SUPPLIER QUALITY REQUIREMENTS MANUAL

(SPEC\640\3.009)

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Preface:

Stahl Specialty Company will be a leader in the aluminum casting industry by improving our know-how for outstanding quality and developing innovative partnerships with our customers. This customer-focused commitment will be achieved by following a documented quality system, using teamwork, and embracing the philosophy of continuous improvement.

Stahl Specialty Company continuously positions itself for the future. We are prepared to meet the growing challenges of business by focusing on continuous improvement through Best Quality, Lower Cost, and Innovative Technology. In conjunction with our commitment to Stahl Customers, is the Stahl commitment toward development, support, and expansion of our business relations with our suppliers.

Key among expectations for suppliers is a structured QMS system that entails a company-wide understanding and commitment to Customer Specific requirements, product safety, environmental awareness, and ethical behavior.

Stahl Specialty is aware that the success of Stahl is dependent on the quality, cost, service, and technology provided by our suppliers. We are committed to developing strong supplier partnerships through mutual trust and commitment.

1. Introduction

1.1 Scope

1.1.1 This requirements manual defines the fundamental quality systems and procedures required for suppliers within the supply chain who provide production material, component parts, or services, **that directly impacts the quality of production aluminum castings and assemblies,** to Stahl Specialty Co., unless otherwise noted on the purchase order. This document applies to those suppliers who have been identified by Stahl Specialty Co. Purchasing and Quality Assurance as "**Approved**" suppliers.

1.1.2 This requirements manual is part of the purchase order issued by Stahl Specialty Co., and **acceptance of the purchase order constitutes acceptance of this manual.** The supplier's obligations can only be waived by Stahl Specialty Co. in writing.

1.1.3 The requirements of this manual shall be satisfied in addition to the detail requirements on engineering drawings and in specifications, any "special" quality procedures specified on the purchase order, and other elements of the purchase order, **including any customer flow-down as and when available**. Stahl Specialty Co. reserves the right to change this manual as needed.

1.1.4 If quality requirements specified on engineering drawings conflict with this requirements manual, engineering drawings shall prevail.

1.1.5 The supplier's quality system is subject to Stahl Specialty Co. review **as well as the right of access by Stahl's customer(s) and regulatory authorities to the applicable areas including documented information at any level of the supply chain as requested.** When instances occur, which warrant the review of a subsupplier's process or control system, the supplier will coordinate such reviews as requested.

1.1.6 Special requirements for heat-treated and plated parts (Section 6.1) are also included in this requirements manual.

1.1.7 Nothing in this manual shall in any way limit the supplier's obligation to ship 100% defect-free parts.

1.2 General Requirements

1.2.1 **Purpose:** Reflecting Stahl Specialty Co.'s operating philosophy, it becomes necessary to define and describe performance requirements for suppliers since purchased material can have a direct impact on the quality of Stahl Specialty Co. products. Where suppliers have proprietary process / design information and they are required to include it in their quality documentation, Stahl Specialty Co. will respect the confidentiality of this information.

1.2.2 **Quality Policy:** Suppliers should have a clearly stated quality policy that includes a commitment to quality, continuous improvement, and total quality principles. This policy should be visibly displayed and documented. It is the responsibility of the supplier's management to ensure that all work-related actions of the supplier's employees are in concert with the quality policy, and that the policy is understood, implemented, and maintained at all levels in the organization.

1.2.3 **Quality Management System (QMS):** Suppliers are responsible for developing and maintaining a quality system (Section 2.1) which ensures that **products and services comply** with all the requirements included on the drawing and prescribed on the purchase order and extenuating documents as needed. The supplier is also responsible for maintaining facilities in support of this requirement.

Product Quality: Suppliers are responsible for furnishing parts, assemblies, materials, and services to the requirements of current engineering drawings and specifications as identified on the purchase order. Suppliers are not to rely on Stahl Specialty Co. Receiving Inspection or PPAP Approval to determine the quality of their products. Zero Defects is required from all suppliers.

1.2.5 **Engineering Drawings:** Suppliers are responsible for understanding and complying with the requirements on engineering drawings **and any flow-down requirements from Stahl or its customers**. Suppliers are also responsible for assuring security and confidentiality of any drawings and specifications received from Stahl Specialty Co.
Drawing clarifications are to be resolved before production tooling is finalized or production parts are made, and in no case are the engineering drawings and specifications superseded by any informal agreements. Stahl Specialty Co. will strive for expedient

resolution of issues regarding engineering drawings and specifications.

1.2.6 **Special Characteristics:** Certain purchased parts include dimensions and / or specifications, which affect either compliance with governmental standards, or other important fit and functional characteristics of the final product. Those characteristics will be designated on the drawings or specifications as Special Characteristics.

1.2.7 **Nonconforming Material:** The supplier is responsible for repairing or replacing nonconforming material to specifications in order to meet Stahl Specialty Co. timing requirements (Section 2.9). In some cases, nonconforming material may be sorted or reworked by Stahl Specialty Co. at the supplier's expense.

1.2.8 **Opportunities:** Suppliers who meet the requirements of this manual and their other commitments to Stahl Specialty Co., and who provide quality and competitively priced products delivered on time, will continue to be considered to supply current and new products to Stahl Specialty Co. Nothing in this manual shall commit Stahl Specialty Co. to purchase products from suppliers. Suppliers failing to meet the requirements of this manual will be subject to action by Stahl Specialty Co. up to and including termination as a supplier.

1.2.9 **Sub-Supplier Quality Requirements: The supplier is responsible for extending the requirements of this document to their subsuppliers unless otherwise agreed upon in writing**. For subsuppliers of aluminum, steel, and raw materials, it is required to control quality through certification of each lot or shipment from the sub-supplier, including coupons for additional testing of materials. Flow-down of all requirements, including monitoring for counterfeit products, is the responsibility of the supplier.

1.2.10 **Preventative Maintenance:** The supplier is expected to have implemented a Preventative Maintenance (PM) Program when applicable.

1.2.11 **Identification of Stahl Specialty property**: The supplier is responsible for providing a permanent identification on all tooling, fixtures, gauging, and test equipment paid for by Stahl Specialty Co. This identification must include part number and property of Stahl Specialty Co., as well as location and status.

1.2.12 **Additional Requirements:** There may be specific and / or additional requirements that are not detailed in this manual. These additional requirements will be provided to the supplier by Stahl Specialty Co.

1.2.17 **Quality system records**: Quality performance records must be maintained for **fifteen (15) year(s) after the last shipment of items affected by these documents.**
Quality performance records include any records pertaining to the specifications of the part or material such as but not limited to: Metallurgical data, SPC data, Inspection results, and other documentation as deemed appropriate. Suppliers shall immediately present all quality records when requested by Stahl Specialty Co.

1.2.18 Ethical Behavior: Stahl is committed to the highest standards of business conduct. Stahl expects the same demonstration of commitment to legal, ethical, and social responsibilities for external suppliers who share in in Stahl's business given our mutual success depends on integrity and principled business conduct.

1.2.19 Prevention of Counterfeit product: Stahl is committed to the appropriate measures for the prevention of counterfeit or suspect counterfeit parts. Stahl expects the same demonstration of commitment from its suppliers.

1.2.19.1 Suppliers must adhere to all specifications on the Purchase order or otherwise flowed down to the supplier by Stahl.

1.2.19.2 Supplier shall have controlled processes to ensure that counterfeit product does not reach Stahl. This shall cover products and services provided, including documentation as required.

1.2.19.3 Under no circumstances shall the supplier provide counterfeit product in lieu of goods or services specified on the purchase order. Detection of counterfeit product during incoming inspection and subsequent downstream inspection may result in the removal of the supplier from the approved supplier list.

1.2.20 Quality control guidelines for Continuous Improvement shall follow the **ISO9001** requirements. Maintaining ISO9001:2015 and working toward IATF16949 and/or AS9100 as applicable.

