John N. Zorich, Jr.
Zorich Technical Consulting & Publishing
Sunnyvale, California
(cell) 408-203-8811
http://www.johnzorich.com johnzorich@yahoo.com

This copy of the Validation Protocol / Report

ZTC-7, for version 4 of ZTCP's

"Statistical Analysis of Gages.xls"

was prepared and performed for use *only*** by and at

b

When you purchase a copy of STATISTICAL ANALYSIS OF GAGES.XLS, you will be sent, free of charge, signed copies of the most current revision of the validation protocol and of the completely executed validation report.

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VALIDATION PROTOCOL #ZTC -7

For version 4 of ZTCP's

"STATISTICAL ANALYSIS OF GAGES.xls"

For the name and signature of the author of this Protocol, see the CoverPage of this combined Protocol + Report PDF file.

1.0 OBJECTIVE

This document outlines a validation protocol for version 4 of the file named by Zorich Technical Consulting and Publishing (ZTC) as "Statistical Analysis of Gages.xls" (SAG).

2.0 SCOPE

This document ap section above, but which might be named diffe d by the purchaser, the "Instruct n its first row.

Th The XX refers to ts or to improve , and therefore is required to ted.

cells etc.).

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3.0

e of SAG is to es to make a

- q n each other
- quanti
- quantify over ccessary "guardbands".

By using the word "validation" in this protocol, it is not meant to imply that SAG's program "code" is being validated. SAG is a relatively simple "application" based upon a commercial program, MS Excel, which has been sold by Microsoft Corporation for more than a dozen years. By saying that SAG is to be "validated" is to say that its functions and features will be critically and systematicly checked, to see if they meet their pre-determined design requirements and intended end-user purposes. SAG contains no

"macros" or other code-based add-ons (such as VBA scripts); SAG does not even use any ActiveX controls. SAG contains only standard Excel mathematical and statistical equation functions, and charts, and thus no additional code to validate.

4.0 REFERENCES

Excel 2002 Formulas, by J. Walkenbach, 2002 by M&T Books.

Primary References for Gage Correlation:

- *Statgraphics-Plus, v. 3, User Manual*, 1997 by Manugistics Inc.
- *Engineering Statistics*, by A. H. Bowker & G. J. Lieberman (2nd edition, 1972 by Prentice-Hall Inc.)
- *Experimental Statistics: National Bureau of Standards Handbook 91*, by M. G. Natrella, published 1963 by the U.S.
- *Introduction to* der & E. B. Roessler, published 1977 by
- *Intro* blished 1979 by

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Primary Referenc

- *Measurement Syste* by the Automotive Industry Action Group, AIAG (This text is commonly referred to as "MSA-3".)
- *Statgraphics-Plus, v. 3 and v. 5, User Manual*, 1997 and 2001, by Manugistics Inc.
- *Introduction to Probability and Statistics*, 6th edition, by H. L. Alder & E. B. Roessler, published 1977 by W. H. Freeman & Co.

Primary References for Specification / Inaccuracy Ratios & Specification Guardbanding:

- *Measurement Systems Analysis*, 3rd edition, 2002, published by the Automotive Industry Action Group, AIAG (This text is commonly referred to as "MSA-3".)
- *Experimental Statistics: National Bureau of Standards Handbook 91*, by M. G. Natrella, published 1963 by the U.S. Government Printing Office.

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- "Agilent Metrology Forum" website (http://metrologyforum.tm.agilent.com)
- *NIST Tech Note 1297* (1994), "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results"
- *ISO/IEC 17025* (formerly EN45001 + ISO Guide 25) "General Requirements for the Competence of Calibration and Testing Laboratories".
- *ISO 10012-1*, "Quality Assurance Requirements for Measuring Equipment"
- *EA-4/02*, "Expression of the Uncertainty of Measurement in Calibration"

5.0 DEFINITIONS

Bias	The arithmetic difference between a measured value and the "true value"
MSA-3	*Measurement Systems Analysis*, 3rd edition, 2002, published by the Automotive Industry Action Group, AIAG
SAG	The MSExcel file named by Zorich Technical Consultants as "Statistical Analysis of G
SGP or SGP3	package used to validate ts of SAG.
SGP5	ed to validate
R8	process
F	
Re	en
"Same"	G must produce book, and must be isplayed by SGP3 (5 digits; the "+/– 5" tolerance compensates for differences between SAG and SGP3 as to when and how intermediate and final rounding off of displayed digits is accomplished). FOR NON NUMERICAL RESULTS, "same" means that SAG must produce a result identical to that by SGP3 or the Reference book.

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FOR GAGE BIAS, GAGE LINEARITY, AND SPECIFICATION / INACCURACY + GUARDBANDING ONLY

Results are considered the "same" if they differ by 1% or less; this allows for differences in rounding between SAG and the reference textbook or method.

All other terms are equivalent to the common definitions in standard statistical textbooks.

6.0 INSTALLATION VALIDATION

SAG is a standard Microsoft Excel File, without added macros, ActiveX controls, or VBA scripts. To function correctly, the file needs to be used on a computer running Microsoft Windows (v 95, NT4, or later), that is running MSExcel version 8 or later (that is, "Excel 97" or later). (NOTE: Excel 97 thru Excel XP all use the same file format, per Walkenbach, p. 5, as referenced above; according to press releases from Microsoft, the version of Excel being sold for use with the newest version of Windows ("Vista"), has the same file format as does the Excel XP version.). Per Microsoft's website, Excel 2007 has a new file format ("XLSX") that has the capability of automatically configuring itself to be fully compatible with "XLS" files such as SAG. Installation validation is performed by verifying that the file is installed on such a computer. Since the file cannot run on any other type of installation, this validation is self-evident and will not be documented as part of implementing this protocol.

7.0 DESIGN VALIDATION

SAG comprises 5 primary worksheets: one each that calculates either Gage Correlation, Gage R&R, Gage Bias, Gage Linearity, or Specifi Ratio & Guardbanding..

Design validation i tion-containing cells) are user modifiabl

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eet)

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...for other Gage BIAS and LINEARITY worksheet equations and principles:

- MSA-3

...for Gage CORRELATION worksheet,

the equations are provided by means of Excel functions (e.g., "Correl" and "Stdev"), rather than any particular textbook. The principles involved are those found in any standard statistical textbook, such as Alder & Roessler.

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8.0 PERFORMANCE VALIDATION

VALIDATION PLAN FOR THE GAGE CORRELATION WORKSHEET

Significance is calculated by the program automatically looking up comparison values in a table; the table has only 4 significance levels: they are 0.01, 0.02, 0.05, and 0.10.

Step	INPUT			CRITERIA FOR SUCCESS
1	N (= # of data points per gage)	Approx. Avg of data points	Alpha (=significance)	For all listed combinations, SAG calculates the "same" average value for each gage as does SGP3
	10	-10	0.01	
	10	-10	0.02	
	10	-10	0.05	
	10			
	10			
	10			
	50			
	50			
	50			
	50	100	0.02	
	50	100	0.05	
	50	100	0.10	
	50	100,000	0.01	
	50	100,000	0.02	
	50	100,000	0.05	
	50	100,000	0.10	

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Step	INPUT			CRITERIA FOR SUCCESS
2	N (= # of data points per gage)	Approx. Avg of data points	Alpha (=significance)	For all listed combinations, SAG reaches the "same" conclusion, in regard to statistical significance as does SGP3's paired signed-rank test, in comparisons of... Gage#2 vs. Gage#1, and (if have 3 gages) Gage#3 vs. Gage#1, and Gage#3 vs. Gage#2.
	10	-10	0.01	
	10	-10	0.02	
	10	-10	0.05	
	10	-10	0.10	
	10	0	0.01	
	10	0	0.02	
	10	0	0.05	
	10	0	0.10	
	10	100	0.01	
	10	100	[illegible]	
	10	[illegible]	[illegible]	
	10	[illegible]	[illegible]	
	10	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	
	50	[illegible]	[illegible]	
	50	[illegible]	[illegible]	
	50	[illegible]	[illegible]	
	50	100,000	[illegible]	
3	Data sets from the textbooks listed in the references that have chapters and demo data on the Wilcoxon paired- signed-rank tests.			For all listed data sets, SAG calculates the "same" T value and reaches the "same" conclusion in regard to statistical significance, as shown in each of the textbooks.

