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CAPABILITY PROCESS ANALYSIS WELDING MACHINE HEAD CAP MODIFIED

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ABSTRACT

In line with the competition in world market of printer business that is increases, the company claimed to make improvements in all aspects continuosly. This is done in order to reduce production costs, so the printer can be produced with so good quality products at affordable prices can be produced.

One of improvement activity in the PT. Indonesia Epson Industry is a change of their purchases of new machines Welding Cap Head by imported, with the utilization of machines Welding Filters which are not used and stored in warehouse. The study was conducted to analyze the ability of the Cap Head Welding machines modified at each stage of the evaluation.

Process capability analysis is a part of quality control activities that will examine the extent to which a process can meet the specifications that have been defined. In this research, the quality of the measured variable is the height (variables A1 and A2) and the diameter of the welding (variables B1 and B2).

The results suggest that the final value of the process capability index (Cp) at evaluation phase there are 1.61 (variable A1), 1.56 (variable A2), 4.04 (variables B1), 4.06 (variable B2). This value indicates that the ability of the Head Welding Cap is above the industry minimum standard (Cp) of 1.50 for new processes, so that the statistical process meets the defined requirements.

***Keywords**: Improvement, Proses Capability and Process, Capability Index.*

1. INTRODUCTION

Competition in the business printer product and printers available in the market can have uniformity between one product with another. One attempt to get a cheaper product prices are lower production costs. PT. Indonesia Epson Industry (IEI) is a Foreign Investment Company (PMA), which is part of the Seiko Epson Corporation, based in Hirooka, Japan. PT. Epson is a company engaged in manufacturing for the process of making the printer and have the marketshare for Asia, Australia and Europe. Printer product is in production at PT. Epson is generally divided into two types: the ink-based printers (Ink Jet) and tape-based printer (Dot Matrix).

One of the routine activities at PT. Epson to meet the varying needs of the machine are purchasing production machinery is imported, mainly from the country of Japan. In following up this case, the Machine & Tool Dept proposes to replace the activities planned purchase of new machinery Cap Head Welding is imported with the utilization of machines that have gone unused or economic life stored in warehouse storage. In the implementation of the utilization of these required an additional process such as process modifications. This is as one of the aspects of kaizen activities of production machinery needs.

Beginning with the collection of information and consideration of the technical aspects, there are a number of Welding machines that are not used and allowed to be reused for Cap Head Welding process through the stages of the process of modification. Of several alternative machine is then carried considerations include aspects of economic and technical aspects. Economical aspects include the costs necessary to make the machine can be used in production activities, among others: the cost of modifications, cost evaluation, and maintenance costs. While the technical aspects of the process include the ease of modification and parts availability machine.

Table 1. Data Number of Machines Welding And Estimated Total Cost Modification

No	Machine Name	Asset No	QTY	Total Modify Cost
1	Filter Welding	MC0002265	24	$ 5,200
2	Case Head Welding	MC0001877	20	$ 5,300
3	Cover Head Weding	MC0002022	17	$ 5,400
4	Diaphragm Welding	MC0002385	16	$ 5,500
5	CSIC Welding	MC0001980	12	$ 5,600

The machine has a total estimated cost of the lowest modification and have the convenience of the technical aspects will be selected into the machine to be used for the process of modification. The selected machine is a machine Welding Filter. Additionally this machine is also a machine that stored the most amount of storage warehouse.
However, efforts to lower the cost of production machines needs to consider also the quality of the product to be produced. Product quality is a top priority and should be improved. To keep activity modification Cap Head Welding machine is fixed according to Standard Quality Product from EPSON printer, it is necessary to analyze the ability of the machine. It is very necessary to ensure that the machine is really worth to be used in mass production, so it can be economically beneficial
In this study the authors take the title 'Process Capability Analysis Cap Head Welding Machine Modified In PT. Indonesia Epson Industry. The researcher formulates the problem of whether Cap Head Welding machine modification has the ability to process according to industry standards and feasible for use in mass productionn order to study more directly and to clarify the scope of the problem, there should be some restrictions. The extent of the problem used are:

1. The research was conducted at the Department of Machine & Tool PT. Indonesia Epson Industry
2. The research was conducted at the Head Welding Cap Model F-N45.
3. The research was conducted in the period May 2012 to July 2012.
4. Analysis of the cost of investment is beyond the scope of this study.
5. How the operation and maintenance of the machine is applied in accordance with the provisions of the company is considered standard and are beyond the scope of this study.
6. The process of manufacturing the components and calculation of the power for the engine modification is beyond the scope of this study.

