Variation analysis of leak value in the engine cylinder head sub-assembly.

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BACKGROUND OF THE PROBLEM

PURPOSE

- In order to meet the market standards we need to produce best quality motorcycles which is possible only with setting appropriate specifications in the machines.

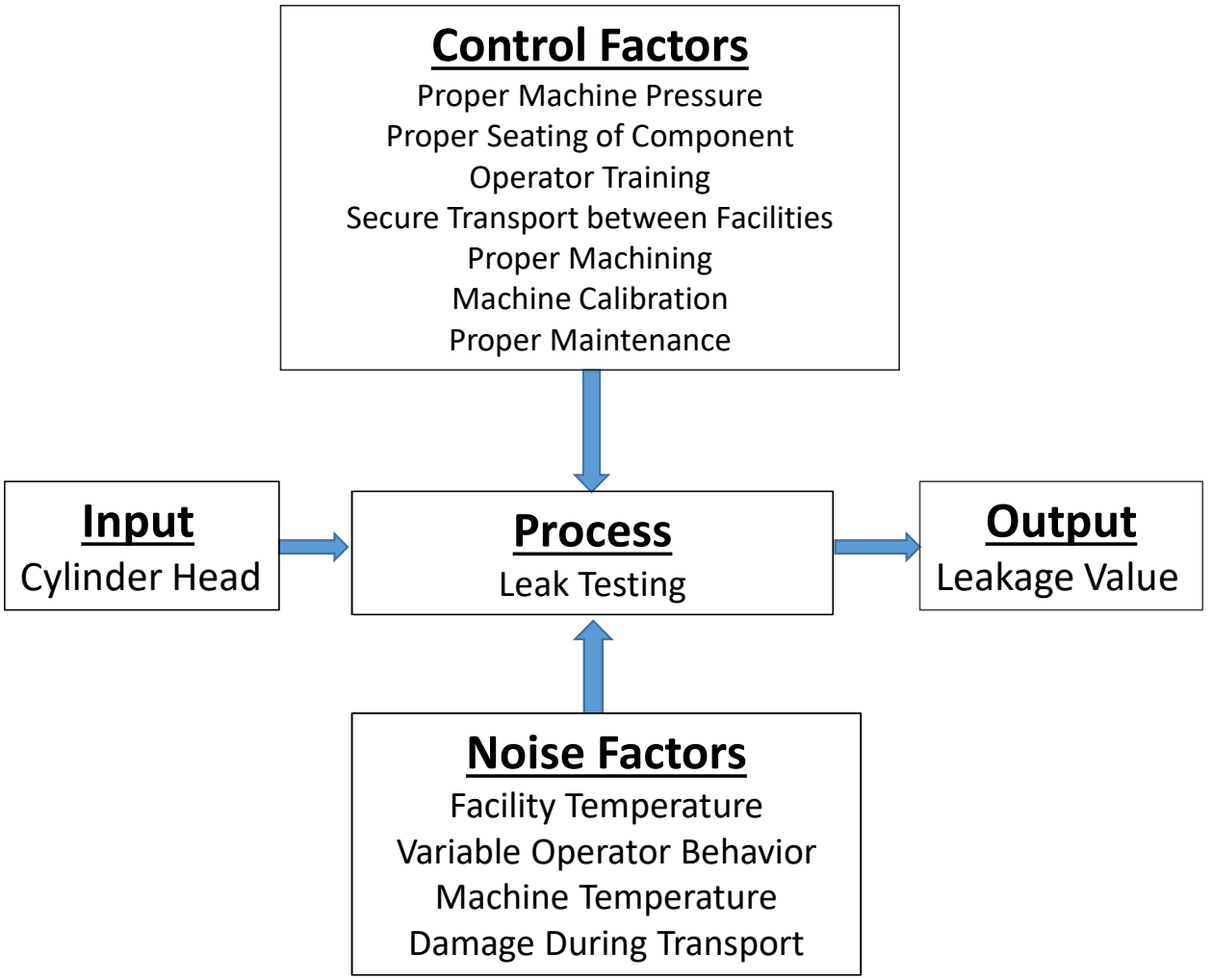
SCOPE

- Our project focuses on proving the R&R value for the leak testing machine in Cell1 and Cell2 in machine shop as well as in Engine Assembly. It also deals with setting the specification in leak testing machines through various experiments.