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VALIDATION PLAN FOR THE GAGE R&R WORKSHEET

In contrast to the Gage Correlation method above, no "table lookup" process is involved in calculation of Gage R&R. That is, all values are obtained purely by mathematical calculations. Therefore, instead of "significance" being compared between SAG and SGP3, comparisons are made between SAG and SGP3 in regard to the calculated Mean Square (MS) and Probability values (these are compared in Step 4, below). In effect, MS values are then used by SAG and SGP3 to calculate the Gage R&R values (these are compared in Step 5, below). Whether or not a certain probability level is "significant" is left up to the user of the program; SAG does output an opinion for consideration by the user, but that opinion is not being validated here.

The "High" an[illegible] the basis for %R&R will be set at an arbitrary valu[illegible] this Protocol (see Step 6, below [illegible] d in Step 6).

[illegible] ell will be left

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2				
2				
3	2			
3	2	10	2	0
3	3	10	2	100
3	3	10	3	100,000

Step	INPUT	CRITERIA FOR SUCCESS
5	Data sets from Step 4 (# of Gages = 1 **) and % confidence intervals set to either 95%, 99%, or 99.7%, using the following number of Std Deviations for the width of a "normal distribution" confidence interval (these are the same values typically used in textbook Gage R&R studies, except carried out to many more significant digits): 95% 99%	For all 12 combinations, SAG calculates the "same" Gage R&R confidence interval width values as does SGP3 (comparisons using the SGP3 ANOVA method, without interaction).

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100,00		
-10	1.00	0.1000
0	1.00	0.0100
100	10.00	1.0000
100,000	1000.00	100.0000

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ns using the
ANOVA method,
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VALIDATION PLAN FOR THE GAGE BIAS WORKSHEET

BIAS worksheet performance validation is to be accomplished by verifying that:

STEP#7,

Part#A

Using on-test-gage measurement data derived from an example in MSA-3 (pp. 85-88), and the reference value in that same example, SAG generates results that are the "same" (see definition, above) as those in MSA-3. Because the number of on-test measurement data points in MSA-3's example is not large, validation will include placing that data at various places in the S[illegible]ble. And because the "standard deviation" i[illegible]mple, the standard deviation in MS[illegible]t (it will be entered i[illegible]d deviation using [illegible] footnote # 36; [illegible]ts).

[illegible] data

ST[illegible] (see [illegible]aces

STEP#[illegible]

U[illegible] reference" valu[illegible]ion, above) as those in [illegible]e reference-gage data entry ta[illegible]

STEP#10

Using 3 other randomly generated data sets (of size n = 10, 20, and 30), SAG generates results that are the "same" (see definition, above) as those generated by SGP3 for a one sample t-Test vs. an hypothesized value.

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VALIDATION PLAN FOR THE GAGE LINEARITY WORKSHEET

LINEARITY worksheet performance validation is to be accomplished by verifying that:

STEP#11

Using on-test-gage measurement data derived from the example in MSA-3 (pp. 92-96), SAG generates results that are the "same" (see definition, above) as those in MSA-3. Because the number of data points in MSA-3's example is not large, validation will include placing that data at various places in the SAG on-test-gage data entry table (however, row 1 must contain data, as required by the pro

STEP#12

that are the "same" (see
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n = 10, 20, and 30 each),
as those generated by SGP5's
Gage Li

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VALIDATION PLAN FOR THE INACCURACY+GUARDBANDING WORKSHEET

INACCURACY... worksheet performance validation is to be accomplished by verifying that:

STEP#15

Using a range of "uncertainty intervals", "divisors", "confidence levels", and "upper" & "lower" specification limits, SAG generates results that are the "same" (see definition, above) as those derived "by hand" where "by hand" is meant by use of a hand-held calculator and Z-tables from a statistics textbook.

VALIDATION REPORT for Protocol # ZTC-7

For version 4 of ZTCP's

"STATISTICAL ANALYSIS OF GAGES.xls"

For the name and signature of the author of this Report, see the CoverPage of this combined Protocol + Report PDF file.

1.0 INSTALLATION VALIDATION

Self-evident -- see protocol for discussion.

2.0 DESIGN VALIDATION

All the equations on the hidden calculation worksheets were found to match the relevant equations in the referenced textbooks.

All the references on worksheet t[illegible] the appropriate cell(s) on the hidden calculation worksheets [illegible]

The logic of t[illegible] heets were examined and all found [illegible]

All [illegible] eets (e.g., si[illegible] page)

[illegible] (e.g., [illegible] cument

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3.0 PERFORMANCE VALIDATION

GAGE CORRELATION

The text in the cells of the leftmost column in the table below (the "Validation Plan) are either summaries (in parentheses) or literal copies (no parentheses) of the relevant text from Protocol # ZTC-7.

The text in the cells of the center column in the table below ("Criteria for Success") are literal copies of the relevant text from Protocol # ZTC-7.

The "Results" column is based upon comparing the data outputs that are referenced (the references are to "Attachments" to this Report).

VALIDATION PLAN	CRITERIA FOR SUCCESS	RESULTS
Step 1 (24 data sets, with averages ranging from -10 to +100000, of sample size = 10 or 50, arranged in either sets of 2 or 3 gages)	For all listed combinations, SAG calculates the "same" average value for each gage as does SGP3	All criteria were met. See Attachment # 4, page 1
Step 2 (24 data sets ranging fr -10 to +1 size = 1 either		xcept for ssion,
Step Data se listed in t have chapt on the Wilco signed-rank test		

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GAGE R & R

The text in the cells of the leftmost column in the table below (the "Validation Plan) are either summaries (in parentheses) or literal copies (no parentheses) of the relevant text from Protocol # ZTC-7.

The text in the cells of the center column in the table below ("Criteria for Success") are literal copies of the relevant text from Protocol # ZTC-7.

The "Results" column is based upon comparing the data outputs that are referenced (the references are to "Attachments" to this Report).

VALIDATION PLAN	CRITERIA FOR SUCCESS	RESULTS
Step 4 (see protocol) (12 data sets or random numbers, with averages ranging from -10 thru 100000, arranged into 3 sub-groups for use in simulating data from 3 individual gages)	For all listed combinations, "Mean Square (MS)" and "probability" values that are shown in SAG's "ANOVA Analysis Complete Table" are the "same" as those produced by SGP3.	All criteria were met. See Attachment 1, "image" #s 1-3, 8-10, 15-17, 22-24 Attachment # 2, page 1
Step 5 (4 data sets of rand numbers with a ranging from 100000, ea different c		met.
Step 6 (Using Step 5, % Tolera conditions		

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GAGE BIAS, and GAGE LINEARITY

The data results from Steps # 7 thru 14 are shown in the "TABLES" below. In all cases, the Protocol criteria were met, in that all results calculated by (SAG) were within 1% of the required comparative values (either those produced by StatGraphicsPlus, SGP3 or SGP5, as required by the Protocol, or those found in MSA-3).

SPECIFICATION / INACCURACY RATIO + SPECIFICATION GUARDBANDING

The data results from Step # 15 are shown in the "TABLES" below. In all cases, the Protocol criteria were met, in that all results calculated by (SAG) were within 1% of the results calculated "by hand".

EXCEPTIONS TO THE VALIDATION PROTOCOL:

Step # 2

StatGraphicsPlus (SGP3) and Statistical Analysis of Gages (SAG) did not agree on the significance of 3 of the tested data sets. Examination of the "T" values calculated revealed that SGP3 was calling any result "non significant" only if it the calculated T value was less than the corresponding table-value of T. Such a practice contradicts the instruction found in every one of the textbooks used to design SAG (see list in Protocol); the instruction in the textbooks is to call "significant" any result that is either less than the table-value of T or equal to it. The non-agreement results are shown highlighted in dark background on Attachment # 4, and are also listed in the table below:

Input data sets on Attachment # 5	Calculated T value (SGP	Tabular T value in	SGP conclusion	SAG conclusion
4, 5				Significant
10				Significant
				Significant

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5.0 ATTACHMENTS (RESULTS OF GAGE CORRELATION AND GAGE R&R VALIDATION):

Attachment # 1	Gage R&R results from "Stat-Graphics-Plus" (SGP3)
Attachment # 2	Gage R&R results from "Statistical Analysis of Gages. Xls" (SAG)
Attachment # 3	Gage R&R data-sets (SGP3 and SAG)
Attachment # 4	Gage Correlation validation results (SGP3 and SAG)
Attachment # 5	Gage Correlation data-sets (SGP3 and SAG)

