VMKC (AS9103) EVALUATION
Detailed Tool
(For Use by Boeing or Suppliers)

This Detailed Tool is intended as a guideline for evaluation of organization implementation of Variation Management of Key Characteristics (AS9103). It is based on the Addendum 1 VMKC Evaluation Tool, which is imbedded row by row in the evaluation sections below. The line items under Questions to Ask and Look for These Examples are suggestions only – do not feel obligated to ask every question or look for objective evidence for every example. The breadth of activity in the organization for a given topic should be considered when assigning a score. An isolated example of an activity should not be accepted as evidence of widespread use. Examples that correspond to required elements (shaded boxes) are labeled with the word Minimum. Some questions and examples will be more relevant in a given organization than others. Feel free to ask other questions and develop supplementary examples to look for.

Expectation: The analysis of products and processes, implementation of improvement projects, or the existence of customer defined Key Characteristics may indicate that variation management activities are required. Statistical process control charts can be an effective means of controlling variation and obtaining process knowledge. This process knowledge will help establish mistake proof processes, develop upstream process controls, contribute to process and product redesign, and eventually alleviate the reliance on control charts. The identification, control, and optimization of key processes impacts the performance measures. When a process is not in control, the out -of-control condition must be investigated and corrective action shall be taken. If the process is not capable, the organization will identify and control sources of variation and take corrective action.

1. Variation Management (General Requirements) - The analysis of products and processes, implementation of improvement projects, or the existence of customer defined Key Characteristics may indicate that variation management activities are required. Variation control methods other than SPC may be used, but measurable evidence must demonstrate that the controls are effective. For Boeing defined Key Characteristics, the requirement to control and reduce variation may be waived in situations where it is impossible or prohibitively expensive to meet the control and capability requirements of AS9103 Section 5. These exceptions must be documented by the organization and approved by Boeing.

VARIATION MANAGEMENT OF KEY CHARACTERISTICS

1.1 Documentation of KC or process Information

1	2	3	4	5
Little or no documentation on identified Key Characteristics.	Documentation exists for all identified Key Characteristics, including mfg. process elements that influence variation in KCs as well as their control techniques and measurement methods. Ref. AS9103, 5.2	Variation management documentation exists for core manufacturing processes in addition to KCs.	Variation management documentation contains lessons learned.	Documentation and understanding of processes leads to further improvement.

a) Why is this important?
Documentation provides an important record of relevant information on key characteristics for parts and/or processes.

b) Questions to ask:
What documentation exists for Boeing key characteristics?
What documentation exists for your own key characteristics?

c) Look for these examples:
Complete documentation for identified key characteristics *(Minimum)*
The more information that is filled out in the KC documentation, the higher the score.
(Choose the score above based on the level of the majority of the documents reviewed.)

1.2 Need for variation reduction and KCs

1	2	3	4	5
Organization has not considered the need for variation reduction.	When analysis indicates, KCs have been identified. Ref. AS9103,5.2c	Organization examines for part-family or process Key Characteristics.	Advanced analytical methods are used to identify Key Process Parameters.	Variation is managed through process control.

a) Why is this important?
There often exist part or process features whose variation has a strong effect on quality and waste. These features should be identified as key characteristics, and variation in those key characteristics should be controlled and reduced. Since the customer feels the effect of variation, the reduction of variation in these features should lead to higher quality, better function, lowered waste and costs, and greater customer satisfaction.

b) Questions to ask:
Have key characteristics been identified?
Have the parts or processes been evaluated for variation sensitive features?

Has a risk analysis, FMEA, VSA, DOE, or other tool for identifying KCs for the part or process been performed?
If key characteristics have been found, are they part oriented only or can they be generalized to a process?
Can part families be identified as a step to move towards process control?
Are key characteristics related to process parameters? Analytically (i.e., through correlation studies)?

c) Look for these examples:
Procedures for identifying key characteristics.
Risk analyses, or other methods, are documented. *(Minimum)*
Key characteristics are statistically controlled and process capabilities established.
DOEs or other formal analytical tools are used to identify process parameters affecting the KC – and they are well documented.
A key characteristic database has been developed.

