Statistical Process Control Implementation and Reporting

1.0 Purpose - To define the areas requiring statistical process control (SPC) implementation and the resulting data parameters that trigger action.

2.0 Scope - The scope of this work instruction is to list, document, and reference the procedure for defining the production areas that require SPC, the interval in which SPC data is reviewed, and the resulting quality response to the interpretation of SPC data.

3.0 References

- Requirements for SPC http://www.verizonnebs.com/TPRs/VZ-TPR-9404.pdf

4.0 Definitions

- **SPC** –Statistical Process Control. A method of quality control using statistical methods. Used to monitor and control manufacturing processes.

5.0 Responsibility - The manager of Quality Assurance is responsible for maintaining this instruction.

6.0 Procedure

6.1 **Statistical Process Control Areas & Type**

6.1.1 List Procedural Requirements Statistical Process Control (SPC) shall be implemented at critical steps in the fiber optic assembly production process as indicated by all in-process inspection areas. These areas are deemed critical as they all are areas in which in-process quality feedback allows for tight controls over production yields and efficiencies.

6.1.2 The following areas are subject to <u>attribute data</u> (first pass percentage yield) statistical process control with data collection EVERY day for 100% of all FIBER LINE 1.X(all) terminations regardless of type and/ or volume:

- Load Parts Inspection
- Connect Inspection
- Cleave Inspection
- Scope Inspection
- EFG Inspection
- Loss Testing

6.1.3 In addition, the following areas are subject to variable data (actual measured value) statistical process control with data recorded EVERY day for 100% of FIBER LINE 1.X SCU and LCU single mode connectors:

- EFG Inspection (Radius, Height, & Apex Offset)
- Loss testing – Return Loss
- Loss Testing – Insertion Loss
- Connector Volume (per type)

6.2 **Data Recording, Collection, and Reporting**

6.2.1 SPC data shall be recorded daily by the production operators on designated P-charts and collected at the end of each day by production group leader. The data shall be loaded into the appropriate SPC data logs (located in S:\FIBER\FIBER_GROUP\SPC_Data) for Quality Assurance review and manipulation into control charts distributed for Management Review and Quality Data Summaries.

6.2.2 The group leader shall load the daily totals for Automated Fiber Stripper uses and total number of production JOB's for the previous day into the CONNECT SPC data log file. The strip total is located via LCD display after selecting total. After recording, the total shall be zeroed each day.

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6.2.3 Quality or Engineering shall generate SPC charts for Management Review Meetings and Quality Data Summaries. The following are instructions on how to generate the graphs for these meetings:

### *FOTS – Insertion Loss & Return Loss (SCU & LCU only)*

1. Open Data_Reporting_Utility Workbook (Excel).
2. Click FOTS GEN.
3. Generate report for S/N's shown below for the 1st-15th
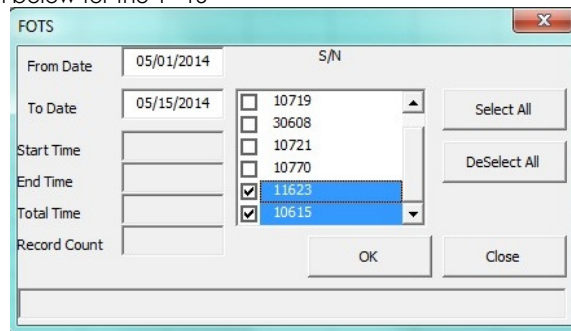
4. Click close.
5. Select "COMBINED AVERAGES" tab & COPY tab to new workbook.

| 42 | 6/19/2014 | SCU | 0.1 | 58.6 | 0.09 | 59.87 | 10721,10615,10719,11623 |
| 43 | 6/20/2014 | SCU | 0.09 | 58.14 | 0.08 | 59.29 | 10721,10719,11623,10615 |

◄ ◄ ► ►I \ Generate / Raw Data / All Data ASide / All Data BSide / Average / **Combined Averages** / DAISI Raw Data /

