1 Introduction
Variation is inherent in any manufacturing and/or assembly process. Knowledge of the magnitude and consequences of this variation helps Engineers design appropriate products and processes within appropriate parameters that meet or exceed customer requirements. The Key Characteristic Designation System helps the Product Engineer communicate additional product and process requirements to the manufacturing/assembly community.

The Key Characteristic Designation System aids in the economical manufacture of quality products by supporting the control and reduction of variation in the manufacturing/assembly process and by supporting the development of robust designs (e.g., Design for Six Sigma).

Note: Nothing in the specification supersedes applicable laws and regulations unless specific exemption has been obtained.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Scope. This standard does:

1.1.1 Apply to all General Motors planning, product and process designs, manufacturing and assembly processes.

1.1.2 Apply to all Suppliers (internal and external) of products and processes to General Motors that are used in the design, manufacture, assembly, and distribution of GM products.

1.2 Purpose. To define how General Motors uses the Key Characteristic Designation System (KCDS) to standardize its approach for the identification, documentation and communication of characteristics that requires additional care to ensure consistency and compliance to customer requirements and government regulations within GM and its supplier community.

1.3 Policy. This standard is intended to ensure a method of application that is clear, uniform and consistent with other standards used at General Motors and its supplier community.

This standard also supports the understanding that:

• All dimensions, specifications, and tolerances displayed on product drawings or Master Process Plans (MPP) are important.

• All part dimensions and specifications must meet requirements and be produced within tolerance.

2 References
Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.
ISO 9001
ISO/TS 16949

2.2 GM Standards/Specifications.
C2B
GMW3059
GMN11011

2.3 Additional References.

2.3.1 For GM internal users of this standard.
KCDS Web Page. Use this URL to locate KCDS Templates, GM KCDS RASICs, Global KCDS Designation Reference spreadsheets, and additional reference standards.
http://gmna1.gm.com/vp/sedfss/kcds/
For GM Powertrain users, reference the Global Quality Base Requirements GQBR-016

2.3.2 Additional Information.
DaimlerChrysler, Ford Motor Company, and General Motors Supplier Quality Requirements AIAG/ASQ reference material obtained through the GM Quality Network or the AIAG at www.aiag.org.
AIAG Advanced Product Quality Planning and Control Plan, APQP-2
AIAG Potential Failure Mode and Effects Analysis
AIAG Statistical Process Control, SPC-3
Supplier Quality Statement of Requirements 1927-3.
The Deming Route by William W. Scherkenbach

3 Method

3.1 Planning Stage. During the Planning Stage, parts and/or systems that need to go through the
KCDS process are selected based on new unique design or technology, past history and current items listed on KCDS templates.

3.1.1 Multidisciplinary Team. Implementing KCDS within any product program timing requires a multidisciplinary (cross-functional) team approach, including departments and regions. Appropriate and affected functional areas should be involved in the selection of all parts, part features and/or assemblies requiring Additional Care and their related process control plans for a given part, sub-system, system, of a vehicle or program.

3.1.2 Team Identification. The KCDS Cross-Functional Team includes the full range of activities from Engineering to manufacturing including but not limited to design, supplier development, Quality/Reliability, and supplier communities (internal and outside).

Identifying variable characteristics (KPC and PQC) and attribute quality characteristics (Product Traceability and Confirmation), which require additional care, involves judgment and experience and is best done through a Cross-Functional Team and a broad range of experience.

3.1.3 Team Member Selection. The list of team members is intended to be functional in nature and actual membership or titles of the people could vary widely from group to group. Some members of the team are required on an “as needed basis.” As a minimum, the team must include representation from Product Engineering, Quality/Reliability and Manufacturing Engineering/Supplier Quality Engineering.

For example:
- Design Release Engineer/Designing Engineer
- KCDS Engineer/Facilitator
- Supplier Quality Engineer
- Manufacturing Engineer
- Manufacturing/Assembly Representative
- Quality/Reliability Engineer
- Dimensional Management Engineer
- Service Engineer
- Product Safety Representative
- Fastening Engineer

3.2 Stage 1 - Additional Care Selection. It is important in this Stage for the team, lead by the Design Release Engineer/Designing Engineer, to review Standard Care practices and procedures (see Glossary, 5.1.1) and discuss standard care expectations of the assembly/manufacturing facility prior to selecting the items which need additional care.

