*Six Sigma

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                                              .1974/1973   1973/1972
                                                   1991

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<u>**Six Sigma   .2**</u>

Total Quality Management

(Sigma Six)   .**(Harry,2000:33)** .

(6σ)   .   Motorola
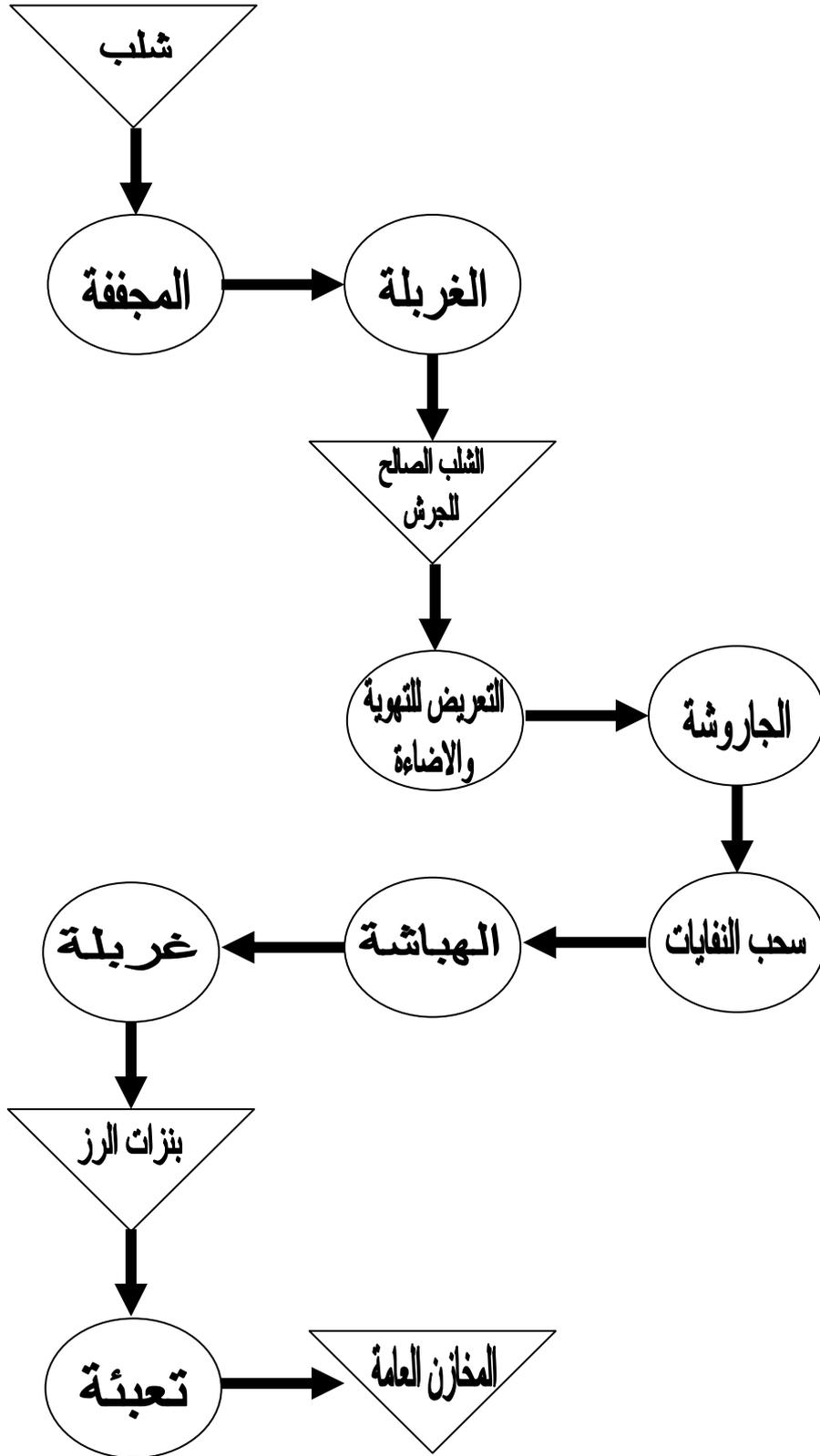
(   )   Motorola

(- SO GOOD-   )

WWW.) .

(Westgard. Com

(6σ)

Improving   Measuring   Controlling

.**(Maguire,1999:32)**   (   )

(6σ)   (6σ)

(Breyfogle,1999:1) .

.**(Maguire,1999:32)**

```
                    ┌─────────┐
                     ╲  شلب  ╱
                      ╲─────╱
                        │
                        ▼
               ╭─────────╮        ╭─────────╮
               │ المجففة │ ────→  │ الغربلة │
               ╰─────────╯        ╰─────────╯
                                       │
                                       ▼
                              ┌──────────────┐
                               ╲ الشلب الصالح ╱
                                ╲  للجرش    ╱
                                 ╲────────╱
                                     │
                                     ▼
               ╭──────────────╮        ╭──────────╮
               │ التعريض للتهوية│ ────→ │ الجاروشة │
               │   والاضاءة    │        ╰──────────╯
               ╰──────────────╯              │
                                             ▼
   ╭─────────╮     ╭──────────╮       ╭────────────╮
   │ غربلة  │ ←──  │ الهباشة │ ←──── │ سحب النفايات │
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        │
        ▼
   ┌──────────┐
    ╲ بنزات الرز ╱
     ╲────────╱
        │
        ▼
   ╭─────────╮       ┌──────────────┐
   │ تعبئة  │ ────→  ╲ المخازن العامة ╱
   ╰─────────╯        ╲────────────╱
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- (6σ) **SIGMA CONCEPT**

SIGMA (Six

.Sigma-Making Customer fell quality.htm)

Σ

.(www.aluenet.com)

Six Sigma (3.4)

Six Sigma .(Maguire, 1999: 32)

.(Stinikov, 2002: 3)

: -(Wary & Hogan, 2002: 3)

◄ .

◄ : -

◄ (Re-engineering) .

◄ -Preventing Problems- .

◄ -Delighting- .

◄ .

◄ (Black Belts) ( ) (Change)

experts (Greer Belts) ( ) (Change Supporters).

◄

(www.aluenet.com).

◄ : - (www.Pivotalresources.com)

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● ( )

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(6σ)

(www.juran.com).

(6σ)

(6σ) Management by)

Facts)

(6σ)

(6σ)

(Google: six sigma glosary) -:

◄

Opportunity   (3.4)

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.**(Hahn et al., 2001:6)**

Incarnation   ◄

.**(www.aluenet.com)**

(6σ)   -: **(www.pivotalresources.com)**

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◄

◄

◄

(2)

.[f(x)   ]   (Y)   (X)

Six Sigma   -:**(Google:Quality System & Tools-Six Sigma)**

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◄

◄

◄

Six Sigma

(Westgard, 2002:1) .

$$Y = f(X_1 , X_2 , X_3 ......)$$

(2)   (6σ)   .

Source:- (www.Pivotalresources.com).

.

(3)   .   (6σ).