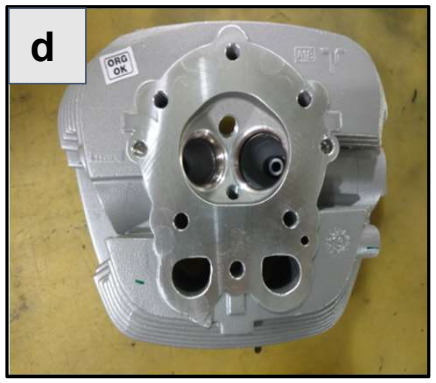
OBJECTIVE

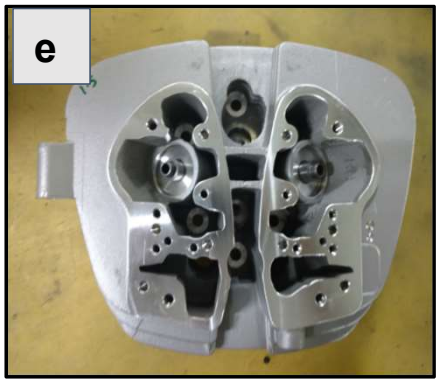
- Proving the R&R of the leak testing machines.
- Set a standard value for the leak testing machine which at present is set by trial and error method in machine shop.
- Identifying the root cause for the failure of cylinder heads in engine assembly after getting passed from the machine shop.

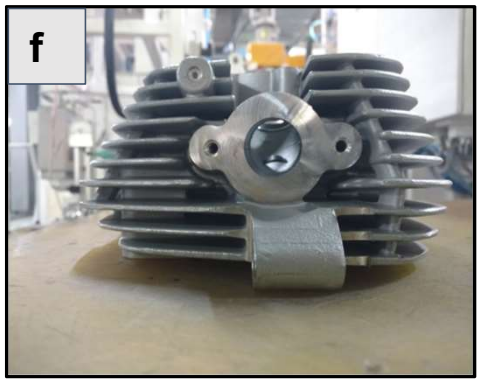
P-Diagram


Control Factors
Proper Machine Pressure
Proper Seating of Component
Operator Training
Secure Transport between Facilities
Proper Machining
Machine Calibration
Proper Maintenance
Input
Cylinder Head
Process
Leak Testing
Output
Leakage Value
Noise Factors
Facility Temperature
Variable Operator Behavior
Machine Temperature
Damage During Transport

LEAK TESTING MACHINES AND CYLINDER HEAD





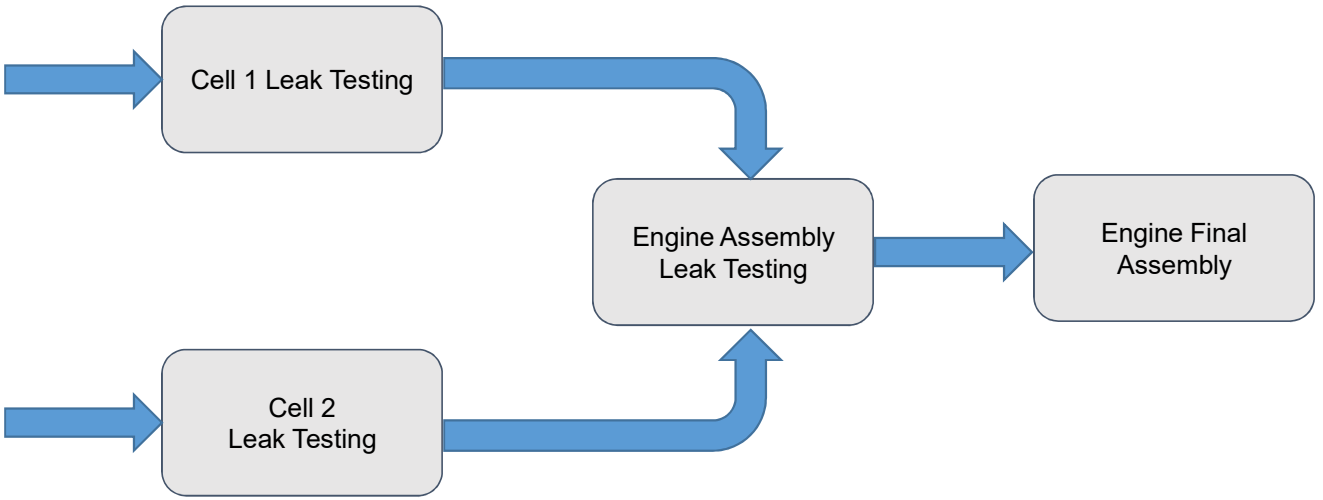


Leak Testing Machines
a- Cell 1 Machine Shop
b- Cell 2 Machine Shop
C- Engine Assembly