2. PROCESS CAPABILITY ANALYSIS

Process capability analysis aims to measure how well a process to produce products that meet certain quality requirements. There are two types of process capability indices are commonly used, namely Cp and Cpk indices. Cp index aims to determine the potential ability where if the value is ≥ 1, then the process is said to be potentially capable, so there is still a tendency incapable process. Meanwhile, to determine whether or not the absolute capacle, use the index Cpk.
Based on the results of data processing at each stage of the evaluation, it has been known that the normal distribution and the whole process is in statistical control limits. It is very important to note as compliance critical in the analysis of process variable data capabilities.
The ability of the formulation is usually indicated by ± 3σ or 6σ overall cover, where σ indicates the standard deviation in a state in control.

Process Capability Index (Cp)

Cp is one way to look at the reliability of a process, ie comparing the types of products resulting from the process undertaken producers to customer specifications. The formula used is:

$$Cp = \frac{USL - LSL}{6\sigma}$$

USL = Upper Specification Limit
LSL = Lower Specification Limit
σ. = Standard deviation

Interpretation of the value of Cp is as follows;

- Cp > 1; process is still good
- Cp < 1: Process unfavorable
- Cp = 1: This process similar to consumer specifications

Standard deviation can be determined through a formula approach:

$$\sigma = \frac{R}{d_2}$$

R : The average value of the range.
d_2 : coefficient to estimate the standard deviation (Appendix C)

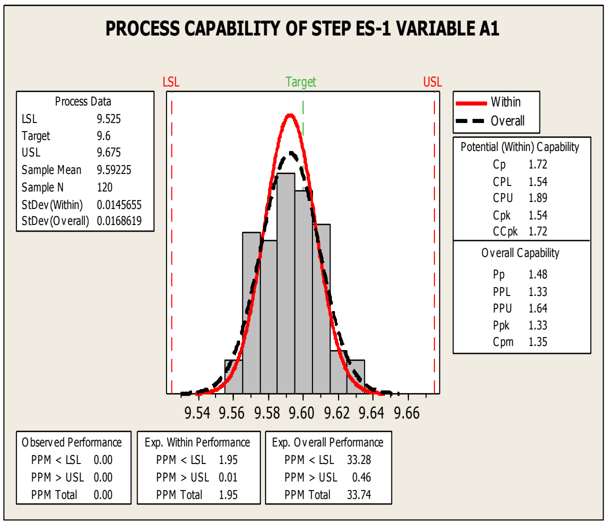

Figure 1. Process Capability Evaluation Phase Chart ES-1 Variable A1

CALCULATION PROCESS CAPABILITY ES-1 VARIABLE PHASE A1

By using the formula process capability, the evaluation stage of the calculation results obtained ES-1 for variable height A1 as follows:

Given:

$\bar{\bar{X}} = 9.5923$

$\bar{\sigma} = R / d_2 = 0{,}0267 / 1{,}693 = 0{,}0158$

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{9{,}675 - 9{,}525}{6\ x\ 0{,}0158} = 1{,}59$$

Process Capability Index (Cpk):

$$CPL = \frac{\bar{\bar{X}} - LSL}{3\sigma} = \frac{9{,}5923 - 9{,}525}{3\ x\ 0{,}0158} = 1{,}42$$

$$CPU = \frac{USL - \bar{\bar{X}}}{3\sigma} = \frac{9{,}675 - 9{,}5923}{3\ x\ 0{,}0158} = 1{,}75$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 1{,}42$$