2. Quality System Requirements for Purchased Materials, Components, and Services.

2.1 **Quality System**

2.1.1 The supplier will have a quality management system, which provides for control of incoming material, in-process material, and finished products. The system shall provide emphasis on prevention of defects through the use of statistical methods and shall be supported through the preparation of written procedures, which are clear, complete, and current. The supplier's quality system shall be formalized, documented, and should address the following minimum areas as appropriate:

- Quality Policy and Scope, including Interested Parties
- Process Map
- Management Commitment (Quality Policy and Organizational Charts)
- QMS reflective of customer requirements, governing bodies (ISO9001) as applicable, and internal requirements with exceptions, if any.
- **Purchased Parts Control and Sub-supplier Quality Requirements, including flow down of customer requirements**.
- **APQP process**
  - Failure Mode and Effects Analysis (FMEA) Development
  - Measurement System Analysis including Gage Control, Calibration, Capability and Facilities, as applicable.
  - Control Plans
  - Process Flow Charts
  - First Piece Inspection
  - Production Part Approval Process (PPAP) as required.
- **Production Process**
  - Material Identification, Traceability, and Inventory Control
  - Material Certification
  - Nonconforming Material Control / Corrective Action
  - Returned Product Analysis / Corrective Action
  - Rework / Repair Procedures as warranted.
- Documentation and Record Retention
- **Product Safety and Counterfeit Product**
- **Importance of Ethical Behavior**
- **Employee Training and Employee Involvement, including understanding of how actions affect product health and safety**.
- Quality System Internal Audits

- Initial Production Shipment Audit
- Continuous Improvement
- Preventative Maintenance

NOTE: Refer to the ISO Quality System Requirements standard.

2.1.2 The supplier shall have in place a method for confirming the quality of outgoing products.

2.2 **Production Part Approval Process (PPAP)**

2.2.1 The Production Part Approval Process (PPAP) published by AIAG has been accepted by Stahl Specialty Co.

The intent of this procedure is to specify uniform requirements for the supplier to follow when preparing samples and documentation for production approval. It establishes the minimum practices, procedures, and necessary documentation of records by the supplier.

Stahl Specialty Co. expects every part submission to be correct and accepted the first time it is submitted.
Note: Government standards may necessitate additional requirements, which will be supplied by Stahl Specialty Co. Purchasing.

2.2.2 **Policy:** Stahl Specialty Co.'s intent is that all suppliers become self-certifying (Level 1) for purposes of initial samples. This goal is attained when the Stahl Specialty Co. requests only the Part Submission Warrant as evidence of satisfactory completion of initial sample requirements. However, Stahl Specialty Co. Quality activities may request any of five possible submission levels:

Level 1 - Warrant only (and for designated appearance items, an Appearance Approval Report) submitted to the customer.

Level 2 - Warrant with product samples and limited supporting data submitted to the customer.

Level 3 - Warrant with product samples and complete supporting data submitted to the customer.

Level 4 - Warrant (no product samples) with complete supporting data submitted to the customer.

Level 5 - Warrant with product samples and complete supporting data reviewed at the supplier's manufacturing location.

LEVEL 3 IS THE DEFAULT LEVEL, TO BE UTILIZED FOR ALL SUBMISSIONS UNLESS SPECIFICALLY ADVISED OTHERWISE BY THE CUSTOMER'S PART APPROVAL ACTIVITY.

Stahl Specialty Co. Quality will determine, based on experience with previous initial samples, the level that will be used for each supplier on a specific part.

2.2.3 **General Requirements:** Initial production sample approval is required prior to the first production shipment. For all submissions except Level 1 (paragraph 2.2.2) the supplier is required to submit one (1) dimensional and three (3) laboratory samples. (Note: Multi-cavity tools require one (1) sample per cavity). These samples are to be taken from a three hundred (300) unit minimum production run, generated from production tools and processes. These requirements may be deviated from at the discretion of Stahl Specialty Co. Initial samples are required for:

- New Parts
- Existing parts produced by a new supplier
- Existing parts from optional construction and / or material from a current supplier
- Existing parts from new tooling or a new process
- Change of source for designated parts, materials, or services
- Emergency sourcing changes
- Parts from each mold or cavity from multiple cavity molds / dies

Samples being submitted because of engineering change or a correction to the original part requires at least the changed portion, and any other area affected by the change, to be checked and submitted.

When special characteristics have been identified: (a) on the print, (b) through the FMEA, (c) on the Control Plan, or (d) through other specifications requiring statistical process control (SPC), the supplier is obligated to perform gage repeatability and reproducibility (Gage R&R) studies and determine process potential results (Section 5.1) for those characteristics. A minimum process potential index of 1.67 Cpk or greater is required.

If an acceptable process potential cannot be attained by the time of sample submission, or if there are dimensional or material results that are out of specification, a corrective action plan must be developed and reviewed with Stahl Specialty Co. prior to sample submission.

2.2.4 **Dimensional:** The supplier must perform the necessary measurements to determine conformance with all specifications. If all required inspections cannot be performed, such services must be procured from a qualified source.

All measurements must be documented and referenced by number to the corresponding Stahl Specialty Co. drawing. Also, all tests required by the part drawing and related specifications are to be listed along with the result of each test. Blanket statements of conformance are not acceptable.

Any results that are outside the specifications must be documented and highlighted on the part submission documents.

2.2.5 **Material:** The supplier must perform testing as required by the material specification and Control Plan. If the producer cannot perform the required tests, services must be procured from a qualified outside source, supplier certifications, or Stahl Specialty Co. test laboratory. All tests required by the part drawing and related specifications are to be listed along with the results of each test. Blanket statements of conformance are not acceptable. Indicate the laboratory, which tested the sample or indicate “own” if tests performed in supplier laboratory.

Any results that are outside specifications must be documented and highlighted on the part submission documents.

2.2.6 **Production Part Approval Status:** The supplier will be notified in writing by Stahl Specialty Co. as to the disposition of the submission. When the submission is approved, the supplier shall be held responsible for assuring that future production continues to meet Stahl Specialty Co.’s requirements and is within engineering specifications. The following categories may be assigned to production sample submissions:

- **Full Production Approval** - indicates that the supplier has manufactured material that conforms 100% to all specifications and requirements.

- **Interim Approval** - Permits the shipping of material on a limited time or piece quantity basis against authorized shipping schedules. Provisional approval status will be issued for parts in the following categories:

A. Parts pending additional inspections and / or tests such as laboratory requirements which may require lengthy time duration, or to determine appearance or other qualifications under assembly conditions.

B. Parts for which an engineering change is in process that will alter the blueprint specifications to agree with the part as manufactured.

C. Parts pending the review and approval by Stahl Specialty Co. of statistical process control data which demonstrates acceptable process capability on a specified control characteristic, or gage studies which demonstrate acceptable repeatability and reproducibility variation.

Material that subsequently **fails** laboratory or long-term testing, or which has not received Full Production Approval either by the expiration date or when the authorized quantity has been shipped, is automatically in **Rejected** status. **No additional shipments are authorized** unless superseded by a Full Production Approval or an extension of the Provisional Approval.

- **Rejected** - Indicates the material submitted and the group of parts it represents have failed to meet requirements. Corrected samples shall be submitted and approved before any parts are authorized for shipment.

2.2.7 **Record Retention:** The supplier shall retain adequate records at their manufacturing location showing part conformance to all physical, chemical, dimensional, metallurgical, and test specifications. The supplier shall retain a copy of the information submitted with the samples, such as the checked print and initial sample report forms. Retention requirements shall be as specified in Section 2.7 of this document.

2.3 Recertification of Product Requirements

2.3.1 Recertification on an annual basis is required for all parts unless otherwise specified by a Stahl Specialty Co. representative or unless the part is not received for a period exceeding one (1) year. The recertification date occurs in one-year increments following the initial sample approval date. The supplier is responsible for having knowledge of the recertification date and to submit the required information prior to this date.

2.3.2 The supplier must submit samples and receive approval before production shipments can be made when any of the changes indicated in Section 2.2.3 occur. It is the supplier's responsibility to notify Stahl Specialty Co. Purchasing when such changes are anticipated. Changes to an optional material or an optional construction are also included.