(3)   (6σ)
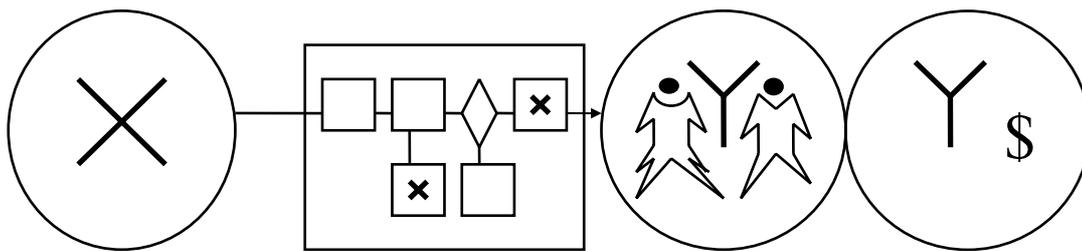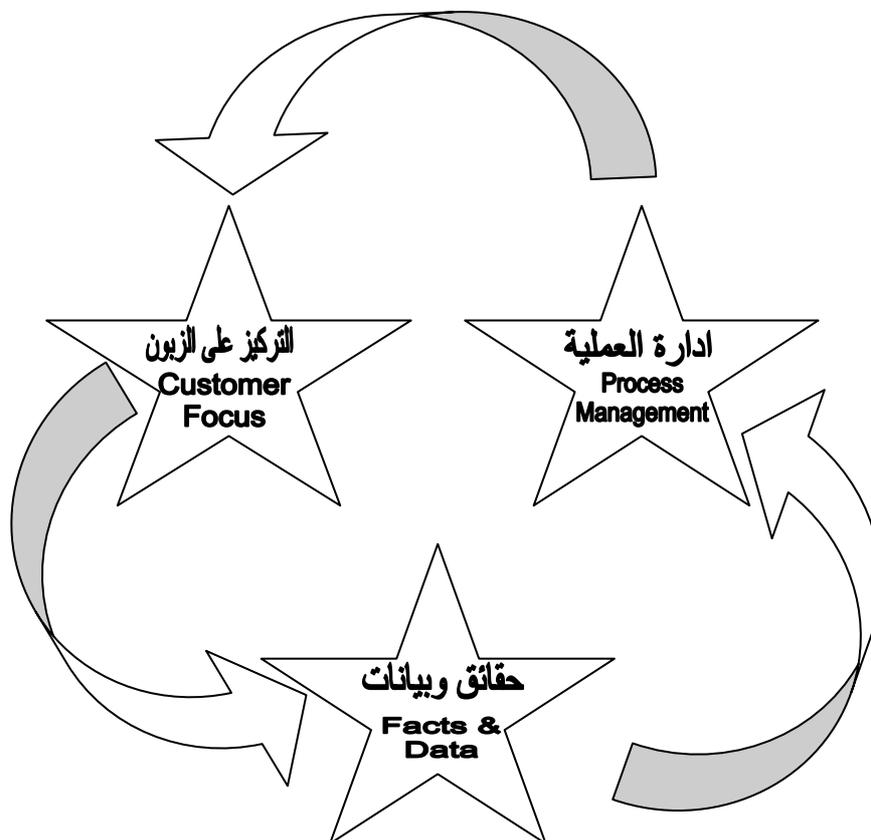
Source: Pande, Pete.,"Using Six Sigma to Improvement the Supply Chain", Pivotal Resources, USA,2002:4.

-   Six Sigma Philosophy (6σ)

Six Sigma

‐ ‐

Google: Sixsigma-Making Customer Feel Quality) -Zero Defect-

(6σ)

(www.aluenet.com) Six Sigma .

(Wary & Hogan, 2002:4)

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(6σ)

(4) (6σ)

$:(6\sigma)$

6σ

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6σ

(6σ) (4)
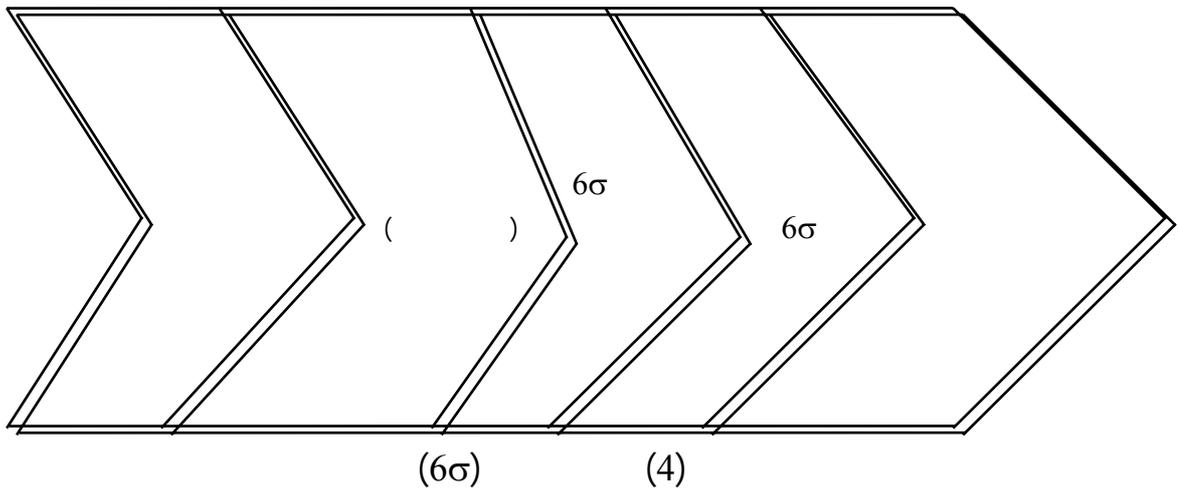
Source: Wary, Bruce & Hogan, Bob "Why Securities Operation" Bank of America, USA, 2002:20.

(6σ) **: -(www.aluenet.com)**

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- **Application Scope**

(6σ)

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- - -: Design for-
Productability ( )

- -:

-:

-: Simulation.
-: Short Cycle Manufacturing.
-: Standardization .
-: Statistical Process Control (SPC).
-: Paricipative Management Practices.
-: Design of Experiment (DOE).
-: Failure Mode and Effect Analysis (FMEA).
( )

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- (6σ) **Six Sigma Importanat**
(6σ) -:

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◄ .
◄ .

(5) (6σ) (Traditional)
( )
(Less Obvious) -:

◄ .
◄ .
◄ Installation- .
◄ .
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( )
obvious

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%25-20
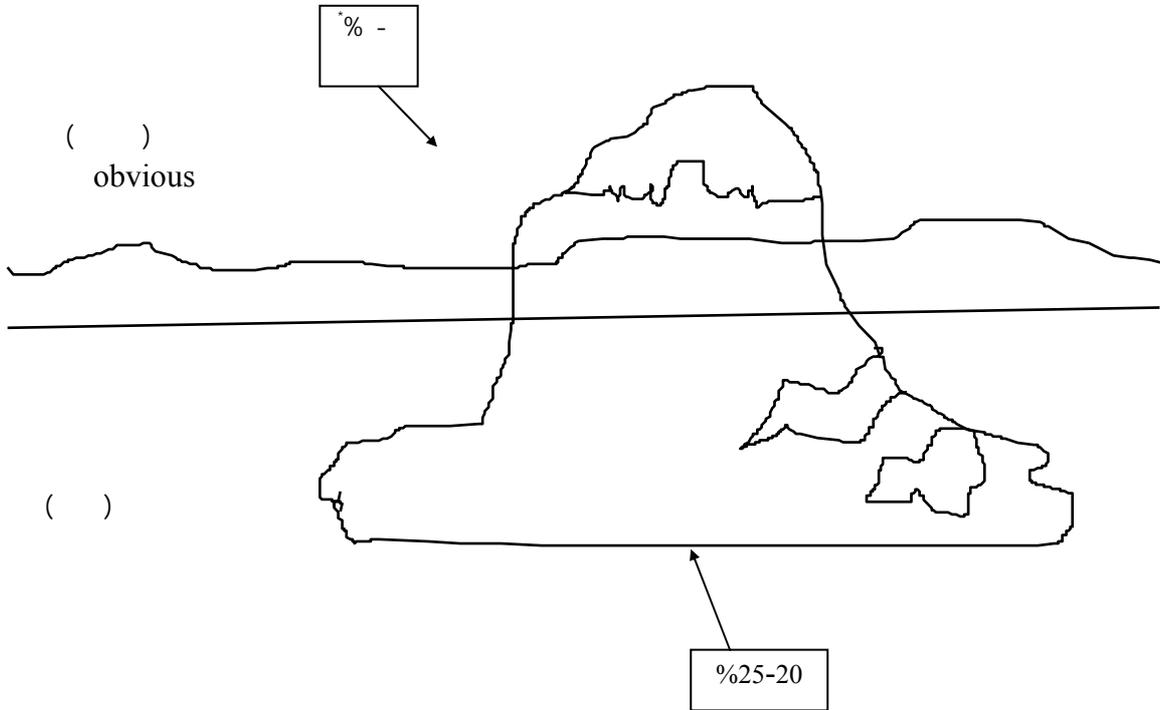
Loss Obvious

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(6σ)   (5)

Source: Wary, Bruce & Hogan, Bob. "Why six sigma in a securities operation" Bank of America, USA, 2002:17.

