JDS-G223 Supplier Quality Manual

2015 Version Update

January 2015

JOHN DEERE

Todays Training Agenda

1st Hour - Awareness and overview

- History of manual
- Change process
- Major changes
- Additional training events
- Questions

2nd Hour - More depth on content changes

- Program Requirements
- PDP & OFP flow charts and Annex2
- Questions

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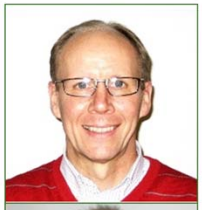
How to ask questions thru Webcast

If just want awareness feel free to drop off after first hour

Leading today's session



Wendell Hunt,
Mgr. Enterprise Supplier Quality Planning

DeWayne Hatcher,
Global Commodity Quality Manager

Gary Ghere,
Mgr. Product Verification & Validation

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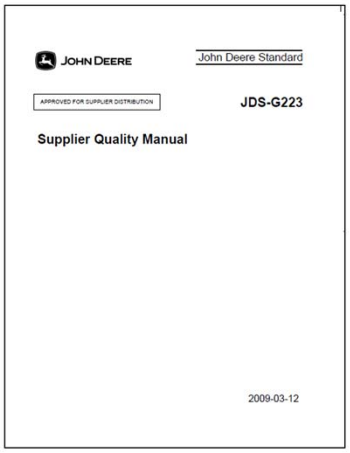
JDS-G223 History

John Deere Standard

Issued in June 1998

Version history:

- 2001
- 2005
- 2009
- 2015



Layout of 2009 Version:

- Pages 1-30 - Program Requirements (includes examples)
- Pages 31-63 – Process control flowcharts, samples of forms & checklists
- Pages 64-86 – Questionnaires (G223, PVA, Red Flag, PEQ & Information Survey

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Purpose of SQM – Establishes the Quality System Requirements to become and remain a direct or indirect material supplier to John Deere.

Pages 31-63 the referencing was not as clear as it should have been

Project Summary

- Aug 2012 Kicked off project
- Received input from all JD divisions and regions worldwide. (134 total suggestions)
- Core team reviewed every suggestion and provided feedback to every contributor
- Authored new content in Annex2 on process control
- Aug 2014 Completed balloting (120 comments)
- Jan 2015 Published

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18 Person Core Team

Sent survey to all SQE's worldwide Thank you

Balloted in June 2014

Core team

Wendell Hunt	Supply Management-Quality
K'uang Ku	Staff Engineer
Valerie Newkirk	Product Standards
Phillip Hammerand	Staff Engineer
Mike Harper/Rob Day	JD-QPS and 6 sigma
Rhea Antoine/Jesy Yeates	A&T Supplier Quality
Gary Ghere	PV & V
Ed Schwanekamp	A&T Supplier Quality
Leonardo Aguirre	Strategic Supply Engineering
Todd Herzog	JDPS Quality
Terry Skelton	Corp. Engr. Standards
Stewart Carter	Supply Management
Dewayne Hatcher	A&T Supplier Quality
George Kalemkarian	Director Quality (retired)
• Jim Stevenson	Master Black Belt (retired)
• Harpreet Singh	Master Black Belt
• Scott Vandenbos	Master Black Belt
• Abraham George	Global Quality Manager

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Project on top of everyone's normal workload

Intent of change

Improve overall usability of manual

- Improved logic of content flow
- Removed redundant material
- Improved readability
- Improved referencing ability in manual

Add new leading edge content

- Annex 2 - Methods and Examples

Stay aligned with industry standards (ISO/TS16949)

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New Structure

1. Program Requirements (all examples moved to Annex 2)
2. Annex 1 – Sample Forms (removed all questionnaires)
3. Annex 2 - Methods and Examples (~50% new content)

Total number of pages increased from 88 to 142 (61% increase)

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1.) Now purely "Program Requirements"

Size increase ½ due to new content and ½ due to expanding existing content

New formatting and numbering changes

Each "shall" requirement is individually numbered

- Improves identification and clarity of requirements
- Improves ability to reference to specific requirements (G223 Questionnaire)

Example from 2009 version

Gage Repeatability and Reproducibility

A gage repeatability and reproducibility (R&R) study measures the total repeatability and reproducibility of a gage system as a percentage of the total specification. The personnel who will be using the measuring instrument in production should always conduct the Gage R&R study. John Deere recommends that Gage R&R studies be performed whenever production personnel using the measuring instrument are changed. The method for performing the Gage R&R study is either the Range Method or the ANOVA method, with three or more operators.

Gage R&R studies apply to variable gages. Attribute gages (such as ring or plug gages) do not require gage R&R studies unless otherwise specified by John Deere. Attribute gages shall be checked periodically for accuracy. For non-dedicated gages such as coordinate measuring machines, a repeatability and reproducibility analysis shall be conducted utilizing specific part programs on all key characteristics plus other characteristics that are identified by John Deere.

Gage R&R studies are required for each unique variable gage used to monitor key product or process characteristics. Studies on families of gages or equipment are not acceptable, unless the study uses an industry-approved methodology such as found in Concepts for R&R Studies (See Section 34, Reference 4). Some types of equipment, such as flow meters and hardness testers do not lend themselves to Measuring System Analysis. This type of equipment shall be identified in the calibration program and verified at a specified frequency using traceable standards.

Total variation is the ratio of the uncertainty of the repeatability and reproducibility of the gaging system to the tolerance range of the characteristic to be measured. If the total variation of the repeatability and reproducibility of the gage system (gage and operator) is less than 30 percent of the total tolerance range, the gaging system is acceptable for use. If the supplier uses a gage with a total variation greater than 30 percent, John Deere shall be contacted for approval. A gage shall be proven repeatable and reproducible before it can be used in a capability study or is used to accept or reject parts. If the gage system fails, the supplier shall take corrective action to make the gage measurements repeatable and reproducible.

Same content in 2015 version

6.7.3 Gage Repeatability and Reproducibility

D R A F T

6.7.3.1 A gage repeatability and reproducibility (Gage R&R) study measures the total repeatability and reproducibility of a gage system as a percentage of the total specification. The personnel who will use the measuring instrument in production should always conduct the Gage R&R study (see clause 5 in JDS-G223X2 (2015)).

6.7.3.2 Gage R&R studies should be performed whenever new production personnel begin using the measuring instrument. The method for performing the Gage R&R study shall be either the Range Method or the ANOVA method (see clause 5 in JDS-G223X2 (2015)).

6.7.3.3 Gage R&R studies apply to variable gages. Attribute gage R&R studies (such as ring or plug gages) can be required by John Deere (if required see clause 8 in JDS-G223X2 (2015)).

6.7.3.4 Attribute gages shall be checked periodically for accuracy.

6.7.3.5 For non-dedicated gages such as coordinate measuring machines, a repeatability and reproducibility analysis shall be conducted utilizing specific part programs on all key characteristics plus other characteristics that are identified by John Deere.

6.7.3.6 Gage R&R studies are required for each unique variable gage used to monitor key product or process characteristics. Studies on families of gages or equipment are not acceptable, unless the study uses an industry-approved methodology such as found in Concepts for R&R Studies (see clause 5 in JDS-G223X2 (2015)).

6.7.3.7 Gage R&R studies on families of gages shall be agreed to by John Deere prior to completion of the DPAR.

6.7.3.8 Some types of equipment, such as flow meters and hardness testers do not lend themselves to Measuring System Analysis. This type of equipment shall be identified in the calibration program and shall be verified at a specified frequency using industry standards.

6.7.3.9 If the total variation of the repeatability and reproducibility of the gage system (gage and operator) is less than 30 percent of the total tolerance range, and meets the additional requirements in JDS-G223X2 clause 5.8 (2015), the gaging system is acceptable for use. If the supplier uses a gage with a total variation greater than 30 percent, John Deere shall be contacted for approval.

6.7.3.10 A gage shall be proven repeatable and reproducible before it is used in a capability study or is used to accept or reject parts.

6.7.3.11 If the gage system fails, the supplier shall take corrective action to make the gage measurements repeatable and reproducible.

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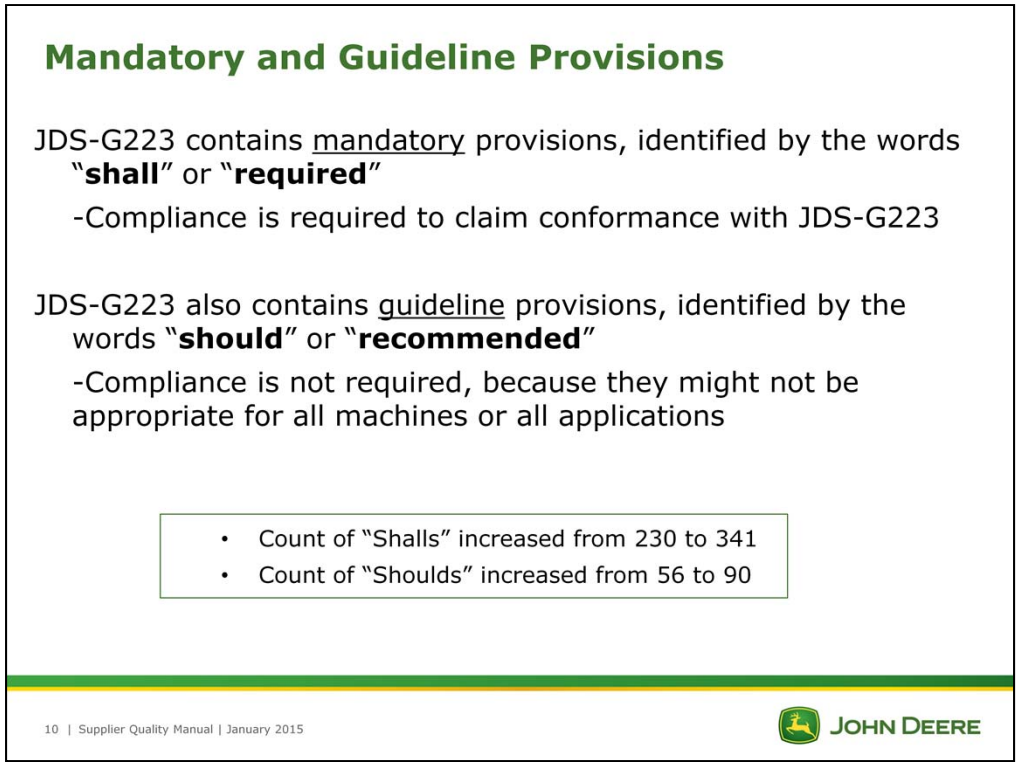
Aligned with ISO/TS 16494 as much as possible while also complying with JD 155 Standard's guidelines.