2.3.3 Parts and data submitted for annual recertification will meet all drawing and purchase order requirements. Stahl Specialty Co. will indicate the required approval process: on-site review, delivered, self-certified with or without supporting documentation. Typically, a layout and material analysis is required as a minimum. For parts produced from multiple tools, cavities, patterns, etc., a layout inspection report on parts from all tools, cavities, patterns, etc. is required as noted:

Sample sizes for recertification purposes are as follows:

Number Cavities, Patterns. Etc.	Sample Size for Complete Layout
1- 10	1
11 - 25	2
26 - 100	3
101 - 200	5
201 & greater	10

The sample cavities shall be representative of all areas of the tooling (corners, centers, etc.) insofar as possible with the sample size. Further submissions shall be from different cavities, such that in time all cavities will be sampled. Stahl Specialty Co. reserves the right to require layouts on all cavities annually as needed.

Visual comparison of parts from all cavities must be made with a part for which a satisfactory inspection layout has been completed. This inspection is to assure that parts from all cavities are free from visually discernible imperfections or omissions.

2.3.4 If no production requirements occur within one year, recertification is required with the first reactivated shipment. The next recertification will be scheduled twelve (12) months later.

2.4 Functional Testing

2.4.1 When a supplier performs functional testing for either initial certification, change approval, or recertification, Stahl Specialty Co. is required to document approval of the test equipment, controls, recording devices, and the test procedure before test results are acceptable. Test parameters, including the level of input, temperature, pressure, travel, rates, cycle rates, etc., must be recorded and documented to verify that functional testing conforms to appropriate requirements. The supplier will maintain schematics of the complete test equipment, controls, recorders, etc. (including identification by supplier and part number) such that repetitive approvals are not required.

2.5 Gage Facility Requirements, Calibration and Control

2.5.1 Sufficient control shall be maintained over all measurement systems used in the development, manufacture, installation and servicing of product to provide confidence in decisions or actions based on measurement data. Procedures shall be established to monitor and maintain the measurement process under statistical control, including equipment, procedures and operator skills. When measuring processes are found to be out of control or where measuring and test equipment is found to be outside the required calibration limits, corrective action is necessary. Evaluation shall be made to determine the effects on completed products and to what extent rework, retest or rejection may be necessary.

2.5.2 The supplier must obtain Stahl Specialty Co. design approval of all gages, fixtures, or test equipment proposed for inspection use if paid for by Stahl Specialty Co.. Approval must be obtained prior to manufacturing such gages, fixtures, or test equipment; otherwise, the supplier shall be responsible for the cost of changes when required. All gages must demonstrate conformance to Gage Repeatability and Reproducibility (Gage

R&R) requirements as stated in the AIAG Measurement Systems Analysis Reference Manual.

2.5.3 The supplier must provide and maintain adequate gages and other measuring and testing devices in quantities necessary to ensure that parts conform to the Control Plan and purchase order requirements. The devices must be checked by the supplier at sufficiently frequent intervals to ensure continued accuracy and updated to reflect any appropriate engineering changes. The supplier must prepare, maintain, and conform to a written schedule for the maintenance and calibration of such equipment. Personal gages, if used, must be included in the calibration system.

The supplier shall include a gage control facility in their plant or subcontract this service. The facility shall be temperature and humidity controlled and be used to inspect gages, test equipment, and functional masters. The facility shall include master calibration gages and standards that are traceable to National Standards (in the U.S. - National Institute of Standards and Technology (NIST)). Procedures for the control of gages shall be maintained by the gage control facility to ensure that gage accuracy is maintained in production operations.

2.6 Control Plan Requirements

2.6.1 The supplier is expected to prepare, maintain, and follow a Control Plan, which specifies the quality planning routine for a part or family of parts. The Control Plan shall cover all stages of production, from receipt of purchased materials through packaging and shipping. The Control Plan will be subject to review by Stahl Specialty Co. The supplier-provided **FMEA** will be used in evaluating the Control Plan. Control Plans must include at a minimum: proper identification of the part and operation, date issued and approved, engineering change level, frequency and quantity of pieces or process parameters to be inspected for each characteristic, the acceptance / rejection criteria, the method of inspection (type of gages, test equipment, etc.), and the reaction plan for suspect / nonconforming conditions. The reaction plan must address quarantine / segregation, purging of nonconforming material, and verification of corrective actions.

2.6.2 **The Control Plan must, at a minimum, address each Stahl Specialty Co. Special Characteristic.** The Control Plan shall also include supplier-selected characteristics or elements of the

processes which impact Special Characteristics or are critical to the process.

2.6.3 Operator Instructions shall be issued for manufacturing operations based upon Control Plan requirements and shall be used on the shop floor to monitor quality performance.

2.7 Record Retention

2.7.1 The supplier must retain records on all component characteristic documentation that demonstrates product compliance to drawing specifications. The records shall allow for entries to be recorded showing date of inspection, quantity of parts inspected, quantity of parts found defective, description and number of defect(s), disposition of material and / or lot, and identification of the person performing the inspection.

2.7.2 The supplier must retain all quality policies, procedures, records, Control Plans, operator instructions, and sub-supplier / subcontractor records for Quality system records (quality plan, inspection instructions) must be maintained for fifteen (15) year(s) after the last shipment of items affected by these documents. Records must be protected from fire and shall be submitted upon request to Stahl Specialty Co. as well as right of access by Stahl's customer(s) and regulatory authorities to the applicable areas including documented information at any level of the supply chain as requested.

2.8 Material Identification, Traceability, and Inventory Control

2.8.1 The supplier (including subsuppliers, if appropriate) shall maintain a system at all times for material identification, processing, and quality status through the use of stamps, tags, routing cards or other means.

2.8.2 The system shall provide for lot control traceability from the receipt of raw material through manufacturing / processing and shipping. Lot numbers should increase, be consecutive by date, and change when a significant event occurs (i.e., shift change). The system shall assure that shipments to Stahl Specialty Co. are in order of manufacturing lot sequence.

2.8.3 Where special lot control and identification is required, it must be defined and identified on the Control Plan.

2.9 Nonconforming Material

2.9.1 When the supplier's quality system detects lack of conformance to requirements, the supplier must immediately identify and segregate nonconforming material to prevent shipment of that material. Operations that produce nonconforming material shall be stopped immediately and promptly corrected. Nonconforming material must not be returned to the normal production flow until the material has been sorted and / or reworked, inspected and approved. The supplier must obtain written approval from Stahl Specialty Co. to use operations, which differ from the normal production process to repair or salvage nonconforming material. Reworked or sorted material must receive independent quality inspection before being returned to the production flow.

The supplier must maintain a material disposition procedure that requires nonconforming material and scrap to be isolated from the normal production flow. A specific containment area, well defined with limited access (secured) and segregated from the normal production flow, must be available. Specific identification must be attached to the nonconforming material.

2.9.2 Nonconforming material must not under any circumstances be shipped to Stahl Specialty Co.

2.9.3 Stahl Specialty Co. Quality Control is to be immediately notified if it has been discovered that nonconforming material has been shipped. The supplier's procedure shall provide a reaction plan that alerts all customers when quality issues / nonconformity's are discovered with raw materials, parts, or services.

2.9.4 Nonconforming material detected at Stahl Specialty Co. will be returned to the supplier except when schedules dictate an immediate sort is required to support production. Stahl Specialty Co. determines that this sort will be performed on site either by the supplier or at the supplier's expense. The supplier will be notified by telephone or by fax of the actions that will be taken, and when required, the supplier will have available personnel to sort on site to support production schedules.

2.9.5 Nonconforming material, which cannot be reworked, will be scrapped at Stahl Specialty Co. after giving the supplier the opportunity to review it. Samples will be returned to the supplier when required for analysis. Another option is that the nonconforming material will be returned to the supplier freight

collect. Fourteen (14) working days after supplier notification is considered ample time for final disposition. If the supplier fails to respond within this time period, Stahl Specialty Co. will automatically scrap the material at the supplier's expense.

2.9.6 When a design change creates obsolescence, the obsolete material will be appropriately dispositioned as nonconforming material. Obsolete parts for which a rework procedure is deemed appropriate will be identified as nonconforming until the rework is complete. The rework procedure must have prior approval by Stahl Specialty Co.

2.10 Corrective Action

2.10.1 The supplier is to provide timely corrective action when notified of nonconforming parts. An initial response from the supplier is required within 48 hours from the time of notification with written corrective actions submitted within two weeks. An extension of time may be granted by Stahl Specialty Co. Quality based upon the corrective actions required or the nature of the nonconformance.

