

# MEASUREMENT SYSTEM ANALYSIS FOR VARIABLES

• **A P T I V** •

## Non-Destructive Test

For information on the theory and constants used in the form see MSA Reference Manual, 4th edition.

Input data in green-shaded cells as required

|                                  |                     |                     |                       |                                                                                                             |         |                            |                            |
|----------------------------------|---------------------|---------------------|-----------------------|-------------------------------------------------------------------------------------------------------------|---------|----------------------------|----------------------------|
| K <sub>1</sub>                   | Number of Trials    | 3                   | Must be either 2 or 3 | Study Method:<br><input checked="" type="radio"/> TOLERANCE<br><input type="radio"/> PART to PART VARIATION | USL     | 8.600                      | Reset form and delete data |
| K <sub>2</sub>                   | Number of Operators | 3                   | Must be either 2 or 3 |                                                                                                             | LSL     | 8.300                      |                            |
| K <sub>3</sub>                   | Number of Parts     | 10                  | Between 2 and 10      |                                                                                                             |         |                            |                            |
|                                  |                     |                     |                       | Tolerance / 6 >>                                                                                            | 0.05000 |                            |                            |
| Initiator Eliezer Vazquez        |                     | Gage Number E200298 |                       | Plant 9800                                                                                                  |         | Part Number 15514637       |                            |
| Phone # 844 311 3705             |                     | Gage Name OGP       |                       | Location Confiabilidad                                                                                      |         | Part Name TAXI LOCK RETAIN |                            |
| Date 9 / Junio / 2021            |                     | Gage ECL / Revision |                       | Supplier Eliezer Vazquez                                                                                    |         | Part ECL / Revision 4      |                            |
| e-mail eliezer.vazquez.martinez@ |                     |                     |                       | Segment                                                                                                     |         | Customer P/N GM            |                            |