Each sentence/paragraph that conveys unique "shall" requirement is numbered

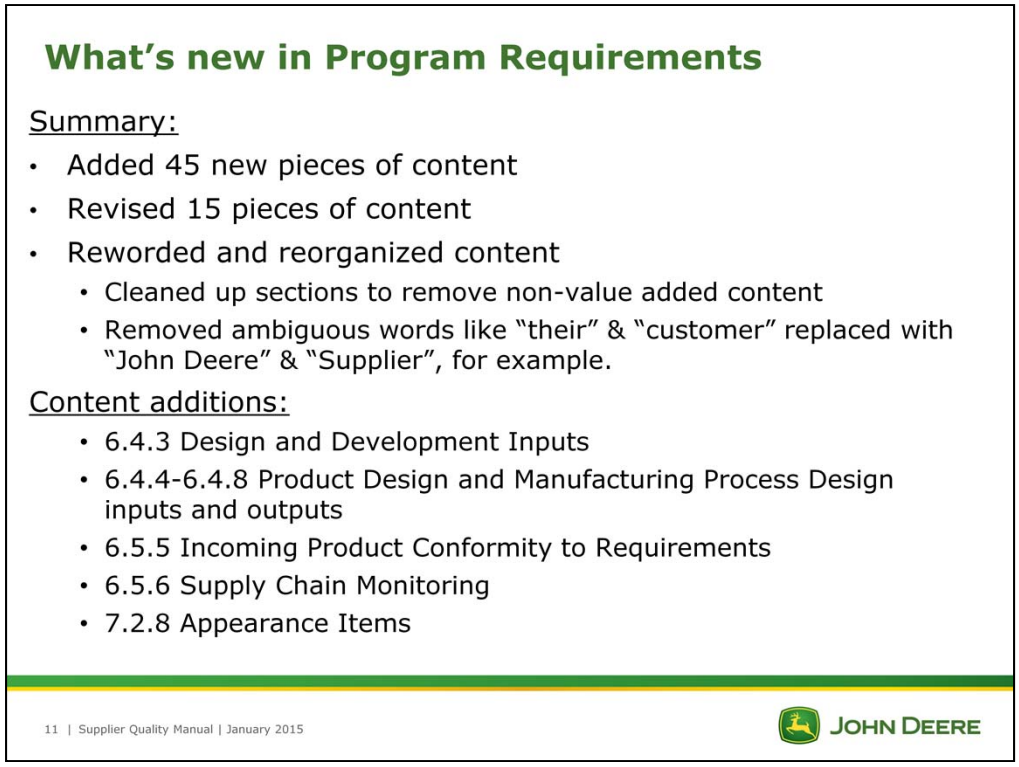
Example is from old section 7.6 Just one lump of content with maybe 3-5 "shall" requirements in a paragraph.

G223 Questionnaire now can specifically reference the precise location of the SQM basis for the question.



The Shall/Should provisions are not new, but the 2015 version is much crisper in application of this wording.

For example, the previous manual contained several "musts", which were changed to "shalls"



New sentence in a paragraph, a new paragraph, or a completely new section

Changed wording to improve clarity

Moved stuff around i.e moved terms and definitions to the front, cleaned up content on Vision, Goal, Purpose.

Make it very clear on responsibility's

6.4.3 – 4 new pages with tables defining Reliability Goals, and Usage Environment Conditions and working with the supplier to develop the PV&V plan.

6.4.4-6.4.8 Is product Design and Mfg. Process Inputs and Outputs. This was changed to remain aligned with changes to TS16949

6.5.5 New content on requirements for suppliers to ensure the quality of their purchased product

6.5.6 New content on requirements for supplier to monitor their supply chain.

7.2.8 New content on requirements for supplier's manufacturing parts designated by John Deere as appearance items

Will cover this in more detail in the 2nd hour.

What's new in Annex 1 – Sample Forms

- Updated John Deere Verification Warrant
- Removed all questionnaires (latest versions posted on JDSN)

What's new in Annex 2 – Methods and Examples

- Updated PDP and OFP Process Control Flowcharts
  - Provide step-by-step directions of when and how to conduct capability studies and establish process controls.
- Added guidance how to use statistical software to perform each analysis
  - Used Statistica for illustration purposes
- New sections on:
  - Attribute Gage R&R: Visual or Go/No Go gaging
  - Tool Wear Process Capability Calculation
  - Auto Correlated Data

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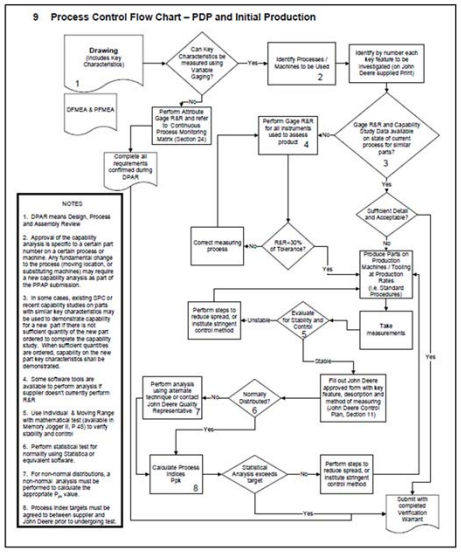
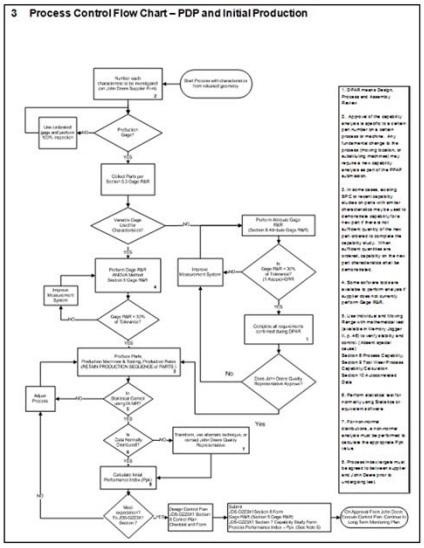
PDP Process Control Flowchart

2009 Version



2015 Version



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OFP Process Control Flowchart

2009 Version

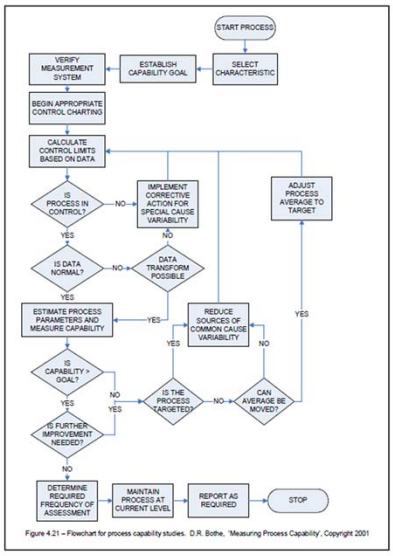
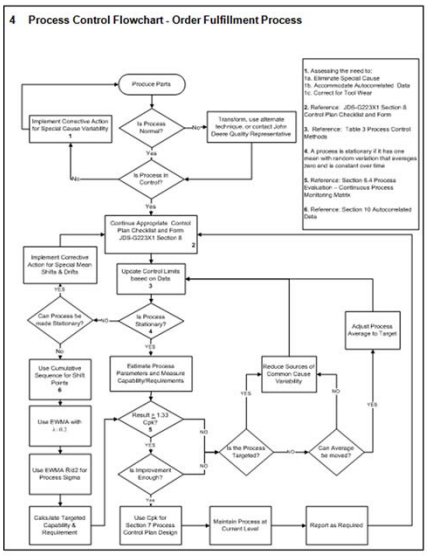


Figure 4.21 – Flowchart for process capability studies. D.R. Bothe, 'Measuring Process Capability', Copyright 2001

2015 Version



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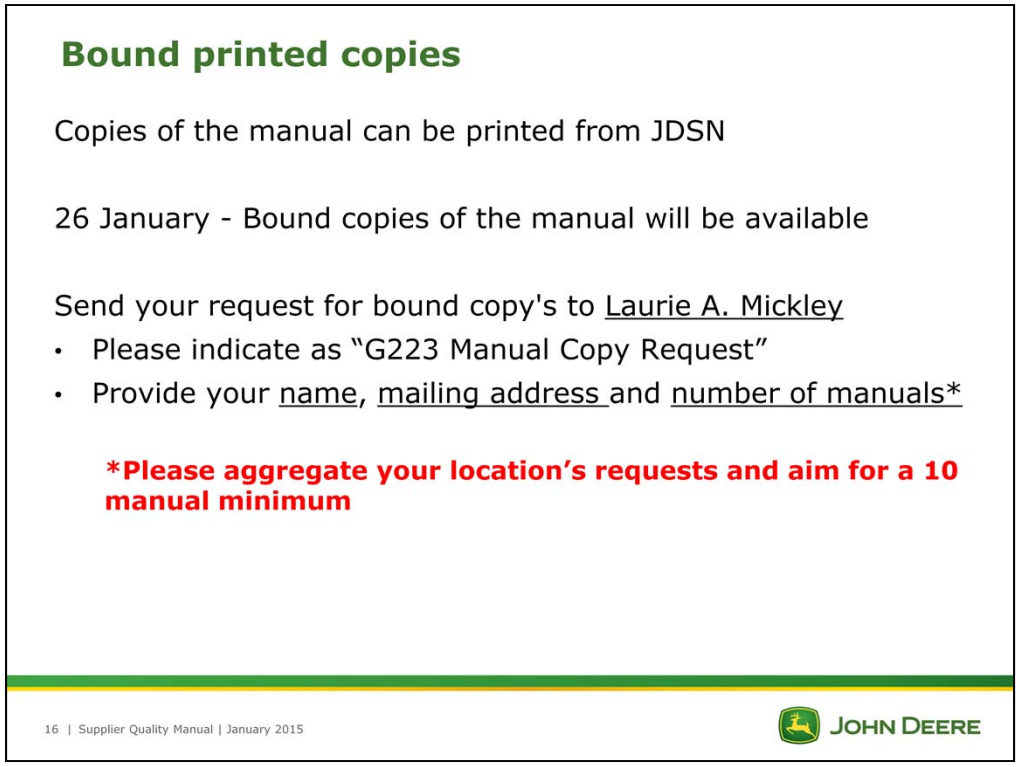
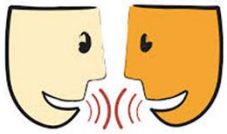