6. Create a folder for the month you're running the data for in S:\FIBER\FIBER_GROUP\SPC_Data\SPC_Data_Reporting
7. Name new workbook for current Month & Data Type, i.e. Loss_Data_May_2014 and save to the folder you created in previous step.
8. Go back to Data_Reporting_Utility and RE-RUN the report for S/N's shown below for the 16th-30/31st.
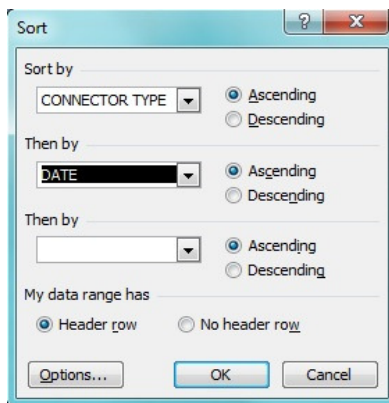
CUSTOMCABLE
AN MFLIGHTWAVE COMPANY
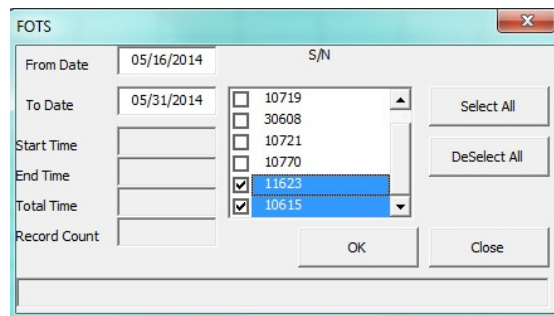
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9. "CUT" all data rows and paste into the created Loss_Data file from step 6.

10. Sort file as shown:

11. Delete all rows from file that are NOT SCU or LCU records.
12. Go to last months Loss Data and Save As this month's. Paste in this month's data and update the source data of the graphs.
13. Add columns for MAX Insertion Loss and MAX Return Loss as shown:

	A	B	C	D	E	F	G	H	I	J
1	DATE	CONNECTOR TYPE	IL@1310	IL@1550	IR@1310	IR@1550	S/N		IL MAX	RL MAX
2	5/1/2014	LCU	0.09	58.72	0.08	59.84	11623,10615		0.2	55
3	5/1/2014	LCU	0.1	58.79	0.1	60	11623,10615		0.2	55
4	5/2/2014	LCU	0.08	59.24	0.07	60.11	11623,10615		0.2	55

14. Create IL & RL tables per connector type for each parameter/ wavelength by date (see previous examples)
15. Insert graphs into presentation media.
16. Complete.

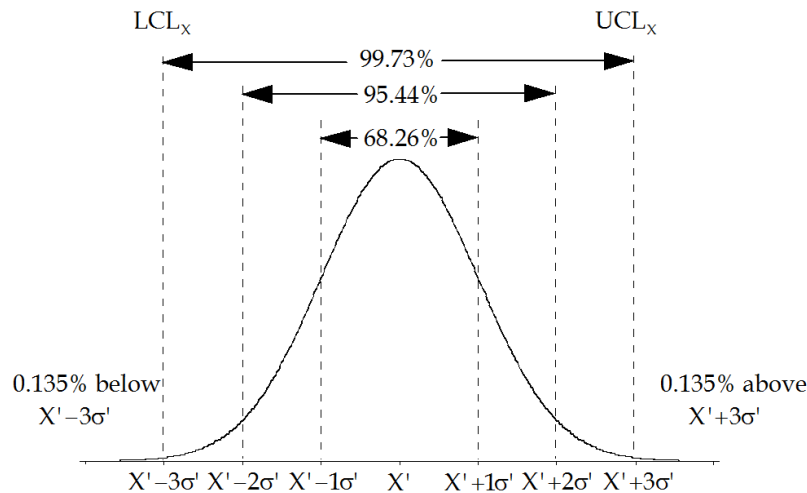## Statistical Process Control Implementation and Reporting

6.3 **Control Limits**

6.3.1 Both attribute data and variable data control charts shall include both upper and lower control limits equal to three (3) standard deviations (Sigma) from the average.

$$UCL_Y = \overline{Y} + 3\sigma_Y$$
$$\overline{Y}$$
$$LCL_Y = \overline{Y} - 3\sigma_Y$$
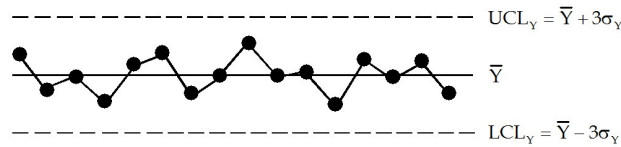
6.3.2 The three sigma limit is used as it represents a balance between the costs of looking for special cause variations when they are not present and the costs of NOT analyzing them when they are present. Common cause variation (less than 3 Sigma) is typical process variation and does not represent an indication of process change or error.