These specific standard care expectations/instructions/process capability data documentation can fall into the following 4 categories and are to be documented on the MPP, on the part drawing (with an AQC or DR symbol), in the Statement of Requirements (SOR), and control plan:
- Functional Check
- Special Component Handling
- Engineering Standard Work Expectations
- Documentation Required (DR)

Following the review of the standard care expectations, the team reviews the parts and/or systems identified in the planning stage and determine which parts, part features and/or assembly characteristics require additional care in manufacturing/assembly.

Data and Engineering judgment are required to arrive at the best list with which to begin. Both discussion and trials help establish confidence in choices. Product Engineering may request documentation of process capability data on specified standard product characteristics with a DR symbol.

The goal is to arrive at the critical few, rather than the non-critical many. Select characteristics that promote prevention rather than detection. Communicate the importance of the critical characteristic in a clear and unambiguous fashion. To ensure a robust design, the work in Stage 1 should be reiterated periodically throughout the entire process to reduce the need for long term/continuous additional care.

3.2.1 Variable Characteristic Criteria. A KPC or PQC is traceable back to the design/performance requirements.

Other selection criteria are:
- Part tolerance around a target dimension and other variables that affect final build quality (e.g. tolerance on hole size, form, orientation, location (Regardless of Feature Size-RFS), part length tolerance).
- Measurable and controllable.
- Released in GPDS and/or on the part drawing.

If a final build characteristic, (e.g., clearance, compression ratio, transmission smoothness, leak rate, product performance spec.), is selected, focus must be placed on the individual parts and their contribution to the overall variation. Templates (for Vehicle) and BOD – (for Powertrain) are
available/ linked from the GM Global KCDS website. (See KCDS Web Page, 2.3.1)

**Note:** A variable characteristic should not be designated a Key Product Characteristic or Product Quality Characteristic just because it is important that the specification be met, since all specifications must be met.

### 3.2.1.1 Key Product Characteristic Criteria.
Selection should be based on or indicated by a loss function or other method to identify a customer based target.

### 3.2.1.2 Product Quality Characteristic Criteria.
Selection should be based on or indicated by a loss function or other method to identify a customer based tolerance.

### 3.2.2 Attribute Quality Characteristic Criteria.
Attribute characteristics that are listed on KCDS templates apply to all parts of the same functional name, unless otherwise specified on the Template. New designs and their new parts/assemblies not listed should be reviewed for error proofing of the critical attributes.

When designating an attribute that requires additional care, an attribute control method (which insures 100% compliance) shall be used. This method should only be used where the costs are off-set by reductions in the risks and costs of product problems, including costs of detection and remedy. Data, which may be obtained from DFMEA, DRBFM, PFMEA, customer returns or warranty claims, should be available to support this request.

Attribute characteristics are selected by the type of attribute, and may fall into the following categories as defined above and are released into GPDS, MPP and/or on the part drawing (with an AQC symbol):

- Confirmation
- Product Traceability

### 3.3 Stage 2 - Controls and Process Selection.
In this stage the Team, lead by the Manufacturing Engineer, determines the controls and/or process requirements for all parts/part features and/or assemblies requiring additional care. They also own the development of the process control plans used to document the control or reduction of KPC/PQC variation with a KCC.

#### 3.3.1 Key Control Characteristic Criteria.
Many factors can affect the relationship between a KPC and/or a PQC and its KCC. Examples are changes in material, equipment, and the methods and systems that are used to make a product.

Ongoing control of the KPC/PQC is required and documented on a Process Control Plan. Once KCC’s are defined and process control is in place, product checks for the KPC/PQC should be reduced to a product or process verification/validation level.

A method for adjusting the KCC to set the KPC/PQC to its nominal value is required.