But if you only need 6 go ahead and request 6, don't request 10 and throw 4 away what I don't want is 200 people requesting 1 manual

Supplier Communications

- Announced at December 9th AE supplier Conference Webcast
- Posted on JDSN Engineering Standard's "What's New"
- Note on JDSN external homepage
- Letter from Quality/Supply Management Managers to key supplier personnel
- 2nd Qtr. - Self directed PowerPoint class available



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Just on front edge of planned supplier communications

Next steps

1. Print or request a copy
2. Review highlighted manual
3. Compare side-by-side with current version
4. Make notes, discuss with others in your area
5. Understand what's new, different, removed
6. Be prepared to answer questions from Suppliers
7. Provide feedback on additional training needs
8. Sign up for future training opportunities

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Emphasize for heavy or significant users of the manual

Translations

Translated versions will be available on JDSN in February
(these will not be available in hard copies)

1. Chinese (Simplified)
2. French
3. German
4. Portuguese (Brazilian)
5. Russian
6. Spanish (Universal)
7. Italian

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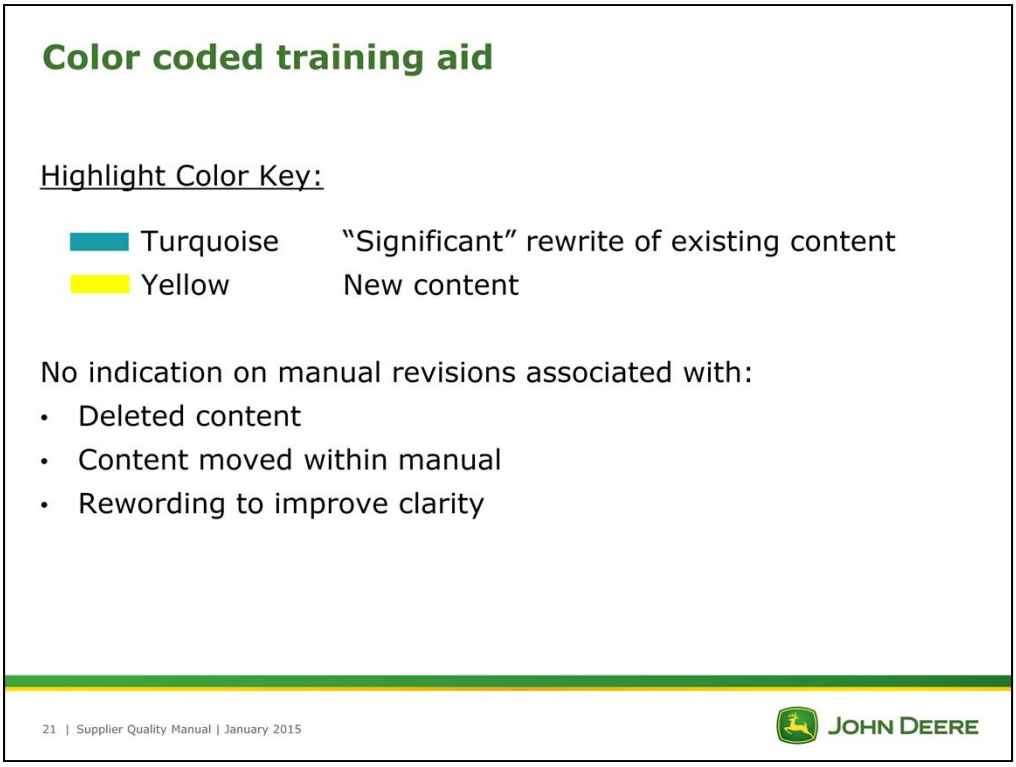
Future Training Opportunities

- We will be conducting a survey to assess additional training needs
- More 2 hour overview sessions , dates to-be-determined
- Series of 1 hour webinars covering concepts and application of content in Annex 2
- Full Day hands-on Train-the-Trainer class covering PDP & OFP flow charts and application of content in Annex 2



Also Summary of Changes from Previous Edition section at the back of the Program Requirements

Supplier Implementation

Suppliers expected to fully comply with Program Requirements

Suppliers should work toward understanding and applying advanced concepts in Annex 2

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Read understand and take steps to comply if not already in compliance.

Annex 2 establishes our preferred methodologies for meeting these requirements. We want the supplier to work toward these methods, however there may be other methods to accomplish the same objectives.

Answers to questions

Does this impact the G223 Questionnaire?

The G223 Questionnaire already reflects the SQM changes.
Available on JDSN and through the Supplier Qualification System

Where can I find this training material?

All training and reference material is available on JDSN

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Mention advanced training in Qtr.2

2nd Hour Agenda

More depth on major content changes

- Changes in Program Requirements
- PDP & OFP flow charts and Annex2
- Questions

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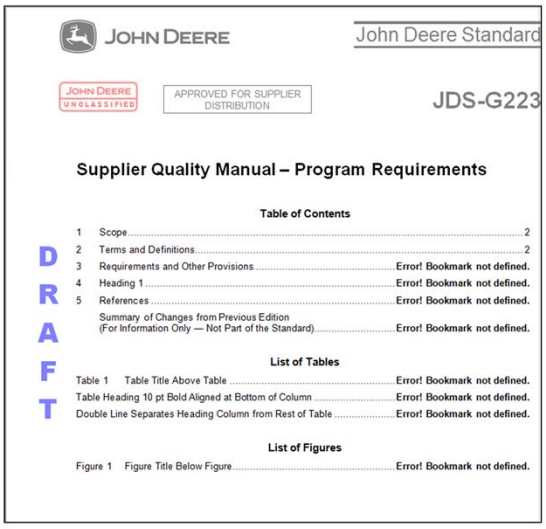
JDS-G223X2 Program Requirements



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John Deere Standard

JOHN DEERE UNCLASSIFIED

APPROVED FOR SUPPLIER DISTRIBUTION

JDS-G223

Supplier Quality Manual – Program Requirements

Table of Contents

DRAFT

List of Tables

List of Figures

Specific Updates

Section 1: Scope

- Additional clarification to the mandatory items with recommended items with "shall" and "should", "required" and "recommended"

Section 2: Terms & Definitions

- Some clarification of terms
- All terms now have a specific number

Specific Updates

Section 3: Quality Management System

Section 3.1: General Requirements

- Additional detail is provided about conducting audits at the suppliers location – quality system, PVA, SPA, PEQ, OFRA

Section 3.2: Supplier Roles & Responsibilities

- Requirement to communicate to JD of any 3rd party certification changes
- Failure to meet standard requirements may restrict business
- All documentation is available on JDSN

3.1.7 John Deere reserves the right to conduct a quality system assessment at the supplier's facility. When conducting this assessment, John Deere shall have access to the supplier's personnel, documentation, gaging, and test facilities. At the close of the assessment, John Deere shall share findings in a debriefing meeting and, at a later date, shall issue a report to the supplier summarizing the results of the assessment.

3.1.8 John Deere may conduct a Product Engineering Assessment using the Product Engineering Questionnaire (PEQ) for components with quality plan Levels ≥ 3 when the supplier has component or subsystem design control.

3.1.9 John Deere may conduct Process Verification Audits (PVA) on selected components. This on-site supplier quality audit is intended for parts with a high level of criticality to determine the effectiveness and conformance of process controls. This audit may also be performed on similar parts when the work has not yet been sourced, or during preparation for full production.

3.1.10 John Deere may conduct Special Process Audits (SPA) of supplier's special processes in the manufacturing of John Deere parts (see clause 6.6.3.1). If a first tier supplier outsources, either temporarily or permanently, the first tier supplier shall be responsible for assessing and approving the second tier suppliers.

3.1.11 John Deere may conduct an Order Fulfillment Risk Assessment (OFRA). This is a high level assessment intended to assess the supplier's order fulfillment (delivery) readiness, identify risks, and drive improvements.

- Communicating to John Deere, within 30 days, any changes to third party certification (quality, regulatory, health and safety, and environmental).

3.2.3 When the supplier chooses to outsource any process that affects product conformity with requirements, the supplier shall ensure control over such processes, including control of raw material. Control of such outsourced processes shall be identified within the quality management system.

3.2.4 Processes needed for the quality management system should include processes for management activities, provision of resources, product realization, and measurement. See clause 6.3 for John Deere notification requirements.

3.2.5 If the supplier does not meet the minimum level of performance of these requirements as measured by the JDS-G223 Supplier Quality System Audit, such failure shall impact and potentially can restrict future business until the identified major non-conformances are corrected, verified, and closed.

3.2.6 John Deere training for JDS-G223, John Deere Standards, and Enterprise Product Delivery Process Supply Chain Integration are available on JDSN.

Specific Updates

Section 3.3: Documentation Requirements

- Specific requirements are outlined for the suppliers document control procedure
  - Approved prior to release
  - Available at point of use
  - …

Section 3.4: Control of Records

- Clarification of data for special processes

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3.3.3 Control of Documents

3.3.3.1 The supplier shall establish and maintain a documented procedure to control all documents and data of internal and external origin such as standards and John Deere drawings.

3.3.3.2 The document control procedure shall include the following:

- Approval for adequacy prior to release.
- Documentation review, update, and re-approval.
- Identification of document changes and current revisions.
- Assurance that documents are available at all points of use.
- Assurance that documents are legible and identifiable.
- Relevant external document identification and distribution.
- Identification of and prevention of unintended use of obsolete documents.

3.4.3 The supplier's supply chain records pertaining to John Deere product shall be retained in the same manner as the supplier's quality records.

Examples of quality records should include, but are not limited to:

- Measurement Data
- Design and Process Failure Modes and Effects Analysis
- Measurement Systems Analysis Data
- Capability and Statistical Process Control Data
- Major Process Change Data
- Production Lot Control Data
- Verification Warrant and Documents
- Corrective Action Requests and Responses
- Gage Calibration and Maintenance Records
- Gage Repeatability and Reproducibility Analysis
- Input data from special processes for example:
  - Heat Treatment
  - Welding
  - Painting
  - Plating
  - Casting
  - Electronics

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Specific Updates

Section 4: Management Responsibility

Section 4.4: Planning

- Clarification of the requirement for the supplier's quality planning process

Section 4.5: Responsibility, Authority, and Internal Communication

- Requirement that management ensures that responsibilities and authorities are defined and communicated

Section 4.6: Management Review

- Clarification of the Management Review process and clarification of required inputs

4.4.2 Quality Plan

4.4.2.1 The supplier shall have a structured quality planning process. The purpose of the quality plan is to drive improvement in both the short-term and the long-term.