The format of the written corrective action will follow the guidelines of what is commonly known as the Eight Discipline (8D) Corrective Action.

The following reporting guidelines shall be used in completing the written corrective action:

1. Select a Problem Solving Strategy / Team

Based on the problem's complexity, establish a team with the product / process / people knowledge, skills, and authority to resolve the problem and implement corrective actions. A facilitator shall be selected by the group to monitor and document the process and oversee the problem's successful and permanent resolution.

2. Define and Describe the Problem

Problem description shall include the problem as reported by Stahl Specialty Co. and any further redefinition developed by the supplier. It shall include the number of parts involved and dates or date codes of the parts.

The team will develop a problem definition, which identifies the deviation in standard from the expected ("should") performance and the "actual" performance. Narrow and focus the definition by using customer terms and specific **"5W / 2H" (Who, What, When, Where, Why, How, How Many)** factors. Define the goals / measurements for an improved process.

3. Protect the Customer Through Containment Action(s)

Take immediate actions to isolate the effect of the problem from customers until permanent corrective action(s) are implemented. Verify that these containment actions are effective. Interim action shall include estimated or actual timing for implementation. Interim action is typically containment oriented and is usually accomplished via 100% inspection. Identify what actions were taken to isolate the effect of the problem. Note what actions were taken to support production and assure delivery of acceptable parts.

4. Identify and Evaluate Root Cause(s)

As an aid to determining the root cause, define the current process using process mapping techniques that include: **Inputs** (internal / external supplier requirements) - **Process** (internal actions depicted by a flowchart) - **Outputs** (internal / external customer requirements). Also define the customer-driven desired outcomes and performance goals / measurements for an improved process.

Identify potential root cause(s) of the problem using the process map, 5W / 2H, "is / is not" comparisons, cause-and-effect diagrams, brainstorming, process analysis, etc. Evaluate the potential root causes through data collection, testing and analysis using check sheets, histograms, Pareto charts, SPC charts, scatter plots, etc.

Root cause shall be fully investigated and defined - not just a superficial analysis. The initially reported root cause(s) may change as the investigation progresses. The final report shall indicate the ultimate root cause(s). **Operator error is not an acceptable root cause.**

5. Determine and Implement Permanent Corrective Action(s)

Create and evaluate the effectiveness of the proposed solution alternatives designed to eliminate the root cause(s). The permanent corrective action solution(s) must meet **all** of the minimum internal / external supplier and customer requirements **("musts")** and as many preferred requirements **("wants")** as possible. Implement the best permanent corrective action solution(s) through process and / or product changes with on-going controls to ensure that the root cause(s) are eliminated. Permanent Actions shall include estimated or actual timing for implementation. Permanent action is of a preventative nature and is typically process oriented.

6. Verification

Verification shall include data, which indicates both before and after levels of performance, thereby substantiating the results and effectiveness of the action taken. This applies to both Interim and Permanent actions.

7. Modify the System(s) to Prevent Recurrence

Modify **all** systems, procedures, processes, FMEA's and provide appropriate training to **prevent** the recurrence of this and similar problems. Document these changes and distribute to other potentially affected areas and similar parts. Monitor and measure the process on a continuing basis to ensure there are no repeat problems, and that all improvements are maintained.

8. Recognize Team's Success

Provide "positive reinforcement" to the team by recognizing the success of the dedicated and cooperative efforts of all team members in permanently solving the problem.

2.10.2 Corrective actions shall always be directed at providing conforming material in a timely manner to minimize the impact to Stahl Specialty Co.. Towards that end, the supplier shall:

A. Identify / segregate nonconforming material.

B. Make provisions to provide conforming material. (This may be done through sorting or replacing material.)

C. Work closely with Stahl Specialty Co. for "A" and "B" above and for coordinating the identification of "Certified" conforming stock.

2.11 Subcontracted Services

2.11.1 Whenever it is necessary for a supplier to subcontract services such as heat-treating, plating, lubrication, protective coatings, subassembly, etc., the supplier will be responsible for the subcontractor's quality to assure conformance to original drawing and engineering specification requirements. The control system used to assure that subcontracted material meets Stahl Specialty Co. requirements shall include one, or a combination of the following:

- Verification to specification using statistical techniques
- Receiving Inspection and / or tests of material
- Subcontractor certification
- Verification by production process

2.11.2 Suppliers shall have an effective system for selecting, assessing and monitoring the performance of subcontractors. The assessment shall assure that the subcontractor has the quality systems and procedures to consistently produce material to Stahl Specialty Co.'s requirements.

2.11.3 The subsupplier's plant must not be used as a shipping point without specific prior Stahl Specialty Co. approval. When approved, direct shipment of parts from a subsupplier shall be recorded on the supplier's Control Plan.

2.11.4 In the case of significant services being subcontracted, Stahl Specialty Co. reserves the right to review and approve subcontracted services. This provision does not alter the rights and responsibilities that exist between supplier and subsupplier.

2.12 Certification

2.12.1 If dictated by government regulations or when specified by the purchase order, written certification of product quality will be required. Details of procedure forms, characteristics, types of inspection and testing frequency and sample sizes required will be communicated to the supplier by Stahl Specialty Co..

2.12.2 All basic raw material as specified on the engineering drawing used to fabricate components must be covered by a material certification. This information is to be retained on file at the

supplier and is subject to Stahl Specialty Co. review. Optionally, Stahl Specialty Co. may request that this information be provided with each shipment. If the required certifications do not accompany the material at time of receipt, Stahl Specialty Co. will not accept the material until it is received.

2.12.3 Certifications must also be available for any additional processing of parts such as heat treat, painting, coating, stress relieving, plating, etc.

2.12.4 Stahl Specialty Co. will periodically validate certifications.

2.13 Handling, Storage, Packaging, Preservation and Delivery

2.13.1 The supplier shall establish, document, and maintain procedures for handling, storage, packaging, preservation, palletizing, labeling, receipt, dispatch and delivery of material. These procedures shall be established during the quality planning stages, prior to product release (PPAP) from Stahl Specialty Co.. The packaging and labeling processes shall be controlled to assure conformance to specifications and maintenance of product quality and integrity.

2.13.2 The supplier shall establish and maintain a material handling system that minimizes the potential for damage throughout all operations: raw materials, purchased components, work-in-process, finished goods, and delivery. The condition of product in stock shall be assessed at appropriate intervals to assure that damage or deterioration has not occurred.

2.13.3 The supplier shall establish and maintain shipping and receiving facilities and ship all products in conformance to Stahl Specialty Co. requirements and transportation routings. The supplier shall arrange for the protection of the quality of the product after the last production operation through delivery to the customer destination.

2.13.4 The supplier should periodically audit these systems for use and effectiveness, record findings, and resolve issues with immediate containment action and permanent corrective action.

2.14 Drawing and Change Control

2.14.1 The supplier must maintain the latest engineering drawings and specifications authorized through Stahl Specialty Co. Purchasing and ensure that these drawings and specifications are present and used where needed in the supplier's facility. These drawings and specifications must be kept secure at all times to protect their confidential nature. Concurrent with the effective dates of product changes, the supplier must ensure that the obsolete information is removed from all points of use in the system. The supplier must maintain a record of change effectivity dates. This record must be available for review by a Stahl Specialty Co. representative.

2.15 Process Change Control

2.15.1 Changing or altering the process used to produce approved PPAP parts may affect dimensional, physical or functional characteristics of the product provided by the supplier. Because of this possibility, potential process changes must be reported to and approved by Stahl Specialty Co. before implementation.

3. Advanced Product Quality Planning (APQP)

3.1 Advanced Product Quality Planning is defined as a team oriented planning process which emphasizes prevention of defects versus the detection of defects. The Advanced Product Quality Planning process combines the benefits of a disciplined step-by-step evaluation procedure with historical data to achieve conformance to requirements, customer satisfaction, and the opportunity for never-ending improvement. The objective is to create a definitive quality plan that will govern the product design, process design, pre-production and first production stages of the product cycle. This Advanced Product Quality Planning process shall be initiated at the earliest practical stage in the product development cycle.

