QUALITY PROCEDURE MANUAL
Measurement System Analysis (MSA) – R & R Study

1.0 PURPOSE

The purpose of this procedure is to certify whether the measurement system is capable of detecting variations in the process. The primary focus is measurement system where the readings can be repeated on each part.

2.0 SCOPE

This procedure covers the followings:

Estimation of the capability of Measurement System with measuring instruments and gauges.
Process control instruments such as pressure gauges and temperature controllers.
Product testing machines.
Appropriate MSA studies are conducted for the above measuring instruments/ test equipments to analyze the variations present in the results. Also the above requirement shall apply to measurement system referenced in the "Control Plan".

3.0 RESPONSIBILITY

Head of Technical & QA
Head of Manufacturing
and All concerned as per the MSA responsibility matrix

4.0 REFERENCE

SIRF Quality System Manual section 4.11
Measurement System Analysis [MSA – Supplementary manual]
QSP-11-01, QSP-11-02, QSP-10-01.

5.0 RESOURCES

Competent personnel for conducting MSA studies,
MSA/ R&R Software Package.

6.0 PROCEDURE :

6.1 R&R :

6.1.1 The Repeatability and Reproducibility can be used for both variable and attribute type data

6.1.2 The variable gauge study can be performed using a number of Techniques. There are three acceptable methods are commonly used as below.

- Range Method
- Average Range method
- ANOVA method

6.1.3 In this chapter the Average range method and ANOVA method are explained in details

6.2 REPEATABILITY

Repeatability (with in appraiser) is the variation in measurement obtained with one measurement instrument when used several times by one appraiser while measuring the identical characteristics on the same part. It is commonly referred as equipment variation (EV).

6.3 REPRODUCIBILITY

Reproducibility (between appraisers) is the variation in the average of the measurement made by different appraisers using the same measuring instrument when measuring the identical characteristics on the same part.

6.4 GAUGE R&R STUDY STEPS

6.4.1 Select the instrument based on respective control plan and frequency chart.

6.4.2 Select two or three appraisers who use the measurement system.

6.4.3 Obtain a sample of 10 parts that represent actual or expected range of process variation.

6.4.4 Number parts 1 through 10 so that numbers are not visible to appraisers.

6.4.5 Identify and Mark the place where measurement to be taken to eliminate within part variation also ensure the measuring instrument / equipment calibration, before continue the study.

6.4.6 Measure 10 parts in random order by appraiser A, with an observer recording results.

6.4.7 Repeat the above step with other appraisers conceals other appraiser readings using a different random order of measurement.

6.4.8 Compute the data and calculate the repeatability (Equipment Variation - EV), Reproducibility (Appraiser Variation – AV), GR&R, Part Variation (PV), Total Variation (TV) and convert to percentage.

6.5 ACCEPTANCE CRITERIA

ACCEPTABLE	%R&R < 10% Of total variation
Concessionally acceptable based on cost of repair	%R&R -- 10% to 30% of total variation
NOT ACCEPTABLE	%R&R > 30% of Total variation

6.5.1 Some of the cause are listed below for **When repeatability is large compared to reproducibility,**

- Instrument needs maintenance
- Redesign gauge for more rigidity
- Improve clamping or location of gauging
- Excessive within-part variation

6.5.2 Draw X bar chart

Acceptance criteria: More than 50% of readings should lie outside Control Limit

Interpretation: Measurement system is adequate enough to capture process variation.

6.5.3 Draw R chart

Acceptance criteria: All Points must be within UCL

Interpretation:

If one appraisers one or more than one is outside UCL:
That appraiser method is different from others.

If all appraisers one or more than one is outside UCL:
That Measurement system is Sensitive to Appraisers skill.

6.5.4 Some of the cause are listed below for **When reproducibility is large compared to repeatability**

- Appraisers need better gauge use training
- Need better operational definition
- Incremental divisions on instrument are not readable
- Need fixture to provide consistency in gauge use.