4.5.1 Responsibility and Authority

4.5.1.1 Management shall ensure that a quality management system is implemented in order to provide confidence that the supplier can satisfy the needs of John Deere. The system should be consistent with the size, culture, and products of the supplier.

4.5.1.2 Management shall ensure that the responsibilities and authorities are defined and communicated within the supplier's organization.

4.6 Management Review

4.6.1 General

4.6.1.1 The supplier's management shall review the supplier's quality management system at planned intervals, to ensure its continuing suitability, adequacy, and effectiveness.

4.6.1.2 This review shall include assessing opportunities for improvement and the need for changes to the quality management system, including the quality policy and quality objectives.

Specific Updates

Section 5: Resource Management

Section 5.3: Human Resources

- Added cross training requirement and operator competency equal to external certification where required

Section 5.4: Infrastructure

- Added requirement that the supplier has support services to verify product conformity to specifications and functions

Section 5.5: Work Environment

- Clarification that the supplier must provide a safe work environment
- Added requirement that the supplier must minimize environmental impact

5.3.4 The supplier should provide cross training to ensure product quality.

5.3.5 Although certification is not required, the supplier should ensure that employees responsible for products produced for John Deere have the same competency as those certified by international quality organizations such as the American Society for Quality (ASQ).

5.4 Infrastructure

5.4.1 The supplier shall provide and maintain facilities, equipment, workspace, hardware, and software to achieve conformity to product specifications and functional requirements.

5.4.2 The supplier shall provide support services, such as simulation models and testing capabilities, to verify conformity to product specifications and functional requirements.

5.5 Work Environment

5.5.1 The supplier shall provide a safe, healthy, and compliant work environment that supports quality objectives by identifying and managing human and physical factors that affect the quality of products and services provided to John Deere.

5.5.2 Suppliers shall conduct operations in a way that minimizes negative impact to the environment, and ensure compliance with laws related to air emissions, water discharges, toxic substances, and hazardous waste disposal.

Specific Updates

Section 6: Product Realization – EPDP

Section 6.1: Planning of Product Realization

- Clarified requirement that the supplier must have a product realization process that supports EPDP with additional reference to the new Annex 2.

Section 6.2: John Deere Related Processes

- Addition of the requirement of the ISIR and the related bubble print to support the ISIR
- Clarification of PFMEA requirement when KCs are identified
- Added requirement for supplier attendees during the DPAR

6.1 Planning of Product Realization

6.1.1 The supplier shall have a documented process for planning of product realization to meet requirements of the John Deere Enterprise Product Delivery Process (EPDP), with evidence of product conformance being driven by the PDP and Initial Production (Pre-Launch), and Order Fulfillment Process (Production) flowcharts. See clause 3 and clause 4 in JDS-G223X2 (2015).

6.2.1.6 Unless otherwise communicated, the supplier shall document conformance to all specifications, dimensions, and drawing notes on the Initial Sample Inspection Report (ISIR). See clause 6 in JDS-G223X1 (2015).

6.2.1.7 A graphical representation (bubble print) shall accompany the ISIR, unless waived by a John Deere quality representative.

Specific Updates

Table 1: PPAP requirements by QPL

- Clarification in table of requirements and the removal of the AIAG Level 2 column

Section 6.3: JD Notification and Submission Requirements

- Clarification of the requirement for an SCR
- Clarification of the when an SCR is required

Section 6.4: Design and Development

- Added the requirement that the supplier must conduct design reviews when the design is owned by the supplier
- Team members must include design competency experts

Table 1 Production Part Approval Requirements by Quality Plan Level

	Requirement	John Deere Quality Plan Level					Complete By
		0	1	2	3	4	
1.	Design Record						
	– for proprietary components / details		R	R	R	R	Prior to supplier shipment
	– for all other components / details		R	R	R	R	Prior to supplier shipment
2.	Engineering Change Documents, if any		R	R	R	R	First supplier production
3.	* John Deere Engineering approval						Prior to supplier shipment
4.	Design FMEA (Failure Modes and Effects Analysis)				R	S	Prior to complete design
5.	Process Flow Diagrams / Process Map		R	R	S	S	Prior to supplier production
6.	Process FMEA			R	S	S	Prior to control plan
7.	Control Plan (including Checking Aids)			S	S	S	Prior to supplier production
8.	Measurement System Analysis Studies – Gage R & R Studies for Key Characteristics			S	S	S	Prior to use
9.	Initial Sample Inspection Report - ISIR (Dimensional Results)		S	S	S	S	Prior to supplier shipment
10.	Material / Metallurgical / Functional / Test Results (as appropriate)		S	S	S	S	Prior to supplier shipment
11.	Initial Process Studies – Capability Studies			S	S	S	Prior to control plan
12.	* Qualified Laboratory Documentation				R	R	Prior to supplier shipment
13.	Appearance Approval Report, if applicable (for JD Class A parts)				S	S	Prior to supplier shipment
14.	Verification Warrant		S	S	S	S	Prior to supplier shipment
15.	Experimental Part Inspection (Engineering)			S	S	S	Prior to supplier shipment
16.	Supplier Functional Verification Testing Results			R	S	S	Prior to supplier shipment
17.	* Sample Product						
18.	* Master Sample						
19.	* Records of Compliance With John Deere-Specific Requirements						

S = the supplier shall submit to John Deere and retain a copy of records or documentation items at appropriate locations.

R = the supplier shall retain at appropriate locations and make available to John Deere upon request.

* If requested by John Deere, provide documentation

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6.3.1 John Deere Notification

6.3.1.1 The supplier shall obtain approval from John Deere prior to making changes to a specification or process for supplied products or services for any change that can impact safety, fit, form, function, performance, durability, or appearance per the requirements listed in Table 2.

6.3.1.2 The supplier shall notify the responsible John Deere design unit of any design or process changes as indicated in Table 2 by using the Supplier Change Request (SCR) system on JDSN.

6.3.1.3 Individual John Deere using units can subsequently elect to require a submission for PPAP approval. Table 2 , which is derived from the AIAG Production Part Approval Process Manual, specifies when notification is required.

6.4.1 General

When design control of the product resides with the supplier, the supplier shall conduct design reviews; include representation from second tier suppliers, and John Deere as appropriate.

6.4.2.3 Design reviews are typically conducted with John Deere and supplier team members (design competency experts) from areas such as product engineering, product verification and validation, reliability engineering, marketing, supply management, quality engineering, manufacturing engineering, and materials engineering.

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Specific Updates

Section 6.4: Design and Development (continued)

- Added requirements regarding component specification and notification requirements to JD when changes occur
- Added three tables:
  - Table 4: Reliability Goal Breakdown
  - Table 5: Component Mounting Location Information
  - Table 6: Usage Environment Conditions
- Additional requirements about PV&V plan and linkage to component requirements
- Additional requirement for PV&V gap mitigation
- Additional requirement for high risk failure modes must be demonstrated following the JD Component Reliability Assessment Process

6.4.3 Design and Development Inputs

6.4.3.1 Component specifications shall be developed, reviewed, and approved with the supplier and John Deere.

6.4.3.2 Any changes after initial approval shall be submitted by the supplier for approval from John Deere.

6.4.3.3 A component specification shall include, but is not limited to, a reliability goal breakdown, mounting location information, and usage environment conditions (see Table 4, Table 5, and Table 6).

Table 4 *Reliability Goal Breakdown*

John Deere Usage Information	
Average User Information	*– Average Annual Usage (AAU) (hours, cycles)* *– Percentile John Deere used for AAU*
Top User Information	*– Annual Usage Period (AUP) (hours, cycles)* *– Percentile John Deere used for AUP*
Warranty Period	*– Warranty Period (years, hours)*
Durability Period	*– Design Life (hours)*
Preferred Confidence Level for Durability/Reliability Testing	*– Confidence Level (%)*
Component Goal Breakdown	
Component Failure Mechanism	*– Define as either wear-out, or overstress mechanism* *– Define the reliability % for the failure mechanism at a given point of time (e.g. B10 = 5,000 hours)* *– Define a specified design safety coefficient*
High Level Duty Cycle Operation	
Expected Usage	*– List of applications* *– Number of actuations per period of time* *– % of time spent on each of the different operations*
Component Allocation	
Warranty	*– Warranty Period (hours, cycles)* *– Reliability required at the end of the warranty period (%)*
Durability	*– Design life of the product (hours, cycles)* *– Reliability required at the end of the design life of the product*

Table 5 Component Mounting Location Information (Examples)

Drawing/Chart	Reason
Component interface diagram (I/O)	An input/output (I/O) diagram illustrates the connection points that a component, or system, may have with other systems. Information from this chart may be used to understand key data to properly set up a test.
Identification of critical components/items in close proximity to the component (e.g. engine, exhaust, etc.)	Clear identification of potential stresses that might act as catalytic agents to induce a particular failure mode. For example, induced vibration from a nearby component, susceptibility due to an electric line, or heat conduction from a hydraulic line.
Drawings of mounting location (with dimensions)	Mounting location drawings are required to accurately replicate component mounting conditions on test fixtures.
Rigidity and cushioning conditions	Identifying any rigidity or cushioning conditions used to support the component in the vehicle. Most commonly used in vibration testing to determine if the design is adequate to avoid some resonant frequencies that may be harmful to the component.

Table 6 Usage Environment Conditions

Condition	Possible Test Conditions
Manufacturing	– Are there any environmental factors that may affect performance? (for example drops, electrostatic discharge (ESD) etc.) – Any assembly line risks associated with the product's manufacturing process (for example improper torque spec)?
Transportation to Dealership/End-Customer	– How is the product packaged (for example, crate, box, etc.)? – What is the mode of transportation? (for example, air, truck, ship, etc.) – Any risks associated with the transportation process? (for example, altitude, vibration, humidity)
Storage Conditions	– What are the expected warehouse environmental conditions? (for example humidity, temperature vapors, etc.)
Startup Conditions	– Are there any special conditions worth noting at startup (for example cold starts)?
Transportation to Field	– Are there any special conditions that the product experiences while transporting to the field (for example, highway conditions, trailer conditions, etc.)?
Operating Conditions	– How is the product used in the field? – What % of time is the product doing each operation? – What are the environmental conditions in the field? (for example, temperature ranges, humidity ranges, vibration) – Any chemicals or liquids present in the operation?
Special John Deere Conditions	– Are there special uses for the equipment? – What are those conditions? – Where are those conditions more prominent? – Are there any special requirements for the countries where the product will be sold (for example electromagnetic interference (EMI))? – Do any of these conditions happen while the product is turned off?