CALCULATION PROCESS CAPABILITY ES-1 VARIABLE PHASE A2

By using the formula process capability, the evaluation stage of the calculation results obtained ES-1 for variable height A2 as follows:

Given:

$\bar{\bar{X}} = 9.5914$

$\bar{\sigma} = R / d_2 = 0{,}0262 / 1{,}693 = 0{,}0155$

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{9{,}675 - 9{,}525}{6\ x\ 0{,}0155} = 1{,}62$$

Process Capability Index (Cpk):

$$CPL = \frac{\bar{\bar{X}} - LSL}{3\sigma} = \frac{9{,}5914 - 9{,}525}{3\ x\ 0{,}0155} = 1{,}43$$

$$CPU = \frac{USL - \bar{\bar{X}}}{3\sigma} = \frac{9{,}675 - 9{,}5914}{3\ x\ 0{,}0155} = 1{,}80$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 1{,}43$$

Process Capability Analysis ES-1 Variable Phase A2 with Minitab

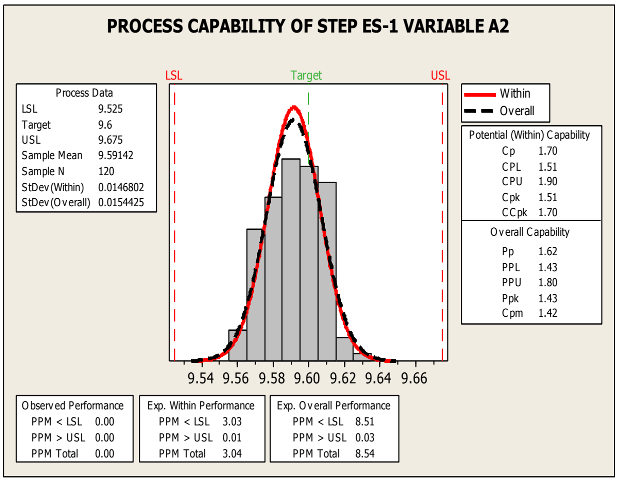

Figure 2 Process Capability Evaluation Phase Chart ES-1 Variable A2

CALCULATION PROCESS CAPABILITY ES-1 VARIABLE PHASE B1

By using the formula process capability, the evaluation stage of the calculation results obtained ES-1 for variable diameter B1 as follows:

Given:

$\bar{\bar{X}} = 1.5989$

$\bar{\sigma} = R / d_2 = 0{,}0155 / 1{,}693 = 0{,}0092$

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{1{,}7 - 1{,}5}{6\ x\ 0{,}0092} = 3{,}64$$

Process Capability Index (Cpk):

$$CPL = \frac{\bar{\bar{X}} - LSL}{3\sigma} = \frac{1{,}5989 - 1{,}5}{3\ x\ 0{,}0092} = 3{,}60$$

$$CPU = \frac{USL - \bar{\bar{X}}}{3\sigma} = \frac{1{,}7 - 1{,}5989}{3\ x\ 0{,}0092} = 3{,}68$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 3{,}60$$

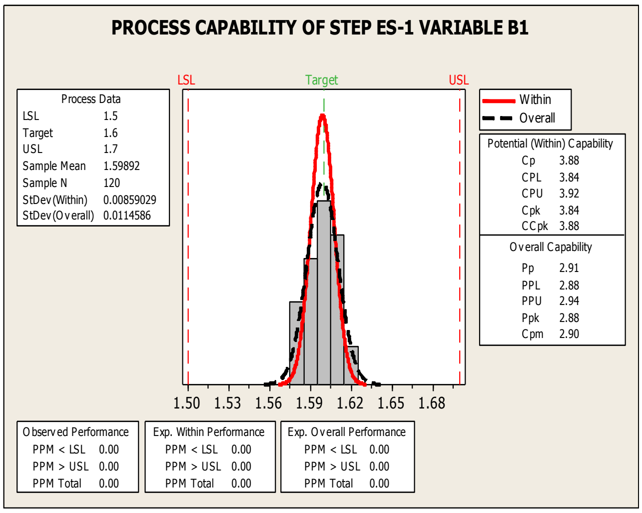

Figure 3. Process Capability Evaluation Phase Chart ES-1 Variable B1

CALCULATION PROCESS CAPABILITY ES-1 VARIABLE PHASE B2

By using the formula process capability, the evaluation stage of the calculation results obtained ES-1 for variable diameter B2 as follows:

Given:

$\bar{\bar{X}} = 1.5985$

$\bar{\sigma} = R / d_2 = 0{,}0158 / 1{,}693 = 0{,}0093$

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{1{,}7 - 1{,}5}{6\ x\ 0{,}0093} = 3{,}57$$

Process Capability Index (Cpk):

$$CPL = \frac{\bar{\bar{X}} - LSL}{3\sigma} = \frac{1{,}5985 - 1{,}5}{3\ x\ 0{,}0093} = 3{,}52$$

$$CPU = \frac{USL - \bar{\bar{X}}}{3\sigma} = \frac{1{,}7 - 1{,}5985}{3\ x\ 0{,}0093} = 3{,}63$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 3{,}52$$

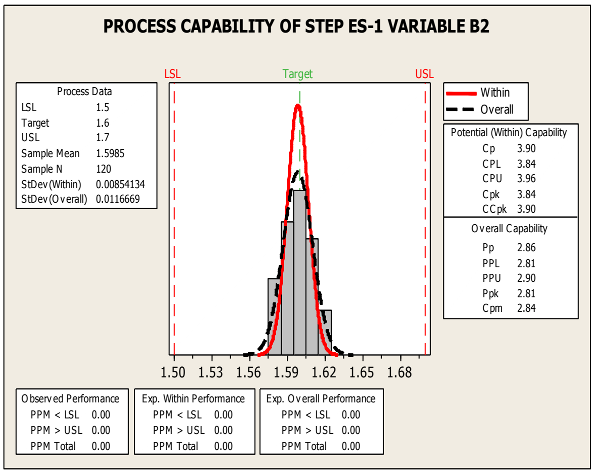

Figure 4. Process Capability Evaluation Phase Chart ES-1 Variable B2

CALCULATION PROCESS CAPABILITY ES-2 VARIABLE PHASE A1

By using the formula process capability, the evaluation stage of the calculation results obtained ES-2 for variable height A1 as follows:

Given:

$$\bar{\bar{X}} = 9.5907$$

$$\bar{\sigma} = R / d_2 = 0{,}0257 / 1{,}693 = 0{,}0152$$

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{9{,}675 - 9{,}525}{6\ x\ 0{,}0152} = 1{,}65$$

Process Capability Index (Cpk):

$$CPL = \frac{\bar{\bar{X}} - LSL}{3\sigma} = \frac{9{,}5907 - 9{,}525}{3\ x\ 0{,}0152} = 1{,}44$$

$$CPU = \frac{USL - \bar{\bar{X}}}{3\sigma} = \frac{9{,}675 - 9{,}5907}{3\ x\ 0{,}0152} = 1{,}85$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 1{,}44$$

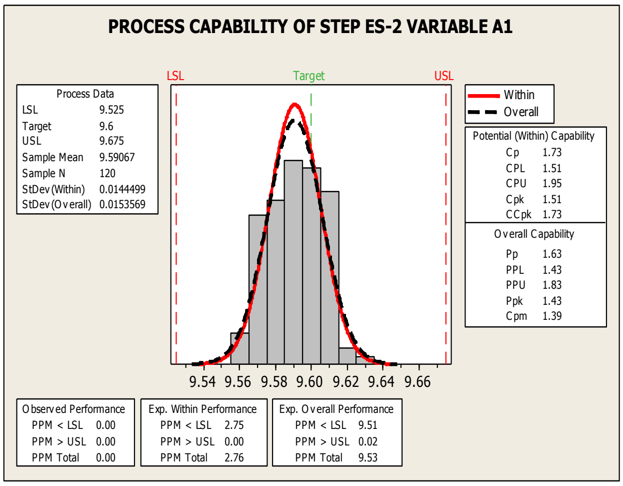

Figure 5. Process Capability Evaluation Phase Chart ES-2 Variable A1

CALCULATION PROCESS CAPABILITY ES-2 VARIABLE PHASE A2

By using the formula process capability, the evaluation stage of the calculation results obtained ES-2 for variable height A2 as follows:

Given:

$$\bar{\bar{X}} = 9.5891$$

$$\bar{\sigma} = R / d_2 = 0{,}0247 / 1{,}693 = 0{,}0146$$

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{9{,}675 - 9{,}525}{6\ x\ 0{,}0146}$$

$$= 1{,}71$$

Process Capability Index (Cpk):

$$CPL = \frac{\bar{\bar{X}} - LSL}{3\sigma} = \frac{9{,}5891 - 9{,}525}{3\ x\ 0{,}0146}$$

$$= 1{,}46$$

$$CPU = \frac{USL - \bar{\bar{X}}}{3\sigma} = \frac{9{,}675 - 9{,}5891}{3\ x\ 0{,}0146}$$

$$= 1{,}96$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 1{,}46$$

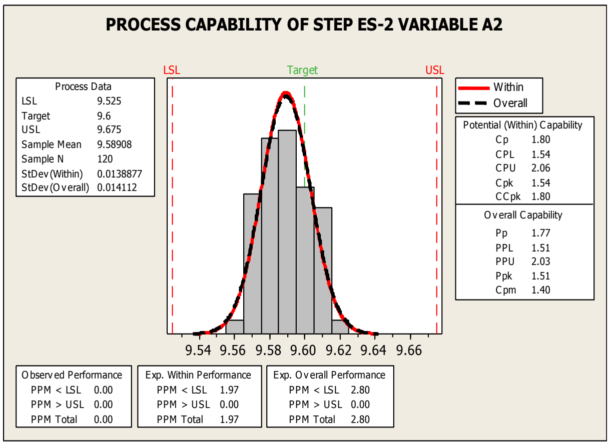

Figure 6 Process Capability Evaluation Phase Chart ES-2 Variable A2

CALCULATION PROCESS CAPABILITY ES-2 VARIABLE PHASE B1

By using the formula process capability, the evaluation stage of the calculation results obtained ES-2 for variable diameter B1 as follows:

Given:

$\bar{\bar{X}} = 1.5974$

$\bar{\sigma} = R / d_2 = 0{,}0148 / 1{,}693 = 0{,}0087$

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{1{,}7 - 1{,}5}{6\ x\ 0{,}0087} = 3{,}81$$

Process Capability Index (Cpk):

$$CPL = \frac{\bar{\bar{X}} - LSL}{3\sigma} = \frac{1{,}5974 - 1{,}5}{3\ x\ 0{,}0087} = 3{,}71$$

$$CPU = \frac{USL - \bar{\bar{X}}}{3\sigma} = \frac{1{,}7 - 1{,}5974}{3\ x\ 0{,}0087} = 3{,}91$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 3{,}71$$

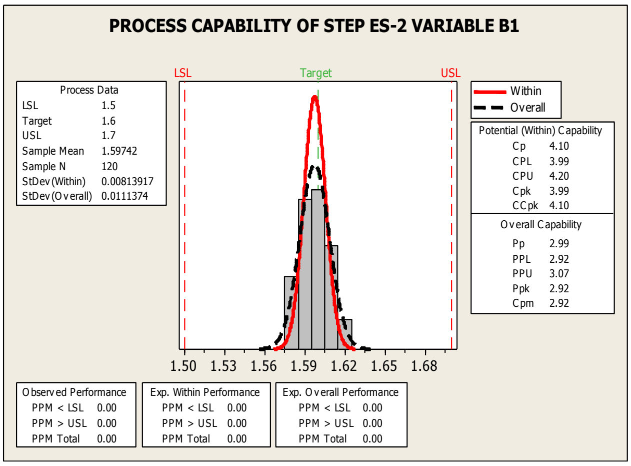

Figure 7 Process Capability Evaluation Phase Chart ES-2 Variable B1

CALCULATION PROCESS CAPABILITY ES-2 VARIABLE PHASE B2

By using the formula process capability, the evaluation stage of the calculation results obtained ES-2 for variable diameter B2 as follows:

Given:

$\bar{\bar{X}} = 1.5978$

$\bar{\sigma} = R / d_2 = 0{,}0140 / 1{,}693 = 0{,}0083$

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{1{,}7 - 1{,}5}{6\ x\ 0{,}0083} = 4{,}03$$

Process Capability Index (Cpk):

$$CPL = \frac{\bar{\bar{X}} - LSL}{3\sigma} = \frac{1{,}5978 - 1{,}5}{3\ x\ 0{,}0083} = 3{,}94$$

$$CPU = \frac{USL - \bar{\bar{X}}}{3\sigma} = \frac{1{,}7 - 1{,}5978}{3\ x\ 0{,}0083} = 4{,}12$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 3{,}94$$

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Process Capability Analysis of ES-2 Variable Phase B2 with Minitab

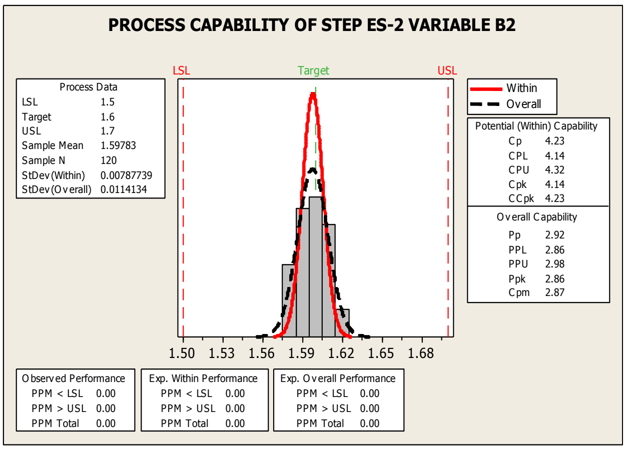

Figure 8. Process Capability Evaluation Phase Chart ES-2 Variable B2

CALCULATION PROCESS CAPABILITY VARIABLE PHASE PLS A1

By using the formula process capability, the evaluation stage of the calculation results obtained for variable heights PLS A1 as follows:

Given:

$\bar{\bar{X}} = 9.5912$

$\bar{\sigma} = R / d_2 = 0,0245 / 1,693 = 0,0145$

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{9,675 - 9,525}{6\ x\ 0,0145}$$

$$= 1,73$$

Process Capability Index (Cpk):

$$CPL = \frac{\bar{\bar{X}} - LSL}{3\sigma} = \frac{9,5912 - 9,525}{3\ x\ 0,0145}$$
$$= 1,52$$

$$CPU = \frac{USL - \bar{\bar{X}}}{3\sigma} = \frac{9,675 - 9,5912}{3\ x\ 0,0145}$$

$$= 1,93$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 1,52$$

Process Capability Analysis Variable Phase PLS A1 with Minitab

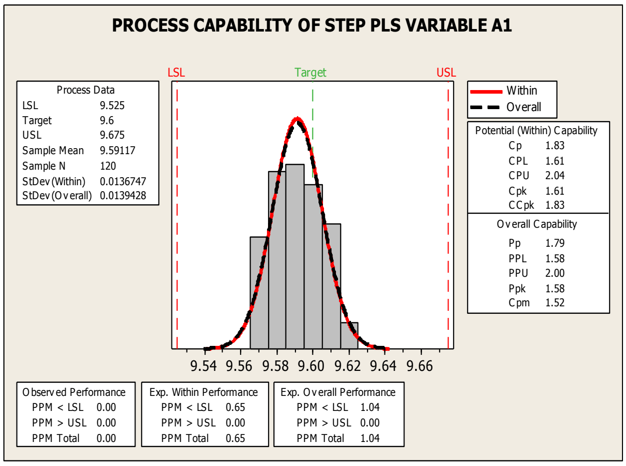

Figure 5.33. Charts Process Capability Evaluation Phase Variable PLS A1

interpretation:

In the picture above, see the value of the process capability index (Cp) results altitude welding products PLS Cap Head on stage, that is equal to 1.83. Cp values > 1 indicate the variations that occur in the process are small enough so that the process is said either.

Cpk index value is equal to 1.61. This value is the value of the CPL is the lowest value taken from the value of the CPU and CPL. Cpk values > 1:33 indicate the variations that occur in the process are small enough so that the process is said either.

PLS Calculation Process Capability Variable Phase A2

By using the formula process capability, the evaluation stage of the calculation results obtained PLS for variable height A2 as follows:

Given:

$\bar{\bar{X}} = 9.5913$

$\bar{\sigma} = R / d_2 = 0,0257 / 1,693 = 0,0152$

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{9,675 - 9,525}{6\ x\ 0,0152}$$

$$= 1,65$$

Process Capability Index (Cpk):

$$CPL = \frac{\overline{\overline{X}} - LSL}{3\sigma} = \frac{9{,}5913 - 9{,}525}{3\ x\ 0{,}0152} = 1{,}46$$

$$CPU = \frac{USL - \overline{\overline{X}}}{3\sigma} = \frac{9{,}675 - 9{,}5913}{3\ x\ 0{,}0152} = 1{,}84$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 1{,}46$$

PLS Analysis Process Capability Variable Phase A2 with Minitab

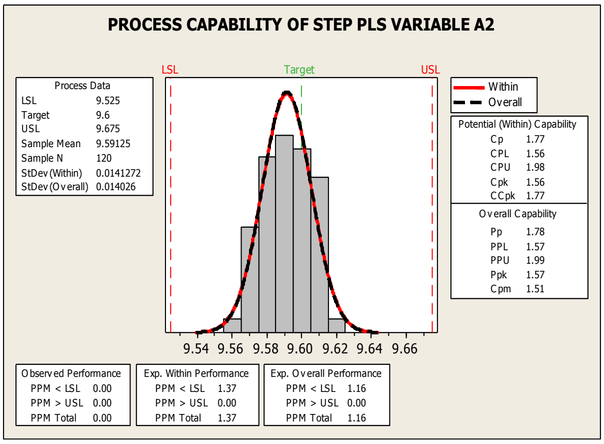

Figure 5.34. Charts Process Capability Evaluation PLS Variable Phase A2

$\overline{\overline{X}}$ = 1.5993

$\bar{\sigma}$ = R / d_2 = 0,0150 / 1,693 = 0,0089

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{1{,}7 - 1{,}5}{6\ x\ 0{,}0089} = 3{,}76$$

Process Capability Index (Cpk):

$$CPL = \frac{\overline{\overline{X}} - LSL}{3\sigma} = \frac{1{,}5993 - 1{,}5}{3\ x\ 0{,}0089} = 3{,}74$$

$$CPU = \frac{USL - \overline{\overline{X}}}{3\sigma} = \frac{1{,}7 - 1{,}5993}{3\ x\ 0{,}0089}$$