6.0 TABLES (RESULTS OF GAGE BIAS, GAGE LINEARITY, and ACCURACY+GUARDBANDING VALIDATIONS):

DATA FROM STEP # 7

Part A

Comparis
Averag
Upper 9
Lower

Part B

Con
Firs
First 2
All 30 rows of Co

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DATA FROM STEP # 8

Comparison of Bias Results: SAG vs. MSA-3		
	SAG *	MSA-3
Average Measurement		6.0067
Average Bias		
Upper 95% confidence limit		
Lower 95% confidence li		

*

DATA FROM STEP # 9

Co	
Averag	
Upper 95% co	
Lower 95% con	

Data set used for STEP#3 was:

2.5 3.0 3.5 4.0 4.5 9.0 9.5

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DATA FROM STEP # 10

| Compari | | |

DATA FROM STEP # 11

Comparis		MSA-3	
		3 **	
Average (by Part) of Measurements		rcept	Slope
2.49166		7	- 0.131667
4.12500			
6.0250			
7.708			
9.38			

* Results were the sam

** SAG calculates the ave ove for "Average"
MSA-3 are equal to: th , and 10 respectively).

NOTE: The SAG slope and inte

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DATA FROM STEP #12

| Co | | |

DATA FROM STEP # 13

Comparison of Linearity Results: SAG vs. MSA-3				
SAG *		MSA-3 **		
Average (by Part) of Measurements	Interc	Part) of	Intercept	Slope
2.49166			0.736667	- 0.131667
4.12500				
6.02500				
7.70833				
9.3833				

* Results were the sa

** SAG calculates the e for "Average"
MSA-3 are equal t d 10 respectively).

NOTE: The SAG slope

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1.8				9.0
1.6	3.6	5.4	7.2	8.0
1.4	3.4	5.1	6.8	7.0
1.2	3.2	4.8	6.4	6.0
1.0	3.0	4.5	6.0	5.0

DATA FROM STEP # 14

Comparison		SGP5
DATA SET		Slope
A		53381
B		33
C		
D		
E		
F		
G		
H		
I		

		20
G		1 thru 30
H		, rows 1 thru 30
I	Master Da[illegible] A thru J, rows 1 thru 30	

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NOTE: The SAG slope and intercept values are viewed on the (hidden) worksheet named "LinearityCalcs".

DATA FROM STEP # 15

DATA SETS	Data Set A	Data Set B	Data Set C	Data Set D	Data Set E
Uncertainty Intervals	0.0001 on the first 4 rows of the table; all other rows blank	0.2 on all 7 rows in the table			12,345 on the last 4 rows of the table; all other rows blank
Divisors	all = 3				all = 10
Confidence level	52.0				99.9 %
Lower Specification Limit				21	5,000,000
Upper Specification Limit				ntered)	5,100,000

The hand-held calculator t

Z-tables used were take ort)

RESULTS Data Set				s % of Hand"
Specification Inte				.0 %
Combined Extend Uncertainty				.9 %
Lower Limit of the Expanded Specificatio				00.0 %
Upper Limit of the Expanded Specification				100.0 %
Lower limit of the Guardbanded Spec				100.0 %
Upper limit of the Guardbanded Spec	0.01		047	100.0 %
Spec / Inaccuracy Ratio	7.43		0	100.0 %

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RESULTS Data Set B	SAG result	"By Hand"	SAG minus "By Hand"	SAG as % of "By Hand"
Specification Interval	2		0	100.0 %
Combined Extended Uncertainty			000007877	99.9 %
Lower Limit of the Expanded Specifica			10	100.0 %
Upper Limit of Expanded Speci				99.9 %
Lower limit Guardband				99.9 %
Upper lim Guardban				100.0 %
Spec / Inaccu				100.0 %

RESULTS Data				SAG as % of "By Hand"
Specification Int				(not applicable)
Combined Extended Uncertainty			5	99.9 %
Lower Limit of the Expanded Specification			pplicable)	(not applicable)
Upper Limit of the Expanded Specification	23.1740		-0.000015506	100 %
Lower limit of the Guardbanded Spec	(not applicable)	(not applicable)	(not applicable)	(not applicable)
Upper limit of the Guardbanded Spec	22.825925070	22.82590956	0.000015510	100 %
Spec / Inaccuracy Ratio	(not applicable)	(not applicable)	(not applicable)	(not applicable)

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RESULTS Data Set D	SAG result	"By Hand"	SAG minus "By Hand"	SAG as % of "By Hand"
Specification Interval	(not applicable)	(not applicable)	(not applicable)	(not applicable)
Combined Extended Uncertainty	[illegible]	[illegible]	-0.000015506	99.99 %
Lower Limit of the Expanded Specific[illegible]	[illegible]	[illegible]	[illegible].000015510	100 %
Upper Limit [illegible] Expanded Sp[illegible]	[illegible]	[illegible]	[illegible]icable)	(not applicable)
Lower li[illegible] Guardb[illegible]	[illegible]	[illegible]	[illegible]6	100 %
Upper [illegible] Guard[illegible]	[illegible]	[illegible]	[illegible]	(not applicable)
Spec / I[illegible]	[illegible]	[illegible]	[illegible]	(not applicable)

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RESULT[illegible]	[illegible]	[illegible]	[illegible]	SAG as % of "By Hand"
Specifica[illegible]	[illegible]	[illegible]	[illegible]	100.0 %
Combined [illegible] Uncertai[illegible]	[illegible]	[illegible]	[illegible]13	99.9 %
Lower Limit o[illegible] Expanded Specifica[illegible]	[illegible]	[illegible]	[illegible]000000	100.0 %
Upper Limit of the Expanded Specification	[illegible]	[illegible]	[illegible]10.963000000	100.0 %
Lower limit of the Guardbanded Spec	50[illegible]	[illegible]	-10.963000000	100.0 %
Upper limit of the Guardbanded Spec	5091875.608	5091864.645	10.963000000	100.0 %
Spec / Inaccuracy Ratio	6.15	6.15	0	100.0 %

MASTER DATA SET # 1

Reference Value	2	4	6	8	10	12	14	16	18	20
Part ID#	A	B	C	D	E	F	G	H	I	J
Replicate Measurement #										
1	2.499641	4.692375	5.196					16.08289	17.20686	20.69953
2	1.51769	4.547488						16.18319	17.13233	19.88417
3	1.676264	3.8599							18.20109	20.86703
4	1.498754	3.							17.5435	19.9367
5	2.622153								34786	19.55426
6	1.56596								661	20.75876
7	2.342								7	19.7866
8	2									19.84214
9	1.									19.65335
10	1									19.05003
11										0.93873
12										.06372
13										20.345
14										.51634
15										.85936
16										0.68781
17										9.03425
18	2.									19.7353
19	1.9									20.25212
20	1.33									20.30944
21	1.872								88	19.75251
22	1.168079								1368	20.65236
23	1.752839	4							17.95098	20.7551
24	1.486227	4.7							18.4565	19.78847
25	1.820715	3.741715						4436	18.16029	19.45598
26	1.581544	4.636599	6.4					16.68138	18.69547	20.40354
27	1.213163	3.342147	5.900457				14.72904	15.4122	17.77094	20.99707
28	1.344624	4.393047	6.402714	8.343467	9.529519	11.36455	13.43726	16.017	18.19275	20.57938
29	2.973736	4.124521	5.201951	8.523757	10.18674	12.13188	13.32202	15.50509	18.61897	20.70545
30	2.154458	4.89901	6.354445	8.875685	9.690392	12.27115	14.43325	16.50547	17.04242	19.57055

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MASTER DATA SET # 2

Reference Value	2	4	6	8	10	12	14	16	18	20
Part ID#	A	B	C	D	E	F	G	H	I	J
Replicate Measurement #										
1	2.192954	4.095873	6.075206	8.46966			13.66155	15.79555	17.95043	19.91622
2	2.147322	4.093425	6.3163					15.97011	17.86093	19.82865
3	2.124264	4.171086						626	17.79856	19.90996
4	2.0005	4.1430							17.76897	19.83239
5	2.173342	4.0							98044	19.91214
6	2.147456								016	19.95779
7	2.193759									19.93027
8	2.0273									19.83738
9	2.047									9.88636
10	2.05									.87763
11	2.0									.9241
12	2.									9428
13	2									5599
14	2									3557
15	2									0078
16	2.									4274
17	2.0									97265
18	2.1									.91518
19	2.05									9.96835
20	2.0838									19.92008
21	2.188550									19.89082
22	2.07724								25	19.88272
23	2.132291	4.							3155	19.86127
24	2.127898	4.242							17.91589	19.93804
25	2.146086	4.070412							17.76052	19.92841
26	2.138172	4.11045	6.0					.61157	17.79062	19.92644
27	2.078455	4.087342	6.103654					15.83345	17.84344	19.83062
28	2.04543	4.113517	6.060564	8.437782			13.87719	15.78997	17.82756	19.89479
29	2.054845	4.032954	6.137332	8.297148	10.16991	11.97312	13.65313	15.87251	17.81835	19.81355
30	2.114948	4.195816	6.247022	8.299581	10.16518	11.75643	13.56047	15.99051	17.80368	19.96936