6.4.3.7 The PV&V plan should have clear linkage between the component requirements and the tests.

6.4.3.8 Product Verification and Validation gaps shall be identified and mitigated through the use of processes and tools such as:

- Design analysis
- Key Technology Analysis
- FMEAs
- Design Reviews
- Lab and field testing

6.4.3.9 Component reliability shall be demonstrated for high risk failure modes and mechanisms through the John Deere Component Reliability Assessment Process, which shall include both overstress and wear-out failure mechanisms. See clause 3 in JDS-G223X1 (2015).

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Specific Updates

Section 6.4: Design and Development (continued)

- Additional requirement that the supplier must utilize the appropriate **product** design **input** requirements with a list of potential inputs
- Additional requirement that the supplier must utilize the appropriate **manufacturing** design **input** requirements with a list of potential inputs
- Same requirements as listed above of design **outputs** for **product** and **manufacturing**

6.4.4 Product Design Input

6.4.4.1 The supplier shall identify, document, and review the product design input requirements.

6.4.4.2 Design input requirements shall include the following:

- John Deere requirements (contract review) such as key characteristics, identification, traceability, and packaging.
- Process to deploy information gained from previous design projects, competitor analysis, supplier feedback, internal input, field data, and other relevant sources, for current and future projects of similar nature.
- Targets for conformity to product requirements, life, reliability, durability, maintainability, timing and cost.

6.4.5 Manufacturing Processes Design Input

6.4.5.1 The supplier shall identify, document, and review the manufacturing process design input requirements.

6.4.5.2 Manufacturing process design inputs shall include:

- Product design output data
- Targets for productivity, process and cost
- John Deere requirements
- Experience from previous developments

6.4.7 Product Design Output

6.4.7.1 The product design output shall be expressed in term that can be verified and validated against product design inputs.

6.4.7.2 The product design outputs shall include:

- Design FMEA
- Reliability results
- Product key characteristics and specifications
- Product error-proofing, as appropriate
- Product definition including drawings or mathematically based data
- Product design review results
- Diagnostic guidelines, where applicable

6.4.8 Manufacturing Process Design Outputs

6.4.8.1 The manufacturing process design output shall be expressed in terms that can be verified against manufacturing process design input requirements and validated.

6.4.8.2 The manufacturing process design output shall include:

- Specifications and drawings
- Manufacturing process flow chart/layout
- Manufacturing process FMEA
- Control plan (see clause 8 in JDS-G223X1 (2015))
- Work instructions
- Process approval acceptance criteria
- Data for quality, reliability, maintainability, and measurability
- Results of error-proofing activities, as appropriate
- Methods of rapid detection and feedback of product and manufacturing process nonconformities

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Specific Updates

Section 6.5: Purchasing

- Clarification that the supplier must monitor supply chain
- Clarification of the requirement to meet the Restricted Materials List
- Addition of conflicts with local laws and the Restricted Materials List and which takes precedence
- Addition of requirement to notify JD if PO requirement cannot be met
- Additional information regarding Incoming Product Conformity and Supply Chain Monitoring by the supplier

6.5.1.5 The supplier shall monitor second tier supply chain's performance on a reoccurring basis.

6.5.2.7 The supplier shall comply with the John Deere Restricted Materials List (for example, asbestos or lead in paint) and applicable laws that supplied products do not contain substances in excess of the amounts set forth on John Deere's Restricted Materials List, or any substances restricted by applicable laws.

6.5.2.8 If there is a conflict between the John Deere Restricted Materials List and applicable laws, the more stringent requirements shall be met. The Restricted Materials list is located on JDSN.

6.5.3.2 All John Deere purchase order requirements shall be met. Any exceptions shall be documented, communicated to John Deere, and approved prior to acceptance of a John Deere purchase order.

6.5.4.3 Suppliers may utilize John Deere audit forms for qualification of the supplier's supply chain.

6.5.5 Incoming Product Conformity to Requirements

6.5.5.1 The supplier shall have a process to ensure the quality of purchased product. See clause 6.5.4.

6.5.5.2 The process shall include one or more of the following:

- Receipt of and evaluation of statistical data by the supplier
- Receiving inspection or testing such as sampling based on performance
- Second or third party assessments of supplier sites, when coupled with records of acceptable delivered product conformity to specifications
- Part evaluation by a designated laboratory
- Another method agreed upon with John Deere

6.5.6 Supply Chain Monitoring

6.5.6.1 The supplier shall ensure supply chain monitoring of manufacturing processes.

6.5.6.2 Supply chain performance shall be monitored through the following:

- Delivered product conformity to specifications
- Customer disruptions including field returns
- Delivery schedule performance, including incidents of premium freight
- John Deere notifications related to quality or delivery issues

Specific Updates

Section 6.6: Production and Service Provision

- Additional requirement requiring creation of control plans and items that are included in control plans
- Clarification about equipment owned by JD and located at a supplier location
- Additional requirement about cleanliness and corrosion upon delivery
- Additional requirement about shipping, packaging, and cleanliness of JD owner containers

6.6.2 Control Plan

6.6.2.1 The supplier shall plan and carry out production and service provisions under controlled conditions.

6.6.2.2 The supplier shall develop control plans (see clause 8 in JDS-G223X1 (2015)).

6.6.2.3 Control plans shall include the following:

- Processes at the system, subsystem, component or material level for the product supplied.
- Processes producing bulk materials as well as parts.
- A plan for pre-launch and production; that takes into account the design FMEA and manufacturing process FMEA outputs.
- All elements specified by John Deere.

6.6.5.4 The supplier shall maintain processing equipment, tooling, measuring equipment, and fixtures owned by John Deere in an acceptable operating condition capable of meeting John Deere production requirements.

6.6.6.2 Unless otherwise specified or communicated by the John Deere representative, all products shall be visually clean, free from visible corrosion upon delivery to the intended destination and withstand 90 days of non-climate controlled indoor storage without the development of visible corrosion.

6.6.6.3 Packaging shall meet all applicable shipping laws, codes, and regulations. Packaging shall meet all requirements imposed by John Deere. The supplier should ensure John Deere owned packaging is maintained to be clean and free from dirt, debris, foreign materials, and damage, while packaging is under supplier control.

Specific Updates

Section 6.7: Control of Monitoring and Measuring Device

- Additional requirements regarding calibration activities, record retention, and activities if a gage is found to be out of calibration
- Additional clarification and requirements for Gage R&R with reference to new details found in Annex 2

Section 7: Measurement, Analysis and Improvement

Section 7.1: General

- Additional requirement for use of the appropriate statistical tools during quality planning
- Additional requirement of basic statistical concepts being understood within the suppliers organization

6.7.2.3 Records of calibration activities shall be maintained.

6.7.2.4 When using an external laboratory for calibration, the laboratory shall be accredited by a national or international accreditation body (for example, ISO/IEC 17025).

6.7.2.5 Gages shall be reviewed for potential revisions following engineering changes.

6.7.2.6 Whenever a gage is found out of calibration and it has been used to verify parts for John Deere, the supplier shall notify John Deere of the suspect parts.

6.7.2.7 Suspect part notification shall include:

- An assessment of the impact of out-of-specification condition
- Statements of conformity to specification after calibration and verification

6.7.3.2 Gage R&R studies should be performed whenever new production personnel begin using the measuring instrument. The method for performing the Gage R&R study shall be either the Range Method or the ANOVA method (see clause 5 in JDS-G223X2 (2015)).

6.7.3.7 Gage R&R studies on families of gages shall be agreed to by John Deere prior to completion of the DPAR.

6.7.3.8 Some types of equipment, such as flow meters and hardness testers do not lend themselves to Measuring System Analysis. This type of equipment shall be identified in the calibration program and shall be verified at a specified frequency using industry standards.

7.1.4 The appropriate statistical tools for each process shall be determined during advanced quality planning and included in the control plan.

7.1.5 Basic statistical concepts, such as variation control (stability), process capability, and over-adjustment shall be understood and shall be utilized throughout the supplier's organization.

Specific Updates

Section 7.2: Monitoring and Measurement

- Clarification and additional requirements regarding internal audits at the supplier's location
- Additional requirement about control plan submission
- Recommendation to use advanced tools as outlined in Annex 2 when tool wear can cause conformance issues
- Additional requirements about appearance items

Section 7.3: Control of Nonconforming Product

- Additional requirements about containment of nonconforming product
- Additional information about reworked product and record retention

7.2.3.2 A formal corrective action process shall include root cause determination to correct deficiencies.

7.2.3.3 The supplier shall have qualified internal auditors who are independent of area being audited perform the audits.

7.2.6.7 Manufacturing processes susceptible to tool wear and auto correlated data should consider using the analytical methods described in clause 9 and clause 10 in JDS-G223X2 (2015).

7.2.7.3 For new or changed parts or processes, product conformance is driven by process control flow chart, PDP and Initial Production (see clause 3 in JDS-G223X2 (2015)), Order Fulfillment Process (see clause 4 in JDS-G223X2 (2015)), and Process Control Plan Design (see clause 8 in JDS-G223X1 (2015)).

7.2.8 Appearance Items

For supplier's manufacturing parts designated by John Deere as appearance items, the supplier shall provide the following:

- Appropriate resources for evaluation (for example, enhanced lighting).
- Masters for color, grain, gloss, metallic brilliance, texture, and distinctness of image (DOI), as appropriate.
- Maintenance and control of appearance masters and evaluation equipment.
- Verification that personnel making appearance evaluations are competent and qualified (see clause 8 in JDS-G223X2 (2015)).

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7.3.1.4 If containment of non-conforming product is unsuccessful, then third party inspection can be required by John Deere, to be performed at the supplier's expense.

7.3.2.2 Reworked product shall pass appropriate functional tests, in accordance with the original control plans.

7.3.2.3 All serialized product shall have documented records of rework. See clause 6.6.4.

Specific Updates

Section 7.4: Analysis of Data

- Additional requirement to monitor warranty in JDSN and initiate warranty improvement projects

Section 7.5: Improvement

- Additional requirement for a formal continuous improvement process
- Additional requirements regarding FMEAs and use of RPN to identify areas for improvement

7.4.4 Suppliers shall monitor warranty performance on JDSN, and shall initiate warranty improvement activities based on warranty trends and analysis results. Suppliers are responsible for requesting specific warranty parts needed for investigations, and shall support John Deere in warranty reviews when requested by John Deere.

7.5.1 Continuous Improvement

7.5.1.1 Suppliers shall demonstrate a commitment to continuous improvement in products, processes, and services provided to John Deere.