1.3 Key Characteristic Management

1	2	3	4	5
Little or no variation control/reduction activities.	Plan in place to manage identified key characteristics. Ref. AS9103 5.5	Key characteristic activities are given a high priority.	Key characteristics are periodically reviewed for suitability.	Advanced variability reduction tools are used to avoid variation in product and/or process development.

a) Why is this important?
Key characteristics represent the significant features of a product or process that are sensitive to variation. Managing the key characteristics properly will help ensure high quality of the most important features, reduce costs in scrap, rework and repair, and help management assign resources to the areas that need the most attention.

b) Questions to ask:
How do you identify key characteristics? Do you have a standard process or method for identifying keys?
Do you keep some form of key characteristic control for the product and process keys?
Does management review these on a monthly basis to see if they are capable (e.g., Cpk>1.33)? Does management prioritize the keys where special attention is needed?
Are statistical methods or other tools used to reduce variation?
How do you ensure that once a process is in control and capable, it is held there in a stable and predictable manner?
Are key characteristics reviewed periodically to ensure previously identified keys are still appropriate, and that overlooked variation sensitive features are now identified as key?

c) Look for these examples:
Key characteristic control plans for all products or processes – including business processes.
Management reviews that rank the capabilities of the key characteristics so as to assign resources to those needing the most attention.
Documentation showing a review process (and results) for the elimination/suspension of formerly identified keys.
Key characteristic information is communicated to new product developers.

1.4 Variation Management Activities

1	2	3	4	5
Little or no variation management activity observed on Key Characteristics.	Variation management activities performed on identified KCs until control and capability established, unless agreed to by the customer. Ref. AS9103, 5.1, 5.3e & 5.6	Demonstrable improvement exists from part level variation management activities.	Part families and/or process variation management activities implemented.	Demonstrable improvement in part family and/or process variation management activities.

a) Why is this important?
Variation management is highly beneficial when variation is particularly hurtful or costly (scrap, rework, missed schedules, etc.) to the product or process. Reducing the variation in parts or processes will lead to added economic value as well as improved quality.

b) Questions to ask:
(Randomly select KC's from several sources) What activities are currently being applied to reduce variation on the listed KC?
Who is responsible to analyze the information?

c) Look for these examples:
Established teams and meetings to manage any excessive variation *(Minimum)*
Brainstorming to determine what the possible causes of the variation could be *(Minimum)*
Techniques used to reduce variation *(Minimum)*
Projects assigned to investigate and determine causes
Responsibilities assigned to complete improvements and expectations
Tracking of results and degree of success

1.5 Verification of Control Method and Process Monitoring

1	2	3	4	5
Little or no measurable evidence of control.	Measurable evidence demonstrates that the selected variation control method is effective. Appropriate monitoring methodology implemented to ensure continued performance. Ref. AS9103, 5.1& 5.4	Organization performs regular validation of control method effectiveness. Monitoring methodology drives improvement activities.	Monitoring methodology implemented that ensures process performance through control of process settings.	Comprehensive database of control techniques and methods is consistently used to establish effective and efficient process controls.

a) Why is this important?
Control methods and process monitoring are put in place to ensure that any improvement to the product/process is maintained over time.

b) Questions to ask:
1. What was put in place to maintain stability and capability of the product/process?

c) Look for these examples:
Measurable evidence of process stability and capability *(Minimum)*
Control charts / Cpk (or equivalent)
Run charts, group charts, etc.
Tooling to control variation
Mistake proofing
Database of control techniques to establish effective and efficient process controls

1.6 Variation Control Methods

1	2	3	4	5
Little or no standardized processes exist.	Variation control methods such as tooling, control of process settings, standard processes and mistake proofing may be used to ensure process stability and capability. Ref. AS9103, 5.4	Key Processes are standardized through the use of variation control methods.	Demonstrated improvement is evident from use of variation control methods. (e.g. Mistake proofing is used to ensure non-conforming product is not passed on.)	Process settings are well controlled to ensure consistent processes.

a) Why is this important?
A variety of methods, usually linked with lean manufacturing, can result in processes that meet customer requirements consistently with higher quality and lower cost.

b) Questions to ask:
What is being done to standardize processes?
Are process flow diagrams used to minimize variation?
Do production workers know their internal customers and suppliers?
What use is made of mistake proofing?
What controls are placed on process settings?

c) Look for these examples::
Consistent way of documenting standardized processes *(Minimum)*
Variation control methods in place to ensure process stability and capability *(Minimum)*
Ample evidence of standardized process flows
Regular use of mistake proofing methods
Effective controls on process settings to ensure consistency

2. Variation Control Methods - Statistical process control charts can be an effective means of controlling variation and obtaining process knowledge. This process knowledge will help establish mistake proof processes, develop upstream process controls, contribute to process and product redesign, and eventually alleviate the reliance on control charts. The requirements in this section are conditional on the selection of SPC as the variation control method.

