the thickness and adhesion and mapping of the retouched regions

NOTES:

- i. It shall be understood that raw material certificate is origin certificate of the material, coming from the plant / steel mill. Certificates from reseller / distributor are not considered valid. Certificates shall have chemical composition, mechanical tests, heat treatments etc. They shall also indicate the manufacturing process and specific process requirements, which shall meet the specific product standard.
- ii. Other examinations, tests, inspections and tests required in the contractual documentation shall be included in the list of Quality Records.
- iii. Records shall be legible, identified, tracked, signed (identified signature), dated and protected against damage and losses.
- iv. The Supplier shall submit, during manufacture, all inspection records provided for in the ITP with the corresponding clearance in the manufacturing process.
- v. The Supplier shall submit to manufacturing inspection responsible all technical documentation of the equipment components foreseen in the ITP, after clearance from quality control and before beginning the assembly in the equipment.

9.3 Receiving inspection report

The raw materials receiving inspection report shall be submitted along with the certificate of previously analyzed material, using the criteria of material classification code and contractual requirements.

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The Raw Material Certificate shall be issued by the mill, not being accepted certificate issued by sub-supplier (resellers and distributors). Material qualification tests are acceptable if witnessed by manufacturing inspection responsible.

In addition to the project reference information, the report shall include:

- a) Description of the inspected material or component;
- b) Evidence of analysis of the Material Certificate;
- c) Results of visual and dimensional inspections of plates and internal parts and external equipment (fasteners, profiles parts, pipes, flanges etc.);
- d) Traceability number.

9.4 Certificates of welding consumables

When applicable, and specified in contract, consumables shall be certified by the FBTS Qualification and Certification System of Consumables.

Welding consumables not certified by the FBTS implies in the requalification of the welding procedures. Certificates shall be reviewed and approved by welding inspector as per I-ET-0000.00-0000-972-1AL-001 using the classification criteria of the material code and contractual requirements.

9.5 Quality certificates for abrasives, paints and solvents


Where applicable, certificates shall be provided from the paint manufacturer, analyzed and approved by the paint inspector in accordance with I-ET-0000.00-0000-972-1AL-001.

9.6 Data Book

The Supplier shall prepare the Data Book based on the criteria defined in the Quality of Materials General Requirements, the contractual and project documents.

In addition to the other contractual requirements, the Data Book shall contain at least the following documents:

- a) Project and manufacturing drawings;
- b) Quality Certificates of the Materials used;
- c) Records of all stages of the processes listed in the ITP;
- d) Welders Performance Qualification (WPQ) and Welding Operator Performance Qualification (WOPQ);
- e) WPS, PQR, weld joints map and repair map;
- f) NDT procedures;
- g) Non-conformity reports of critical components, from the supplier, sub-suppliers and manufacturing inspection responsible;
- h) Reports of loading, transport and weighing;
- i) Technical consultations and concessions;

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j) Release Notice (CLM).

10. HANDLING, PRESERVATION, STORAGE AND SHIPMENT

Supplier shall have and submit, when required by contract, specific procedures for handling, preservation, packaging and shipment, for all components and equipment provided for in the scope of supply, for analysis and clearance by manufacturing inspection responsible.

The procedures shall considered protection and control practice to avoid internal and external corrosion during equipment transportation and storage.

10.1 Special Alloys

Stainless steel materials, nickel or titanium and their alloys shall be stored, handled and processed completely separated from other materials in order to avoid the risk of contamination.

The manufacturer shall separate an area of shop floor for manufacture of stainless steel equipment and / or parts in order to avoid contamination. Coverings of rollers, work surfaces, manufacture devices, as well as specific tools for such materials shall be adopt.

11 COMPLEMENTARY NOTES


11.1 Valves

If the supply of industrial valves and / or relief valves and safety valves is included in the scope of the purchase order, the Complementary Quality Requirements for Valves I-ET-0000.00-0000-972-1AL-023 shall apply.