7.5.1.2 Suppliers shall have a formal continuous improvement process. The goal should be to reduce defects, scrap, and re-work to improve safety, reduce cost and RPN, and to improve operation efficiency and production capacity. Quality system emphasis is placed on preventing rather than detecting non-conformity.

7.5.3.2 FMEAs and other production documentation shall be maintained through the life of the product.

7.5.3.5 Use of the Risk Priority Number (RPN) can be a useful tool because RPN indicates overall risk levels. The limitation of using the RPN method needs to be fully understood, however, and the use of RPN thresholds alone to determine action priority is not recommended. Consideration of high severity ≥ 5 with high occurrence ≥ 5 can be an indication of required follow-up actions. For additional information, see AIAG Failure Mode and Effects Analysis Manual and SAE.

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JDS-G223X2 (Annex 2) Process Control

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JDS-G223X2

Supplier Quality Manual – Method and Examples

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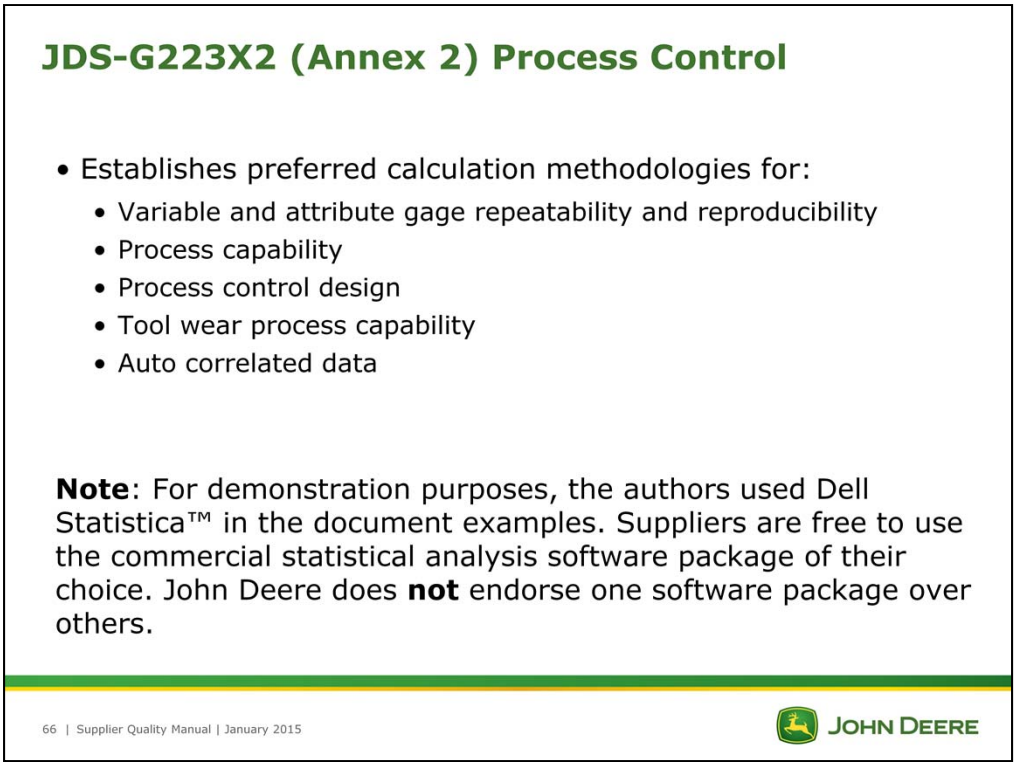
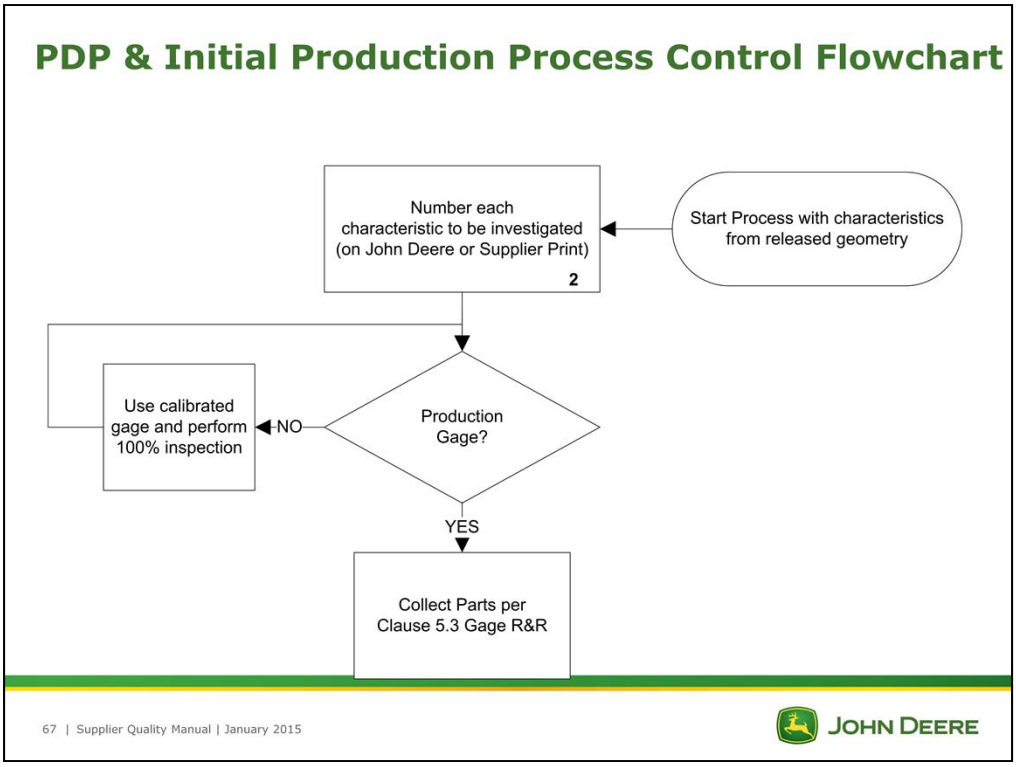


Establishes the preferred methodologies for calculation of gage repeatability and reproducibility, process capability, process control design, attribute gage repeatability and reproducibility, tool wear process capability, and auto correlated data. These statistical tools are used not only on processes and products, but also in measuring John Deere satisfaction and supply chain performance.

There are many different commercial software packages available to suppliers for statistical analysis. John Deere does not endorse one software package over others. Suppliers are free to use the software package of their choice.

For the purpose of demonstrating the examples in this document, the authors used Dell Statistica™.



2. Approval of the capability analysis is specific to a certain part number on a certain process or machine. Any fundamental change to the process (moving location, or substituting machines) may require a new capability analysis as part of the PPAP submission.

The parts should be numbered and measured in a randomized order for the first trial, then re-randomized for each trial.

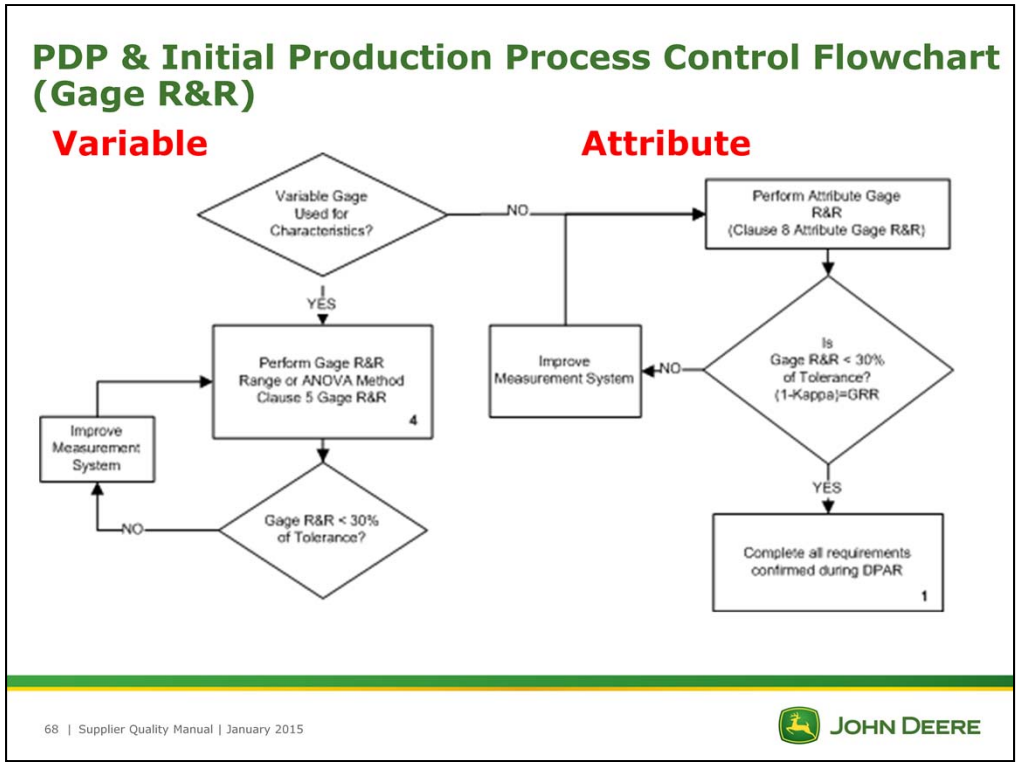
The appraiser (production operator and others familiar with the gage) should be unaware of the previous values while obtaining subsequent measurements.

Process capability parts do not make good Gage R&R samples since the range of dimensions is usually too small in the process capability study. For Gage R&R studies if available, the greater the range beyond the specification is better. For this reason, $Cp \leq 1.0$ is recommended; maximum $Cp = 1.10$.

Ten parts from smallest to largest allowed by the specification with one at each extreme and remainder equally distributed through the entire specification.

The Gage R&R study shall include the following:

- 10 parts recommended, 5 parts minimum
- 3 appraisers recommended, 2 appraisers minimum
- 3 measures on each part recommended, 2 measures on each part minimum
- Parts × measures ≥ 15 required



1. DPAR means Design, Process and Assembly Review

4. ANOVA is John Deere preferred. Some software tools are available to perform analysis if supplier does not currently perform Gage R&R.

Acceptance of Gage

The gage acceptance criteria shall include the following:

- Gage R&R value is < 30 %
- The 90 % confidence interval for the Gage R&R is 15 % or less

Note: The goal of the analysis is to find the Gage R&R and its 90 % confidence interval. The sample size and the number of measures should be sufficient so that the 90 % confidence interval is no wider than 15 % (For example, the Gage R&R is to be, at worst 20 % ± 7.5 %. This means a 90 % upper confidence limit of 27.5 % and 90 % lower confidence limit of 12.5 %).