2.1 Data Collection and Usage

1	2	3	4	5
Control charts do not represent normal production output.	Measurements used for control charts represent the normal production output. Ref. AS9103, 5.3a	Summaries of control chart data are readily available to all employees.	Lessons learned from data being used on similar products/processes.	Control chart data is analyzed at a more detailed level (i.e. by shift, machine, etc).

a) Why is this important?
In order to yield an accurate description of a process as it functions over time, only data that represents the normal and current output should be used.

b) Questions to ask:
If they have produced parts, is there data representing that output on the control chart?
If the process has produced rejectable product, is that output represented on the control chart?
If product has been reworked, is it represented on the control chart, and if so is it appropriately identified as reworked product on the control chart?

c) Look for these examples::
Measuring 100% of the parts/product is not usually necessary, so if the production output is sampled, then the parts/product measured must represent the entire output.
Data from current production is on the control chart
Reworked parts/product, if represented on the control chart, are appropriately identified as such
Process Owners are filling out the control chart as the parts/product are being produced
Histograms and other summary data are available for review by the Process Owner
Differences between Process Owners' data, different shifts, different machines, different seasons, etc., are analyzed for significant impact on variation in the data

2.2 Control Chart Selection and Usage

1	2	3	4	5
Control Chart chosen is inappropriate for application.	Control Chart chosen is appropriate for application. Ref. AS9103, 5.3a	Control charts periodically reviewed for appropriateness.	Process shifts and trends are investigated (e.g. Western Electric rules)	Advanced methods of control are used (e.g. Target charts, Multivariate charts, EWMA).

a) Why is this important?

In order to effectively display and manage variation in process output over time and to be able to identify when a process changes, the control chart used must be appropriate for the application. Maintaining appropriate control charts will provide a basis for improvement, distinguish special from common cause variation, and help assign causes of variation.

b) Questions to ask:

When using variable data, are both the average and variability of the process monitored?

Are Xbar and Range (R) charts used for high production rate processes with a subgroup size > 1, and IX and Moving Range (MR) charts used for low production rate processes with a subgroup size of 1?

Are the employees trained and can proficiency be demonstrated on the type of control chart that is applicable to their process and associated Key Characteristics?

Are methods to display process shifts and trends being used, and can the employees demonstrate proficiency in their use?

Are more advanced control charts being used to combine similar parts with the same Key Characteristics (Target Control Charts), to identify and control multiple sources of variation (Three-Way Control Charts, Multivariate Control Charts), and/or to identify small shifts in the variation of the process/Key Characteristic (Moving Average Control Charts, Exponentially Weighted Moving Average Control Charts)?

c) Look for these examples:

Xbar control charts accompanied by R control charts.

IX control charts accompanied by MR control charts.

Xbar and R control charts are used for those processes that have a high production rate (>30 parts per shift), and IX and MR control charts are used for those processes that have a low production rate (<30 parts per shift).

Employee training records and proficiency (evidenced by compliance with the control chart rules, and proper answers to associated questions) in the use of the control charts associated with their processes/Key Characteristics.

Employee understanding of and proficiency with the Western Electric Rules (evidenced by compliance with the control chart rules, and proper answers to associated questions).

Examples of Advanced Methods:

- Three-Way or Multivariate control charts are used when there are multiple measurement locations per part for the Key Characteristic.
- Target control charts are used when data from multiple, similar parts with the same Key Characteristic is combined on one chart.
- Multivariate control charts are used when there are multiple sources of variation for the Key Characteristic.
- Moving Average and Exponentially Weighted Moving Average control charts are used to detect smaller, less obvious shifts in the process/variation.