11.2 Identification of alloys

Components made of metal alloys, except for carbon steel, when required under contract, shall have their chemical composition confirmed by positive material identification (PMI) with issue of report. Confirmation shall be carry out using one of the following options:

- a) Positive Material Identification - PMI (API RP 578);
- b) Product Analysis (ASTM A751);
- c) Identification of materials by spot test, X-ray fluorescence spectrometry and optical emission spectrometry (ABNT NBR 16137).

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ANNEX A – PIPES

A.1. APPLICATION

This Annex applies to pipes for pipeline transportation systems, intended for industrial facilities, and heat exchange tubes made of carbon steel (whether or not coated), alloy steels, stainless steels, titanium, copper and nickel alloys,. It shall not apply to pipes intended for exploration and production facilities and to onshore or offshore pipelines.

A.2. IDENTIFICATION, MARKING AND TRACEABILITY

The supplier shall have work instructions for transference of original marking/identification, in this way is possible obtain traceability of raw material certificate.

Pipes shall have individual, physical, legible and indelible markings with the information (manufacturer's name or logo, standard, nominal diameter, outside diameter, schedule, classification, heat number etc.) corresponding to product standard or contractual documentation.


A.3. MANUFACTURING AND INSPECTION

A.3.1. Visual and dimensional examination

The following characteristics of the pipes shall be checked according to the applicable specifications / standards:

- a) Length;
- b) External diameter;
- c) Internal diameter;
- d) Wall thickness;
- e) Circularity on both extremities;
- f) Absence of ovalization, which shall be determined by the difference between the largest external diameter and the smallest external diameter, measured in the same orthogonal plane;
- g) Pipe ends;
- h) State of internal and external surfaces (dent and corrosion);
- i) Rectilinearity (no warpage);
- j) Plane-end pipe perpendicularity;
- k) Reinforcement of welds (when applicable);
- l) Coating quality (when applicable).

Tolerances shall be established by the product standard, which shall be subject to which differences in dimensions and tolerances may be adopted, subject to prior agreement between the purchaser and the manufacturer and provided it has been formally evidenced.

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The cut of ends shall be perpendicular to the axis of the tube and shall not present burrs or imperfections that prevent sealing or coupling of fittings and groove execution. They shall be clean and free from corrosion, paints, grease, dirt, dents and serrated. Pipes shall be supplied with the ends as specified in the contract:

- smooth (edged, beveled, faced or cut directly from the machine, without burrs);
- grooved (by lamination or cut); or
- threaded.

The quantity purchased shall be measured according to the contractual unit of measurement (mass, meters or number of pipes), and the maximum or minimum variation allowed shall be contractually specified.

A.3.2. Defects and repairs

The presence of surface imperfections, its acceptable dimensions (when applicable), and the method for removal of such imperfections shall be provided for in the product standard and / or contractual documentation.

A.3.3. Pressure test

The strength and tightness of the tubes shall be verified by hydrostatic testing, being, alternatively allowed the use of electromagnetic methods (ASTM E570), eddy current (ASTM E309 or ASTM E426) or ultrasonic (ASTM E213 or ASTM E273) as provided for in the product standard.


In the case of hydrostatic testing, no leakage is permit and in the case of electromagnetic testing or ultrasonic testing the acceptance criterion is establish in the product standard.

A.3.4. Metallic Coating

When contract specify galvanization , the supplier shall have instructions for monitoring zinc coating (hot-dip) according to ABNT NBR 6323, ASTM A153 or other contractual standard, and to present records evidencing monitoring. The zinc coating applied by electrolytic medium shall be accept only when specified in contract. Metallic coating shall not affect the sealing and welding areas or damage the normative marking and identification.