Cylinder Head
d- bottom view
e- top view
f- side view

COMPARISON OF LEAK TESTING PARAMETERS

Sl.no	Setting parameter	Engine sub assembly leak testing	Machine shop leak testing	
		Combustion chamber test	Cell 1	Cell 2
1	Leak checking machine	ATEQ leak testing	cosmo	cosmo
2	Leak checking method	Flow rate decay	Pressure decay	Pressure decay
3	Leak checking unit	ml/min	ml/min	ml/min
5	Air pressure unit	ml bar	ml bar	ml bar
6	Air filling time	7 secs	10 secs	10 secs
7	Stabilisation time	5 secs	5 secs	5 secs
8	Testing time	3 secs	10 secs	10 secs
9	Maximum set bar	350 mbar	300 mbar	300 mbar
10	Minimum set bar (drop)	255 mbar	30 mbar	30 mbar
12	Maximum permissible leak	20 ml/min	20 ml/min	20 ml/min
13	Minimum permissible leak	-10	-10 ml/min	-10 ml/min
14	Clamping pads	Brass tip	Brass tip	Brass tip
15	Clamping area	Stud holes	Stud holes	Stud holes
16	Leak sealing material	O ring	silicon rubber pad	silicon rubber pad



Process Flow Diagram

DATA COLLECTION

Data was collected in orderly manner through the following tests:

1. R & R Proving of leak testing machines.
2. Temperature variation in readings
    a. 10 cylinder heads were leak tested at different temperature after a fixed duration of time.
3. 100 Components comparison between Machine Shop(Cell 1 & Cell 2) and Engine Assembly
    a. 2 sets of 100 cylinder heads were leak tested in each leak testing machine
    b. Variation in leakage value was calculated.
4. Bias analysis
5. Rejected parts analysis from Engine Assembly to Machine shop.
    a. Rejected Cylinder heads in Engine Assembly were leak tested again in Machine Shop after disassembling the child parts.
6. Valve inspection and analysis
7. Cylinder head profile check.