2.3 Calculation of Control Limits

1	2	3	4	5
Errors in control limit calculation.	Control limits computed appropriately and reflect the current process. Ref. AS9103, 5.3a	Control limits 'frozen' with appropriate data and the data used in control limits is readily identifiable.	Control limits are reviewed periodically for needed changes.	Control Limits are recalculated for processes that exhibit statistically significant change.

a) Why is this important?
Since Control Charts are used to monitor and control variation in the process/Key Characteristic, it is important that the control limits are calculated appropriately for the type of chart chosen, and that the data used is process data, not engineering specifications. It is also important that the control limits reflect the variation in the process as changes/improvements are made, so they should be recalculated accordingly.

b) Questions to ask:
Are the control limits calculated using the appropriate rules for the type of control chart chosen?
Are the control limits calculated using process/Key Characteristic data instead of engineering specifications?
Do the control limits look appropriate relative to the pattern of plotted points?
If the process displays a change, have the control limits been recalculated to reflect this change?
Are the control limits frozen, and can the organization demonstrate it, along with the data that was used in the calculation?
Do those monitoring control charts review the control limits for needed changes, and do they understand how and when the control limits should be recalculated?

c) Look for these examples:
Control limit calculations can be verified as using the appropriate rules for the control chart being used. *(Minimum)*
Data used in the control limit calculations can be verified as being process/Key Characteristic data and not engineering specification data. *(Minimum)*
Control limits look appropriate for the current pattern of plot points (i.e., on Xbar and IX control charts the control limits are equal distance from the centerline, there is not an unusually large amount of space between the outermost plot points and the control limits, the Xbar and IX control limits are not unusually tight for the process, etc.).
The control limits have been recalculated when the pattern of plot points displays a change in the process (i.e., there has been an obvious reduction in variation on the mean chart (Xbar or IX), and/or on the variation chart (R or MR)). *(Minimum)*
The software, or manual calculations, shows that the calculated control limits are frozen and are the ones currently displayed on the control chart.
When interviewed, those who are monitoring the control charts can accurately explain how the control limits are calculated, and when they should be recalculated.

2.4 Control Charting Processes

1	2	3	4	5
Little or no Control Chart usage.	When similar KCs from different products are combined on the same control chart, the characteristics shall have similar variability and be traceable to the specific part or product. Ref. AS9103, 5.3.c	Reduction of control chart frequency is evident as a result of Process Improvement.	Process control is used extensively in lieu of charts for each Key Characteristic.	Process control yields improvements in other, non-Key Characteristics.

a) Why is this important?
Since it is the process that makes the product "good" or "bad", limited benefit will be gained from monitoring and controlling only the product instead of the process. Also, identifying part groupings with similar Key Characteristics, and controlling their variation on the same control charts, will reduce the number of control charts to be monitored while retaining the integrity of the control charts being maintained.

b) Questions to ask:
If part/product families or process output is being monitored, do the parts have similar variability and is part/product traceability being maintained?
Are control chart frequencies being reduced as a result of process improvement?
Has this approach become the way of doing business, as verified by extensive use of Target control charts and the combining of control plans?
Has this approach become the way of doing business, as verified by extensive use of Target control charts?
Is the chosen approach (part/product families, or process output) yielding improvements in other part/product/process characteristics that are considered non-key?

c) Look for these examples::
Rationale for the groupings/approach is documented and logical. *(Minimum)*
An explanation can be provided as to how similar variation is verified. *(Minimum)*
Plotted points can be traced back to a specific part number/product (i.e., documented changes in work orders, part numbers, etc.). *(Minimum)*
Target control charts are used in cases that are appropriate, and part control is only used for unique and isolated cases.
Process control results in improvements in virtually all product characteristics.

2.5 Process Control and Correction

1	2	3	4	5
Out-of-control conditions are identified, but no action taken.	Out-of-control conditions identified, and investigated. Action is taken to remove or minimize the effect of these causes. Ref. AS9103, 5.1	Corrective action consistently addresses the root cause of the out of control condition.	Processes are stable and predictable.	Processes are designed to minimize or eliminate out-of-control conditions.

a) Why is this important?
Well-designed variation management systems use objective data for the understanding and management of processes. When the data indicates the stability (or instability) of a given process, appropriate action(s) must be taken.

b) Questions to ask:
Are the organization's processes monitored through appropriate data collection and analysis?
Are out-of-control conditions recognized by operators/process owners?
Are appropriate actions taken in response to out-of-control processes?
Is data collection activity sensitive to performance measures?