- The number of distinct categories is at least 5
- Part variation is 100 % or larger (exceptions can be granted by John Deere Quality Representative)

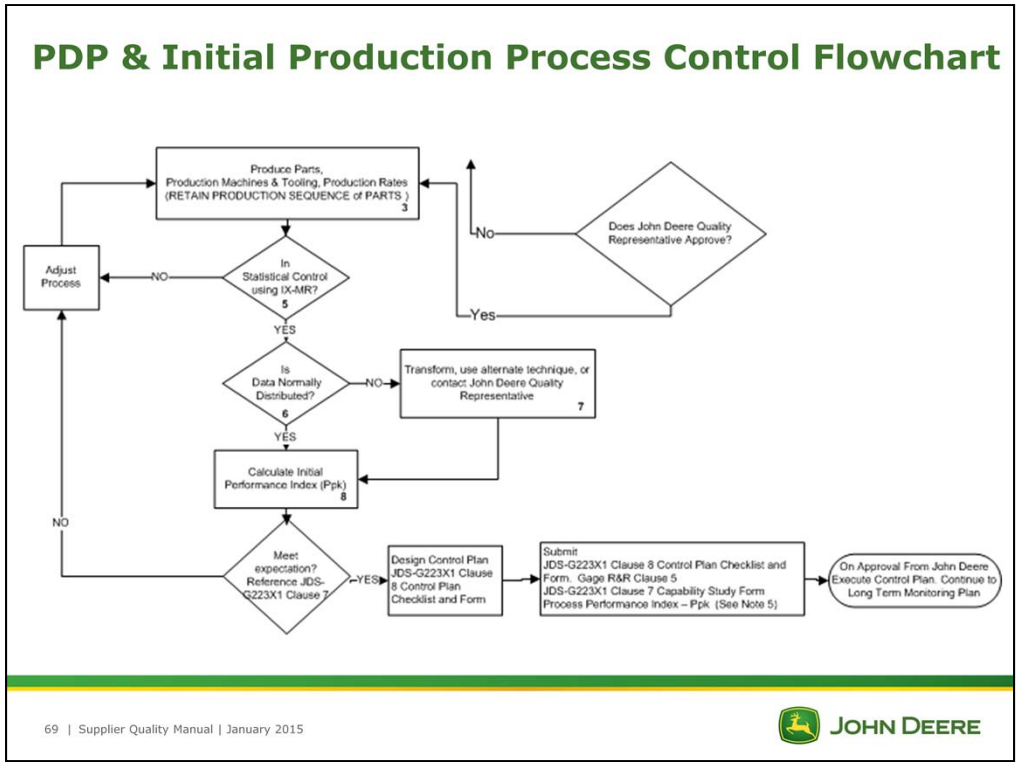
Attribute gages

The primary reasons for using attribute gages are its economy and rapid results. The purpose of attribute gage R&R is to ensure agreement among users of the gage so that consistent appraisal occurs.

Attribute Gage R&R are also conducted with standards. The purpose in this example is to judge whether the method and device yield trustworthy results in the eyes of the customer who desires product conforming to specifications.

Required Method. The following steps shall be followed for Attribute Gage R&R:

- Sample selection is very important. Management shall provide at least 12 pieces for the study to be used as the standards.
    - 2 pieces beyond the upper acceptance limit (Go/No Go)
    - 8 pieces with acceptable range
    - 2 pieces below the lower acceptance limit (Go/No Go)



3. In some cases, existing SPC or recent capability studies on parts with similar characteristics may be used to demonstrate capability for a new part if there is not sufficient quantity of the new part ordered to complete the capability study. When sufficient quantities are ordered, capability on the new part characteristics shall be demonstrated.

5. Use Individual and Moving Range with mathematical test (available in Memory Jogger II, p. 46) to verify stability and control. (Absent special cause)

Special cause examples: Human (Operator) error, unplanned events, freak occurrences that are not part of the way the process normally operates or is present because of an unlikely combination of process steps. Special causes must be eliminated before the Control chart can be used as a monitoring tool.

Clause 6 Process Capability, Clause 9 Tool Wear Process Capability Calculation, Clause 10 Autocorrelated Data

6. Perform statistical test for normality using Statistica or equivalent software.

Examples of inherently non-normal process measures include flatness, concentricity, tensile strength, casting hardness, and parallelism.

7. For non-normal distributions, a non-normal analysis must be performed to calculate the appropriate Ppk value.

8. Process Index targets must be agreed to between supplier and John Deere prior to undergoing test.

Process Control Design:

Determine the subgroup size (n) for process sampling to assure control of process

Identify sampling rate (r) to assure response to process changes in a timely manner

Compute the control limit width factor, k, and limits ($m_0 \pm k/\sqrt{n}$) for a statistical process behavior chart to identify special causes to maintain process control and identify opportunities for process improvement.

Required inputs shall include the following:

Estimate of process sigma,

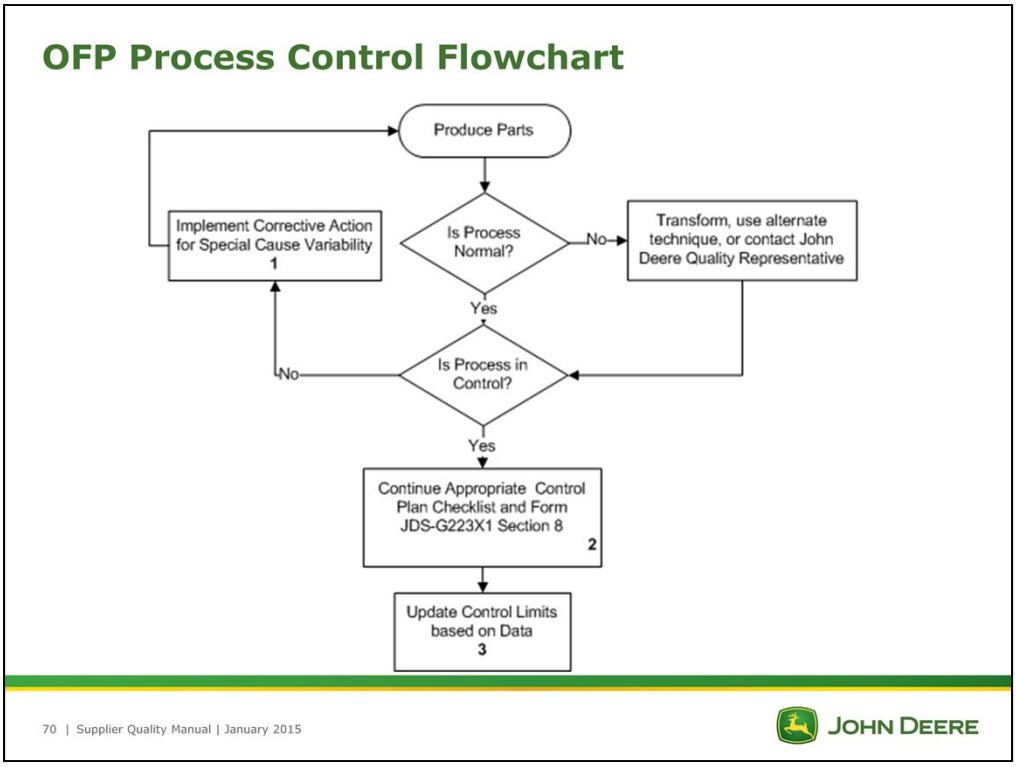
Process performance index, targeted $\hat{P}$pk (or Ppm, see clause 7)

Order to produce production quantities

Average Production Length (APL_0) before a false alarm is generated (alpha risk). Generally this is 6 months of demand.

Average Production Length (APL_d) before a signal is generated when the process mean has moved d σ units from the target (beta risk). John Deere requires this to be no > 1 day's consumption

Number of σ between specification limit and the process target = 3Ppk



1. Assessing the need to:

- Eliminate Special Cause

Special cause examples: Human (Operator) error, unplanned events, freak occurrences that are not part of the way the process normally operates or is present because of an unlikely combination of process steps. Special causes must be eliminated before the Control chart can be used as a monitoring tool.

- Accommodate Autocorrelated Data
- Correct for Tool Wear

2. Reference: JDS-G223X1 Section 8 Control Plan Checklist and Form

3. Reference: Table 3 Process Control Methods

Table 1 Process Control Methods

Process control methods can include, but are not limited to the following:	
Control Method	**Description**
Acceptance Sampling	A sampling technique in which units of product are drawn from a specific lot. The information from these samples is used as a basis for making acceptance decisions concerning parts or processes. This method can be used for large numbers of parts from discreet batches (ASQ Statistics Division, 2004).
Continuous Sampling	This method requires that a consecutive number of pieces pass inspection before starting normal sampling cycles. This method can be used when the product stream is continuous in processes such as painting, welding, assembly, and machining.
Modified SPC	Modified control charts have control limits that are not established by conventional, control limit-setting techniques. Modified control charts are sometimes referred to as Acceptance Control Charts. They can establish whether, or not, a process can satisfy product or service tolerances, and is "in a state of statistical control". It is generally assumed that assignable causes can create shifts in the process level. These shifts should be small enough, in relation to tolerance requirements, to be considered uneconomical to control with conventional SPC Charts (ASQ Statistics Division, 2004).
Pre-Control	Pre-control is effective for any process where the quality characteristic of interest can be adjusted. The process can have either a continuous output, (e.g., heat-treat furnace data) or a discrete output (e.g., machine parts). There are no additional requirements and no underlying assumptions concerning capability, or normality of the quality characteristic. This method can be used temporarily, as a precursor to a conventional SPC chart, or as a permanent control method (De Feo & Juran, 2010).
Restudy	Measurement data is used to verify process capability and C_{pk} on a periodic basis.
Setup Check	Part characteristics are checked whenever the process is set-up and at periodic intervals. Examples include CMM checks, roundness checks, and gear geometry checks.
Short-Run SPC	Short-run SPC is used for small lot sizes of parts with characteristics common to a process. Each characteristic is transformed and plotted with other characteristics on the same chart (Bothe, 2011) For additional information reference International Quality Institute, Inc., SPC for Short Runs.
SPC Control Charts	SPC control charts are used as a basis to make decisions about a process. Control determinations are made by comparing the values of statistical measures of an ordered series of samples, or subgroups, with control limits. Examples include p, np, c, u, Xbar & s, Xbar & R, and IXMR. SPC control charts demonstrate whether, or not, the process is "in control". SPC control charts can be used in an acceptance sense, calling for action or investigation when a process shifts from its standard level. SPC Control Charts can be used with variable or attribute data. These continuous control methods are appropriate for mistake-proofing when abnormal process variations are not present (ASTM Committee E-11 (1976)), (Western Electric, 1982), and, (AT&T Statistical Quality control Handbook, 11th Ed).
Tool Control	A control method where the first part is checked after a new tool is installed. If the part checks OK, the process is run for the expected life of the tool. The last part produced with the old tool is then checked. If it is OK, then all the parts are OK.