Cell 1 Machine Shop – Engine Assembly

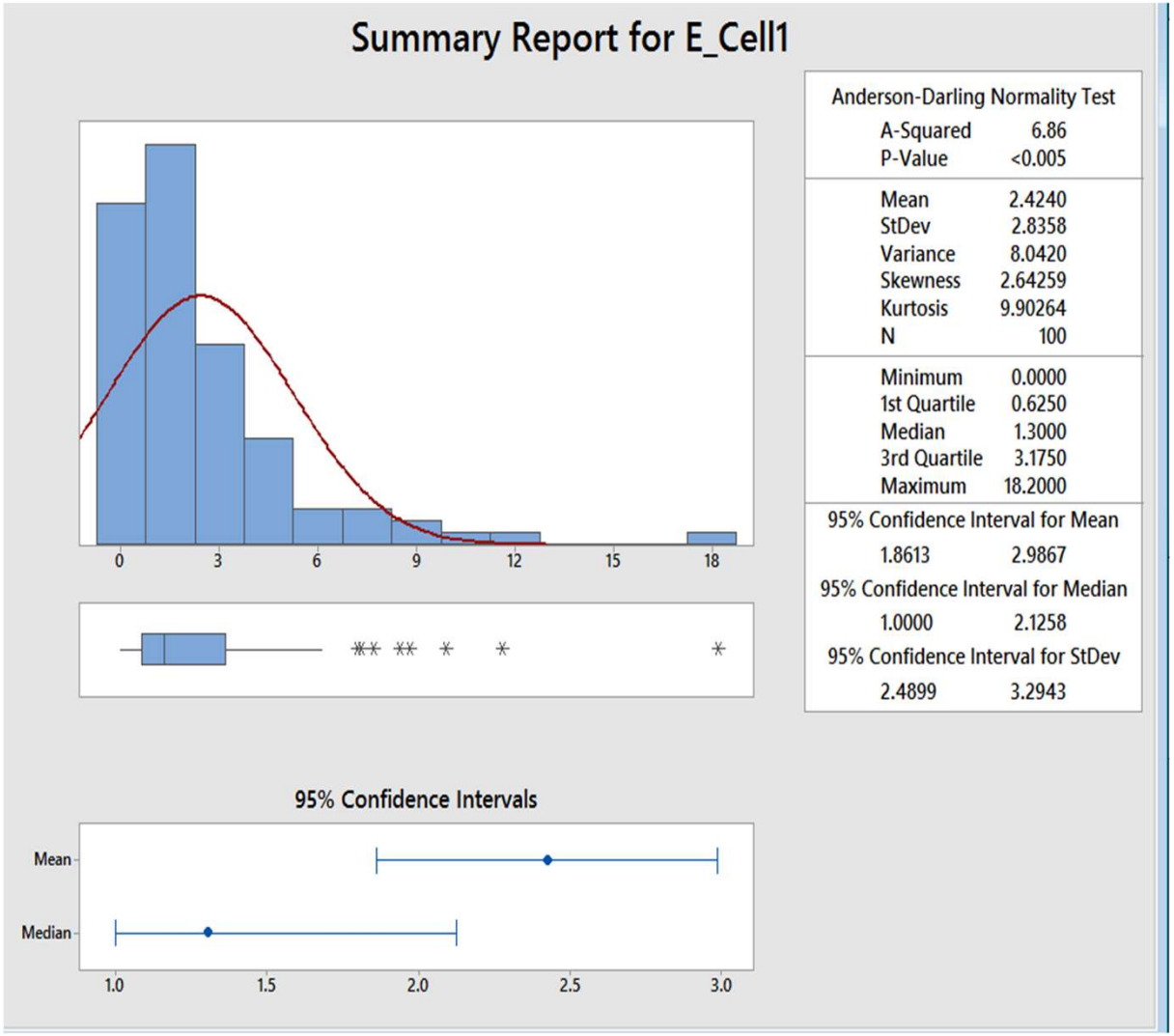
	Leakage				Leakage				Leakage				Leakage	
Part No.	Cell 1 MS	Engine Assembly		Part No.	Cell 1 MS	Engine Assembly		Part No.	Cell 1 MS	Engine Assembly		Part Number	Cell 1 MS	Engine Assembly
C32	4.809	0.1		C52	4.643	0.3		A36	3.529	2.8		A107	2.5	0.8
C108	3.439	1.6		C46	4.168	0.7		A46	0.994	1.6		C66	13.948	0
C95	7.769	0.9		C96	4.26	3		A14	0.712	0.8		B25	14.645	2.3
C29	3.264	0.2		C98	5.917	18.2		A38	4.333	0.8		C84	5.629	1.6
C85	9.73	5.2		C65	4.032	0.7		A47	2.599	6.1		A118	4.9	0.8
C105	2.67	4.5		C99	4.349	4.4		A33	4.909	1.2		A52	2.7	1.8
A10	3.625	3.2		C97	3.904	2.8		A56	1.709	2.2		A24	2.235	0.2
A29	7.098	1.1		C49	7.114	0.3		C69	1.903	0.7		C79	15.298	0.6
A78	0.483	2.5		C28	6.435	0.3		C53	0.774	1		C18	2.2	0.9
B111	1.9	0.1		C103	3.038	2.8		C58	1.58	3.1		A06	3.315	0.3
A74	1.9	0.1		C10	3.39	4.2		C87	1.113	0.5		B64	1.269	0.2
A68	5.5	4.5		C93	6.751	8.5		A81	2.72	3		B37	11.126	7.7
C11	2.253	0.4		C101	5.862	3.3		A03	6.07	0.2		A08	0.426	0.4
A81	4.4	0.9		C100	4.134	4.2		C77	1.924	5.4		A108	13.343	1.2
A72	4.919	7.3		C106	4.491	1.2		A53	3.584	0.2		B87	7.3	1.2
A3	2.318	1.4		A35	5.042	7.2		A96	7.313	0.8		B114	4.8	1.1
A58	0.258	4.8		A40	4.683	2.1		B46	3.616	1.2		A92	2.5	0.2
A59	1.852	0.8		A34	3.473	3.6		C107	10.157	2.7		C141	2.65	0.2
B42	0.7	2.6		A23	1.821	8.8		A51	1.762	0.3		B04	2.8	0.6
A15	2.439	2.2		A44	0.919	1.8		A57	14.677	4.1		A83	3	0.3
A52	0.846	3.2		A49	3.785	3.5		A82	2.256	0.6		A90	8.1	0.7
C21	3.972	1		A39	3.757	0.1		C49	14.036	11.6		A71	3.8	0.6
C47	3.903	1		A6	4.182	2.1		B127	3.802	1.7				
A41	0.911	4.3		A39	4.75	2.1		C68	14.695	3.1				
C45	5.264	2.2		A45	4.395	6		B98	8.177	1.2				
C55	2.024	2.7		A42	3.807	0.9		A92	0.994	9.9				