Similarly, draw Error Chart, X-Y Plot, etc.,

6.6 Attribute Gage Study (Alternate) Method

FALSE ALARM : REJECTING A GOOD PART
MISS : ACCEPTING A BAD PART

Probability of false alarm = (FA)	No. of false alarm / Opportunity for making false alarm

Probability of MISS =	No. of MISS / Opportunity for making a MISS

TABLE: 01

Sample Size for Inspection Capability Studies		
No. of Appraisers	Minimum No. of Parts	Minimum No. of Trails
1	24	5
2	18	4
3 or 4	12	3

TABLE: 02

Special Cases in Computing BIAS			
P(FA)	P(Miss)	B	Decision or Action
0	More than 0	0	Unacceptable.
More than 0	0	No Value	Use E, P(FA) and P(Miss) directly.
0	0	No Value	This is same as B=1 since P(FA)=P(Miss) Acceptable
More than 0.5	0.5 or Less	More than 1.5	Unacceptable.
0.5 or Less	More than 0.5	Less than 0.5	Unacceptable.
More than 0.5	More than 0.5	No Value	Bias unimportant study is unacceptable based on P(Miss) and P(FA) being more than 0.5.

Bias Factor Table for Inspection Capability Studies Involving Attribute Data

TABLE: 03

P(FA) or P(Miss)	B(FA) or B(Miss)	P(FA) or P(Miss)	B(FA) or B(Miss)	P(FA) or P(Miss)	B(FA) or B(Miss)	P(FA) or P(Miss)	B(FA) or B(Miss)
0.01	0.0264	0.14	0.2227	0.27	0.3312	0.40	0.3867
0.02	0.0488	0.15	0.2323	0.28	0.3372	0.41	0.3885
0.03	0.0681	0.16	0.2444	0.29	0.3429	0.42	0.3910
0.04	0.0863	0.17	0.2541	0.30	0.3485	0.43	0.3925
0.05	0.1040	0.18	0.2613	0.31	0.3538	0.44	0.3945
0.06	0.1200	0.19	0.2709	0.32	0.3572	0.45	0.3961
0.07	0.1334	0.20	0.2803	0.33	0.3621	0.46	0.3970
0.08	0.1497	0.21	0.2874	0.34	0.3668	0.47	0.3977

0.09	0.1626	0.22	0.2966	0.35	0.3712	0.48	0.3984
0.10	0.1758	0.23	0.3034	0.36	0.3739	0.49	0.3989
0.11	0.1872	0.24	0.3101	0.37	0.3778	0.50	0.3989
0.12	0.1989	0.25	0.3187	0.38	0.3814		
0.13	0.2107	0.26	0.3251	0.39	0.3836		

TABLE : 04

Evaluation Criteria for Inspection Capability Studies involving Attribute Data

Parameter	Acceptable	Marginal	Unacceptable
E	0.9 or More	0.8 to 0.9	Less than 0.8
P(FA)	0.05 or Less	0.05 to 0.1	More than 0.1
P(Miss)	0.02 or Less	0.02 to 0.05	More than 0.05
B	0.8 to 1.2	0.5 to 0.8 or 1.2 to 1.5	Less than 0.5 or More than 1.5

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A SAMPLE DATA COLLECTION SHEET FOR ATTRIBUTE R & R

Date : Conducted By:
Parameters : Part No. :
Guage No. : Gage Type :

Sl. No.	APPRAISER 1			APPRAISER 2			APPRAISER 3			MASTER STATUS
	TRIALS			TRIALS			TRIALS			
	1	2	3	1	2	3	1	2	3	

□ MISS (accepting a bad part)

B – Bad
G – Good

◯ - FALSE ALARM (rejecting a good part)

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A SAMPLE DATA COLLECTION SHEET FOR ATTRIBUTE R & R

Date :
Parameters :
Guage No. :

Conducted By :
Part No. :
Guage Type :

Sl.No	PARAMETERS	APPRAISER		
		1	2	3
1	TOTAL NO. OF SAMPLES (N)			
2	NO. OF TRIALS (n)			
3	NO. OF GOOD SAMPLES (N_G)			
4	NO. OF BAD SAMPLES (N_B)			
5	NO. OF MISS (N_M)			
6	NO. OF FALSE ALARM (N_{FA})			
7	NO. OF GOOD DECISION (N_{GD})			
8	PROBABILITY OF MISS $[p(m)] = \frac{N_m}{N_B \times n}$			
9	PROBABILITY OF P (FA) FALSE ALARM $= \frac{N_{FA}}{N_G \times n}$			
10	EFFECTIVENESS (E) $= \frac{N_{GD}}{N \times n}$			
11	* B (MISS)			
12	* B (FALSE ALARM)			
13	BIAS FACTOR $= \frac{B\ (FALSE\ ALARM)}{B\ (MISS)}$			
14	* CONCLUSION			

* Refer Table