### 3.3.2 Key Control Characteristic Identification Guidelines.

- **3.3.2.1** It is directly traceable to a KPC/PQC.
- **3.3.2.2** There is a strong causal relationship to the KPC/PQC.
- **3.3.2.3** It is particularly significant in ensuring a KPC/PQC achieves its target value.
- **3.3.2.4** It is not (usually) specified on product drawings or product documentation.
- **3.3.2.5** Is documented on a Process Control Plan.

The tests apply to characteristics that are measured by either variable or attribute data.

### 3.3.3 Key Control Characteristic Methodology.
Identify the operations that impact each KPC/PQC with a flowchart of the process. Identify any process parameters in each operation that impact each KPC/PQC. A Fishbone (Cause & Effect) Diagram is a useful tool for this.

Determine the causal relationship to the characteristics.

Process characteristics with the strongest causal relationship become control characteristics.

Record the information on a process control plan.

#### 3.3.4 Attribute Characteristic Methodology.
Controls for attribute characteristics, which have been identified as needing additional care, require 100% conformance to requirements and therefore error proofing is the best method.

### 3.4 Stage 3 - Required Actions.
In this stage, controls of the parts requiring additional care are implemented into the manufacturing/assembly process to ensure product conformance. Controls on the KCC are implemented to ensure that variation is controlled or reduced.

#### 3.4.1 Key Product Characteristic.
The manufacturing/assembly plant must control the target nominal for each KPC. Controls shall include: statistical process control (SPC), process control plans, quality procedures or 100% variable inspection. Continuous improvement is required up to Cpk 2.0 (6 sigma).

#### 3.4.2 Product Quality Characteristic.
The manufacturing/assembly plant must maintain the
tolerance for each PQC through appropriate process control plans and quality procedures.

3.4.3 Attribute Quality Characteristic. The Following two designations fall under AQC.

3.4.3.1 Confirmation. The manufacturing/assembly plant must ensure that all attribute characteristics designated with a Confirmation minimally have 100% check for conformance to requirements, and other specific additional tasks as described by Product Engineering and shown designation will on the MPP or part drawings. This could include 100% secondary check.

3.4.3.2 Product Traceability. The manufacturing/assembly plant must ensure that all parts designated for traceability must be documented/tracked to the supplier’s lot number, date of manufacture, and Vehicle Identification Number (VIN) or for Powertrain the Engine Unit Number (EUN) or the Transmission Unit Number (TUN). The associated trace data must be kept according to a retention schedule.

3.4.4 Functional Checks. The manufacturing/assembly plant must perform functional checks as directed by Product Engineering and shown on the MPP or part drawings.

3.4.5 Special Component Handling. The manufacturing/assembly plant must adhere to specific part/assembly/system handling procedures as directed by Product Engineering and shown on the MPP or part drawings regarding identified components.

4 Tools

4.1 Error Proofing. Error proofing is the design and development of product and manufacturing processes used to prevent the manufacture or shipment of nonconforming products.

4.2 Loss Function. Loss Function is “The incremental economic/customer satisfaction loss for any deviation from a customer specified target zone. The target zone is the tolerance zone that will lead a customer to praise the product.” (The Deming Route by William W. Scherkenbach).

4.3 Statistical Process Control (SPC). Statistical Process Control is used to control various processes. It allows manufacturers to take appropriate action to achieve and maintain a state of statistical control and improve process capability. One way of using this data is to calculate the process capability. Reference AIAG Statistical Process Control (SPC-3).

4.4 Process Capability Study. The purpose of a Process Capability Study is to determine if the process is likely to produce a product that will meet the customer’s requirements. Reference AIAG Statistical Process Control (SPC-3).

4.5 Design Failure Mode and Effects Analysis. Process Failure Mode and Effects Analysis (DFMEA and PFMEA). Systematic group of activities to:

- Recognize and evaluate potential failures of a product/process and their effects.
- Identify actions that eliminate or reduce the chance of the failure to occur.
- Document the entire process.

Reference AIAG Potential Failure Mode and Effects Analysis.

4.6 Process Flow Diagram. A Process Flow Diagram is a schematic representation of the current or proposed process flow. Reference AIAG Advanced Product Quality Planning and Control Plan (APQP-2).