A.4. STORAGE AND PACKAGING

When the pipe ends are thread, they shall be properly protect against mechanical damage and corrosion. In general, tubes ends shall be protect against corrosion, transport and storage by the use of a transparent and removable organic coating of corrosion-resistant grease, sleeves or other alternatives set out by the manufacturer. Pipes shall be protect in order to prevent oxidation, when they are not coat.

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ANNEX B – FLANGES AND FITTINGS

B.1. APPLICATION

This Annex sets out the minimum requirements for manufacturing inspection to be met in supply forged flanges, nipples and forged and tubular fittings, seam or seamless.

B.2. Handling, preservation, storage and packaging

Flanges and fittings sealing areas shall be protect from mechanical damage. Sealing areas, bevels and machined surfaces shall be protect with anti-corrosion product.

B.3. ACCEPTANCE CRITERIA

B.3.1. Dye penetrant inspection (DPI) or magnetic particles inspection (MPI)


The supplier shall have procedure and foreseen DPI or MPI testing on fittings and flanges in:

- a) Areas built for field welding except fittings ASME B16.11 and MSS SP-83;
- b) Flange sealing surfaces RTJ;
- c) All accessible "CAP" surfaces according to ASTM A234 made of rolled bar;
- d) All accessible plug surface according to ASME B16.11 made of rolled bar;
- e) All accessible surface of flanges and fittings made of alloy steel after heat treatment of quenching and tempering;
- f) In the external region of fittings subjected to metal spinning and drawing/ bending , as for example: tees , reducing and curves;
- g) In all extension of the weld in tubular fittings, regardless of the material, considering the area of the bevels and 25 mm adjacent to these regions;
- h) All accessible surface of flanges and fittings in stainless, duplex, super duplex and hyper duplex stainless steels after final heat treatment;
- i) All accessible surface of ASME B16.11 tees, elbows and crosses in alloy steel and stainless steels after final heat treatment.

The supplier or contracted company shall issue a report with inspection result. Acceptance criterion shall be the following:

- It is not allowed any types of discontinuities for conditions a) and b)
- For the other conditions: according to ASME Sec. VIII - Div. 1, Appendix 6 for magnetic particles or Appendix 8 for dye penetrant.

The DPI or MPI on hot-formed fittings and conditions a), b), d), e), f), g), h) and i) can be perform by sampling according to item 14; in case there is a non-compliant product, 100% of the batch shall be tested.

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Cold-formed fittings and condition c) shall be 100% tested. The reports shall indicate the quantity of the batch and the sample tested, and which parts / locations the tests carried out on the parts.

B.3.2. Visual and dimensional inspection

B.3.2.1. Visual inspection

The surface finish of the fittings presented to manufacturing inspection responsible shall be describe in the supplier's report. The surface condition of the fittings shall allow visual inspection to detect impurities indicated in the specific product standard or contractual requirements. Relevant linear indications on forged fittings, with special attention to tees, elbows and crosses, shall be analyze by testing with dye penetrant or magnetic particles.

B.3.2.2. Dimensional inspection

A report containing a sketch shall be issue by the supplier, indicating the verified dimensions. In the report, the permitted values and the values found shall be indicate according to the applicable standard, after the dimensional inspection.

It is acceptable for the report to indicate the minimum and maximum dimensions found in the batch. The flanges and fittings (when the geometry and thickness of the part allow) in austenitic stainless steel shall have at least one dimension evaluated by 02 methods:

- a) Mechanical measuring instruments;
- b) Ultrasonic method with 5 MHz ultrasonic transducer;


The dimension to be evaluate shall be as large as possible, but no less than 18.00 mm.

Measurements by ultrasonic method shall be perform by devices that do not have external gain control, and the differences between the two measurements (mechanical x ultrasonic instrument) cannot vary by more than 0.15 mm.

The dimensional examination of RTJ groove shall be perform with appropriate ball-gage or similar instruments. The finish of contact surface of the flanges and the side of the RTJ groove can be analyze by visual comparison through calibrated standards, which the supplier shall have and make available to manufacturing inspection responsible use.