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(σ)   (1)

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-: (σ)

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Defect Per Million (DPM) ◄ .

YIELD ◄ .

(1)   (6σ)

Sigma Level 6σ	DPM	Yield
2	308.538	69%
3	66.807	93%
4	6.210	99.4%
5	233	99.97%
6	3.4	99.9996549%

Source: Wary, Bruce & Hogan, Bob. "Why Six Sigma in A Securities Operation". Bank of America, USA, 2002: 9.

(2)   (6σ) (3σ).

( )   (6σ) (3σ)

(6σ)	(3σ)
.	54000 .
3 100 .	40500 .
(16) .	.
35 .	54000 .

Source: Wary, Bruce & Hogan, Bob. "Why Six Sigma in A Securities Operation" Bank of America, USA, 2002: 22.

(6)   (6σ)

-          (6σ) **Six Sigma Stages**

(6σ)   -: **(www.uist.gov: 43)**

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○   .

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○   .

○

6σ
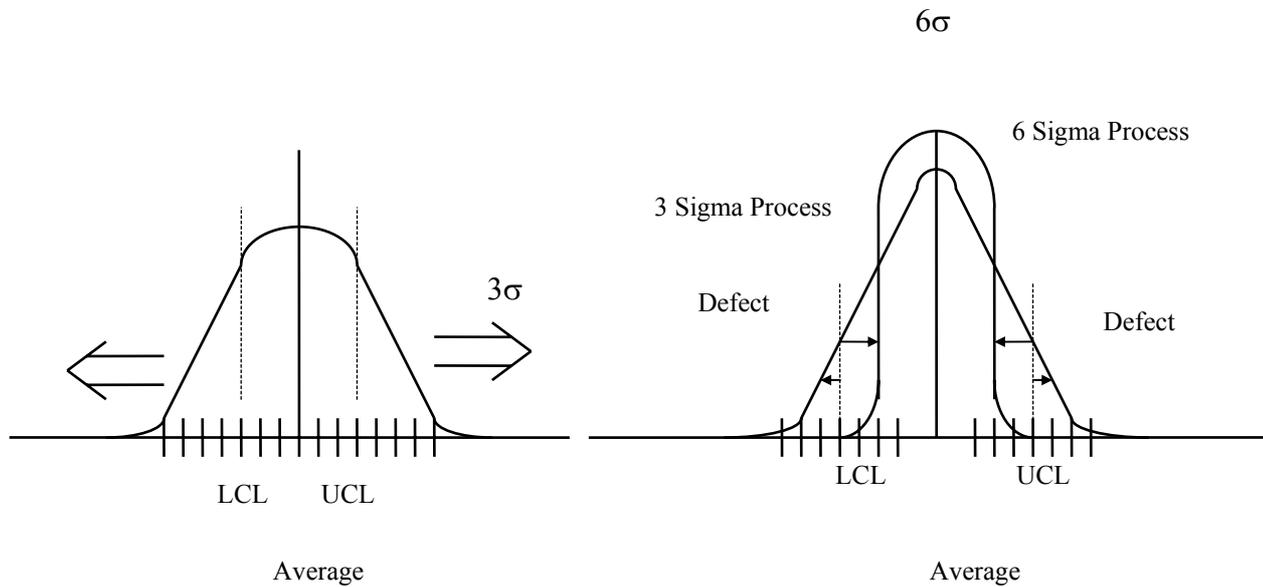
3 Sigma Process

6 Sigma Process

3σ

Defect

Defect

LCL   UCL

LCL   UCL

Average

Average

(6)   (3σ, 6σ)   (6σ) .

Source: Wary, Bruce & Hogan, Bob. "Why Six Sigma in A securities Operation". Bank of America, USA, 2002: 8.

(6σ)

(6σ)

(7)   -:

المرحلة الاولى: مرحلة التحديد Define Phase

: **(Wary & Hogan, 2002:22)**

◄   (6σ) .

◄   (Pain) .

◄   (3-4) .

◄   .

◄   .

المرحلة الثانية: مرحلة القياس Measure Phase

(2002:144).

: (www.aluenet.com)

-:   "Characteristic Critical to Quality"(CTQ)

-:   .

-:   Validate   .

-:   (Wary &

Hogan, 2002: 23)

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المرحلة الثالثة: مرحلة التحليل Analyze Phase

(2002 :146).

-: (www.aluenet.com)

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-                    .

-

(Wary & Hogan, 2002:23).

المرحلة الرابعة: مرحلة التحسين Improve Phase

-: (www.aluenet.com)

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-                .

-                .

(2002: 146)
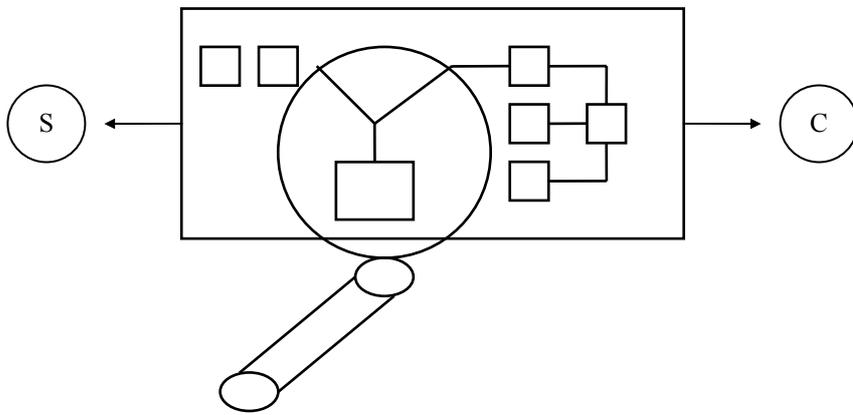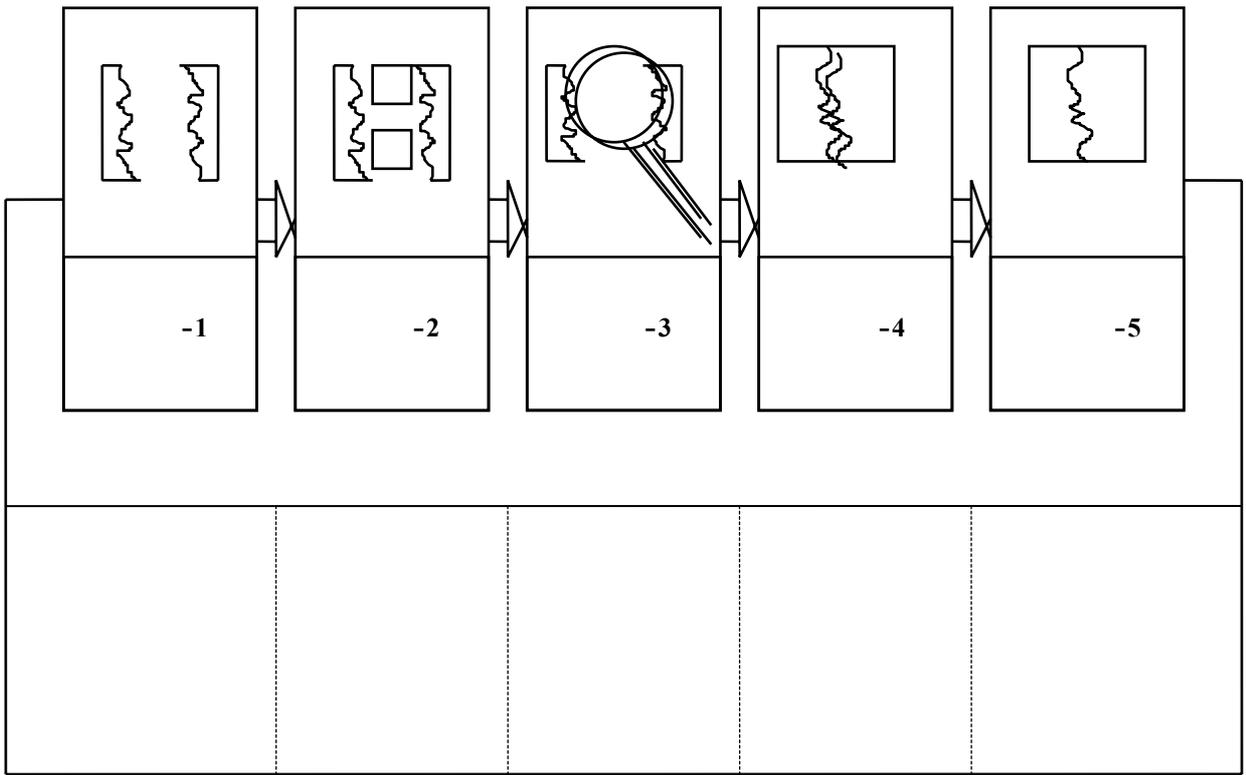
(6σ)   (7)

Source:- (www.Pivotalresources.com)

( )

(Wary & Hogan, 2002:24)

✍ .

✍ .

المرحلة الخامسة: مرحلة السيطرة Control Phase

(**2002: 147**) .

-: (**www.aluenet.com**)

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- **Implementation Strategy**

(6σ) (3)

-: (**www.aluenet.com**)

أولا"- منظمة (6σ) Six Sigma Organization

(6σ)

(6σ)

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ثانيا"- منظمة هندسة (6σ) Six Sigma Engineering Organization

(6σ)

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ثالثا"- اختيار المجال الاستراتيجي The Strategic Field Choice

(6σ)

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(3)

.(6σ)

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(**)**:

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(%6)

.(%12)

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(%0.1) .(%0)

(Burr,1996:51-57) :

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- . (6σ)

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(10) (5)

(4)

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(8).

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$$\bar{R} = \frac{\sum R}{n} = \frac{20}{10} = 2$$

$$\bar{\bar{X}} = \frac{\sum \bar{X}}{n} = \frac{98.4}{10} = 9.84$$

$$UCL = \bar{\bar{X}} + A_2 \cdot \bar{R} = 9.84 + 0.577 \times 2 = 10.99$$

$$CL = \bar{\bar{X}} = 9.84$$

$$LCL = \bar{\bar{X}} - A_2 \cdot \bar{R} = 9.84 - 0.577 \times 2 = 8.69$$

(4)

	X_1	X_2	X_3	X_4	X_5	$\overline{X}$	R	S
1	11	12	11	11	12	**11.4**	**1**	**0.548**
2	9	11	12	10	9	**10.2**	**3**	**1.304**
3	8	9	9	9	8	**8.6**	**1**	**0.548**
4	8	9	10	9	9	**9**	**2**	**0.707**
5	10	11	9	9	9	**9.6**	**2**	**0.894**
6	10	12	12	11	10	**11**	**2**	**1**
7	12	11	11	12	11	**11.4**	**1**	**0.548**
8	11	12	10	9	9	**10.2**	**3**	**1.304**
9	8	7	9	9	9	**8.4**	**2**	**0.894**
10	7	8	9	9	10	**8.6**	**3**	**1.140**
						98.4	**20**	**8.887**

$2.3 = (8.69\text{-}10.99)$ $(\%38)^{*}.$

.   **(8).**

$$UCL = \overline{R} \cdot D_4 = 2 \times 2.115 = 4.23$$

$$CL = \overline{R} = 2$$

$$LCL = \overline{R} \cdot D_3 = 2 \times 0 = 0$$

(8)   .

.   **(9)**

$$UCL = \overline{\overline{X}} + A_3 \overline{S} = 9.84 + 1.427(0.89) = 11.11$$

$$CL = \overline{\overline{X}} = 9.84$$

$$LCL = \overline{\overline{X}} - A_3 \overline{S} = 9.84 - 1.427(0.89) = 8.57$$

$2.54 = (8.57\text{-}11.11)$ $.(\%42).$

(8)

.(9)   .
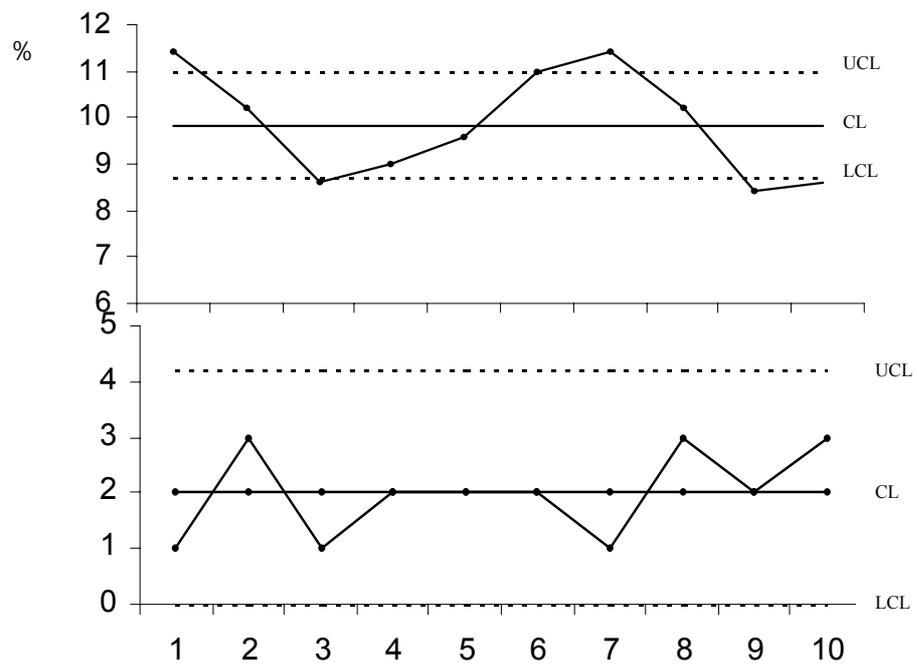
$$UCL = \overline{\overline{X}} + A_3\overline{S} = 9.84 + 1.427(0.89) = 11.11$$
$$CL = \overline{\overline{X}} = 9.84$$
$$LCL = \overline{\overline{X}} - A_3\overline{S} = 9.84 - 1.427(0.89) = 8.57$$
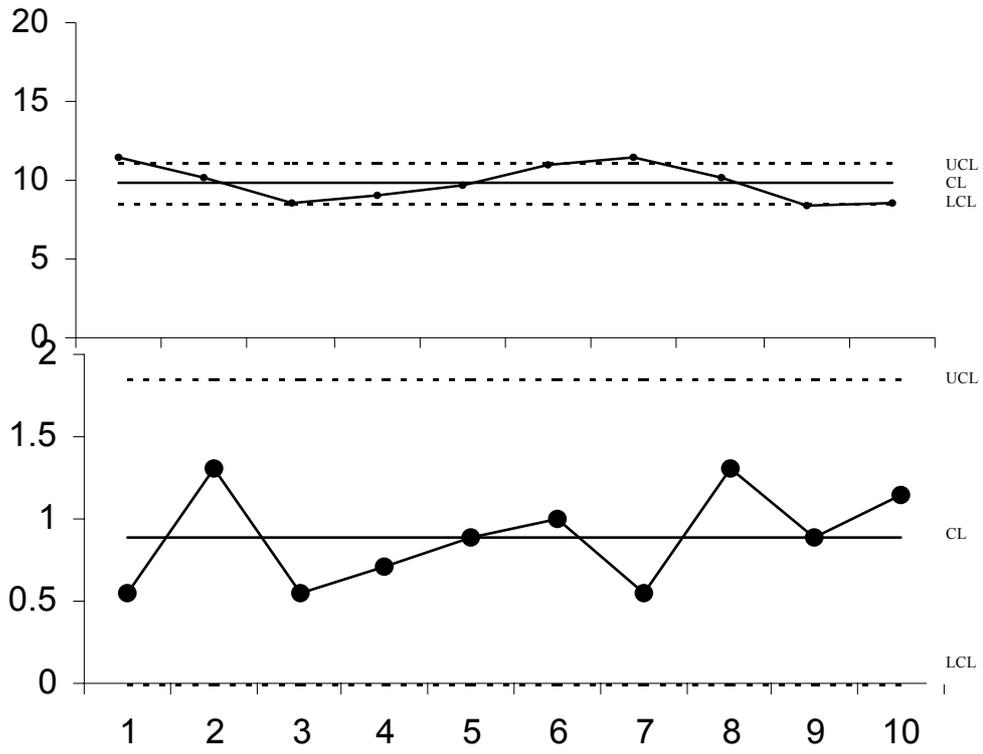
(9)

(5)

2	7.5	-7
5	8.5	-8
18	9.5	-9
7	10.5	-10
10	11.5	-11
8	12.5	13-12
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(5)

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.(6) (P)

(9)
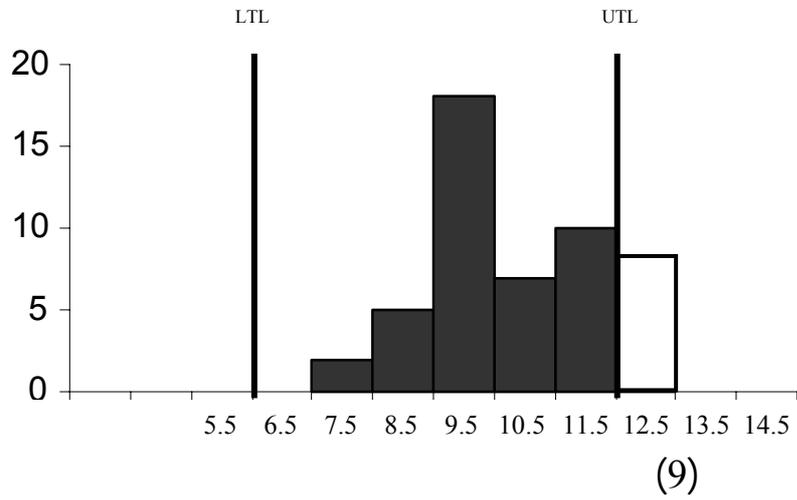
(6)

P	j	J		
100/50 (1.5-0.5) = 2	1.5	2-1	**2**	7.5
100/50 (5-0.5) = 9	5	7-3	**5**	8.5
100/50 (16.5-0.5) = 32	16.5	25-8	**18**	9.5
100/50 (29-0.5) = 57	29	32-26	**7**	10.5
100/50 (37.5-0.5) = 74	37.5	42-33	**10**	11.5
100/50 (46.5-0.5) = 92	46.5	50-43	**8**	12.5

.   **(6σ)**   .

$$UCL = \overline{\overline{X}} + \frac{6}{\sqrt{5}}\overline{S} = 9.84 + 2.68(0.89) = 12.23$$

$$CL = \overline{\overline{X}} = 9.84$$

$$LCL = \overline{\overline{X}} - \frac{6}{\sqrt{5}}\overline{S} = 9.84 - 2.68(0.89) = 7.46$$
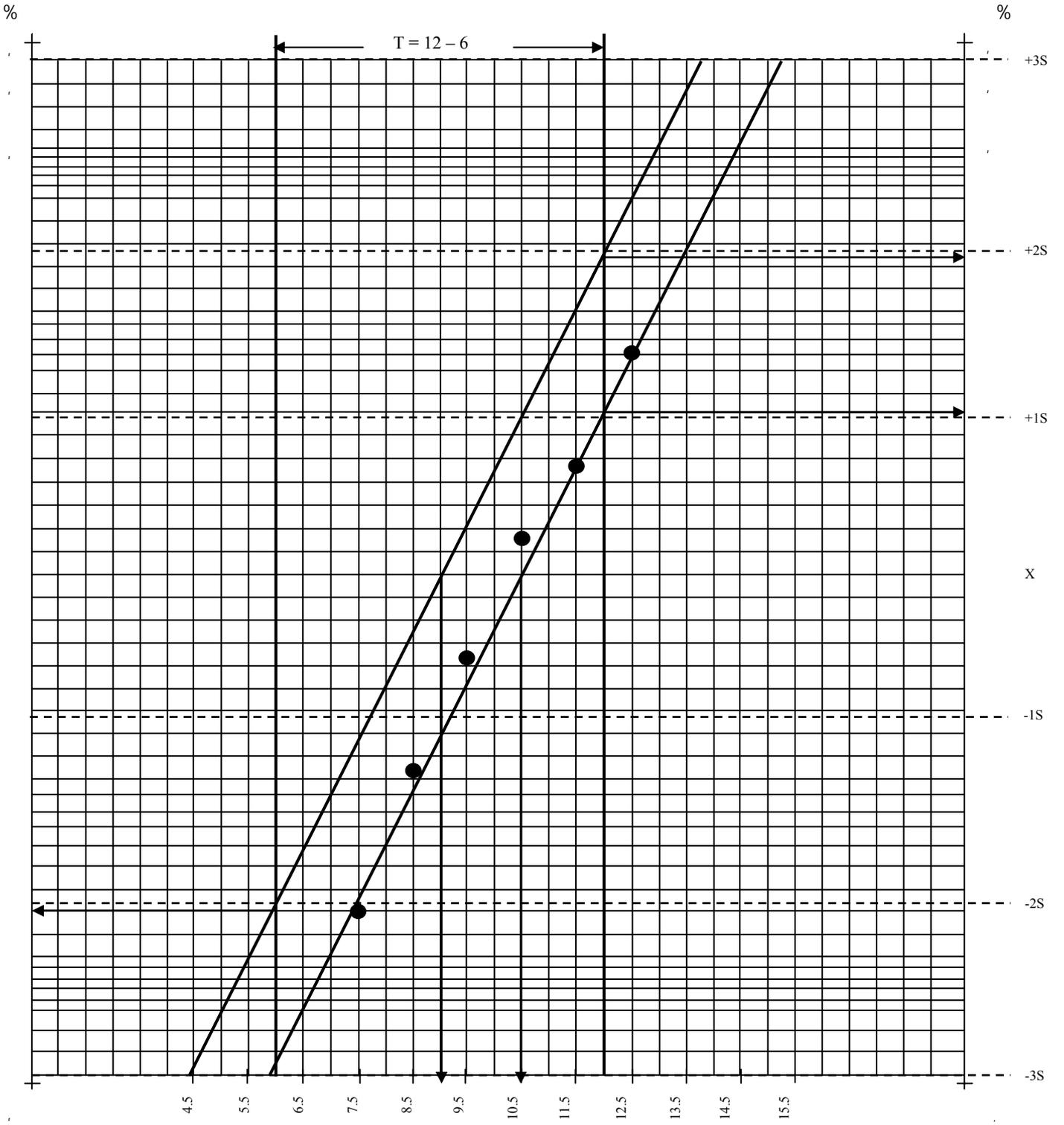
(10)

.(80%)   4.77 = (7.46-12.23)

(Process Sigma)

" " :

$$\sigma = \frac{\overline{S}}{C_4} = \frac{0.89}{0.94} = 0.95$$

$$Cp = \frac{12-6}{6 \times 0.95} = 1.05$$

:

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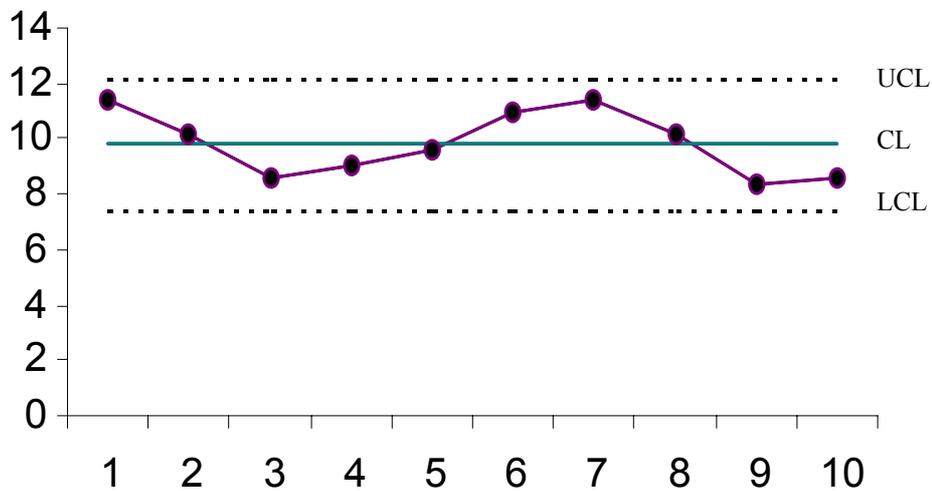
(11)

(6σ)

PS = 3 CP

PS = 3 × 1.05 = 3.15

(C_pk)   :

$$\sigma = \frac{\overline{R}}{d_2} = \frac{2}{2.326} = 0.86$$

$$Z_{UCL} = \frac{UCL - \overline{X}}{\sigma} = \frac{10.99 - 9.84}{0.86} = 1.34$$

$$Z_{LCL} = \frac{\overline{X} - LCL}{\sigma} = \frac{9.84 - 8.69}{0.86} = 1.34$$

$$C_{PK} = \frac{Z(\min)}{3} = \frac{1.34}{3} = 0.45$$

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(2.3)

(2.54)

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(1.5)   (10.5)

.(9)

•

(%15)

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(4.77)

.%80

(%1.5)   (10)   •

(%2.5)

.   (%2)

(PS)   .(1.05)   (Cp)   •

PS =)   (0.15)   (3.15)

.(Cp = 1)   (3

- (Cp) (1.05) (1)

(C$_{PK}$)

(0.15)

(12).

(σ)

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LTL   PS = 3 × 1.05 = 3.15   UTL

(+0.15 σ)

-3 σ   +3 σ

(12)

:
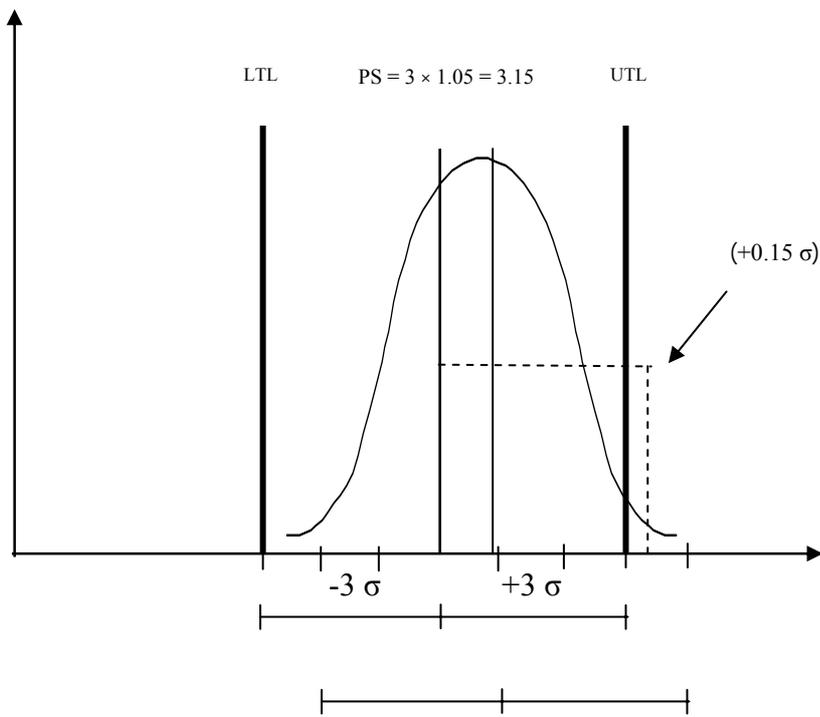
(5)   (10)   (7)

.

S	R	$\overline{X}$	X_5	X_4	X_3	X_2	X_1	
0.005	0.01	0.048	0.05	0.05	0.05	0.04	0.05	1
0.007	0.02	0.02	0.02	0.03	0.02	0.02	0.01	2
0.005	0.01	0.056	0.06	0.05	0.06	0.06	0.05	3
0.005	0.01	0.066	0.06	0.06	0.07	0.07	0.07	4
0.012	0.03	0.06	0.06	0.08	0.06	0.05	0.05	5
0.008	0.02	0.022	0.03	0.03	0.02	0.02	0.01	6
0.005	0.01	0.096	0.1	0.1	0.09	0.09	0.1	7
0.009	0.02	0.064	0.07	0.06	0.07	0.07	0.05	$CL = \overline{R} = 0.017$ 8
0.01	0.02	0.06	0.07	0.05	0.07	0.06	0.05	9
0.009	0.02	0.036	0.03	0.05	0.03	0.04	0.03	10
0.075	0.17	0.523						

:

. **(13)**   "   .

$$\overline{R} = \frac{\sum R}{n} = \frac{0.17}{10} = 0.017$$

$$\overline{\overline{X}} = \frac{\sum \overline{X}}{n} = \frac{0.528}{10} = 0.053$$

$$UCL = \overline{\overline{X}} + A_2 \cdot \overline{R} = 0.053 + 0.577 \times 0.017 = 0.063$$

$$CL = \overline{\overline{X}} = 0.053$$

$$LCL = \overline{\overline{X}} - A_2 \cdot \overline{R} = 0.053 - 0.577 \times 0.017 = 0.043$$

.**(13)**   .

$$UCL = \overline{R} \cdot D_4 = 0.017 \times 2.115 = 0.036$$

$$CL = \overline{R} = 0.017$$

$$LCL = \overline{R} \cdot D_3 = 0.017 \times 0 = 0$$

.

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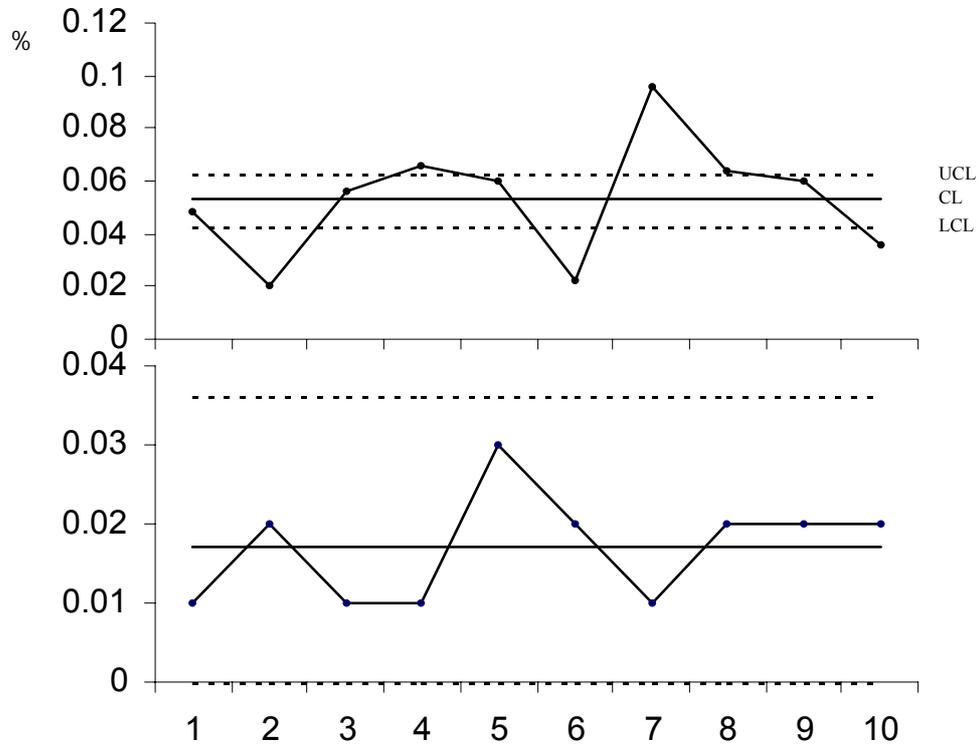
.(13)

.(%22)   0.022 = (0.042-0.064)

$$UCL = \overline{\overline{X}} + A_3\overline{S} = 0.053 + 1.427(0.0075) = 0.064$$

$$CL = \overline{\overline{X}} = 0.053$$

$$LCL = \overline{\overline{X}} - A_3\overline{S} = 0.053 - 1.427(0.0075) = 0.042$$

.(14)   .

$$UCL = \overline{S}B_4 = 0.0075 \times 2.089 = 0.016$$

$$CL = \overline{S} = 0.0075$$

$$LCL = \overline{S}B_3 = 0.0075 \times 0 = 0$$

0.12
0.1
0.08
0.06 UCL
CL
0.04 LCL
0.02
0

0.02

UCL

0.015

0.01 CL

0.005

0 LCL

1 2 3 4 5 6 7 8 9 10
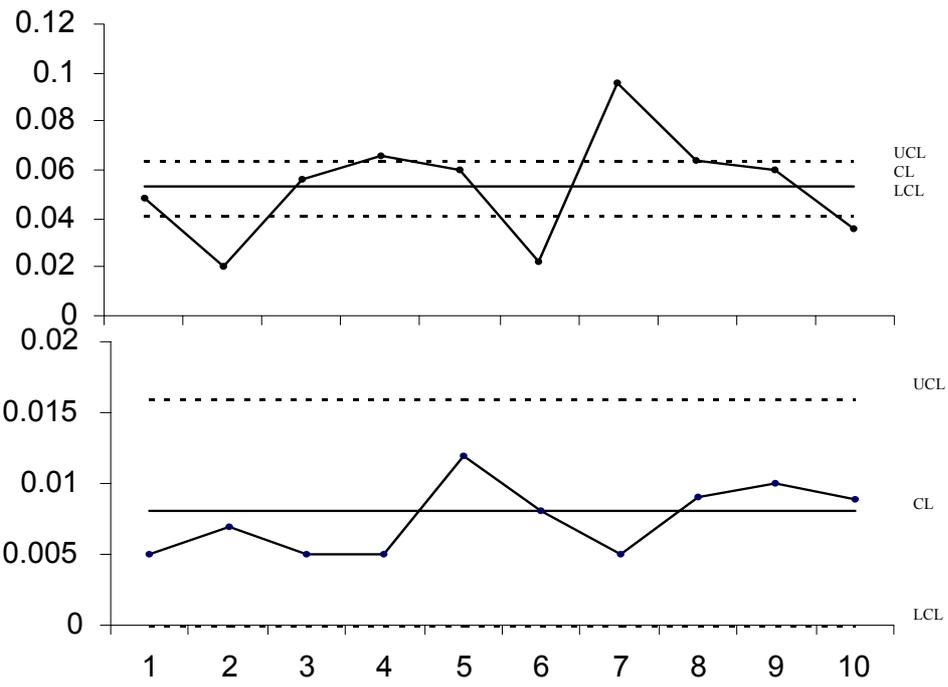
(14)

.

(12)   .

(8)

7	0.02	‑0.01
8	0.04	‑0.03
21	0.06	‑0.05
9	0.08	‑0.07
5	0.1	0.11‑0.09
50		

(9)   (P).
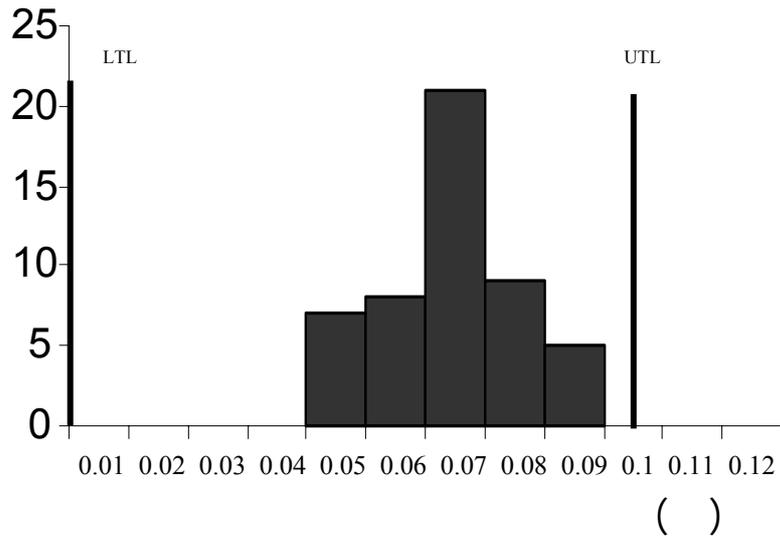
(9)

P	J	j		
100/50 (4-0.5) = 7	4	7–1	**7**	0.02
100/50 (11.5-0.5) = 22	11.5	15–8	**8**	0.04
100/50 (26-0.5) = 51	26	36–16	**21**	0.06
100/50 (41-0.5) = 81	41	45–37	**9**	0.08
100/50 (48-0.5) = 95	48	50–46	**5**	0.1

(6σ) .

$$UCL = \overline{\overline{X}} + \frac{6}{\sqrt{5}}\overline{S} = 0.053 + 2.68(0.0075) = 0.073$$

$$CL = \overline{\overline{X}} = 0.053$$

$$LCL = \overline{\overline{X}} - \frac{6}{\sqrt{5}}\overline{S} = 0.053 - 2.68(0.0075) = 0.033$$

(16)
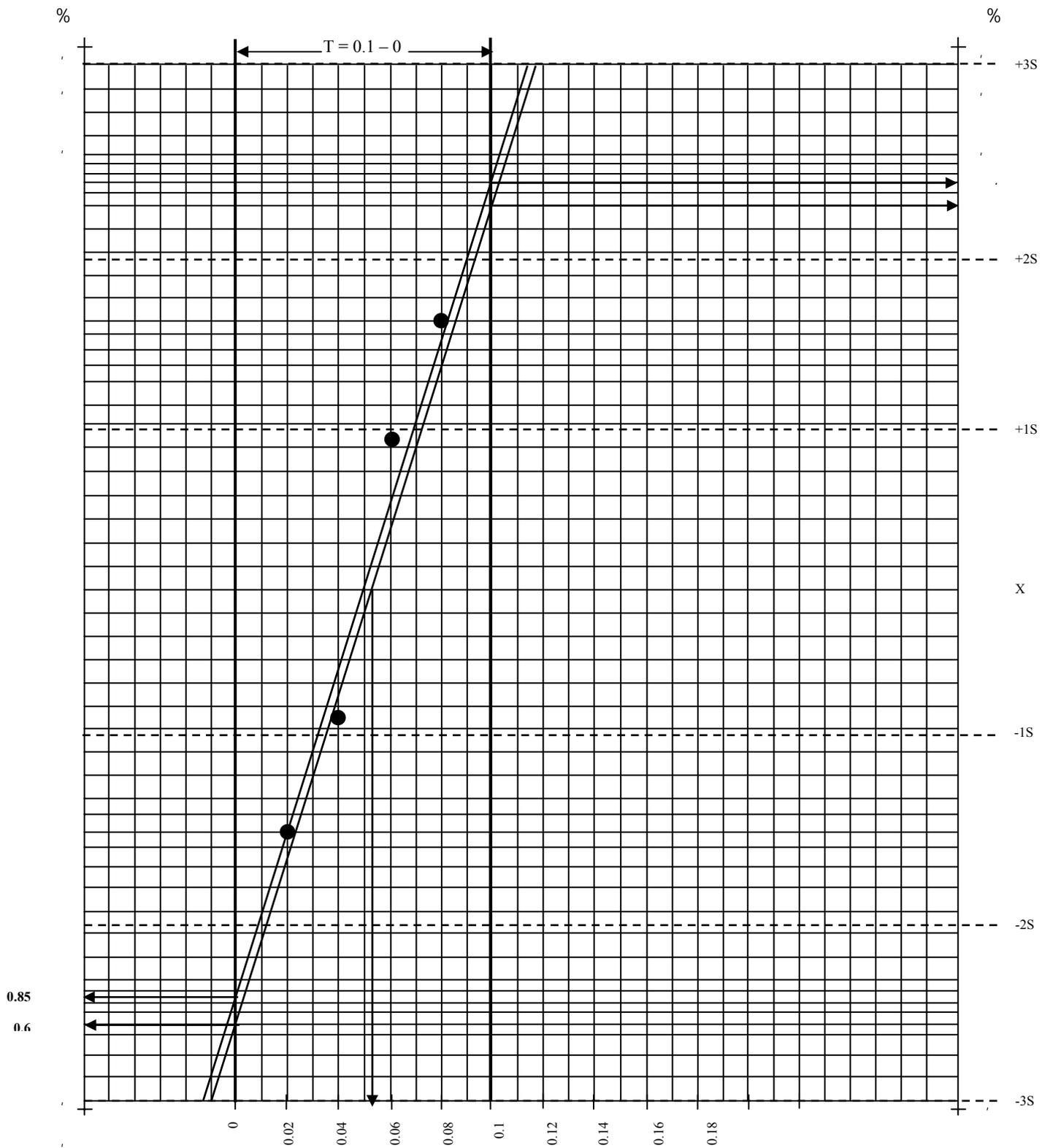
.(%41)   0.04 = (0.033-0.073)

:

$$\sigma = \frac{\overline{S}}{C_4} = \frac{0.0075}{0.94} = 0.008$$

$$Cp = \frac{0.1 - 0}{6 \times 0.008} = 2.08$$

:

(6σ)   (17)
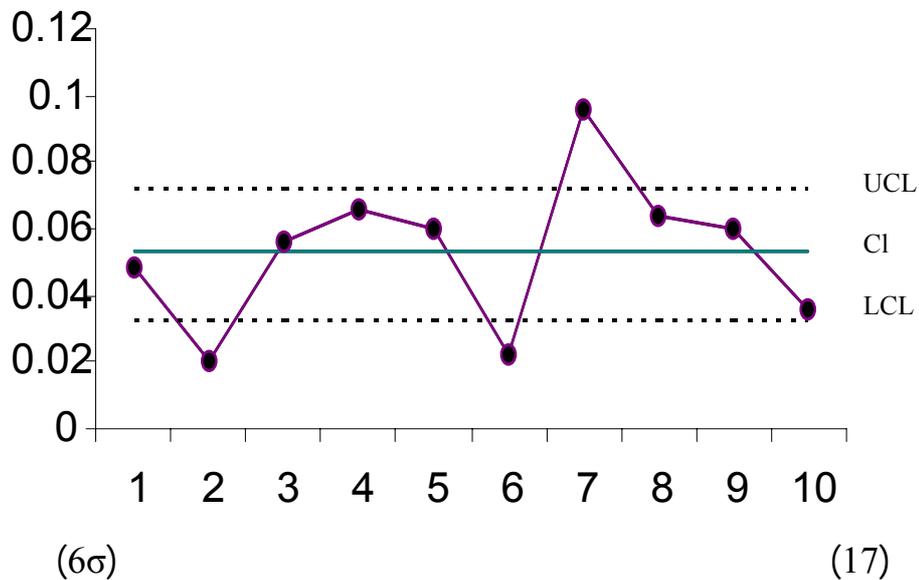
PS = 3 CP
PS = 3 × 2.08 = 6.24

(C_{PK}) :

$$\sigma = \frac{\overline{R}}{d_2} = \frac{0.017}{2.326} = 0.007$$

$$Z_{UCL} = \frac{UCL - \overline{X}}{\sigma} = \frac{0.063 - 0.053}{0.007} = 1.43$$

$$Z_{LCL} = \frac{\overline{X} - LCL}{\sigma} = \frac{0.053 - 0.043}{0.007} = 1.43$$

$$C_{PK} = \frac{Z(\min)}{3} = \frac{1.43}{3} = 0.48$$

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(16) .

(0.054) . (%1)

.(%0.6)

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(%0.8) (0.004)

.(%0.85)

-

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(PS=6.24) (3.24)

-

(2,6) . (PS)

.%41 (17) .

- (Cp) (2.08)

(1)

(%1)

(0.48)   (C_{PK})

LTL   PS = 3 × 2.08 = 6.24   UTL

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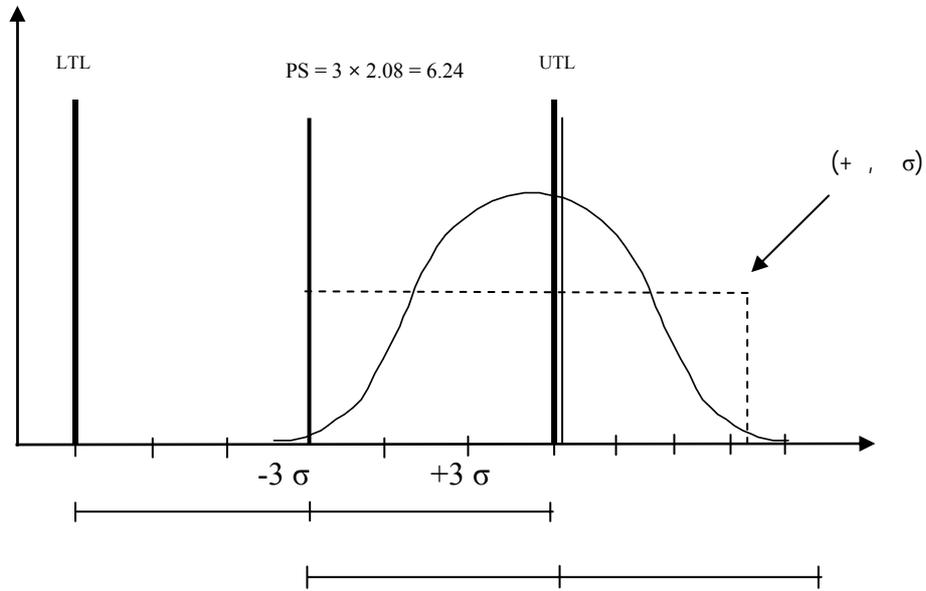
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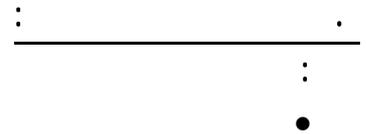
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