$$= 3{,}79$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 3{,}74$$

PLS Analysis Process Capability Variable Phase B1 with Minitab

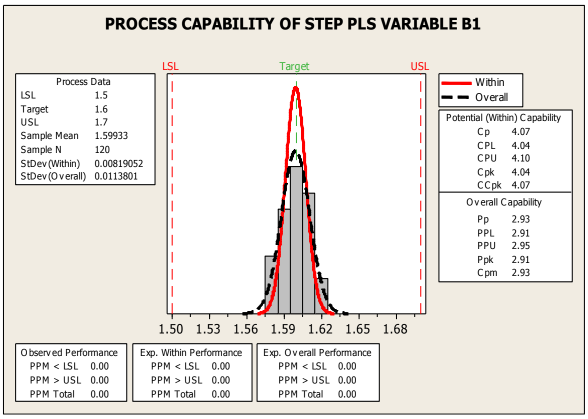

Figure 5.35. Charts Process Capability Evaluation PLS Variable Phase B1

PLS Calculation Process Capability Variable Phase B2

By using the formula process capability, the evaluation stage of the calculation results obtained PLS for variable diameter B2 as follows:

Given:

$\overline{\overline{X}}$ = 1.5985

$\bar{\sigma}$ = R / d_2 = 0,0148 / 1,693 = 0,0087

Process Capability Index (Cp):

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{1{,}7 - 1{,}5}{6\ x\ 0{,}0087} = 3{,}81$$

Process Capability Index (Cpk):

$$CPL = \frac{\overline{\overline{X}} - LSL}{3\sigma} = \frac{1{,}5985 - 1{,}5}{3\ x\ 0{,}0087} = 3{,}76$$

$$CPU = \frac{USL - \overline{\overline{X}}}{3\sigma} = \frac{1{,}7 - 1{,}5985}{3\ x\ 0{,}0087}$$

$$= 3{,}87$$

$$Cpk = Min\{CPL, CPU\}$$

$$Cpk = 3{,}76$$

PLS Analysis Process Capability Variable Phase B2 with Minitab

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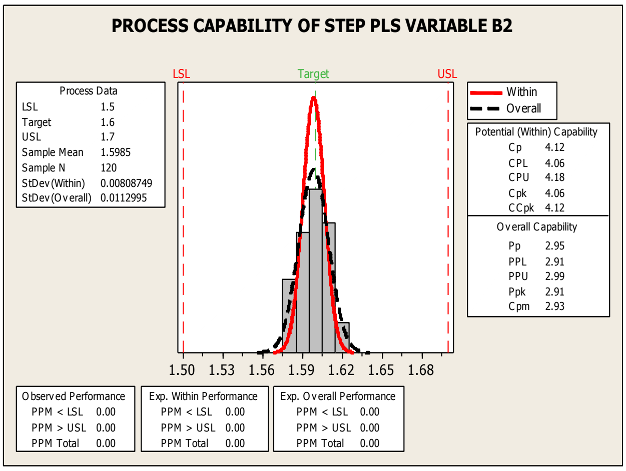

Figure 5.36. Charts Process Capability Evaluation PLS Variable Phase B2

3. CONCLUSION

Based on the analysis of the ability of a process that has been done, because the process capability index over the index values for the industry recommended specifications of the two sides of the new process, which is equal to 1.50, then the Cap Head Welding processes at each stage of statistical evaluation meets the requirements specified. Value of the process capability index (Cpk) of the results of the study can be seen in the following table:

Table 2. Value Research Process Capability Index (Cpk)

Varibel		Evaluation ES-1	ES-2	ES-3	CPK Estimation	Result
Height	A1	1,54	1,51	1,61	1,61	Qualify
	A2	1,51	1,54	1,56	1,56	Qualify
Diameter	B1	3,84	3,99	4,04	4,04	Qualify
	B2	3,84	4,14	4,06	4,06	Qualify

4. RECOMMENDATION

Advice is to be conveyed after the author drew the conclusion above is:

1. Companies should establish a process capability analysis of performance requirements for new machinery and equipment, in order to obtain a good production process.
2. Event engine modifications should still consider periodic engine maintenance. It is necessary to maintain the quality of the product remains stable and in accordance with the standards of product quality.
3. In the process of designing the engine modifications, you should avoid the use of standard parts are classified as no longer sold by the manufacturer. It is necessary to avoid the difficulties of procuring spare parts in case of trouble on the machine.
4. This research may still proceed with further research on comparative cost of purchasing a new machine at a cost of utilization of unused machines.

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