Virgin Orbit

Gage Repeatability and Reproducibility

OPERATOR A:	PART										AVERAGE	
	1	2	3	4	5	6	7	8	9	10		
TRIAL #1												0.000
TRIAL #2												0.000
TRIAL #3												0.000
AVERAGE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	X bar A=	0.000
RANGE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	R bar A=	0.000

OPERATOR B:	PART										AVERAGE	
	1	2	3	4	5	6	7	8	9	10		
TRIAL #1												0.000
TRIAL #2												0.000
TRIAL #3												0.000
AVERAGE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	X bar B=	0.000
RANGE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	R bar B=	0.000

OPERATOR C:	PART										AVERAGE	
	1	2	3	4	5	6	7	8	9	10		
TRIAL #1												0.000
TRIAL #2												0.000
TRIAL #3												0.000
AVERAGE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	X bar C=	0.000
RANGE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	R bar C=	0.000

AVE. X-BARp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Rp =	0.000

R - bar - A =	0.000
R - bar - B =	0.000
R - bar - C =	0.000
SUM =	0.000
R - BAR =	0.000

Max X-bar =		0.0
(-) Min X-bar =		0.0
X-bar DIFF=		0.000
TRIALS	D4	D3
2	3.27	0
3	2.58	0

UCL-R =	R-bar *	D4
=	0	
LCL-R =	R-bar *	D3
=	0	

* D4=3.27 for 2 trials and 2.58 for 3 trials. UCL - R represents the limit of individual R's. Circle those that are beyond this limit. Identify the cause and correct. Repeat these readings using the same appraiser and unit as originally used or discard values and re-average and recompute R and the limiting value from the remaining observations.

Part # & Name:		Gage Name:		Date:	
Characteristics: Tolerance:		Gage No./ID: Gage Type:		Performed by:	

From data sheet:	R-bar =	0.000	X-bar Diff=	0.000	

MEASUREMENT SYSTEM ANALYSIS

Repeatability - Equipment Variation (EV)

EV = R-bar * K1

EV = 0

Trials	K1
2	0.8862
3	0.5908

Reproducibility - Appraiser Variation (AV)

AV = $\sqrt{}$ [(X-DIFF)*(K2)]squared-[(EV squared)/nr]

AV = 0

Operators	2	3
K2	0.7071	0.5231

Repeatability & Reproducibility (R&R)

R&R = $\sqrt{}$ (EV) squared + (AV) squared

R&R = 0

Part Variation (PV)

PV = Rp * K3

PV = 0

Parts	K3
2	0.7071
3	0.5231
4	0.4467
5	0.4030
6	0.3742
7	0.3534
8	0.3375
9	0.3249
10	0.3146

Total Variation (TV)

TV = $\sqrt{}$ R&R squared + PV squared

TV = 0

% OF TOLERANCE

%EV = 100[EV/TOLERANCE]

= #DIV/0!

%AV = 100[AV/TOLERANCE]

= #DIV/0!

n = number of parts
r = number of trials

%R&R= 100[R&R/TOLERANCE]

= #DIV/0!

%PV= 100[PV/TOLERANCE]

= #DIV/0!

1) All calculations are base upon predicting 5.15 sigma (99.0% of the area under the normal distribuiton curve).
2) K1 is 5.15/d2, where d2 is dependent on the number of trials (m) and the number of parts times the number of operators (g) which ism assumed to be > 15
3) AV - If a negative value is calculated under the square root sign, the appraise variation (AV) defaults to zero (0).
4) K2 is 5.15/d2, where d2 is dependent on the number of operators (m) and (g) is 1, since there is only one range calculation.
5) K3 is 5.15/d2, where d2 is dependent on the number of parts (m) and (g) is 1, since there is only one range calculation.
6) d2 is obtained from Table D3, "Quality Control and Industrial Statistics". A.J. Duncan.