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MASTER DATA SET # 3

Reference Value	2	4	6	8	10	12	14	16	18	20
Part ID#	A	B	C	D	E	F	G	H	I	J
Replicate Measurement #										
1	2.112816	4.392706	6.072567	8.007125	10.67991	12.71403	15.33674	16.73379	18.49739	20.04049
2	2.067505	4.008995	6.037046	8.473889	10.78585	12.05307	14.79915	16.40417	18.09828	20.90563
3	2.004023	4.118735	6.271234	[illegible]	[illegible]	[illegible]	15.32176	16.53977	18.66701	20.93447
4	2.155131	4.366722	6.09[illegible]	[illegible]	[illegible]	[illegible]	[illegible]5796	17.24586	18.83123	20.93609
5	2.187878	4.343178	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.62219	18.54574	21.69345
6	2.193428	4.352422	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]6.37592	19.16528	20.22976
7	2.094284	4.1697[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]8549	19.06196	20.77657
8	2.009497	4.2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]4	18.88763	20.40226
9	2.109243	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18.38218	20.8016
10	2.115472	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19.68598	20.1847
11	2.088564	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18.54731	20.81762
12	2.025464	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].53826	21.99591
13	2.1224	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]62668	21.07243
14	2.0177	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]2791	21.22422
15	2.146	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]089	21.29182
16	2.184	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]096	21.79053
17	2.07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]251	20.85308
18	2.073	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]925	21.04446
19	2.193	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]349	21.44866
20	2.018	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]442	20.34603
21	2.1898	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]6044	20.67277
22	2.0286	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]1609	20.80207
23	2.06410	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].00711	20.04339
24	2.18177	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]8.61589	21.17827
25	2.002282	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19.60117	20.70293
26	2.052414	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18.4156	21.56934
27	2.195866	4.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18.61885	21.45256
28	2.045126	4.00[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]432	19.23729	20.02864
29	2.026121	4.33455[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].64927	18.9625	21.40645
30	2.180681	4.226294	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.41609	18.38335	21.64161

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Attachment #1 to Validation Report #ZTC -7

This attachment contains mostly screen-capture images from the computer software package called Stat Graphics Plus (SGP3) (see Validation protocol).

The data-set ID# that was used to generate a particular SGP3 image is indicated in the text box that precedes the image (the text box could be on the page prior to the page on which the image appears), and the data set itself can be constructed from Attachment # 3.

The images themselves are numbered, and their assigned number is shown in underline italic font, immediately above the image.

Data Set # 28, usin
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```
                                                                    848
                                                                   .5274
                                                                  0.5922
                                                                  0.2413
                                                                  0.6843
                                                          58      0.4968
                                                        1.37      0.4213
ABD                                                     0.75      0.5711
ACD                                                     0.02      0.9764
BCD                                          166667     0.01      0.9171

RESIDUAL                    0.240833      2       0.120417
-------------------------------------------------------------------------------
TOTAL (CORRECTED)            1.81833     23
-------------------------------------------------------------------------------
All F-ratios are based on the residual mean square error.
```

Data Set # 28, using data from Gages # 1 and 2
(using the first 2 operators, first 2 parts, and first 2 replicates)

In this next table (see S Square" is what is referred to in SAG as "Mea

In

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```
-----
alue
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4

4
13
179
6344
.6344
0.5000
0.9626
0.7513

RES
---------------------------------------------------------------------
TOTAL (CORRE
---------------------------------------------------------------------
All F-ratios are based on the residual mean square error.
```

Data Set # 28, using data from Gage # 1 only
(using the first 2 operators, first 2 parts, and first 2 replicates)

In this next table (see **Step 4 in the Protocol**), the "Mean Square" is what is referred to in SAG as "Mean Square (MS)"

Image #3

```
Analysis
------
Sourc
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MA

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All
```

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Step 5 in the Protocol

In these next 3 images, the "number of Std Deviations" is shown above the text "Std. dev." These tables contain the

- SGP3 calculations of the "confidence interval widths" asked for in Step 5 of the Protocol (the "widths" are found beneath the text "Std. Dev.")
- %TV values when the Standard Deviation option cell is left "blank" (the "blank" %TV values are fo labeled "Percent Study Variation"), as a

Imag

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n

62

Image #6

Measurement Unit Analysis and Study Variation

	5.93544 Std. dev.	Percent Study Variation	Percent Contribution
Repeatability	1.49274	73.72	54.35
Reproducibility	0.104925	5.18	0.27
R & R	1.49642	73.90	54.62

Step 6 in the Protocol

In this next table, the

- "Percent of Tolerance" is what is referred to in SAG as "Confidence interval as % of Tolerance"; and
- "Percent of Process Sigma" is the same as the SAG term "Confidence interval as % of TV" when the protocol StdDev is entered (the "process sigma" in this table is the value calculated by SGP3 by multiplying 5.15166902914643 times [illegible] option" listed in Step 6 of the Protocol) (5.1[illegible] Distribution 99% confidence [illegible]
- For %T[illegible] above.

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Data Set # 29, using data from Gages # 1, 2, and 3
(using the first 2 operators, all 10 parts, and the first 2 replicates)

In this next table (see **Step 4 in the Protocol**), the "Mean Square" is what is referred to in SAG as "Mean Square (MS)"

Image # 8

```
Analysis of Variance
-----------------------------------------------------------------------
Source                                                          P-Value
-----------------------------------------------------------------------
MAIN EF
 A:Ga
 B:

-
TOT
-----
All F-r
```

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Data Set # 29, using data from Gages # 1 and 2
(using the first 2 operators, all 10 parts, and the first 2 replicates)

In this next table (see **Step 4 in the Protocol**), the "Mean Square" is what is referred to in SAG as "Mean Square (MS)"

Image # 9

```
Analysis of Varia
-------------
Source
--------
MAIN E
 A:O
 B
RES
----
TOTAL
--------
All F-ratio
```

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Data Set # 29, using data from Gage # 1 only
(using only the first 2 operators, all 10 parts, and the first 2 replicates)

In this next table (see **Step 4 in the Protocol**), the "Mean Square" is what is referred to in SAG as "Mean Square (MS)"

Image # 10

```
Analysis of Variance for Measurement - Type
-------------------------------------
Source                 Sum of Sq
-----------------------------
MAIN EFFECTS
 A:Operator
 B:Part
 C:Replicate

INTERACTIONS
 AB
 AC
 BC

RESIDUAL
-----------
TOTAL (CORR
-----------
All F-ratio
```

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Step 5 in the Protocol
In these next 3 tables, the "number of Std Deviations" is shown above the text "Std. dev." These tables contain the

- SGP3 calculations of the "confidence interval widths" asked for in Step 5 of the Protocol (the "widths" are found beneath the text "Std. Dev."), and the
- %TV values when the Standard Deviation option cell is left "blank" (the "blank" %TV values are found in the column labeled "Percent Study Variation"), as asked for in **Step 6 of the Protocol**.

Image # 11

Mea

Percent
ntribution
3

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Image

Measurement Unit Analysis - Study Variation

	5.93544 Std. dev.	Percent Study Variation	Percent Contribution
Repeatability	1.47077	81.38	66.23
Reproducibility	0.242796	13.43	1.80
R & R	1.49068	82.48	68.04

Step 6 in the Protocol
In this next table, the

- "Percent of Tolerance" is what is referred to in SAG as "Confidence interval as % of Tolerance"; and
- "Percent of Process Sigma" is the same as the SAG term "Confidence interval as % of TV" when the protocol StdDev is entered (the "process sigma" in this table is the value calculated by SGP3 by multiplying 5.15166902914643 times the "Standard Deviation option" listed in Step 6 of the Protocol) (5.15166902914643 is the width of a Normal Distribution 99% confidence interval, in units of standard deviations).
- For %TV values when the StdDev value is left blank, see Image # 12, above.