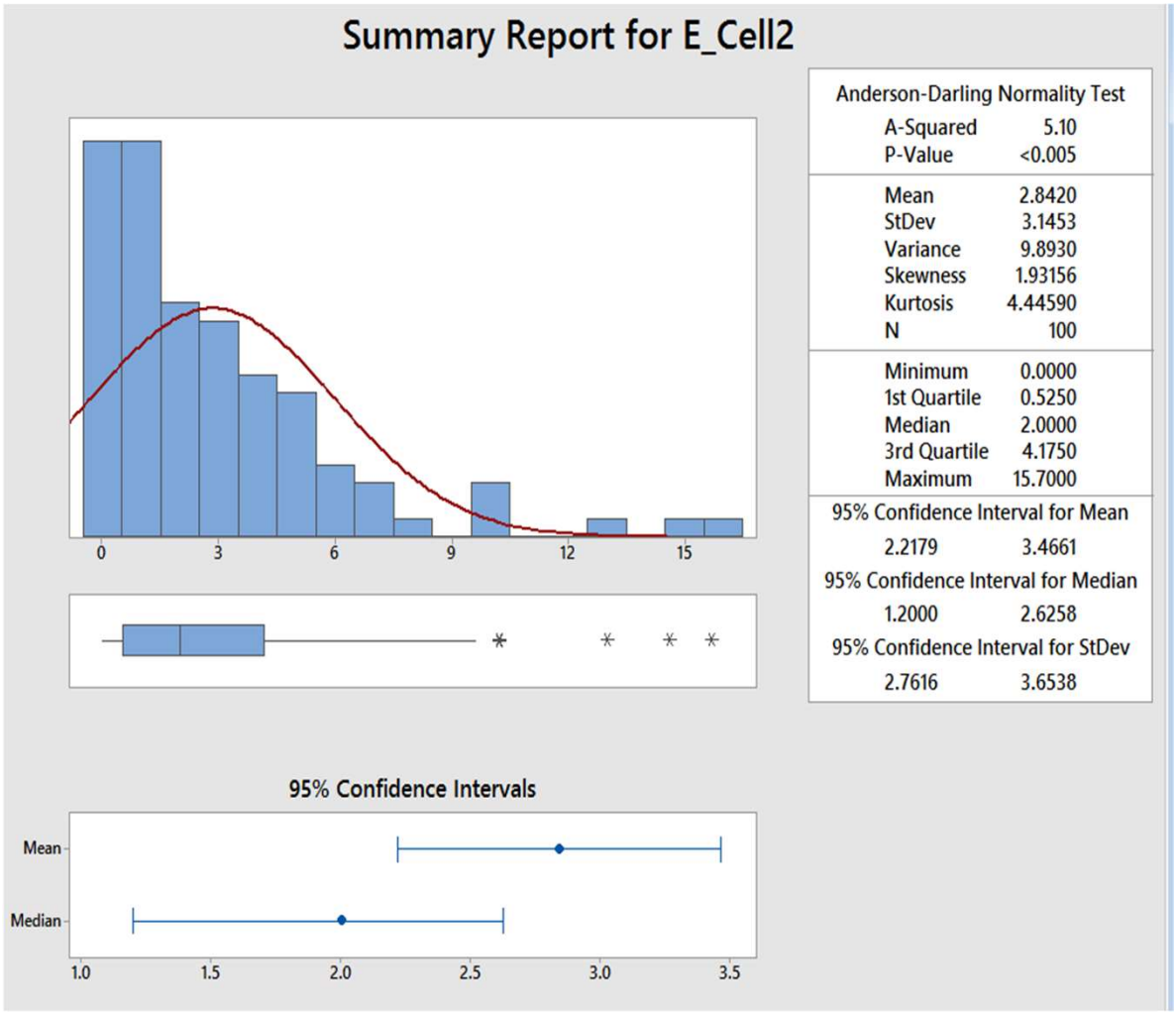
Cell 2 Machine Shop – Engine Assembly

	Leakage				Leakage				Leakage				Leakage	
Part No.	Cell 2 MS	Engine Assembly		Part No.	Cell 2 MS	Engine Assembly		Part No.	Cell 2 MS	Engine Assembly		Part Number	Cell 2 MS	Engine Assembly
C54	7.884	0		C102	5.139	2		B13	17.9	0.9		A92	3.6	0.2
C61	8.006	1.1		A002	3.548	7.9		B54	5.652	0.4		A52	2.2	2.2
A15	1.435	10.2		C105	4.947	1.9		A93	4.3	3.9		A49	3.6	0.1
A26	10.429	5.2		A003	3.769	4.2		B068	4.15	13		A04	9.5	1
A16	6.513	5.2		C106	3.612	2.7		B106	3.722	0		C130	5.2	2.3
A29	8.994	3.9		C104	6.209	4.7		A82	5.4	2		C128	1.3	0.3
A13	1.546	0.5		A010	6.614	3.1		A89	3.8	4.2		B43	19.19	14.6
A21	9.679	4.5		B046	18.919	4.7		C58	2.85	3.3		C92	3.042	0.8
A25	4.688	4.4		C70	5.147	0.3		C95	5.15	0.1		C44	10.447	5.6
A23	9.142	3.7		C97	16.4	3.3		A103	4.625	4.1		B138	11.192	4.7
A14	2.904	2.1		B108	7.4	0.6		A94	5.2	3		C98	8.44	4.8
A24	8.253	1.9		B74	9.3	1.2		A110	3.97	2.2		C107	7.23	7.2
C69	5.966	0		B02	8.9	0.1		A086	11.819	2.6		A72	2.6	2.6
A60	14.325	15.7		B40	8.5	0.6		B97	1.939	0		A24	2.6	1.6
C95	2.945	0.6		B63	0.1	0.1		B84	4.72	0.7		C112	2.9	4.1
C103	4.949	0.5		B88	10.1	3		C134	4.541	0.3		A87	3.5	2.3
C63	4.204	1.4		A35	2.3	1.2		A91	13.421	6.5		B80	4.445	0.6
C29	4.198	3.6		A66	5.2	0.5		A83	10.483	0.6		A092	2.565	2
B140	8.246	6.3		A002	7.58	1.2		A95	5.399	2.7		A74	17.4	3.1
C107	4.878	1.2		A010	4.33	1.2		B22	4.174	0.1		C89	0.012	0.1
C93	6.438	10.2		A44	9.973	7.3		A52	6.274	9.6		A55	5.5	0.2
C102	5.37	0		B102	1.614	0.1		C134	2.3	0.2		B51	6.424	1.1
C99	6.48	0		B60	7.818	0.9		A98	13.091	4.5				
C35	10.814	0.3		A20	2.4	0.9		A54	3	5.7				
C119	7.78	0		B22	4.1	2		A28	2.6	6.2				
C97	10.392	2.1		A21	3.5	2.5		A64	3.53	3.1				