6.3.3 As shown below ~ 93.73% of all points (common cause variation) fall within three Sigma of the average if the process is in statistical control.

LCL_X UCL_X

99.73%

95.44%

68.26%

0.135% below $X'-3\sigma'$ 0.135% above $X'+3\sigma'$

$X'-3\sigma'$ $X'-2\sigma'$ $X'-1\sigma'$ X' $X'+1\sigma'$ $X'+2\sigma'$ $X'+3\sigma'$

6.4 **Control Chart Interpretation**

6.4.1 The SPC control chart shall indicate if the process is stable (in-control) with no points outside the control limits or any other tests for control present;

UCL

Avg

LCL
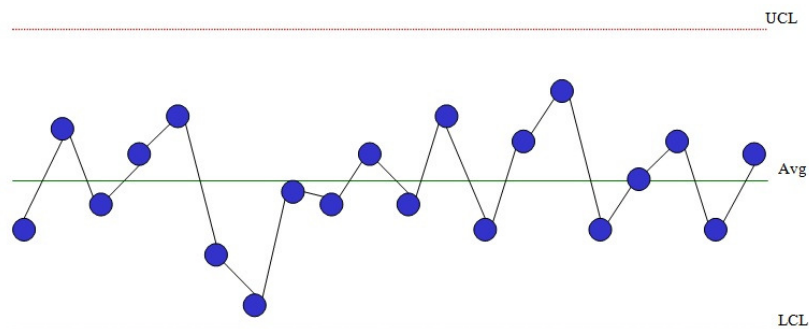
6.5 **Control Chart Frequency & Distribution**

6.5.1 All attribute data control charts shall be reviewed and compiled by Quality Control at an interval of 1 week and distributed to all members of the Leadership via email at the same 1 week interval.

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6.5.2 All variables data control charts shall be reviewed and compiled by Quality Control at an interval of 1 week and distributed to all members of the leadership team via email at the same 1 week interval. In addition, cumulative data shall be recorded and complied on an ongoing basis of 1 quarter minimum for variables data.

6.5.3 The SPC data reports shall be also archived in the following folder and reviewed at bi-weekly management meetings (QA-1136) to address previous actions to mitigate (previously) reported problems.

S:\FIBER\FIBER_GROUP\SPC_Data\SPC_Data_Reporting

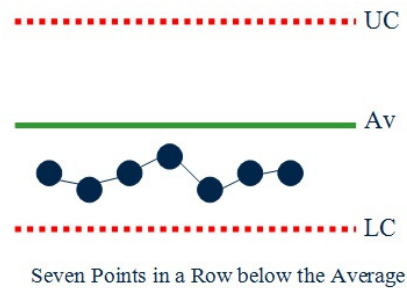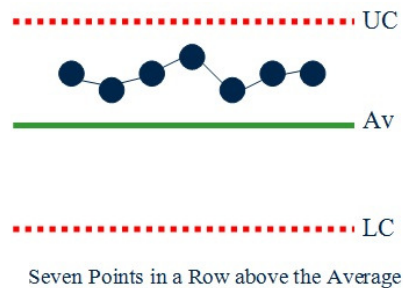## 6.6   **Tests for Control**

6.6.1   Points beyond the Control Limit test

6.6.1.1   If any point on an attribute data or variable data control chart is out of the upper or lower limit control line, a special cause variation is likely present and a formal RCA shall be initiated by Quality Assurance.
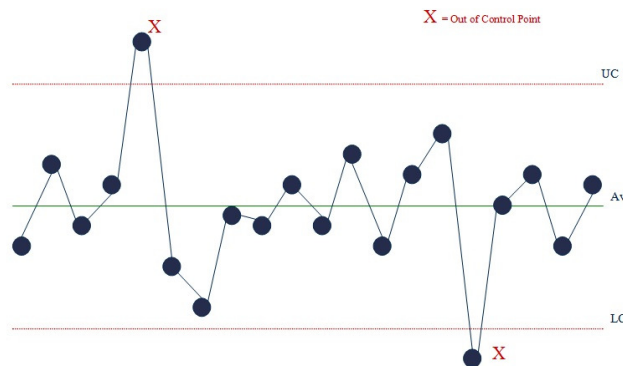
6.6.2   Rule of Sevens Test

6.6.2.1   If any string of data on an attribute data or a variables data control chart includes seven data points in any of the below scenarios, a special cause variation is likely present and a formal RCA shall be initiated by Quality Assurance.