Do out-of-control process responses address the root cause?

c) Look for these examples:
Widespread use and understanding of objective data collection and analysis methodologies.
Control charts and similar metrics with special causes or other significant process events noted and C/A indications where appropriate *(Minimum)*
Evidence that process owners understand what the data are telling them and evidence that they act upon it appropriately *(Minimum)*
Evidence that out-of-control conditions are subject to deliberate and careful root cause C/A

2.6 Identification of Variation Sources

1	2	3	4	5
Potential sources of variation are not consistently identified for incapable Key Characteristics.	Sources of variation are identified and controlled for incapable Key Characteristics. Ref. AS9103, 5.1, 5.2	Sources of variation are identified and controlled for all (including capable) Key Characteristics.	Advanced Statistical Techniques are sometimes used to identify and correlate sources of variation with Key Characteristics.	Advanced Statistical Techniques are routinely used to identify and correlate sources of variation with Key Characteristics.

a) Why is this important?
Reducing variation on Key Characteristics (whether Boeing defined or supplier defined) can be one of the "core values" of a continual improvement system. Properly identifying sources of variation for incapable Key Characteristics is essential.

b) Questions to ask:
Are all KCs charted and controlled?
Have process owners been trained in AQS tools (specifically, identification of types and sources of variation)?
How do process owner(s) identify sources of variation?
Are incapable KCs targeted for special variation reduction efforts?

c) Look for these examples:
KCs that are charted and controlled
Incapable KCs and their supporting processes are subject to investigation into source(s) of variation using appropriate AQS Tools *(Minimum)*
Process changes and resultant KC data show improvement
Process owners (affecting KCs) have formal training in AQS tools

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3. Variation Management Activities - The identification, control, and optimization of key processes impacts the performance measures. When a process is not in control, the out-of-control condition must be investigated and corrective action shall be taken. A process is considered capable if its Cpk exceeds 1.33. If the process is not capable, the organization will identify and control sources of variation and take corrective action. (D1-9000-1 contains information that is useful in diagnosing sources of variation as well as providing guidance in techniques to reduce measurement error and process variation.)

3.1 Establishing Capability Measures

1	2	3	4	5
Data collected but capability measure not established.	Process capability shall be established for Key Characteristics Ref. AS9103, 5.1, 5.3.a	Reporting of process capability to management on a regular basis.	Capability measures calculated for Process Key Characteristics.	Management uses process capability database for process improvement efforts.

a) Why is this important?
The capability of a given process (Cp) is expressed as a ratio between the engineering specification limits of a process or product and the natural productive output of the process in question. The centering of process output within a set of engineering specifications is also expressed as a ratio (Cpk) with the added dimension (k) indicating relative "skewness".

b) Questions to ask:
Do process owners understand Cp/Cpk and the differences between them?
Are process capability measures appropriate for the subject processes?
Can process owners explain the significance of Key Characteristics?
Does management understand and use the data to make process decisions?

c) Look for these examples:
Key characteristics monitored by control charts also have process capabilities calculated. *(Minimum)*
Key Characteristics that are appropriate and measurable.
Process owners / management use of data to make decisions.
Process Key Characteristics developed to control part families (rather than individuals).

3.2 Process Capability and Improvement

1	2	3	4	5
Little or no action plans for incapable processes.	For Cpks (or equivalent measures) that are less than 1.33, corrective action plans are in place for improvement. Ref. AS9103, 5.1, 5.3b	Action plans for capability improvement show progress over time.	Majority of processes have Cpks (or equivalent measures) of >1.33.	Capability values show stability over time.

a) Why is this important?
Incapable processes pose a risk of manufacturing parts that do not meet customer specifications. For purposes of Addendum 1, Boeing has established a Cpk of 1.33 as the lower limit for process capability. A process with a Cpk less than 1.33 requires variation reduction activities.

b) Questions to ask:
Are processes under statistical control being reviewed for Cp/Cpk?
Are Cp/Cpk numbers reasonable, given process fallout?
Are low Cp/Cpk processes subject to aggressive C/A planning and variation reduction activity?
Are variation reduction plans and activities positively impacting the Cp/Cpk numbers?

c) Look for these examples:
Evidence of Cp/Cpk review activity and charting *(Minimum)*
C/A planning and variation reduction activities directly tied to process Cp/Cpk measures *(Minimum)*
Management use of Cp/Cpk data for process improvement
Use of Cp/Cpk methodologies in (other than) manufacturing areas

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3.3 Reduced Frequency of Inspection

1	2	3	4	5
Reduced frequency of inspection is not related to process capability.	Process capability or equivalent fallout rate are calculated whenever capability is used to reduce inspection frequency. Ref. AS9103 5.3d	Process capability and inspection frequencies are reported to management on a regular basis.	Opportunities to reduce inspection frequency based on capability are occasionally reviewed.	Opportunities to reduce inspection frequency based on capability are reviewed on a frequent, scheduled basis.