Image # 14

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Data Set # 30, using data from Gages # 1, 2, and 3
(using all 3 operators, all 10 parts, and the first 2 replicates)

In this next table (see **Step 4 in the Protocol**), the "Mean Square" is what is referred to in SAG as "Mean Square (MS)"

Image # 15

Analysis of Variance for Measurement - Type III Sums of Squares

Source	F-Ratio	P-Value
MAIN EFFEC		
A:Gage		0.4488
B:O		4598
C		17

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Data Set # 30, using data from Gages # 1 and 2
(using all 3 operators, all 10 parts, and the first 2 replicates)

In this next table (see **Step 4 in the Protocol**), the "Mean Square" is what is referred to in SAG as "Mean Square (MS)"

Image # 16

Analysis of Variance for Measurement - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Gage				0.42	0.5244
B:Operator				63	0.5450
C:Part					0.6163
D:Repli					0.8549
INT					

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Data Set # 30, using data from Gage # 1 only
(using all 3 operators, all 10 parts, and the first 2 replicates)

In this next table (see **Step 4 in the Protocol**), the "Mean Square" is what is referred to in SAG as "Mean Square (MS)"

Image # 17

```
Analysis of Variance for Measurement - Type III Sums of Squares
--------------------------------------------------------------------------------
Source                 Sum of Squares     Df    Mean Square    F-Ratio    P-Value
--------------------------------------------------------------------------------
MAIN EFFECTS
 A:Operator                        7
 B:Part                       1
 C:Replicate

INTERACTIONS
 AB
 AC
 BC

RESIDUAL
------------
TOTAL (CORRE
-----------
All F-ratio
```

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Step 5 in the Protocol
In these next 3 tables, the "number of Std Deviations" is shown above the text "Std. dev." These tables contain the

- SGP3 calculations of the "confidence interval widths" asked for in Step 5 of the Protocol (the "widths" are found beneath the text "Std. Dev."), and the
- %TV values when the Standard Deviation option cell is left "blank" (the "blank" %TV values are found in the column labeled "Percent Study Variation"), as asked for in **Step 6 of the Protocol**.

Image # 18

```
Measurement Unit Analysis and Study Variation
---------------------------------------------------------------------
                  3.91992            Percent Study       Percent
                  Std. dev.          Variation           Contribution
Repeatability     9.36609                                 73.37
Reproducibility   1.6745                                     35
R & R             9
```

Image # 19

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Image #

```
Mea
-----

Repeatability
Reproducibility
R & R             14.
```

Step 6 of the Protocol
In this next table, the

- "Percent of Tolerance" is what is referred to in SAG as "Confidence interval as % of Tolerance"; and
- "Percent of Process Sigma" is the same as the SAG term "Confidence interval as % of TV" when the protocol StdDev is entered (the "process sigma" in this table is the value calculated by SGP3 by multiplying 5.15166902914643 times the "Standard Deviation option" listed in Step 6 of the Protocol) (5.15166902914643 is the width of a Normal Distribution 99% confidence interval, in units of standard deviations).
- For %TV values when the StdDev value is left blank, see Image # 19, above.

Image # 21

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Data Set # 31, using data from Gages # 1, 2, and 3
(using all 3 operators, all 10 parts, and all 3 replicates)

In this next table (see **Step 4 in the Protocol**), the "Mean Square" is what is referred to in SAG as "Mean Square (MS)"

Image # 22

```
Analysis of Variance fo                    T Sums of Squares
---------------                                              ---------------------------
Source                                                  F-Ratio    P-Value
------                                                             ----------------
MAT
                                                                     0.8061
                                                                     0.9624
                                                                     0.7924
                                                                     0288
```

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Data Set # 31, using data from Gages # 1 and 2
(using all 3 operators, all 10 parts, and all 3 replicates)

In this next table (see **Step 4 in the Protocol**), the "Mean Square" is what is referred to in SAG as "Mean Square (MS)"

Image # 23

Analysis of Variance for Measurement - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Gage	[illegible]	1	3.05632E6	0.31	0.5835
B:Operator	[illegible]	[illegible]	1.80532E6	0.18	0.8353
C:Part	[illegible]	[illegible]	[illegible]2E6	0.50	0.8645
D:P[illegible]	[illegible]	[illegible]	[illegible]	0.05	0.9497
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0	0.9063
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.6789
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.6372
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.9535
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.6683
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4830
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	429
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	46
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	--

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Data Set # 31, using data from Gage # 1 only
(using all 3 operators, all 10 parts, and all 3 replicates)

In this next table (see **Step 4 in the Protocol**), the "Mean Square" is what is referred to in SAG as "Mean Square (MS)".

Image # 24

Analysis of Variance for Measurement - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Operator	2.60064E6	2	1.30032E6	0.13	0.8824
B:Part	3.96016E7	9	4.40018E6	0.42	0.9130
C:Replicate	4.30891E6	2	2.15446E6	0.21	0.8132
INTERACTIONS					
AB			[illegible]	0.64	0.8447
AC				0.11	0.9771
BC				[illegible].91	0.5723
RES[illegible]					

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Step 5 in the Protocol
In these next 3 tables, the "number of Std Deviations" is shown above the text "Std. dev." These tables contain the

- SGP3 calculations of the "confidence interval widths" asked for in Step 5 of the Protocol (the "widths" are found beneath the text "Std. Dev."), and the
- %TV values when the Standard Deviation option cell is left "blank" (the "blank" %TV values are found in the column labeled "Percent Study Variation"), as asked for in **Step 6 of the Protocol**.

Image # 25

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Image # 27

Measurement Unit Analysis and Study Variation

	5.93544 Std. dev.	Percent Study Variation	Percent Contribution
Repeatability	17401.1	97.04	94.17
Reproducibility	1235.71	6.89	0.47
R & R	17444.9	97.28	94.64

Step 6 of the Protocol
In this next table, the

- "Percent of Tolerance" is what is referred to in SAG as "Confidence interval as % of Tolerance"; and
- "Percent of Process Sigma" is the same as the SAG term "Confidence interval as % of TV" when the protocol StdDev is entered (the "process sigma" in this table is the value calculated by SGP3 by multiplying 5.15166902914643 times the "Standard Deviation option" listed in Step 6 of the Protocol) (5.15166902914643 is the width of a Normal Distribution 99% confidence interval, in units of standard deviations).
- For %TV values when the StdDev value is left blank, see Image # 26, above.

Image # 28

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ATTACHMENT # 2 TO VALIDATION REPORT ZTC-7 (all values were generated by Statistical Analysis of Gages.Xls)

RESULTS OF VALIDATION TESTING, GAGE R&R

DATA SET ID#s >>>	28-1	29-1	30-1	31-1	28-2	29-2	30-2	31-2	28-3	29-3	30-3	31-3
# of Gages	1	1	1	1	2	2	2	2	3	3	3	3
# of Operators	2	2	3	3	2	2	3	3	2	2	3	3
# of Parts	2	10	10	10	2	10	10	10	2	10	10	10
# of Replicates	2	2	2	3	2	2	2	3	2	2	2	3
Approx. Replicate Avg.	-10	0	100	100,000	-10	0	100	100,000	-10	0	100	100,000

SEE STEP 4 IN THE PROTOCOL

MS (= Variance) (from SAG's ANOVA Analysis Complete Table, re-arrang Plus)

Gage	----	----	----					3.05632E+06	0.0379167	0.0684343	4.86667	2.10109E+06
Operator	0.00125	0.0334662	3.65					80532E+06	0.0016667	0.0213333	4.71667	372679.6
Part	0.21125	0.118539	11.3					62E+06	0.0266667	0.0731678	9.51852	5.83702E+06
Replicate	0.00125	0.000042025						9.0	0.0266667	0.0262848	0.0222222	1.82899E+06
FIRST-ORDER INTERACTIONS												
Operator x Gage	----	----							0.0554167	0.0537391	5.88333	3.10041E+06
Gage x Part	----	----							0.107917	0.0884588	12.5148	7.5558E+06
Replicate x Gage	----	----							0.0829167	0.010049	8.42222	4.24354E+06
Operator x Part	0.10125	0.0818785							0.3266667	0.0524242	8.53148	4.36677E+06
Replicate x Operator	0.15125	0.0043472							0.0266667	0.100341	5.10556	5.28679E+06
Replicate x Part	0.03125	0.045666							0.0816667	0.0531301	3.62716	1.24545E+07
SECOND-ORDER INTERACTIONS												
Operator x Part x Gage	----	----							0.165417	0.0930065	9.63333	8.60044E+06
Operator x Gage x Replicate	----	----							0.0904167	0.15527	2.95556	5.44328E+06
Part x Gage x Replicate	----	----							0.00291667	0.0868404	8.2679	6.79996E+06
Operator x Part x Replicate	----	----							0.00166667	0.0682392	4.04383	1.00017E+07
RESIDUAL	0.03125	0.0698198							0.120417	0.109365	5.94012	9.71797E+06

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SEE STEP 4 IN THE PROTOCOL

PROBABILITIES (from SAG's ANOVA Analysis Complete Tab

Gage	----	----	----					0.5835	0.7605	0.5461	0.4488	0.8061
Operator	0.8743	0.5062	0.2260					0.8353	0.9171	0.6640	0.4598	0.9624
Part	0.2338	0.2213	0.0018					0.8645	0.6843	0.7262	0.1517	0.7924
Replicate	0.8743	0.9810	0.0539	0.81			8549	0.9497	0.6843	0.6299	0.9516	0.8288
FIRST-ORDER INTERACTIONS												
Operator x Gage	----	----	----	----	0.6900	0.3158	0.6463	0.9063	0.6848	0.6198	0.4252	0.8644
Gage x Part	----	----	----	----	0.5844	0.1803	0.0030	0.6789	0.5274	0.6713	0.0281	0.7187
Replicate x Gage	----	----	----	----	0.5844	0.8036	0.0563	0.6372	0.5922	0.9126	0.2554	0.7817
Operator x Part	0.3228	0.4081	0.0020	0.8447	0.7513	0.8111	0.0687	0.9535	0.2413	0.8698	0.1737	0.9704
Replicate x Operator	0.2716	0.8086	0.2532	0.9771	0.8179	0.1766	0.7689	0.6683	0.6843	0.3508	0.4319	0.7039
Replicate x Part	0.5000	0.7314	0.0618	0.5723	0.6344	0.7987	0.1960	0.4830	0.4968	0.8654	0.7797	0.2260
SECOND-ORDER INTERACTIONS												
Operator x Part x Gage	----	----	----	----	0.6344	0.2793	0.0191	0.6429	0.4213	0.6326	0.0758	0.6503
Operator x Gage x Replicate	----	----	----	----	0.5000	0.1046	0.4722	0.9036	0.5711	0.2676	0.7376	0.8069
Part x Gage x Replicate	----	----	----	----	0.9626	0.3116	0.0285	0.7646	0.9764	0.6851	0.1946	0.8794
Operator x Part x Replicate	----	----	----	----	0.7513	0.6257	0.4315	0.6537	0.9171	0.7621	0.8066	0.4477

SEE STEP 5 IN THE PROTOCOL

CONFIDENCE INTERVAL WIDTHS (from SAG's Repeatability & Reproducibility Summary Table)

DATA SET ID#s >>>	**28-1**	**29-1**	**30-1**	**31-1**
# of Gages	1	1	1	1
# of Operators	2	2	3	3
# of Parts	2	10	10	10
# of Replicates	2	2	2	[illegible]
Approx. Replicate Avg.	-10	0	[illegible]	
95% confidence intervals				
Repeatability (EV)	0.985844	0.971[illegible]		
Reproducibility (AV)	0.0692951	0.[illegible]		
Gage R&R	0.988276			
99% confidence intervals				
Repeatability (EV)	1.29562			
Reproducibility (AV)	0.0910694			
Gage R&R	1.29882			
99.7% confidence intervals				
Repeatability (EV)	1.4927[illegible]			
Reproducibility (AV)	0.10492[illegible]			
Gage R&R	1.49644[illegible]			

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SEE STEP 6 IN THE PROTOCOL

%TV and % TOLERANCE (from SAG's Repea[illegible]

DATA SET ID#s					**30-1**	**30-1**	**31-1**	**31-1**
					%TV	%Tolerance	%TV	%Tolerance
Results when Standard Deviation option cell is BLANK								
Gage Repeatability (including "interaction" component) (= EV)	73.72[illegible]	[illegible]	[illegible]	[illegible]27.656%	85.65%	123.092%	97.04%	1510.33%
Reproducibility (= all other non-Part sources of variation) (= AV)	5.18%	[illegible]	[illegible]	21.0735%	15.31%	22.0079%	6.89%	107.254%
Repeatability & Reproducibility, combined (= " R & R ")	73.90%	129.882%	82.48%	129.384%	87.01%	125.044%	97.28%	1514.13%
Results when Standard Deviation option cell is PER STEP INSTRUCTIONS								
Gage Repeatability (including "interaction" component) (= EV)	251.496%	129.562%	2477.95%	127.656%	238.936%	123.092%	2931.73%	1510.33%
Reproducibility (= all other non-Part sources of variation) (= AV)	17.6777%	9.10694%	409.061%	21.0735%	42.72%	22.0079%	208.192%	107.254%
Repeatability & Reproducibility, combined (= " R & R ")	252.116%	129.882%	2511.49%	129.384%	242.725%	125.044%	2939.11%	1514.13%

ATTACHMENT # 3 TO VALIDATION REPORT # ZTC-7

DATA SETS USED IN VALIDATION OF GAGE R&R

DATA SET # 28, Randomly generated data, AVG = approx -10

DATA SET ID#		GAGE # 1								
		Operator A			Operator B			Operator C		
		Replicate#1	Replicate#2	Replicate#3	Replicate#1	Replicate#2	Replicate#3	Replicate#1	Replicate#2	Replicate#3
28-1	Part#1	-10.4	-10.4	-10.1	-10	-10.3	-9.8	-9.9	-10.1	-10
	Part#2	-10.1	-9.6	-9.6	-9.9	-10.2	-9.6	-10	-10.4	-9.8
	Part#3	-10.1	-10.3	-10.1	-10.1	-10.5	-10.3	-9.6	-9.6	-10.4
	Part#4	-10.2	-9.9	-9.7	-9.5	-10	-9.6	-9.8	-10.5	-10.5
	Part#5	-9.8	-10.2	-9.7	[illegible]	-10	-10.5	-10.2	-9.8	-9.7
	Part#6	-10.1	-9.8	[illegible]	[illegible]	[illegible]	-10.2	-9.7	-9.8	-10.4
	Part#7	-9.8	-9.6	[illegible]	[illegible]	[illegible]	[illegible]	-9.6	-10.3	-10.4
	Part#8	-10.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10.1	-10.4	-9.5
	Part#9	-9.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10.4	-10	-10.4
	Part#10	-10.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-9.7	-10.4	-10.2
		GAGE								
		Ope								
		Re							Replicate#2	Replicate#3
28-2	Part#1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10.5	-9.8
	Part#2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-9.6	-9.9
	Part#3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10.3	-9.6
	Part#4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10.5	-10.1
	Part#5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10.2	-10.4
	Part#6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10	-10.1
	Part#7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-9.9	-9.6
	Part#8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10.4	-9.9
	Part#9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-9.6	-9.9
	Part#10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10.4	-10.1
		GA								
		Oper								
		Replicat						ate#1	Replicate#2	Replicate#3
28-3	Part#1	-10.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10	-9.9	-10.4
	Part#2	-10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-10.3	-10	-9.5
	Part#3	-10.2	-10.1	[illegible]	[illegible]	[illegible]	[illegible]	-10	-9.7	-9.7
	Part#4	-10.2	-9.8	[illegible]	[illegible]	[illegible]	[illegible]	-9.7	-9.9	-10.2
	Part#5	-9.9	-9.8	-10	[illegible]	[illegible]	-10.1	-10.1	-9.5	-10.1
	Part#6	-10.4	-10.1	-10.3	-10.3	-10.2	-9.6	-9.9	-10.3	-10.2
	Part#7	-9.5	-9.8	-9.6	-10.3	-10.4	-9.8	-9.8	-9.8	-10.4
	Part#8	-10.2	-10.2	-9.8	-10.2	-10.2	-10.2	-10.2	-9.9	-9.7
	Part#9	-10.4	-10.1	-9.6	-9.7	-10.1	-10.3	-10.2	-10.5	-10.3
	Part#10	-9.7	-9.5	-10.2	-9.8	-9.9	-10.3	-10.4	-10	-9.6

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DATA SET # 29, Randomly generated data, AVG = approx 0.00

GAGE # 1

DATA SET ID#		Operator A			Operator B			Operator C		
		Replicate#1	Replicate#2	Replicate#3	Replicate#1	Replicate#2	Replicate#3	Replicate#1	Replicate#2	Replicate#3
29-1	Part#1	0.442	0.343	0.338	0.072	0.137	0.348	0.032	0.433	-0.126
	Part#2	-0.342	-0.076	-0.2			-0.232	-0.251	0.37	-0.032
	Part#3	-0.278	-0.246				0.121	0.074	-0.138	-0.078
	Part#4	-0.342	-0.15					-0.16	-0.162	-0.378
	Part#5	0.026						0.138	-0.044	0.151
	Part#6	0.279						0.317	0.472	-0.449
	Part#7	0.04						035	-0.079	0.367
	Part#8	-0.297							-0.336	0.139
	Part#9	0.2							0.092	-0.386
	Part#10	0							0.033	0.441

G

									licate#2	Replicate#3
29-2	Part#1								203	-0.139
	Part#2								168	-0.412
	Part#3								392	0.136
	Part#4								.05	0.378
	Part#5								.292	-0.015
	Part#6								0.385	0.408
	Part#7								0.432	0.253
	Part#8	0							-0.4	0.141
	Part#9	-0.							0.1	0.22
	Part#10	-0.46							-0.266	-0.371

GAGE # 3

		Operator A						Operator C		
		Replicate#1	Replicate					Replicate#1	Replicate#2	Replicate#3
29-3	Part#1	0.35	-0.018				.463	-0.105	0.182	-0.34
	Part#2	-0.407	0.442	0.17			-0.074	-0.09	0.201	0.399
	Part#3	0.177	-0.368	0.186	0.447	0.413	-0.148	-0.256	-0.068	0.143
	Part#4	-0.158	0.004	0.035	-0.203	0.38	0.338	-0.031	-0.348	-0.303
	Part#5	0.017	0.095	-0.337	0.244	-0.269	-0.344	-0.423	0.488	-0.266
	Part#6	-0.019	0.316	0.268	0.479	-0.018	-0.075	-0.265	0.242	-0.078
	Part#7	-0.478	0.247	0.423	-0.286	-0.291	-0.015	0.196	0.088	-0.07
	Part#8	0.235	0.049	0.225	-0.406	0.054	-0.276	-0.179	0.173	0.047
	Part#9	-0.231	-0.3	0.484	-0.473	0.474	-0.04	-0.498	-0.044	0.288
	Part#10	0.07	-0.369	0.288	0.196	0.364	0.122	0.137	0.112	-0.457

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DATA SET # 30, Randomly generated data, AVG = approx 100

DATA SET ID#		GAGE # 1								
		Operator A			Operator B			Operator C		
		Replicate#1	Replicate#2	Replicate#3	Replicate#1	Replicate#2	Replicate#3	Replicate#1	Replicate#2	Replicate#3
30-1	Part#1	101	97	102	102	96	102	96	97	95
	Part#2	97	95	97	103	[illegible]	102	104	96	97
	Part#3	101	103	97				101	100	102
	Part#4	98	97	97				104	104	100
	Part#5	99	100	[illegible]				[illegible]	99	101
	Part#6	101	100						95	99
	Part#7	100	100						101	95
	Part#8	101	[illegible]						105	101
	Part#9	102	[illegible]						[illegible]	98
	Part#10	96								100

		GAGE # 2								
		Operator A								
		Replicate#								Replicate#3
30-2	Part#1	100								105
	Part#2	99								99
	Part#3	95								96
	Part#4	100								98
	Part#5	102								99
	Part#6	99								99
	Part#7	101								102
	Part#8	98								101
	Part#9	101								102
	Part#10	100								101

		GAGE # 3								
		Operator A								
		Replicate#1	Replicate#2	Rep[illegible]				[illegible]e#1	Replicate#2	Replicate#3
30-3	Part#1	103	98	102				102	97	99
	Part#2	97	99	101				100	100	104
	Part#3	95	99	105	96	95	99	96	95	103
	Part#4	103	102	96	103	95	102	95	98	99
	Part#5	97	105	99	105	102	102	96	98	101
	Part#6	100	103	97	103	96	104	96	100	102
	Part#7	97	98	102	99	103	100	102	103	102
	Part#8	103	104	102	103	102	96	99	97	103
	Part#9	95	96	96	100	98	97	100	100	105
	Part#10	102	100	105	101	102	100	98	101	99

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DATA SET # 31, Randomly generated data, AVG = approx 100,000

GAGE # 1

DATA SET ID#		Operator A			Operator B			Operator C		
		Replicate#1	Replicate#2	Replicate#3	Replicate#1	Replicate#2	Replicate#3	Replicate#1	Replicate#2	Replicate#3
31-1	Part#1	100172	102997	96162	103791	100125	95650	103951	104893	100863
	Part#2	98925	98880	100738	100486	99456	97335	95382	104176	99174
	Part#3	95484	99803	99398	104720	96259	98823	95578	104250	99258
	Part#4	103171	102245	95436	99995	[illegible]	102192	99052	103103	100448
	Part#5	101753	103906	102759	[illegible]	[illegible]	[illegible]	102259	99307	104027
	Part#6	96890	99135	104170	[illegible]	[illegible]	[illegible]	101467	100022	96477
	Part#7	103844	104291	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]43	96117	100679
	Part#8	99697	96434	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97227	102880
	Part#9	97449	97291	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97611	102354
	Part#10	101466	964[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0329	102381

GAGE # 2

		Operator A		
		Replicate#1	[illegible]	Replicate#3
31-2	Part#1	95227	[illegible]	98152
	Part#2	103795	[illegible]	102052
	Part#3	99263	[illegible]	96723
	Part#4	95802	[illegible]	97590
	Part#5	103818	[illegible]	102850
	Part#6	104607	[illegible]	103064
	Part#7	98715	[illegible]	100717
	Part#8	99981	[illegible]	103597
	Part#9	95351	[illegible]	96232
	Part#10	96462	[illegible]	99745

GAGE # 3

		Operator A								
		Replicate#1	Replicate[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]eplicate#2	Replicate#3
31-3	Part#1	102489	101361	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103884	101581
	Part#2	104909	103997	98[illegible]	[illegible]	[illegible]	[illegible]	[illegible]687	96278	98378
	Part#3	102459	97236	99591	[illegible]	[illegible]	[illegible]	101704	104015	100127
	Part#4	100776	103144	101145	[illegible]	[illegible]	[illegible]	103477	104559	95139
	Part#5	97113	95885	103299	103472	101698	102643	104077	97722	103498
	Part#6	103121	103240	103116	99007	95867	101281	96405	96926	102541
	Part#7	97124	102724	95239	104624	95486	101016	96212	104024	99622
	Part#8	102088	102199	101271	97132	95110	103455	104324	96803	98719
	Part#9	99553	95161	101793	99700	98564	97141	102362	104955	95205
	Part#10	103421	99698	95162	96895	101179	95592	101567	96560	96080

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ATTACHMENT # 4 TO VALIDATION REPORT # ZTC-7

RESULTS OF VALIDATION TESTING, GAGE CORRELATION

INPUT						OUTPUT (= Average of Inputed Data Set)						OUTPUT (= Significant, Yes/No)					
			ID# of Gage Correlation Data Sets used as input			SAG (Statistical Analysis of Gages.Xls)			SGP (StatGraphicsPlus)			SAG (Statistical Analysis of Gages)			SGP (StatGraphicsPlus)		
N (= # of data points per gage)	Approx. Avg of data points	Alpha (=signifi-cance)	Gage #1	Gage #2	Gage #3	Gage #1	Gage #2	Gage #3	Gage #1	Gage #2	Gage #3	#2 vs. #1		#2	#2 vs. #1	#3 vs. #1	#3 vs. #2
10	-10	0.01	1	2	3	9.80	9.69	9.49	9.80	9.69	9.49				no	no	no
10	-10	0.02	1	2	3	9.80	9.69	9.49	9.80	9.69						no	no
10	-10	0.05	1	2	3	9.80	9.69	9.49	9.80	9.69						YES	no
10	-10	0.10	1	2	3	9.80	9.69	9.49	9.80	9.6							YES
10	0	0.01	4	5	6	0.0099	0.0495	0.2959	0.0099								YES
10	0	0.02	4	5	6	0.0099	0.0495	0.2959	0.0099								YES
10	0	0.05	4	5	6	0.0099	0.0495	0.2959	0.0099								YES
10	0	0.10	4	5	6	0.0099	0.0495	0.2959	0.009								ES
10	100	0.01	7	8	9	96.4	98.1	99.5	96								
10	100	0.02	7	8	9	96.4	98.1	99.5	9								
10	100	0.05	7	8	9	96.4	98.1	99.5									
10	100	0.10	7	8	9	96.4	98.1	99.5									
10	100,000	0.01	10	11	12	11104	100111	100134									
10	100,000	0.02	10	11	12	11104	100111	100134									
10	100,000	0.05	10	11	12	11104	100111	100134									
10	100,000	0.10	10	11	12	11104	100111	100134									
50	-10	0.01	13	14	15	-9.9596	-9.959	-9.9528	-								
50	-10	0.02	16	17	18	-9.9596	-9.959	-9.9528	-9								
50	-10	0.05	19	20	21	-9.9596	-9.959	-9.9528	-9.								
50	-10	0.10	22	23	24	-9.9596	-9.959	-9.9528	-9.9								S
50	0	0.01	13	14	15	0.01076	0.04532	0.11248	0.010								o
50	0	0.02	16	17	18	0.01076	0.04532	0.11248	0.01076								no
50	0	0.05	19	20	21	0.01076	0.04532	0.11248	0.01076								no
50	0	0.10	22	23	24	0.01076	0.04532	0.11248	0.01076	0.							YES
50	100	0.01	13	14	15	100.58	101.18	102.0	100.58	101.						S	no
50	100	0.02	16	17	18	100.58	101.18	102.0	100.58	101.18						YES	no
50	100	0.05	19	20	21	100.58	101.18	102.0	100.58	101.18						YES	YES
50	100	0.10	22	23	24	100.58	101.18	102.0	100.58	101.18	102.0				YES	YES	YES
50	100,000	0.01	13	14	15	100647	101662	102706	100647	101662	102706				no	YES	no
50	100,000	0.02	16	17	18	100647	101662	102706	100647	101662	102706	YES	YES	no	YES	YES	no
50	100,000	0.05	19	20	21	100647	101662	102706	100647	101662	102706	YES	YES	no	YES	YES	no
50	100,000	0.10	22	23	24	100647	101662	102706	100647	101662	102706	YES	YES	YES	YES	YES	YES

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INPUT		OUTPUT (= results of test)			
Textbook (See Protocol) & page	ID# of Gage Correlation Data Sets used as input	Textbook			
		T value	Significant?	T value	Significant?
Alder & Roesler, p. 205	25	3	yes	3	yes
Bowker & Lieberman, pp. 245 & 249	26	18.5	yes	18.5	yes
Mendenhall, pp. 495, 319, 580	27	2	yes	2	yes

ATTACHMENT # 5 TO VALIDATION REPORT # ZTC-7

DATA SETS USED IN VALIDATION OF GAGE CORRELATION

DATA SET # >>	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8	# 9	# 10	# 11	# 12
Datum # 1	-9.2	-9.1	-9.2	0.01	0.232	0.368	93	93	92	106932	106947	106930
Datum # 2	-10.1	-10.2			0.327	0.438	96	97	92	104072	104037	104059
Datum # 3	-10.2					0.592	93	97	96	97775	97795	97826
Datum # 4	-9.3					-0.102	100	102	107	101814	101818	101827
Datum # 5	-1					276	92	95	96	105812	105829	105818
Datum # 6							96	95	97	96752	96782	96811
Datum # 7							99	102	104	94397	94415	94469
Datum # 8							110	110	113	104293	104305	104344
Datum # 9							92	95	98	91249	91215	91247
Datum # 10							93	95	100	97943	97968	98006

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Data Set #

Lieberman, page 245 & 249 (alpha used = 0.05)

	51
	41
	43
	41
3	47
47	32
52	24
38	43
61	53
56	52
56	57
34	44
55	57
65	40
75	68

Data Set # 27

Mende	
0.135	
0.102	
0.098	0.112
0.141	0.162
0.131	0.135
0.144	0.163

DATA SET # >>	# 13	# 14	# 15	# 16	# 17	# 18	# 19	# 20	# 21	# 22	# 23	# 24
Datum # 1	-9.74	-9.77	-9.75	0.020	0.145	0.560	108	108	112	102420	106394	111891
Datum # 2	-10.67	-10.66	-10.64	0.017	0.043	0.295	93	95	96	100511	96591	92467
Datum # 3	-10.74	-10.77	-10.76	0.000	-0.201	0.282	98	99	101	94106	95841	101070
Datum # 4	-9.18	-9.15	-9.13	-0.005	0.237	0.412	104	101	103	96474	100242	103165
Datum # 5	-9.78	-9.79	-9.77	0.000	0.352	0.785	101	103	107	109738	107589	107922
Datum # 6	-9.2	-9.21	-9.18	-0.003	0.299	0.316	96	95	96	109331	104896	107393
Datum # 7	-10.02	-10.02	-10.02	0.021	-0.375	-0.120	104	107	110	104513	101402	104369
Datum # 8	-10.14	-10.14	-10.14	0.020	-0.209	0.042	109	110	112	99881	103083	107944
Datum # 9	-9.8	-9.81	-9.83	0.020	-0.288	0.028	106	103	102	109677	113147	108141
Datum # 10	-9.88	-9.86	-9.84	[illegible]	[illegible]	[illegible]	102	103	104	98010	102764	102781
Datum # 11	-10.31	-10.3	-10.27	[illegible]	[illegible]	[illegible]	[illegible]	94	98	99909	101948	105542
Datum # 12	-10.26	-10.24	-10.2	[illegible]	[illegible]	[illegible]	[illegible]	94	98	100233	98699	97446
Datum # 13	-9.7	-9.69	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101	97643	98425	102202
Datum # 14	-10.21	-10.22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	107	106639	107982	108971
Datum # 15	-10.08	-10.06	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	102	91310	91828	90557
Datum # 16	-9.57	-9.59	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	108	106445	111053	113538
Datum # 17	-9.99	-9.9[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	93449	94572	98379
Datum # 18	-10.29	-10[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	107518	112226	108609
Datum # 19	-9.64	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	105021	103697	105993
Datum # 20	-10.16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	95679	99364	103120
Datum # 21	-9.82	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	108267	110572	113444
Datum # 22	-9.65	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103093	105632	107211
Datum # 23	-9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101373	98226	97794
Datum # 24	-10.25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	102991	105282	107952
Datum # 25	-10.58	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	94995	97130	92714
Datum # 26	-9.95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	102399	103535	97585
Datum # 27	-9.98	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	91023	91641	93852
Datum # 28	-10.72	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	106978	106898	102554
Datum # 29	-10.08	-1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	96596	98010	92052
Datum # 30	-9.87	-9.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	108087	106190	111116
Datum # 31	-9.45	-9.46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]8	97344	100234	101594
Datum # 32	-10.44	-10.46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	93	98155	95921	93021
Datum # 33	-10.24	-10.24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	91	102433	106023	110430
Datum # 34	-10.91	-10.91	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100	90173	88156	91991
Datum # 35	-9.31	-9.33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	109	104301	105332	105847
Datum # 36	-9.25	-9.25	-9.23	[illegible]	[illegible]	[illegible]	[illegible]	102	99	101790	97322	100009
Datum # 37	-10.06	-10.06	-10.06	[illegible]	[illegible]	[illegible]	[illegible]	95	94	96347	98899	104300
Datum # 38	-9.2	-9.19	-9.17	0.019	[illegible]	[illegible]	99	102	99	99200	102700	105320
Datum # 39	-9.09	-9.11	-9.09	0.012	0.326	0.449	91	92	90	100714	98474	102424
Datum # 40	-10.95	-10.98	-10.96	0.017	-0.282	-0.709	104	104	108	95575	96931	92961
Datum # 41	-10.12	-10.12	-10.1	-0.010	-0.183	-0.133	93	95	95	102989	107201	111526
Datum # 42	-9.71	-9.7	-9.73	0.029	0.240	0.394	106	102	99	99512	102507	107914
Datum # 43	-10.46	-10.44	-10.41	0.000	-0.381	-0.425	104	107	108	105044	108574	112713
Datum # 44	-9.26	-9.25	-9.23	0.020	0.044	0.423	105	106	102	104811	109211	104713
Datum # 45	-10.62	-10.62	-10.6	0.021	0.173	0.469	99	102	105	97295	101761	97565
Datum # 46	-9.59	-9.6	-9.62	0.016	-0.066	0.043	109	112	115	100143	100122	97597
Datum # 47	-9.65	-9.64	-9.66	0.017	0.182	0.257	99	98	97	91923	88465	93129
Datum # 48	-9.86	-9.86	-9.84	0.002	0.091	0.536	106	105	108	109122	106427	109112
Datum # 49	-10.8	-10.78	-10.76	-0.006	0.258	0.351	100	103	106	91803	90922	96679
Datum # 50	-9.75	-9.75	-9.77	0.029	-0.152	-0.236	108	109	107	99346	103078	98680

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