Advanced Product Quality Planning is required in the following situations:

- During the development of new products / processes
- Prior to changes in products / processes
- When reacting to products / processes with quality concerns
- Before existing tooling is transferred to new producers / plants

3.2 The supplier should provide an organizational chart showing where quality planning activities are located within the organization, and indicating the key contact personnel for Advanced Product Quality Planning activities and problem resolution.

3.3 Suppliers are expected to utilize Cross-Functional Teams for the development of new / changed products. The teams will use quality planning techniques and be active throughout the development and launch stages. Composition of the supplier's Cross-Functional Team should include Design (Engineering), Manufacturing, Quality Engineering, Tooling, Production, Purchasing, Sales / Marketing, and may include representatives from Stahl Specialty Co.

3.4 Training is key to the effectiveness of the Advanced Product Quality Planning process. The supplier is expected to emphasize this through allocation of appropriate resources with particular emphasis on the effective use of statistical techniques and project planning skills.

3.5 Stahl Specialty Co. requires that suppliers utilize Advanced Product Quality Planning and have evidence of the following defect prevention techniques prior to the start of **volume** production. Suppliers are expected to implement these defect prevention methods at the earliest practical stage in the product development cycle, in an effort to mitigate or prevent potential risks to supply of material to Stahl Specialty Company:

- Advanced Planning Schedules
- Feasibility Reviews
- Consideration of customer needs / wants (QFD)
- Design / Process Failure Modes and Effects Analysis (FMEA)
- Determination of significant product / process characteristics from:
  -Special Characteristics identified on drawings or otherwise communicated by Stahl Specialty Co.
  -Design / Process FMEA's
  -Items identified by the supplier based on process knowledge
  -Items based upon returned parts analysis
- Supplier determination of process control method, including:
  -Gauging / Test Equipment
  -Personnel requirements
  -Statistical techniques
- Determination of adequate packaging
- Development and updating of Control Plans and Flow Diagrams
- Determination of Employee Training needs
- Use of Employee Involvement

The above list is not meant to be all-inclusive, but shows some of the recognized defect prevention activities that can be utilized.

3.6 The following requirements specific to the above referenced areas as it pertains to Advanced Product Quality Planning include:

A. Blueprints and Specification - will normally be provided to the supplier within a sufficient amount of lead-time to allow completion of the Advanced Product Quality Planning process.

B. Design FMEA - suppliers responsible for the design of products they produce for Stahl Specialty Co. must create a Design FMEA. Stahl Specialty Co. has accepted the FMEA Manual published by the AIAG.

C. Feasibility Analysis - should be completed prior to submitting a response to the Request for Quote.

D. Process Flow Chart - identifies key operations and control points for cross-reference and pre-production discussions critical to development of the Process FMEA, Control Plan, and assignment of Process Potential Studies. Supplier must submit a Process Plan / Flow Chart to Stahl Specialty Co..

E. Process FMEA - helps the supplier anticipate potential problems with a process, which would adversely, affect quality and reliability concerns. A FMEA shall be initiated upon completion of the Process Flow Chart and be continually updated as the process develops. Also, the FMEA should be revised to address quality concerns that were not originally identified on the document. The supplier must submit a Process FMEA to Stahl Specialty Co..

F. Special Characteristics - (as outlined in paragraph 1.2.6 and 2.6.2) must be identified upon the completion of the Process FMEA and must subsequently be addressed in the Control Plan.

G. Control Plan - requirements are outlined in paragraph 2.6.

H. Gage and Test Equipment - requirements are outlined in paragraph 2.5. The supplier is reminded that this item must be addressed in the Advanced Quality Timing Chart and it should indicate both availability and prove out (Gage R&R).

I. Process Potential Studies and Pre-production Run - certain Special Characteristics require the completion of Process Potential studies as outlined in Section 5. The supplier must obtain approval from Stahl Specialty Co. to alter any of these requirements. A significant pre-production run must be conducted which serves to prove-out the production process and corresponding Control Plan.

   All suppliers are encouraged to participate in prototype development. In those cases where suppliers do manufacture prototype parts, the

appropriate initial Advanced Product Quality Planning documentation should be provided with the prototype parts.

The supplier is expected to develop a timing chart that addresses all of the above areas. This chart must include both start and completion dates to allow the launch team an accurate assessment of program progress and identification of activities requiring special attention.

It is Stahl Specialty Co.'s intention to work with the supplier on products that require significant Advanced Planning activities.

4. Quality Plan

4.1 Each supplier manufacturing location is expected to establish and maintain a documented and management-approved Quality Plan that indicates specific goals and objectives for continuous quality improvement. These should include process improvements, rejection rates, system improvements, customer satisfaction levels, supplier development, employee training and other goals and objectives for continuous improvement.

4.2 The supplier is expected to develop a Gantt-type timing chart which addresses the above as a minimum. This chart shall include both "start" and "completion" dates and assign responsibilities to allow for an accurate assessment of planning progress and to highlight areas requiring special attention.

4.3 The Quality Plan, as a "living document," must be subject to continuous review and revision. The plan must be dated and approved. It must be supported by senior management with the allocation of sufficient resources to accomplish the plan.

5. Statistical Methods

The Statistical Process Control Reference Manual published by the AIAG shall be accepted by Stahl Specialty Co. as a standard approach to statistical analysis and application of basic statistical process control techniques.

5.1 Process Potential Studies

5.1.1 Process Potential Studies are conducted using variable data on a minimum of fifty (50) samples taken from a production run of at least three hundred (300) units. The data is gathered in subgroups (typically five consecutive units per subgroup, with

subgroups spaced uniformly throughout the production run) and is analyzed using Average / Range Charts or other appropriate control charts. When the chart shows all points in control without any evidence of trends or non-random patterns in the data, Process Potential may be determined by calculating the standard deviation using the control chart data. For destructive tests, the supplier should consult with Stahl Specialty Co.

5.1.2 Stahl Specialty Co.'s criteria for acceptable Process Potential requires that the measured process average (X-double-bar) ± 5 standard deviations (as determined above) must fall within bilateral specifications. For unilateral specifications, the process average (X-double-bar) plus or minus 5 standard deviations should fall within the relevant minimum or maximum. When these criteria have been met, the decision to proceed relies on the supplier's knowledge of the process, since not all of the variability inherent in the process has been reflected in the collected data. If the machine / process potential is less than ± 5 standard deviations, process improvement actions will be necessary in order to meet the longer term Process Capability requirements below. The supplier must develop a written corrective action plan to improve process capability to required levels. These plans must be available for review. The ± 5 standard deviation requirement equates to a Capability Index (Cpk) of 1.67. Although attribute data for dimensional characteristics provides some useful information for process analysis and corrective action priorities, it should not be used for the purpose of fulfilling Process Potential Study requirements without Stahl Specialty Co. approval.

5.2 Process Capability Studies

5.2.1 Process Capability Studies are an extension of Process Potential Studies. Process Capability Studies are intended for the process output to reflect the effects of operating under actual production conditions with factors such as raw materials, personnel, environment, tool wear, etc., contributing to process variation.

When control charts for Process Capability evaluation exhibit statistical control, actual capability can then be determined.

For ***variable data***, the control chart data is used to calculate the standard deviation of the distribution of individual readings, which is used to determine capability. Stahl Specialty Co.'s criterion for Process Capability, using variable data, is that the measured process average of ± 4 standard deviations must fall within

bilateral specifications or on the favorable side of a unilateral specification. The ±4 standard deviation requirement equates to a capability index **(Cpk)** of **1.33.**

For ***attribute data***, Process Capability is indicated by the average performance (e.g., p) as long as the process is in statistical control. Stahl Specialty Co.'s criterion for Process Capability, using attribute data, is that average performance must be at least **99.99%** of the products conforming to specification. This requires a study with a minimum of 300 pieces all accepted as conforming unless otherwise specified.

5.2.2 When the above criteria are not met, appropriate actions must be implemented. The supplier must immediately initiate investigations to determine the reasons for not meeting the criteria and revise the process accordingly. The implemented actions must be carried out until capability is demonstrated or until an engineering change is approved by Stahl Specialty Co.. The supplier must develop a written corrective action plan to improve process capability to the required levels. These plans must be available for review by Stahl Specialty Co..

5.3 Statistical Process Control

5.3.1 Supplier management must include the use of statistical process control and demonstrate its use to control manufacturing processes in order to understand, improve, predict and make decisions about the process. Plant personnel must be trained and competent to record and chart data and take required actions expected of a qualified operator.

Ongoing Statistical Process Control (SPC) must be applied to Special Characteristics as described in the Control Plan. Capability indices (Cp, Cpk, etc.) must be calculated on a regular basis, monitored as an indicator for continuous improvement, and reported as required to Stahl Specialty Co..

After control limits have been developed and Process Capability has been demonstrated, decisions on process actions and part acceptance should be made according to the following table. The table shown below has been designed to assist in decision making on dispositioning products produced by a process controlled by the use of SPC:

ONGOING PROCESS AND PRODUCT MONITORING

The MOST RECENT POINT on the Control Chart or EVIDENCE OF NON-RANDOM PATTERNS indicates that:	ACTIONS ON THE PROCESS OUTPUT Historical Process Capability (Cpk)		
	<1.33	1.33 - 1.67	>1.67
Process is in control.	100% inspect	Accept product. Continue to reduce process variation.	Accept product. Continue to reduce process variation.
Process has gone out of control in an adverse direction. All individuals in the sample are within specification.	IDENTIFY AND CORRECT SPECIAL CAUSE.		
	100% inspect	Inspect 100% since last in-control point on chart.	Accept product. Continue to reduce process variation.
Process has gone out of control. One or more individuals in the sample are outside specification.	IDENTIFY AND CORRECT SPECIAL CAUSE.		
	100% inspect	Inspect 100% since last in-control point on chart.	Inspect 100% since last in-control point on chart.

This table applies only when stability and capability have been demonstrated and special causes are rigorously identified and eliminated.

Attributes Control Charting: As an aid in the transition to Statistical Process Control using attributes data, sample size and nonconformity's found are to be recorded and plotted on a graph and results of lot screening and process investigations documented. When statistically derived control limits have been established and the process is in statistical control and is operating with an average conformance level of 99.99% or better, 100% sorting is required only when there are nonconforming units in the sample.

5.4 Capability Indices

5.4.1 Capability indices such as Cp and Cpk are used as a measure of how well the supplier's product meets the print requirements, and as an indicator for ongoing improvements.

5.4.2 These indices are valid only if the process is in statistical control (no points outside of the control limits and no non-random patterns).

5.4.3 Computation is as follows:

$$\mathbf{Cp} = \frac{\textbf{Print Tolerance}}{\textbf{6 Times Standard Deviation}}$$

$$\mathbf{Cpk} = \frac{\textbf{Absolute Value of (Mean - Nearest Spec Limit)}}{\textbf{Three Times Standard Deviation}}$$

Standard Deviation - or estimate of the standard deviation is as computed via the control chart method (R-bar / d2) or via standard statistical calculation (formula method as shown in the **AIAG Fundamental Statistical Process Control Reference Manual).**

5.4.4 Computation Examples:

Given the following set of data, Cp and Cpk can be computed as indicated below:

USL = 5.0

LSL = 1.0

TOLERANCE = 4.0

MEAN = 2.0

SIGMA (σ) = 0.5

The **Cp** for the sample item above is:

$$\mathbf{Cp} = \frac{4.0}{3.0} = 1.33$$

The **Cpk** for the sample item above is:

$$\mathbf{Cpk} = \frac{(2.0-1.0)}{1.5} = 0.67$$

5.4.5 The Cpk index is an attempt to identify if the distribution generated by the process is centered about the mean or nominal

of the tolerance. It should be a positive value as long as the mean of the distribution is within specification. If the mean is equal to the specification limit, the numerator of the computation becomes zero; therefore, Cpk = 0. If the distribution is outside of the specification limit, then Cpk should be expressed as a negative value.

5.4.6 Stahl Specialty Co. may request statistical information (i.e., a control chart) on any specified characteristic, at any point in time. In addition, either a verbal or a written request may be made to the supplier to initiate a control chart on any characteristic that has not been identified as critical on an engineering drawing.

5.4.7 Statistical methods for control are not limited to control charts. Other acceptable methods include, but are not limited to:

- Run Charts
- Histograms
- Pareto Charts
- Design of Experiments
- Scatter Diagrams

6. Special Requirements

6.1 Heat Treated and Plated Parts

6.1.1 Processes used to manufacture heat treated and plated parts (particularly fasteners) require special attention and control. Likewise, the parts produced from these operations require special inspection. Therefore, it is required that a supplier of heat treated and / or plated parts submit the following prior to production for approval by Stahl Specialty Co..

- Parts
- Name of Source and Location
- Type(s) of Process
- Process FMEA
- Process Flow Chart, including lot size
- Control Plan, including checks made to verify that process is ready to run, and ongoing checks while process is in operation
- Lot Control / Traceability Plan

6.1.2 Changes in heat treating and plating processes (including reworking parts by “burning off” of applied coatings such E-coatings, powder paints, etc.) must be resubmitted to Stahl

Specialty Co. for approval. A change in sourcing of heat treating or plating is to be considered a process change. Changes to Control Plans, such as inspection method, frequency, and / or sample sizes, also require Stahl Specialty Co. prior approval.

6.1.3 Hydrogen Embrittlement: Process precautions must be established and enforced which will protect against the effects of hydrogen embrittlement from cleaning, plating, coating, and stripping operations. All affected electroplated, mechanically plated, phosphate-coated, and stripped parts must be processed in accordance with approved hydrogen embrittlement relief parameters.

7. Special Requirements for Raw Material Suppliers

7.1 Aluminum Foundry Ingot Suppliers

7.1.1 All suppliers of Aluminum foundry ingot must comply with the specified requirements detailed in Stahl Specialty Co. Purchasing Specification SPEC\640\2.XXX.

7.1.2 The chemical composition of the Aluminum foundry ingot must comply with the specifications detailed in the Aluminum Association publication (latest revision) entitled “Registration Record of Aluminum Association Alloy Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot,” unless otherwise specified. Special alloy compositions will be designated by a Stahl Specialty Co. Engineering Specification (SPEC\500\xxxx).

8. Supplier Requirements to become an approved supplier for Stahl Specialty.

8.1 Suppliers shall at a minimum be certified to ISO 9001 by an accredited certification body **or any other applicable industry standard**; unless otherwise authorized by Stahl Specialty Company and its customers. The supplier must send copies of certificates.

8.1.1 Suppliers must submit copies of their certificates on an annual basis.

8.1.2 Criteria used for reevaluation of suppliers shall conform to Section 9.1

8.2 Second party assessment, performed by Stahl Specialty Company, may be used for: supplier risk assessment, supplier monitoring, supplier QMS development, product audits and process audits

8.4 Suppliers shall notify Stahl Specialty Company of any changes in their registration status, including but not limited to: suspension, revocation, or changing to another registrar

8.5 All suppliers should have access to the latest AIAG publications listed below.

- ISO 9001
- QSA (Quality System Assessment)
- APQP (Advanced Quality Planning and Control Plan reference manual)
- PPAP (Production Part Approval Process)
- FMEA (Potential Failure Mode and Effects Analysis)
- MSA (Measurement Systems Analysis)
- SPC (Fundamental Statistical Process Control)
- Shipping / Parts Identification Label Standard (AIAG B-3)

NOTE: Copies of these documents can be obtained by contacting the AIAG (Automotive Industry Action Group).

Automotive Industry Action Group (AIAG)
26200 Lahser Road, Suite 200
Southfield, MI 48034
Phone: 810-358-3570

8.6 Customer designated (direct buy) products including process sources shall conform to requirements.

8.7 External providers shall apply appropriate controls to their direct and sub-tier external providers to ensure requirements.

9. Supplier Quality Rating System

9.1 Stahl Specialty Co. considers **6** major criteria when assessing the performance of its suppliers. These elements are identified below:

- **Annual Certification Review**
- Quality History (Defective Materials - PPM);
- Delivery Performance (OTD);
- Quality System;
- Number of occurrences of premium freight;
- Customer disruptions at the receiving plant, including yard holds and stop ships

9.1.2 If applicable, the following will also be included in supplier performance assessment:

- Special status customer notifications related to quality or delivery issues;
- Returns, warranty, field actions, and recalls.