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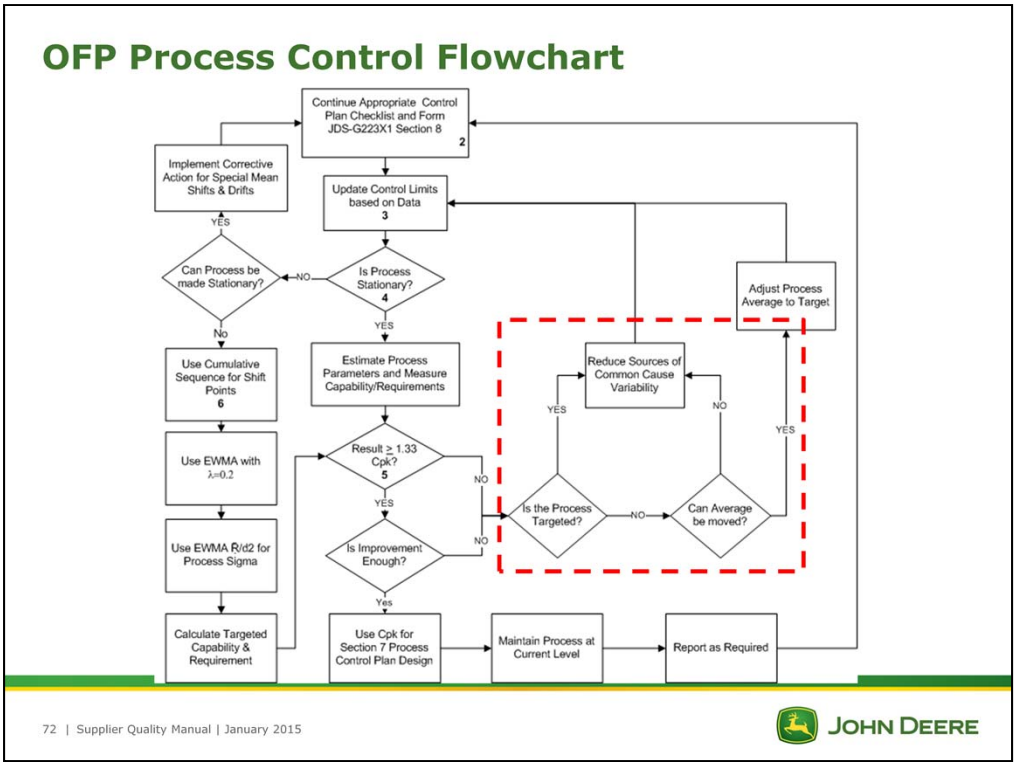


2. Reference: JDS-G223X1 Section 8 Control Plan Checklist and Form

3. Reference: Table 8 Process Control Methods

4. A process is stationary if it has one mean with random variation that averages zero and is constant over time

Process stationary = Process data vary about a constant mean in a stable, consistent manner. If the mean wanders or drifts over time, the process is non-stationary which likely indicates autocorrelation in the process.

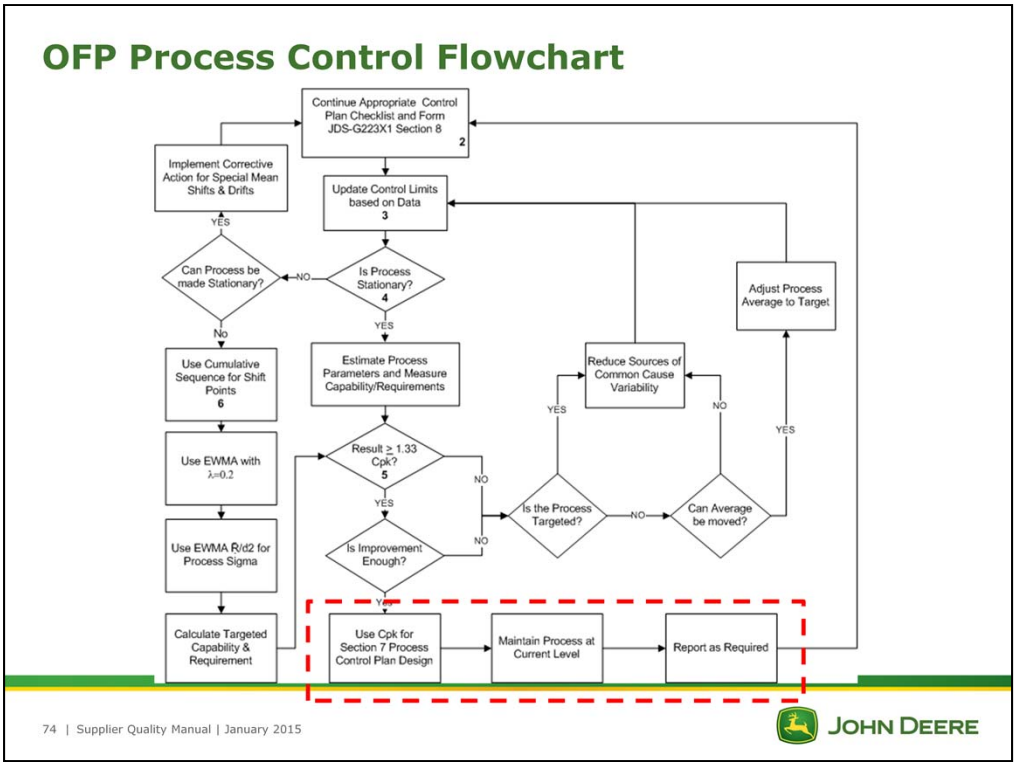
EWMA = Expontentially Weighted Moving Average

5. Reference: Section 6.4 Process Evaluation – Continuous Process Monitoring Matrix

6. Reference: Section 10 Autocorrelated Data

Table 1 Case Representation and Requirements

Case	Graphical Representation	Description Requirement
CASE 1 Cp < 1.0 Cpk < 1.0 or Unknown		This process is not able to continuously produce parts conforming to specifications. Typical SPC cannot help until the process is fixed for both the mean and the variability. If the process capability is unknown, data collection is required to determine the capability of the process.
		These conditions require 100 % inspection and a corrective action plan to improve the process. John Deere written approval is needed prior to shipping parts.
CASE 2 1.0 ≤ Cp < 1.33 Cpk < 1.0		This process is not able to continuously produce parts conforming to specifications. The primary issue is targeting. Mean control is the primary goal.
		This condition requires 100 % inspection and a corrective action plan to improve the process. John Deere written approval is needed prior to shipping parts.
CASE 3 C_p = 1.33 Cpk < 1.0		This process is not able to continuously produce parts conforming to specifications. John Deere written approval is needed prior to shipping parts. The primary issue is targeting. Mean control is the primary goal.
		This condition requires 100 % inspection and a corrective action plan to improve the process. John Deere written approval is needed prior to shipping parts. Audit variance using SPC.
CASE 4 1.0 ≤ Cp < 1.33 1.0 ≤ Cpk < 1.33		This process is capable of producing parts that conform to specifications, but can or cannot be targeted at the nominal specification value. An attempt should be made to determine the special causes that are prohibiting the process from being centered or are creating excess variation. The primary issue is targeting. Variance shall be monitored and reduced.
		Charting (SPC, pre-control, or run charting) to verify the parts being produced conform to design specifications, and a sampling plan to inspect parts per a frequency interval shall be executed. The interval is determined by the Cp value — the greater the Cp value, the less frequent the parts have to be checked. Evidence of < 0.0027 % defective parts is required.
CASE 5 C_p = 1.33 1.0 ≤ Cpk < 1.33		This process is capable of producing parts that conform to specifications, but can or cannot be targeted at the nominal specification value. An attempt should be made to determine the special cause(s) that are prohibiting the process from being centered or are creating excess variation. The primary issue is targeting. Variance shall be monitored.
		Charting (SPC, pre-control, or run charting) shall be used to verify the parts being produced conform to design specifications. Evidence of < 0.0027 % defective parts is required.
CASE 6 C_p = 1.33 Cpk = 1.33		This process is capable, well centered, and in control. Parts produced are conforming. There is little concern of nonconforming product.
		At a minimum, such a process should be verified as appropriate by inspecting the parts being produced, such as during the quartile marks for each run (first, 25 %, 50 %, 75 %, and last piece).



2. Reference: JDS-G223X1 Section 8 Control Plan Checklist and Form

3. Reference: Table 8 Process Control Methods

4. A process is stationary if it has one mean with random variation that averages zero and is constant over time

Process stationary = Process data vary about a constant mean in a stable, consistent manner. If the mean wanders or drifts over time, the process is non-stationary which likely indicates autocorrelation in the process.

EWMA = Expontentially Weighted Moving Average

5. Reference: Section 6.4 Process Evaluation – Continuous Process Monitoring Matrix

6. Reference: Section 10 Autocorrelated Data

Process Control Design:

Determine the subgroup size (n) for process sampling to assure control of process

Identify sampling rate (r) to assure response to process changes in a timely manner

Compute the control limit width factor, k, and limits ($m_0 \pm k/\sqrt{n}$) for a statistical process behavior chart to identify special causes to maintain process control and identify opportunities for process improvement.

Required inputs shall include the following:

Estimate of process sigma,

Process performance index, targeted $\hat{P}$pk (or Ppm, see clause 7)

Order to produce production quantities

Average Production Length (APL_0) before a false alarm is generated (alpha risk). Generally this is 6 months of demand.

Average Production Length (APL_d) before a signal is generated when the process mean has moved d σ units from the target (beta risk). John Deere requires this to be no > 1 day's consumption

Number of σ between specification limit and the process target = 3Ppk

Summary

Improved overall usability of manual

- Segregated program requirements into main body of manual
- Improved referencing within the manual
- Aligned structure and wording to industry standards (ISO / TS 16949)

Added step by step instructions on manufacturing process control (Annex 2)

- Detailed PDP & OFP flowcharts
- Detailed explanation of methodology with examples
- Added leading edge content
  - Gage repeatability and reproducibility studies for attribute gages
  - Tool wear
  - Autocorrelation