a) Why is this important?
A tremendous economic payoff is available to suppliers who improve process capabilities and thereby are able to reduce inspection frequencies. The two need to be tied together formally. In order to reduce inspection frequencies based on process capability or fallout rate, the actual capability or fallout rate need to be calculated and reported.

b) Questions to ask:
Have you reduced inspection frequency due to process capability improvement?
If so, do you have capability or fallout calculations taken before the reduction in inspection?
How are capability and inspection frequencies reported?
Do you review opportunities to reduce inspection frequencies based on process capability or fallout rate? Occasionally? Frequently, on a scheduled basis?

c) Look for these examples:
Evidence of calculation of process capability or fallout rate prior to reduction in inspection frequency.
Reports of process capability, fallout rate and inspection frequency to management.
Scheduled reviews and minutes of process capability and inspection frequency.

3.4 Ensure Customer KC Requirements Are Met

1	2	3	4	5
Little or no activity related to ensuring customer KC requirements are met	KC requirements are flowed to subcontractors, and all KCs are managed to conform to customer requirements. Ref. AS9103 4.0	Log of KCs flowed to subcontractors exists; status of all KCs in house and at subcontractors is recorded.	KC status, both in-house and at subcontractors, is reported to management on a regular basis.	There is an active program to work with subcontractors to improve the control and capability of their KCs.

a) Why is this important?
Much of the manufacture of aerospace products is now managed by partners and major suppliers, with work subcontracted to second- and third-tier suppliers. It is vital that the end customer's requirements for variation management of key characteristics be flowed to these subcontractors to ensure that the requirements are fully met.

b) Questions to ask:
Do you have any KCs that are controlled by subcontractors?
If so, how do you communicate the requirements for KCs to your subcontractors?
How do you exercise control of subcontractor performance on these KCs?
What records do you maintain showing status of KCs in-house and at subcontractors?
How are these records reported?
How do you work with and support subcontractors to improve the performance of KCs they control?

c) Look for these examples:
Records of KCs flowed to subcontractors, along with corresponding customer requirements.
Log showing status of all KCs, both in-house and at subcontractors.
Reports to management showing KC status.
Evidence of active program to work with and support subcontractors who control the performance of KCs.

3.5 Use of Capability Data

1	2	3	4	
Inconsistent records of capability trends.	Capability trends are consistently recorded.	Lesson learned database is shared so as to improve similar parts / processes.	Process capability information is used in choosing the appropriate manufacturing process/equipment (i.e. shop loading, capacity loading, etc.).	Savings from improvements are calculated and reviewed. Plans link capability improvement to cost-benefit ratio.

a) Why is this important?
Data collected on the capability of equipment and processes in a production environment can be very useful. For example, documentation of capabilities can provide a resource for

production planning, lessons learned for the improvement of other processes, or verification of process improvements.

b) Questions to ask:
Are detailed records of improvement activities kept?
How are records of improvement activities used?
Is process capability information used in manufacturing planning?
Do improvement records include cost savings?
Are improvement records linked with the performance measures?

c) Look for these examples:
Formal documentation of improvement activities
Lessons learned database that is used to improve similar parts/processes
Process capability database
Process capabilities used in manufacturing planning
Calculation and review of savings from improvement activities
Capability improvements are evaluated for cost-benefit

3.6 Gage Variation Studies

1	2	3	4	5
Little or no gage variation studies are performed.	Gage variation studies are performed for incapable Key Characteristics when analysis indicates, and corrective action is taken as needed.	Gage variation studies are routinely performed for all (including capable) Key Characteristics, and corrective action is taken as needed.	Gage variation studies are routinely performed prior to any data collection.	Gage variation studies are performed as a regular part of the calibration/certification process.

a) Why is this important?
Any process capability data is heavily dependent upon the quality of the measurement system. Gage variation often accounts for a very large percentage of engineering tolerance bands; therefore it is essential that process owners are able to isolate measurement system variation from process variation when analyzing a manufacturing operation.

b) Questions to ask:
Is gage variation analysis a part of the company's variation management toolkit?
Are studies performed properly and completely?
When gage variation consumes more than 20% of the engineering tolerance, are alternative measurement systems/tools investigated?
Are gage studies performed prior to the start of control charting?
Are operator variation studies performed? (Reproducibility)

c) Look for these examples:
Metrology has gage capability data available.
Gage variation is part of process planning.
Alternative measuring techniques are used when necessary.
Processes with KCs include gage variation studies
Operator variation (Reproducibility) is part of a Gage R and R program.