Leadership, **Technology**, and **Cost** (price stability and competitiveness) are also considered when evaluating the supplier.

9.2 **Quality History** (Defective Materials - PPM, material sorting, lots rejected, etc.)

9.2.1 Performance Measurement Criteria:

- Receiving Inspection rejections for defective material
- Defective material found during in-process operations
- Stahl Specialty Co. customer material rejections determined to be sub-supplier defective material

9.2.2 Performance Measurement Calculation:

$$\text{PPM Defective} = \frac{\text{Total Actual Verified Defective Parts}}{\text{Total Number of Parts Received}} \times 1{,}000{,}000$$

9.3 **Delivery Performance**

9.3.1 Performance Measurement Criteria:

- 95% On-time Delivery

9.3.2 Performance Measurement Calculation:

$$\text{Del. Perf. (\%)} = \left[\frac{\text{(No. of Shipments - Total No. of Late Shipments}}{\text{No. of Shipments}} \times 100\right.$$

9.4 **Quality System**

9.4.1 Performance Measurement Criteria:

Quality system verification will be accomplished by any of the following methods listed below.

- Third-party registration to ISO/TS 16949
- Third-party registration to ISO-9000 (9001, 9002, or 9003)
- Second-party audit (by Stahl Specialty Co.)

9.4.2 Second-party audits (by Stahl Specialty Co.) will follow pages 3-7 of the Supplier Assessment Form (F\640\11.XXX), unless otherwise specified.

10. Glossary

Advanced Product Quality Planning is the process of preparing a plan on how to achieve the quality objectives of producing defect-free parts or services.

AIAG - Automotive Industry Action Group

Attributes are qualitative data that can be counted for recording and analysis. When a record shows only the number of articles conforming and the number failing to conform to any specified requirements, it is said to be a record by attributes. Typically, p, np, c, and u charts are used to analyze attribute data.

Bilateral (Two-Sided) Specifications are those which state both a minimum and a maximum value.

Capability Indices are numerical values used to represent the ratio of the natural process capability to blueprint specification. The two indices used are Cp (may be referred to as Pp for Process Potential results) and Cpk

(Ppk). Capability indices should be computed only for processes which demonstrate stability (in control). For unilateral tolerances, Cp computation is not required; Cpk is computed to the maximum/minimum specification limit only.

Characteristics are product traits or specifications examined to determine conformance, such as height, weight, dimension, color match, etc.

Common Cause is a source of variation always present in a process and / or an inherent part of the process. Its origin can usually be traced to elements of the system which only management can correct.

Continuous Improvement is the process of continually investigating and implementing ways to improve the design, manufacture, quality and to reduce the costs of a product.

Control see **Statistical Control**

Control Chart is a graphic representation of a process or a product showing plotted values of some statistic gathered from that characteristic, and statistically-based control (action) limits. It has three basic uses: to determine if a process is in control; to aid in achieving and maintaining statistical control, especially in avoiding over adjustment; and to evaluate continuous improvement efforts. For purposes of this manual, acceptable forms of control charts include X-bar and R. X-bar and s, median, moving range, np, c, n, and u charts.

Control Plan is a written description of the system required for controlling ongoing quality of parts produced for Stahl Specialty Co.. The system addresses dimensions and specifications, and includes all Special Characteristics and other characteristics specified by the supplier and/or Stahl Specialty Co..
Glossary (continued)
Glossary (continued)

Cross Functional Team typically consists of representatives from Sales, Engineering, Quality, Purchasing, and Manufacturing who share common product-based development and launch through and including customer use activities.

Special Characteristic is any characteristic that has been identified as important as determined by historical, warranty, FMEA, supplier process or other data. It will be included in the Control Plan.

The control methodology for special characteristics requires mechanisms or devices such as fixtures, machine controls, computer controls,

equipment capability (Cpk $\geq$ 1.67), 100% inspections, etc., which provide high confidence that the characteristic conforms to specification. Continuous variable or attribute data collection is not always required; however, capability reports and / or periodic data collection and analysis should be available.

Design Change is a permanent change in dimensions and / or specifications authorized by Stahl Specialty Co. and include changes to an optional material / design / construction.

Design Failure Modes and Effects Analysis (DFMEA) is an analytical technique utilized by Simultaneous Engineering (SE) teams as a means to assure that, to the extent possible, potential failure modes and their associated causes have been considered and addressed. End items, along with every related subassembly and detail part, shall be evaluated. In its most rigorous form, an FMEA is a summary of the SE team's thoughts (including an analysis of items that could go wrong based on experience and past concerns) as a component or system is designed. This systematic approach parallels and formalizes the mental discipline that an SE team normally goes through in the design process.

Design Verification (DV) is testing performed on pre-production or production components to verify design intent.

Detection is a past-oriented strategy that attempts to identify unacceptable output after it has been produced. Detection relies on inspection or sorting by downstream processes.

Dimensional layout includes a complete layout inspection report accompanied by a correspondingly numbered blueprint. The layout report lists every characteristic and note, its tolerance or limits, and the actual findings of each. A blueprint, marked/numbered correspondingly to the dimensional layout and showing the number of each dimension, specification, etc., as it appears on the sample layout report will be included.

Employee Involvement consists of organizing management and hourly employees into teams to draw upon their knowledge and experience to enhance improvement.

Engineering Revision Level is a term used to identify part dimensions and specifications authorized as of a certain date by a Release Number and date or a Change Letter and date.

Engineering Requirements refer to drawings, specifications, or other media established to detail the dimensional, chemical, metallurgical, physical, visual, electrical, life and performance characteristics of a part.

Engineering Specifications are documents containing information necessary to produce or evaluate parts, primarily in written form, and usually issued in conjunction with engineering drawings. An Engineering Specification is used when requirements are best described in writing, such as when specifying engineering tests, or when information applies to a number of parts. An Engineering Specification provides direction to supply, manufacturing, and quality control activities, and is used to validate production (and serves to confirm the design) as well as monitor continuing production. Such information is typically related to function, performance, and durability tests. Both test methods and required results are included.

Feasibility Analysis is a series of reviews by product engineering, process engineering, manufacturing and assembly activities to ascertain whether a proposed design can be manufactured, assembled, tested, packaged, and shipped at acceptable levels. A feasible design must permit meeting production volumes and schedules consistent with meeting engineering, quality, reliability, cost and timing objectives.

Functional Test is the evaluation performed on samples to ensure proper assembly, conformance to functional, reliability, and engineering specifications.

Gage is any instrument of standard or special design which is used to determine the conformance of the characteristic of a part.

Gage Repeatability and Reproducibility (GR&R) Study is a statistical method for determining gage error resulting from variations in (1) repeatability of the gage and (2) reproducibility by the operator.

Initial Sample is a quantity of parts made from production tooling and production processes and requiring Stahl Specialty Co. approval prior to shipment of production parts.

In-Process Tests are functional or durability tests required by product engineering to monitor a particular design feature or characteristic on a continuing basis during production. Sampling and reaction plans for these tests must be included in the Control Plan.

Inspection is the evaluation of parts, materials, or services either by visual means or by use of measuring devices to determine conformance to

engineering specifications covering appearance, dimensional, material or functional characteristics.

Lock is a method used to achieve a failure occurrence probability absolutely equal to zero and includes either removal of the potential cause of the nonconformance or an automatic 100% inspection (mistake proof the process).

Lot is a quantity of product produced under similar conditions so that the product within the lot is expected to be homogeneous in all significant attributes. Unless otherwise stated in the Control plan, a lot shall consist of no more than eight (8) hours production produced within one day.

Lot Inspection is the inspection performed on random samples taken from a defined population of parts which are essentially alike and which were produced from the same production process. Except as noted in an Engineering Specification, lot size shall represent parts produced during a specific operating period of up to eight hours or a working shift. Production rates shall be a determining factor in establishing lot size which must be acceptable to Stahl Specialty Co.

Lot Traceability is a system for tracking and identifying a batch of raw material or components through all steps in the process and identifying the final product when it is shipped to the customer.