Seven Points in a Row above the Average

Seven Points in a Row below the Average

Seven Points in a Row Trending Down

Seven Points in a Row Trending Up

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6.6.3   Number of "Runs" Test

6.6.3.1   If any string of data on an attribute data or a variables data control chart includes evidence of too little/ too much cycling, a special cause variation is likely present and a formal RCA shall be initiated by Quality Assurance.

6.6.3.2   The number of runs = the number of times the average line is crossed plus 1. If the number of runs is smaller than the special critical value or larger than the large critical value, there is special cause variation.

Total Number of Points on Chart	Expected Number of Runs	Small Critical Value	Large Critical Value
10 - 11	5	2	9
12 - 13	6	2	11
14 - 15	7	3	12
16 - 17	8	4	13
18 - 19	9	4	15
20 - 21	10	5	16
22 - 23	11	6	17
24 - 25	12	7	18
26 - 27	13	7	20
28 - 29	14	8	21
30 - 31	15	9	22

Example: There are 20 points below. The expected number of runs is 10. There are 4 runs on this chart. The small critical value is 5. Since 4 is less than this critical value, there is likely special cause variation. The average is not crossed often enough and the process is cycling.
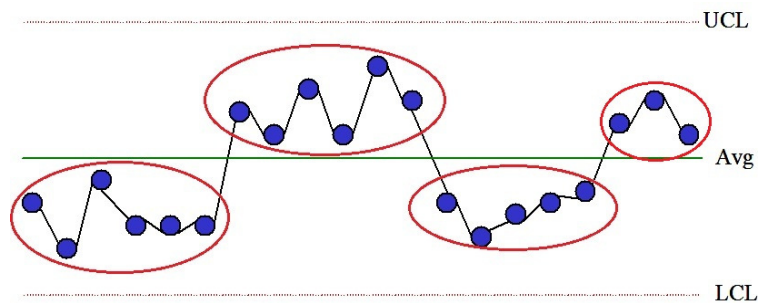
Example: The average line is crossed 17 times. The number of runs on this chart is then 17 + 1 = 18. For 20 points, the large critical value is 16. Since the number of runs is larger than this critical value, there is special cause variation.
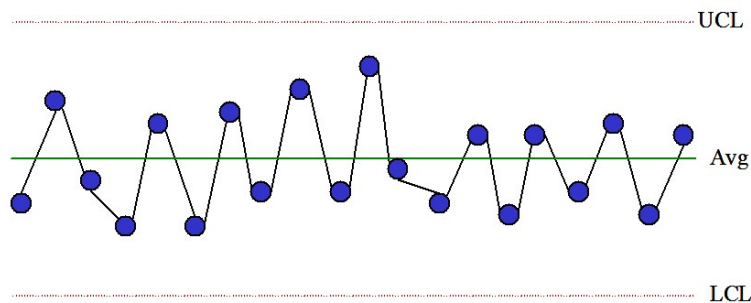
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6.6.4   Control Chart Analysis

6.6.4.1   Upon discovery of "out of control" conditions on reviewed control charts, Quality Assurance shall initiate root cause analysis to be conducted by production management/ engineering.

6.6.4.2   Analysis shall include RCA documentation (QA-1121) and/ or any other information/ rationale related to the analysis and   archive in the following folder:

S:\FIBER\FIBER_GROUP\SPC_Data\SPC_Data_Analysis

6.6.4.3   Corrective Action shall be initiated by Quality Assurance upon review of production management/ engineering analysis as to the root cause of the special cause variation seen in the control charts reviewed as part of the analysis

7.0 RECORDS

- ENG-1011 P-Chart Connect
- ENG-1012 P-Chart EFG Testing
- ENG-1013 P-Chart Load Parts Inspection
- ENG-1014 P-Chart Loss Testing
- ENG-1015 P-Chart Scope Inspection