B.4. SAMPLING

An sampling inspection criterion shall be adopted, according to ABNT NBR 5426, inspection level II, simple sampling plan, normal inspection, for visual, dimensional inspection, hardness measurement, wall thickness measurement. Non-destructive testing (unless otherwise specified) and positive material identification (PMI) shall be performed by type of component and material heat number and can be by sampling, according to standard ABNT NBR 5426, inspection level II, simple sampling plan, normal inspection. If there is non-compliant product, 100% of the batch shall be test. Do not use EQS (NQA) or consumer risk. The purpose is to set the sample size for the inspected batch. In case of a non-

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compliant product, the batch shall be reject and the supplier shall re-inspect 100% of the batch, correct the non-conformities and then recall manufacturing inspection responsible.

B.5. DATA BOOK

Unless otherwise specified in Contract, Purchase Order (PC), Material Requisition (RM) or Technical Specifications (ET), the supplier shall issue a data book of the products, containing, when applicable, at least the following items:

- a) Certificate of the raw material emitted by the mill / steel mill, according to the product standard.
- b) Certificates of mechanical tests (tension test, bending test etc.).
- c) Heat treatment certificates, including records.
- d) Monitoring welding report issued by level 1 weld inspector.
- e) Non-destructive testing reports.
- f) Hardness test report.
- g) Macrographic examination report.
- h) Report on susceptibility to intergranular corrosion.
- i) Alloy identification report.
- j) Visual / dimensional inspection report.
- k) Hydrostatic test report.
- l) Ultrasonic thickness measurement report.
- m) Metallic coatings inspection report.
- n) Painting inspection report.
- o) Non-conformity Reports (NCR) and corrective actions adopted, according to item 8.13.
- p) Copy of all reports issued by manufacturing inspection responsible (RI, RI-RNC, CRM and CLM), relevant to the released products.

The supplier shall create and submit to manufacturing inspection responsible throughout the manufacturing and inspection process all records listed. Alternatively, for shipment to the customer in lieu of the complete Data Book, a Certificate of Conformity can be send. The certificate of each batch of fittings shall identify released product and trace it to the records of inspections indicated in sub-items a) to b) where applicable, containing year and revision of the constructive standard.

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ANNEX C - FASTENERS

C.1. APPLICATION

This Annex presents the minimum inspection requirements in the supply of fasteners such: bolts, studs, threaded rods and nuts.

This technical specification is applicable for fasteners made of carbon steel, alloy and stainless steel according to ASTM A193, A194, A307, A320, A325, A354, A437, A453, A490, A540, A563, F593, F594, F836, ISO 4014, ISO 4032, ISO 4034 to the specified grade.

NOTE: The requirements in this annex do NOT apply to subsea fasteners.

C.2. SAMPLING CRITERION

The manufacturing inspection responsible shall follow the guidelines set out herein and / or sample by visual inspection and dimensional inspection according to the following criteria:

- Batches up to 15 units, the inspection shall be in 100% of the pieces. The occurrence of 01 (one) non-conforming part, causes the batch to be rejected.
- Batches with a quantity greater than 15 units shall be inspect by applying the sampling and acceptance criteria according to NBR 5426, Inspection Level II, Simple-Normal Sampling Plan, in accordance with EQS (NQA) 2.5. The quantity of inspected units shall be equal to the size of the sample given by the plane. If the number of defective units found in the sample is equal to or less than the acceptance number (Ac), the batch shall be consider accepted. If the number of defective units is equal to or greater than the rejection number (Re), the batch shall be reject. In the event of batch rejection, manufacturing inspection responsible shall record this information in the Inspection Report and the Supplier shall replace the batch. If the Supplier chooses to resubmit the same batch, after handling the identified non-conformities, the inspection sampling shall be in accordance with standard NBR 5426, Inspection Level II, Simple-Normal Sampling Plan, according to EQS (NQA) 1.0.