4.8 Design for Six Sigma (DFSS). Design for Six Sigma is a structured design methodology using statistical methods and design of experiments to find the most optimum solution based on customer requirements.

5 Notes

5.1 Glossary.

5.1.1 Care.

Additional Care: Manufacturing and/or assembly evaluation of specific product characteristics and/or government regulations which need additional controls in place in order to consistently meet Engineering Requirements.

Standard Care: The usual and customary practices that are applied in the manufacturing and/or assembly environment to ensure all requirements are consistently met. Standard Care encompasses all of the basic methods (such as loss function) and systems necessary to ensure that the product meets the Voice of the Customer, government regulations and the product engineering drawing requirements. These practices should be described in the standard procedures, business unit procedures and other quality procedures, e.g., GM Worldwide Engineering Standards. Standard Care is typically...
interpreted to mean that the basic quality system should describe the fundamental administrative, product, and process practices and systems. Standard Care requires that the production system be designed to manufacture products that meet requirements, as well as protect customers from any nonconforming material.

**Engineering Standard Work Expectations:** Specific actions required by Engineering of the assembly/ manufacturing facility to perform in order to help ensure parts are installed correctly.

**Functional Check:** Action by manufacturing and/or assembly plant personnel to observe, verify, document and help ensure that the operations of a part, sub-system, system or complete vehicle comply with engineering requirements.

**Special Component Handling:** Handling requirements for sensitive parts/ assemblies that are necessary to help ensure proper handling through the assembly/manufacturing process.

**Documentation Required:** Standard Product Characteristics, that are deemed important to part function, and Product Engineering will require process capability data documentation.

### 5.1.2 Characteristics.

**Attribute Characteristic:** A characteristic that is measured or checked and results in conformance or nonconformance, pass or fail. It may also be applied to parts, part features and/or assemblies that have regulatory requirements and or critical performance or customer satisfaction objectives.

**Attribute Quality Characteristic:** A special characteristic that engineering requires 100% verification of conformance to requirements, or a specific group of parts (by exception) for which Engineering requires error proofing. It can also be used when a secondary check is required to verify conformance to requirements.

**Confirmation:** Engineering requires 100% verification of conformance to requirements, or a specific group of parts (by exception) for which Engineering requires error proofing. The AQC symbol may be used when a supplier is required to verify 100% conformance to requirements. For GM Assembly Plants this requires a KCDS code to be released into GPDS against a part number.

**Product Traceability:** Specific components associated to a particular vehicle (VIN) and is designated for all parts/assemblies listed on the GM Global Traceability list for the purpose of precisely identifying the vehicles involved in a spill or potential field action.

**Key Control Characteristic:** A process parameter for which variation must be controlled around some target value to ensure that variation in a KPC/PQC is reduced or controlled around its target value during manufacturing and assembly.

**Product Characteristic:** A feature of a part, sub-system, or system on engineering documentation. This characteristic can be measured or checked and can be either a variable or attribute depending on the measurement system.

**Standard Product Characteristic:** A characteristic where there is no incremental economic or customer satisfaction loss inside the specification. The customer is equally satisfied across the specification and the customer does not have high dissatisfaction immediately outside the specification. Standard Care is applied to these characteristics.

**Variable Characteristic:** A characteristic that is measurable relative to the specifications on a continuous scale such as millimeters, kilograms, etc., and requires a measurement or gage system.

**Key Product Characteristic:** A variable characteristic where the reasonably anticipated variation within specification (target or tolerance) could significantly affect customer satisfaction with a product.

**Product Quality Characteristic:** A variable characteristic in which the customer is equally satisfied across the entire specification, with high customer dissatisfaction immediately outside of the specification.