Engine Assembly

Cell 1

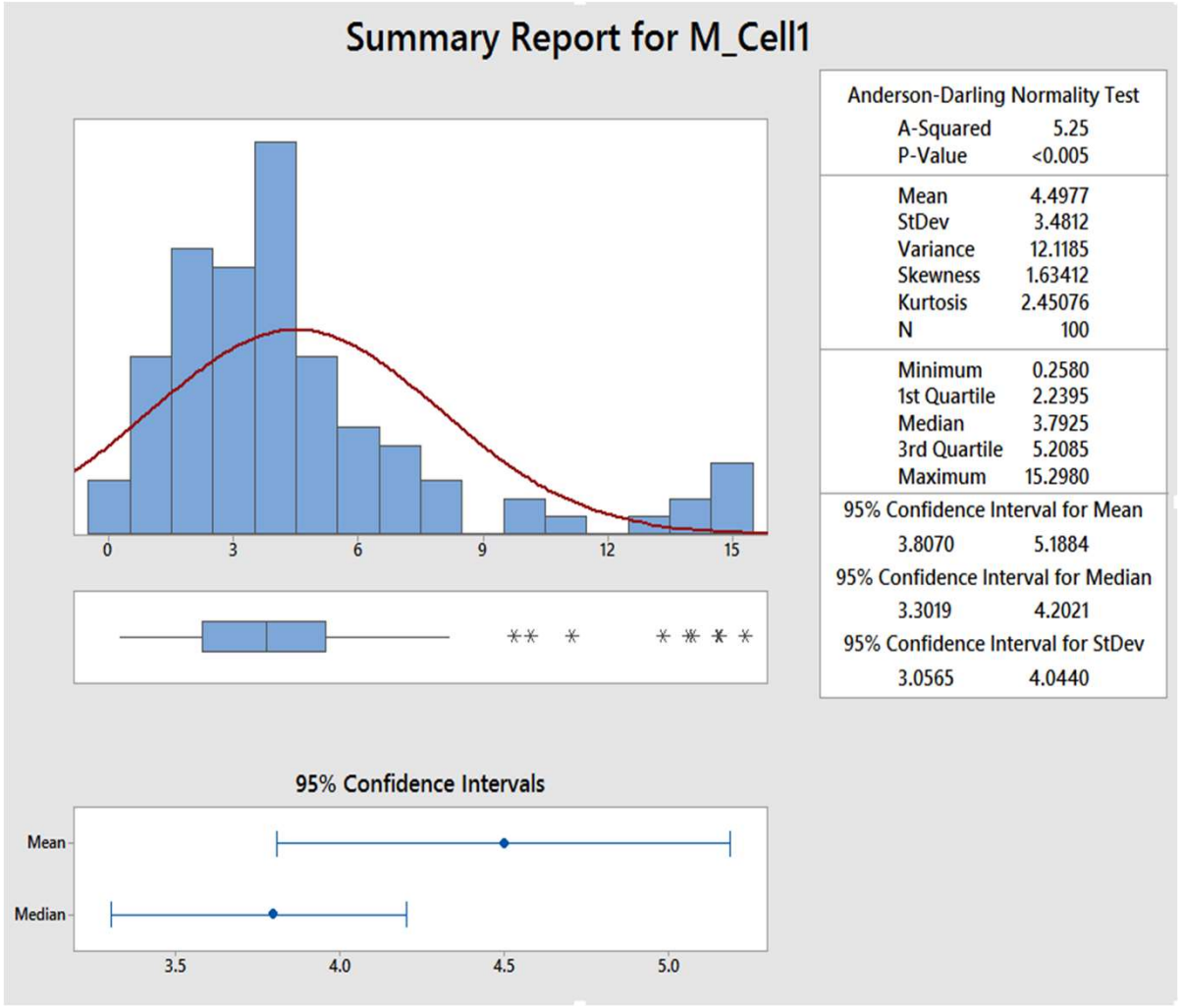


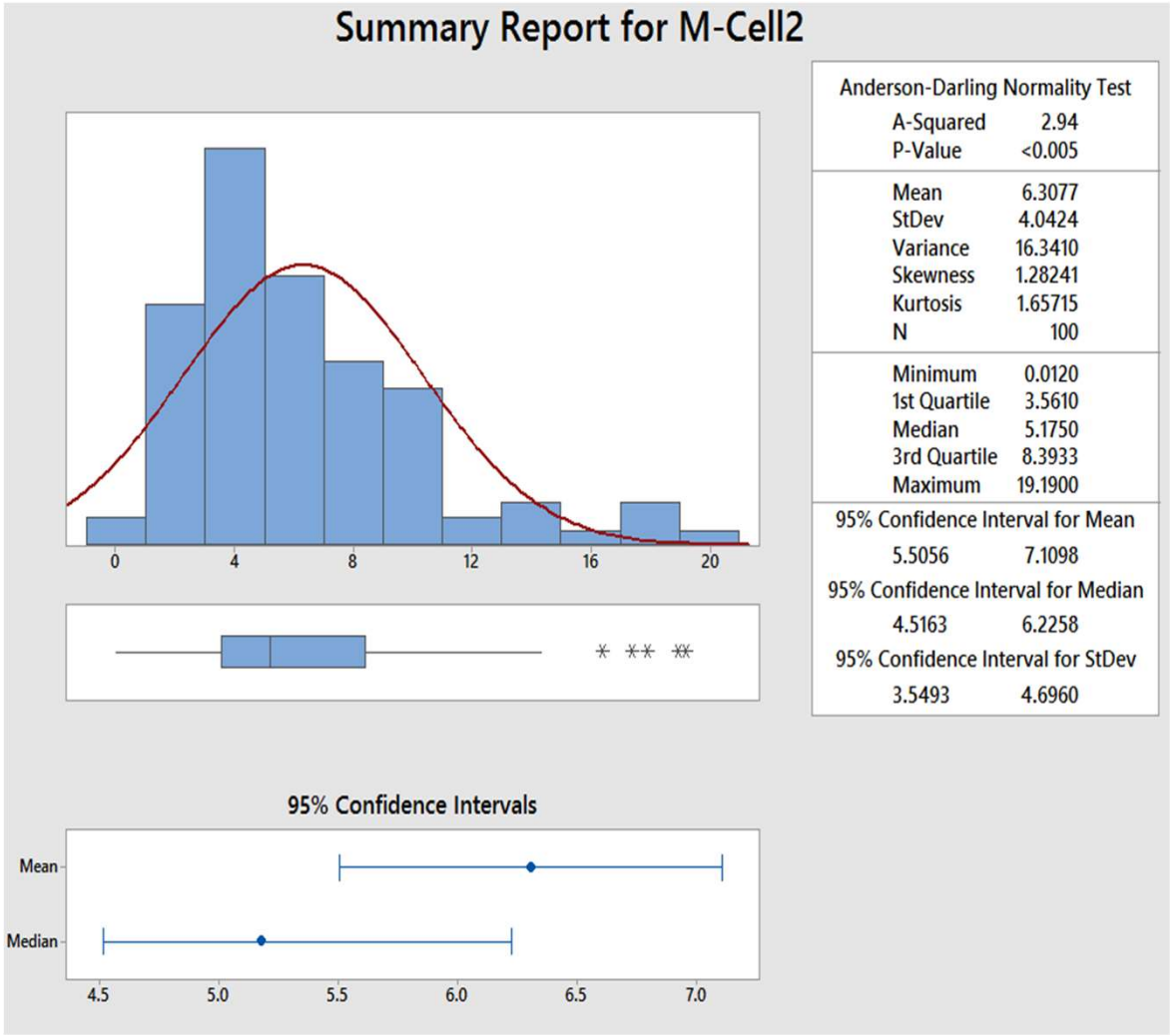


Engine Assembly

Cell 2

Machine Shop
Cell 1





Machine Shop
Cell 2

ANOVA
Cell 1
Machine Shop
Engine Assembly

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Location	1	215.0	215.01	21.33	0.000
Error	198	1995.9	10.08		
Total	199	2210.9			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
3.17494	9.73%	9.27%	7.89%

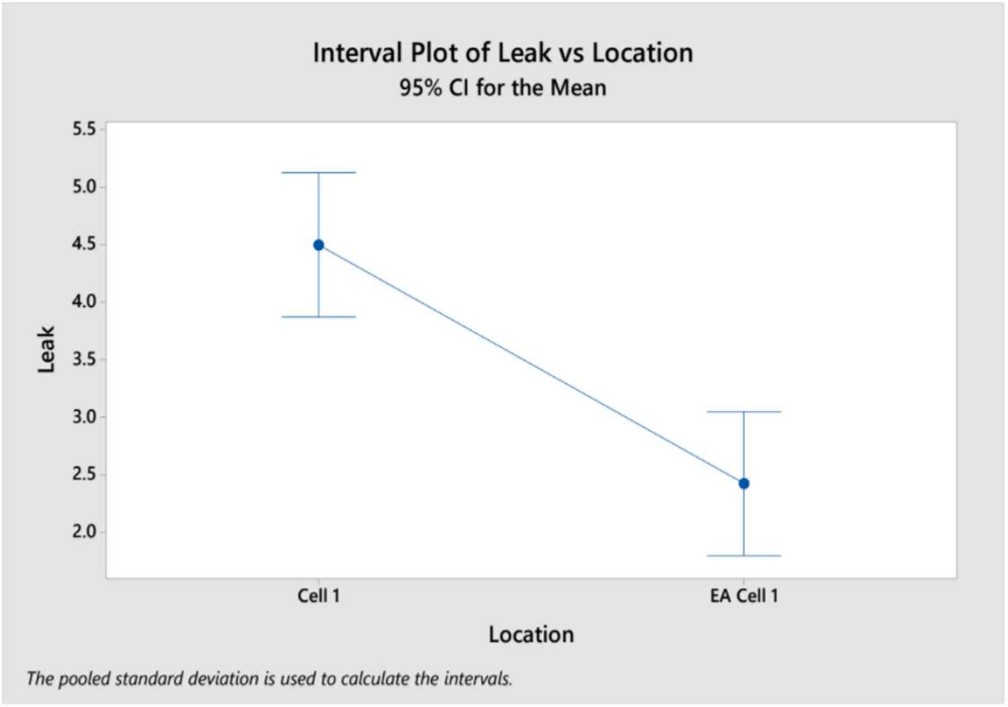
ANOVA
Cell 2
Machine Shop
Engine Assembly

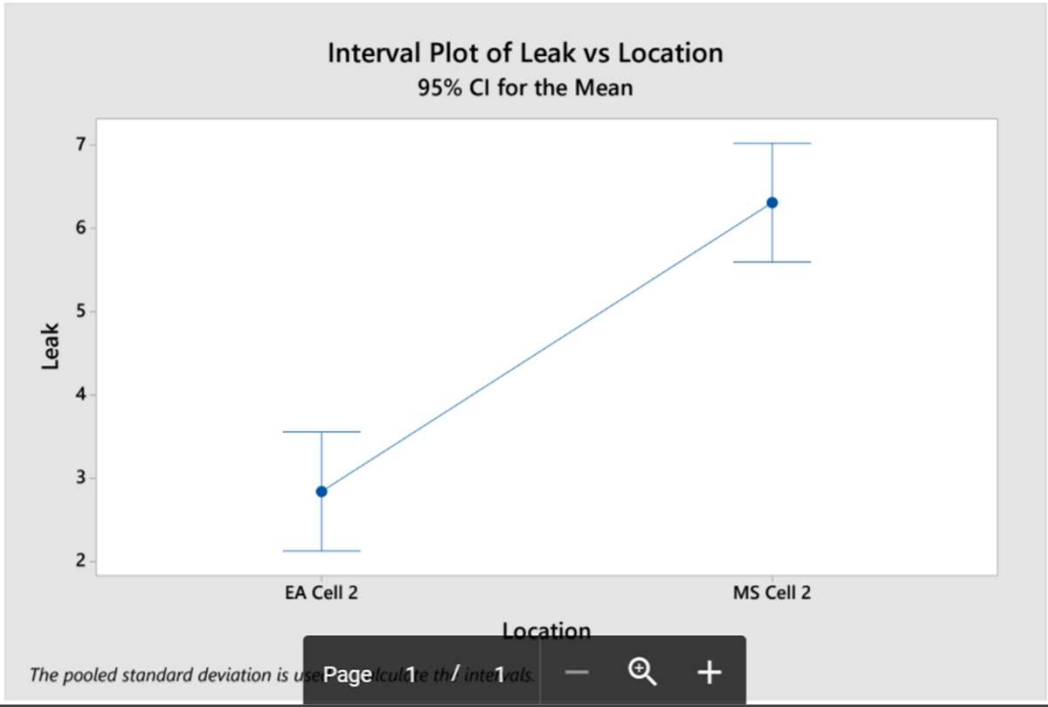
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Location	1	600.6	600.57	45.79	0.000
Error	198	2597.2	13.12		
Total	199	3197.7			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
3.62174	18.78%	18.37%	17.13%





Interval Plots

Results

After conducting the One-Way ANOVA for the cell data using Minitab, we find that the p value is very small, almost approximating to 0. Since $0<0.05$ (α value), we reject the null hypothesis and accept the alternate hypothesis that states that at least one mean is different.

After conducting One-Way ANOVA test for the cell 2 , we find the same that the p value is very small, approximating to 0. Since $0<0.05$ (α value), we reject the null hypothesis and accept the alternate hypothesis that states that at least one mean is different.

This means that a lot of variability is present in the system due to presence of noise factors.