Material Certification is a document that reports the results of a physical and / or chemical quantitative analysis of the material and is approved provided it conforms to requirements. A report that the material conforms to requirements will not be approved without quantitative analysis of data.

Nonconforming Material consists of parts, subassemblies, assemblies, materials, processes, or services that do not meet specification requirements.

Normal Distribution is a continuous, symmetrical, bell-shaped probability distribution. Also known as a bell curve or Gaussian curve.

Preventative Maintenance is an anticipatory system of machine and equipment repair, emphasizing predictive maintenance methods (i.e., recognition and repair of pending problems, as opposed to breakdown repair).

Problem Solving is the process of evolving from symptom, to cause, to corrective action that improves process performance.

Process is the combination of people, facilities / equipment, materials, work methods, machines and tools that produce output (i.e., a product or service).

Process Capability (Cp) is the measured, inherent reproducibility of the product resulting from a process which is in statistical control, the measure of which is expressed in terms of standard deviations or variation and is unrelated to product tolerance.

Process Capability Studies are determined by continuing the control charts (begun during the Process Potential Study phase described below) with the process operating under actual production conditions until all factors likely to contribute to process variation (e.g., raw material, personnel, environment, tool wear) are reflected in the process output. When control charts for this interval show the process to be in statistical control, capability can be determined.

Process Change, as used in this specification, is any change in the processing concept which could alter the capability of the process to meet the design requirements or durability of the part. This will include new, different, rehabilitated, or relocated production machinery or equipment which might cause the characteristic of the part being processed to change; the use of engineering approved alternate materials, new processing concepts, including major changes in the sequence of operations; and changes in chemical compounds, such as adhesives, sealants, lubricants, etc. which are a part of the product.

Process Control is the gathering of data from a process and the use of statistical methods to establish a feedback loop to maintain stability and prevent the manufacture of nonconforming products.

Process Failure Modes and Effects Analysis (PFMEA) is an analytical technique utilized as a means to assure that, to the extent possible, potential manufacturing / processing concerns have been identified and addressed. The Process FMEA identifies potential product-related process failure modes, assesses the potential customer effects of the failures, identifies the potential manufacturing or assembly process causes, and identifies significant process variables to focus controls for Process Control Plan development. It also develops a list of potential failure modes ranked according to their effect on the “customer,” thus establishing a priority system for corrective action considerations.

Process Flow Chart is a graphic representation of the complete sequence of operations and checkpoints used to manufacture and inspect a part. It describes each operation from receipt of raw material to shipping the final product, inclusive of any subcontracted services.

Process Potential Studies provide a preliminary assessment of the potential of the process to produce products that meet Stahl Specialty Co. requirements. Since these studies are of short duration, they cannot provide information about long-term Process Capability. Process Potential Studies are conducted using variable data from samples taken from a production run of at least 300 units.

Production Validation is testing performed by the supplier to validate the production tooling, methods, and processes performed on parts representative of production design configuration and made from production tooling.

Prototype Sample is a part or assembly submitted for evaluation and design verification purposes which is not completely produced using production tooling, materials, manufacturing sources or manufacturing methods.

Purchasing Representative, (Stahl Specialty Co.) as used in this specification, refers to the individual who issues the applicable purchase order(s).

Quality is defined as conformance to requirements ultimately resulting in customer satisfaction.

Quality Cost Analysis is a method of identifying all costs associated with the quality function so that these costs can be measured, improved, and controlled. Typically, cost of quality is the costs for the prevention of defects, the appraisal of plant-wide quality, internal and external failures. Each of these categories is compared as a percentage to Total Quality Cost (TQC). TQC is then compared to one common denominator such as net sales billed, productive hours, or cost of goods sold.

Quality Function Deployment (QFD) is a management system to assist in translating the “voice of the customer” into operational definitions that can be used to produce and deliver products desired by the customer. Specifically, QFD is the development and use of matrices and supporting data to compare customer requirements with the design features of a product. QFD highlights conflicting customer requirements so that customer satisfaction can be maximized.

Quality Performance Records are inspection and test documents which show the results of inspections and tests performed on materials, parts, and assemblies.

Quality System Records include engineering drawings, Control Plans, inspection instruction sheets, laboratory test instructions, and similar documents, which define inspections and tests (including sample size and frequency) to be performed, and the gage and test equipment to be used to determine parts assembly, and material conformance to requirements.

Random Sample is a sample of pieces drawn from a lot in such a manner that all pieces in the lot have equal likelihood of selection as part of the sample.

Rational Subgroups are the basis for SPC data gathering. Rational subgroups are determined by the process and its patterns of variation. Their size and frequency shall be constantly under review to determine if the sampling plan can be improved. Rational subgroups are subgroups within which variations may be considered to be due only to non-assignable chance causes; between which there may be variations due to assignable causes whose presence is considered possible and important to detect.

S is the sample standard deviation.

Sample is one or more individual events or measurements selected from the output of a process (see Rational Subgroups, above).

Setup is a change in the adjustments and / or fixturing to changeover a process from the production of one product to another or a restart of a process after a shutdown.

Sigma (σ) is the Greek letter used to designate the standard deviation of the distribution of individual values for a process parameter or product characteristic.

Simultaneous Engineering is a multi-functional, team-oriented management system that focuses resources to meet company and customer goals and objectives.

Special Cause, also called an **Assignable Cause** or **Root Cause**, is the cause of variation that is unpredictable, intermittent, or unstable. Special causes are indicated by a point on the control chart beyond the control limits, or a run or other non-random pattern of points within the control limits.

Special Manufacturing Controls are quality control methods applicable to Special Characteristics and include Statistical Process Controls, reliable 100% inspection and / or in-process or final testing, or mistake proofing identified by a Process FMEA. Special Manufacturing Controls ensure that

certain selected characteristics of a part are consistently produced within specifications.

Stability is the absence of special causes of variation; the property of being in statistical control; predictable.

Standard Deviation is a measure of the variation in the process output or the spread of a sampling statistic from the process (e.g., of subgroup averages). This statistic is used in calculation of Cpk.

Statistical Capability Monitoring consists of recording and / or graphing the measured results of process output for the purpose of reporting rather than the purpose of control.

Statistical Control is the condition of a process from which all special causes of variation have been eliminated and only common causes remain. A control chart indicates a process is in statistical control by the absence of points beyond control limits and by the absence of non-random patterns or trends within the control limits.

Statistical Process Control (SPC) is the use of statistical techniques such as control charts to analyze a process or its output so as to take appropriate actions to achieve and maintain a state of statistical control and improve the capability of the process.

Supplier, as used in this specification, refers to any facility or manufacturer which provides and is responsible for the quality of materials, parts, or services delivered to Stahl Specialty Co..

Surrogate process capability data may be used to fulfill process potential requirements and is obtained from current production processes which are representative of the planned process for the new parts. The use of surrogate data must be pre-approved by Stahl Specialty Co.

Testing is the evaluation of materials, parts, or results of services by use of approved testing devices to determine conformance to chemical, metallurgical, physical, electrical, life, and / or performance specifications, Engineering Specifications, or other engineering requirements.

Testing Equipment is any certified and calibrated instrument of standard or special design, which is used to test for chemical, metallurgical, physical, electrical, life, and / or performance specifications, Engineering Specifications, and other engineering requirements.

Unilateral Specifications are those which state either a maximum value or a minimum value only. Examples are concentricity (diameters A and B

concentric within 0.5 mm maximum) and flatness (flatness within 0.1 mm maximum).

Variable Data is measurement data recorded using a certified and calibrated gage or other measuring device.

Variation is the inevitable difference among individual outputs of a process. The sources of variation can be grouped in two major classes: Common Causes and Special Causes.

Visual Aids are any pictorials, graphics, parts, or models which are displayed in an appropriate area and assist employees in better understanding the component function, appearance, or assembly techniques.

12 Reference Materials

- ISO 9001:2015 and IATF16949:2016
- AS9100:2016
- APQP (Advanced Quality Planning and Control Plan reference manual)
- PPAP (Production Part Approval Process)
- FMEA (Potential Failure Mode and Effects Analysis)
- MSA (Measurement Systems Analysis)
- SPC (Fundamental Statistical Process Control)