### 5.1.3 Template.

**KCDS Template:** A list of parts, part features and/or assemblies that require additional care as established by global agreement. Templates of the common designated parts are available/linked from:

a. GM Global (Vehicle) KCDS website.
b. Powertrain KCDS website: PMT KCDS templates on the BOD (via above website) (see KCDS Web Page, 2.3.1)

### 5.2 Acronyms, Abbreviations, and Symbols.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AIAG</td>
<td>Automotive Industry Action Group (<a href="http://www.AIAG.org">www.AIAG.org</a>)</td>
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<tr>
<td>AQC</td>
<td>Attribute Quality Characteristic</td>
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<tr>
<td>CTS</td>
<td>Component Technical Specification</td>
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<tr>
<td>BOD</td>
<td>Bill of Design</td>
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<tr>
<td>DFMEA</td>
<td>Design Failure Mode and Effects Analysis</td>
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7 Coding System

This specification shall be referenced in other documents, drawings, Vehicle Technical Specifications (VTS), Subsystem Technical Specifications (SSTS), Component Technical Specification (CTS), etc. as follows:

GMW15049.

8 Release and Revisions

8.1 Release. This standard (based on and improved from GM1805) was originated in January 2006. It was first approved by KCDS Core Team and Directors of Core Members in June 2006. It was first published June 2006.

8.2 Revisions.

<table>
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<th>Rev</th>
<th>Approval Date</th>
<th>Description (Organization)</th>
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<tr>
<td>A</td>
<td>OCT 2006</td>
<td>Revised attribute quality characteristics, Figure 1, Figure 3 title. (KCDS Core Team)</td>
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© Copyright 2006 General Motors Corporation All Rights Reserved
### Characteristics’ Definitions, Capabilities, and Drawing Symbols

<table>
<thead>
<tr>
<th>Capability</th>
<th>Action Plan</th>
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<tr>
<td><strong>Key Product Characteristics:</strong>&lt;br&gt; A special variable characteristic where the reasonably anticipated variation within specification (target or tolerance) could significantly affect customer satisfaction with a product.</td>
<td><img src="image1" alt="Graph" /></td>
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<tr>
<td><strong>Product Quality Characteristic:</strong>&lt;br&gt; A special variable characteristic in which the customer is equally satisfied across the entire specification, with high customer dissatisfaction immediately outside of the specification.</td>
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<tr>
<td><strong>Standard Product Characteristic:</strong>&lt;br&gt; A characteristic where there is no incremental economic or customer satisfaction loss inside the specification. The customer is equally satisfied across the specification and the customer does not have high dissatisfaction immediately outside the specification.</td>
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**Figure 3: KPC/PQC Definitions**
Appendix A: Questions to Facilitate the Identification of Special Characteristics

A1 General
A1.1 Has the manufacturing facility defined and implemented standard care practices to ensure all products meet requirements?
A1.2 Does the plant have appropriate controls and processes in place to identify and contain all non-conformities within the plant?
A1.3 Has error proofing been done on this process?
A1.4 Has Robust Engineering/DFSS been applied?
A1.5 Can and how is this characteristic going to be measured?
A1.6 Will the data be from a measurement system (variable type data) or from a check of meets requirements or not (attribute type characteristic)?
A1.7 Has a measurement system analysis been conducted for the system being used?
A1.8 What data is available to show that the manufacturing process produces a product that consistently meets requirements?
A1.9 Should this characteristic be classified as a DR?
A1.10 What are the consequences of not meeting the requirements?
A1.11 What is the potential impact on customer satisfaction?
A1.12 What is the probability that a non-conformance will be shipped without detection?
A1.13 Does adding Additional Care into the process make good business sense?

A2 Specifically for KPC and PQC Variable
A2.1 Is there a capability study or SPC data available?
A2.2 Will reducing variation aid in minimizing the cost of production?
A2.3 Does the analysis (e.g., loss function) indicate that the reasonably anticipated variation (within specification) significantly affects customer satisfaction?
A2.4 Is there a greater likelihood of occurrence of a nonconformance if variation is not reduced?
A2.5 Does the analysis (e.g., loss function) show there is an adverse risk to the customer if parts are built just outside the tolerance (or requirements)?

A3 Specifically for Attribute
A3.1 Does this part/assembly have any specific handling requirements that the plant needs to be aware of?
A3.2 Is this part on the Traceability template? Is it a “smart” part? How are part changes currently tracked?
A3.3 Does this system require a functional check? Why? Can and how will this be done in the plant?
A3.4 Should this characteristic be designated with AQC?