| OPERATOR             | NUMBER of PARTS |                                                                                                      |         |         |         |         |         |         |         |         | RESULTS: |                              |         |
|----------------------|-----------------|------------------------------------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|----------|------------------------------|---------|
| TRIAL #              | 1               | 2                                                                                                    | 3       | 4       | 5       | 6       | 7       | 8       | 9       | 10      | AVG      |                              |         |
| A                    | 1               | 8.419                                                                                                | 8.42    | 8.442   | 8.443   | 8.419   | 8.423   | 8.414   | 8.443   | 8.419   | 8.421    | A <sub>1</sub>               | 8.42630 |
|                      | 2               | 8.421                                                                                                | 8.414   | 8.434   | 8.439   | 8.418   | 8.425   | 8.415   | 8.435   | 8.418   | 8.415    | A <sub>2</sub>               | 8.42340 |
|                      | 3               | 8.425                                                                                                | 8.42    | 8.436   | 8.439   | 8.423   | 8.429   | 8.409   | 8.443   | 8.424   | 8.419    | A <sub>3</sub>               | 8.42670 |
|                      | Average         | 8.42167                                                                                              | 8.418   | 8.43733 | 8.44033 | 8.42    | 8.42567 | 8.41267 | 8.44033 | 8.42033 | 8.41833  | X <sub>A</sub>               | 8.42547 |
|                      | Range           | 0.006                                                                                                | 0.006   | 0.008   | 0.004   | 0.005   | 0.006   | 0.006   | 0.008   | 0.006   | 0.006    | R <sub>A</sub>               | 0.00610 |
| B                    | 1               | 8.44                                                                                                 | 8.406   | 8.484   | 8.41    | 8.411   | 8.414   | 8.486   | 8.416   | 8.436   | 8.419    | B <sub>1</sub>               | 8.43220 |
|                      | 2               | 8.432                                                                                                | 8.411   | 8.475   | 8.403   | 8.403   | 8.419   | 8.481   | 8.416   | 8.431   | 8.421    | B <sub>2</sub>               | 8.42920 |
|                      | 3               | 8.437                                                                                                | 8.408   | 8.478   | 8.406   | 8.41    | 8.42    | 8.488   | 8.423   | 8.428   | 8.424    | B <sub>3</sub>               | 8.43220 |
|                      | Average         | 8.43633                                                                                              | 8.40833 | 8.479   | 8.40633 | 8.408   | 8.41767 | 8.485   | 8.41833 | 8.43167 | 8.42133  | X <sub>B</sub>               | 8.43120 |
|                      | Range           | 0.008                                                                                                | 0.005   | 0.009   | 0.007   | 0.008   | 0.006   | 0.007   | 0.007   | 0.008   | 0.005    | R <sub>B</sub>               | 0.00700 |
| C                    | 1               | 8.428                                                                                                | 8.409   | 8.433   | 8.42    | 8.449   | 8.423   | 8.425   | 8.421   | 8.415   | 8.425    | C <sub>1</sub>               | 8.42480 |
|                      | 2               | 8.429                                                                                                | 8.417   | 8.439   | 8.419   | 8.45    | 8.417   | 8.43    | 8.415   | 8.418   | 8.424    | C <sub>2</sub>               | 8.42580 |
|                      | 3               | 8.422                                                                                                | 8.416   | 8.429   | 8.427   | 8.443   | 8.422   | 8.429   | 8.413   | 8.418   | 8.428    | C <sub>3</sub>               | 8.42470 |
|                      | Average         | 8.42633                                                                                              | 8.414   | 8.43367 | 8.422   | 8.44733 | 8.42067 | 8.428   | 8.41633 | 8.417   | 8.42567  | X <sub>C</sub>               | 8.42510 |
|                      | Range           | 0.007                                                                                                | 0.008   | 0.01    | 0.008   | 0.007   | 0.006   | 0.005   | 0.008   | 0.003   | 0.004    | R <sub>C</sub>               | 0.00660 |
| Part Avg             |                 | 8.42811                                                                                              | 8.41344 | 8.45    | 8.42289 | 8.42511 | 8.42133 | 8.44189 | 8.425   | 8.423   | 8.42178  | X <sub>PART</sub> = 8.42726  |         |
| Part Range           |                 |                                                                                                      |         | 0.05500 | 0.04000 | 0.04700 | 0.01500 | 0.07900 | 0.03000 | 0.02100 | 0.01300  | R <sub>PART</sub> = 0.03656  |         |
| R̄ =                 |                 | R <sub>A</sub> + R <sub>B</sub> + R <sub>C</sub> / No of operators = 0.00610 + 0.00700 + 0.00660 / 3 |         |         |         |         |         |         |         |         |          | R̄ = 0.00657                 |         |
| X̄ <sub>DIFF</sub> = |                 | [Max (X) <sub>ABC</sub> ] - [Min (X) <sub>ABC</sub> ] = 8.43120 - 8.42510                            |         |         |         |         |         |         |         |         |          | X̄ <sub>DIFF</sub> = 0.00610 |         |
| UCL <sub>R</sub> =   |                 | R̄ * D <sub>4</sub> = 0.00657 * 2.580                                                                |         |         |         |         |         |         |         |         |          | UCL <sub>R</sub> = 0.01694   |         |
| LCL <sub>R</sub> =   |                 | R̄ * D <sub>3</sub> = 0.00657 * 0.000                                                                |         |         |         |         |         |         |         |         |          | LCL <sub>R</sub> = 0.00000   |         |

| OPERATOR | NAME                    | NOTE: The Total Tolerance Method should be used when the gage is used for product release. When out of control conditions exist, analyze the data for Gage acceptability. The total variation method is generally used for variation reduction activities. |
|----------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A        | Carlos Cerda Lobaton    |                                                                                                                                                                                                                                                            |
| B        | Jose Luis Robledo       |                                                                                                                                                                                                                                                            |
| C        | Hector de Jesus Andrade |                                                                                                                                                                                                                                                            |

FROM DATA SHEET: R = 0.00657 X̄<sub>DIFF</sub> = 0.00610 R<sub>PART</sub> = 0.03656

| Measurement Unit Analysis                                                                                                     | Based on the TOLERANCE Method                                                   |
|-------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| <b>Repeatability - Equipment Variation (EV)</b><br>$EV = R * K_1$<br>$EV = 0.00388$                                           | % EV = 100[EV/Tol]<br>% EV = 7.76                                               |
| <b>Reproducibility - Appraiser Variation (AV)</b><br>$AV = \sqrt{[(\bar{X}_{DIFF} * K_2)^2 - (EV^2 / nr)]}$<br>$AV = 0.00311$ | % AV = 100[AV/Tol]<br>% AV = 6.22                                               |
| <b>Repeatability &amp; Reproducibility (GRR)</b><br>$GRR = \sqrt{(EV^2 + AV^2)}$<br>$GRR = 0.00497$                           | %GRR = 100[GRR/Tol]<br>% GRR = 9.95                                             |
| <b>Part Variation (PV)</b><br>$PV = \sqrt{TV^2 - GRR^2}$<br>$PV = 0.04975$                                                    | % PV = 100[PV/Tol]<br>% PV = 99.50                                              |
| <b>Total Variation (TV)</b><br>$TV = (USL - LSL) / 6$<br>$TV = 0.05000$                                                       | Number of Distinct Categories<br>$ndc = 1.41[PV/GRR]$<br>$ndc = 14.106 \sim 14$ |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>GUIDELINES for ACCEPTANCE of GAGE R&amp;R (%GRR)</b><br><ul style="list-style-type: none"> <li>LESS than 10% ERROR: Gage is acceptable</li> <li>10% to 30% ERROR: May be acceptable based upon importance of application:<br/>               1) Reference the RISK MATRIX of the FMEA or<br/>               2) Use the "BREAKPOINT" calculation method shown below,<br/>               (result should be &lt; 37.8 and % Gage R&amp;R &lt; 30%).</li> <li>OVER 30% ERROR: Gage system needs improvement. Identify the problems and have them corrected.</li> </ul> | <b>Initial Result:</b> GAGE IS ACCEPTED<br><br><b>SELECT EVALUATION METHOD for 10% to 30% ERROR:</b><br>RISK MATRIX EVALUATION<br>BREAKPOINT CALCULATION |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                                                                                                                                               |                   |        |   |                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------|---|----------------|
| DETERMINE THE RISK PRIORITY NUMBER (RPN) FROM THE FMEA ASSOCIATED WITH THE DIMENSION BEING GAGED. TYPE THE RPN # IN THE RPN # CELL AND OBSERVE THE RESULT OF SUGGESTED USAGE: | BREAKPOINT = 0.00 | RPN# = | X | %GRR = 0.09946 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------|---|----------------|

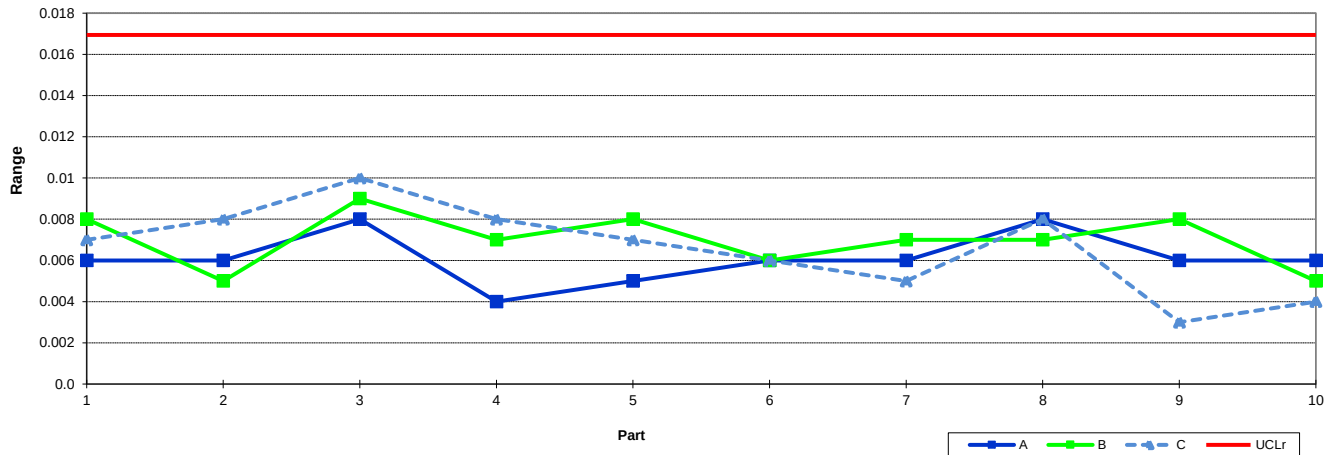
### CONCLUSION:

GAGE APPROVED, USE IT

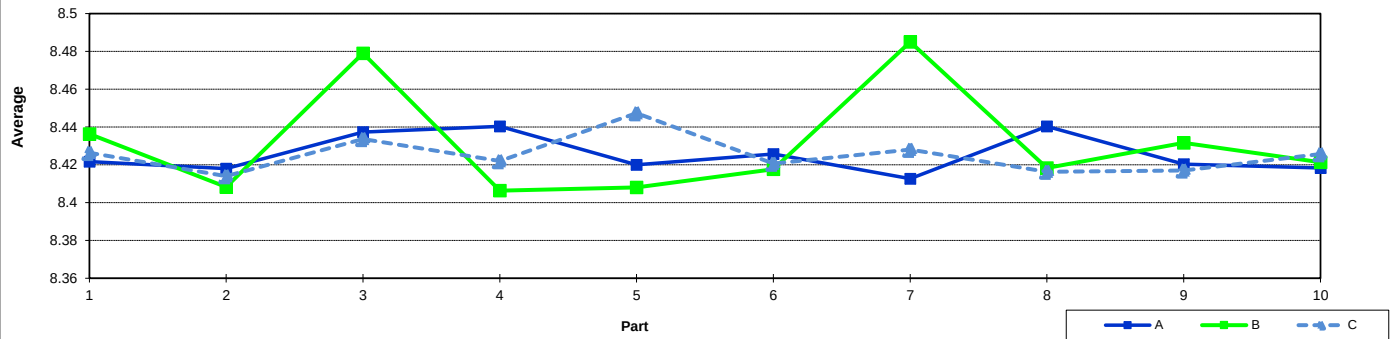
|                                  |                     |                     |                       |                                                                                                                    |                                                             |       |  |
|----------------------------------|---------------------|---------------------|-----------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-------|--|
| K <sub>1</sub>                   | Number of Trials    | 3                   | Must be either 2 or 3 | <b>Study Method:</b><br><input checked="" type="radio"/> TOLERANCE<br><input type="radio"/> PART to PART VARIATION | USL                                                         | 8.600 |  |
| K <sub>2</sub>                   | Number of Operators | 3                   | Must be either 2 or 3 |                                                                                                                    | LSL                                                         | 8.300 |  |
| K <sub>3</sub>                   | Number of Parts     | 10                  | Between 2 and 10      |                                                                                                                    | <input checked="" type="radio"/> Reset form and delete data |       |  |
|                                  |                     |                     |                       | Tolerance / 6 >>                                                                                                   | 0.05000                                                     |       |  |
| Initiator Eliezer Vazquez        |                     | Gage Number E200298 |                       | Plant 9800                                                                                                         | Part Number 15514637                                        |       |  |
| Phone # 844 311 3705             |                     | Gage Name OGP       |                       | Location Confiabilidad                                                                                             | Part Name TAXI LOCK RETAIN                                  |       |  |
| Date 9 / Junio / 2021            |                     | Gage ECL / Revision |                       | Supplier Eliezer Vazquez                                                                                           | Part ECL / Revision 4                                       |       |  |
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### Range Chart by Operator

All Ranges OK



### Average Run Chart by Operator



Comments /  
Notes: